



Effective Teaching & Learning: Insights from Neuroscience

Barbara Oakley, PhD, PE
Distinguished Professor of
Engineering
Oakland University
Rochester, Michigan



St. Columba's College



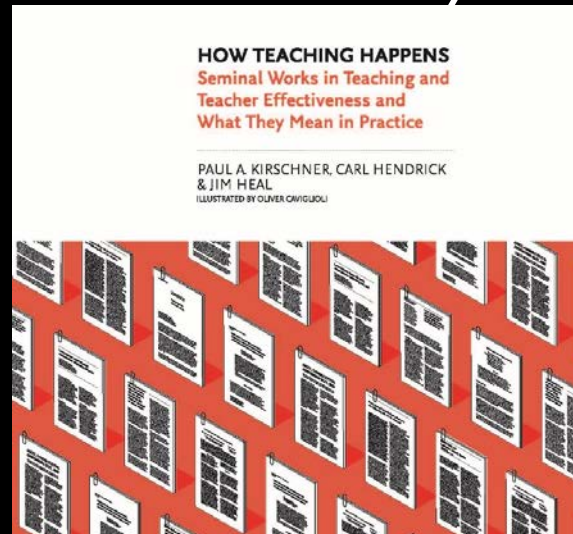


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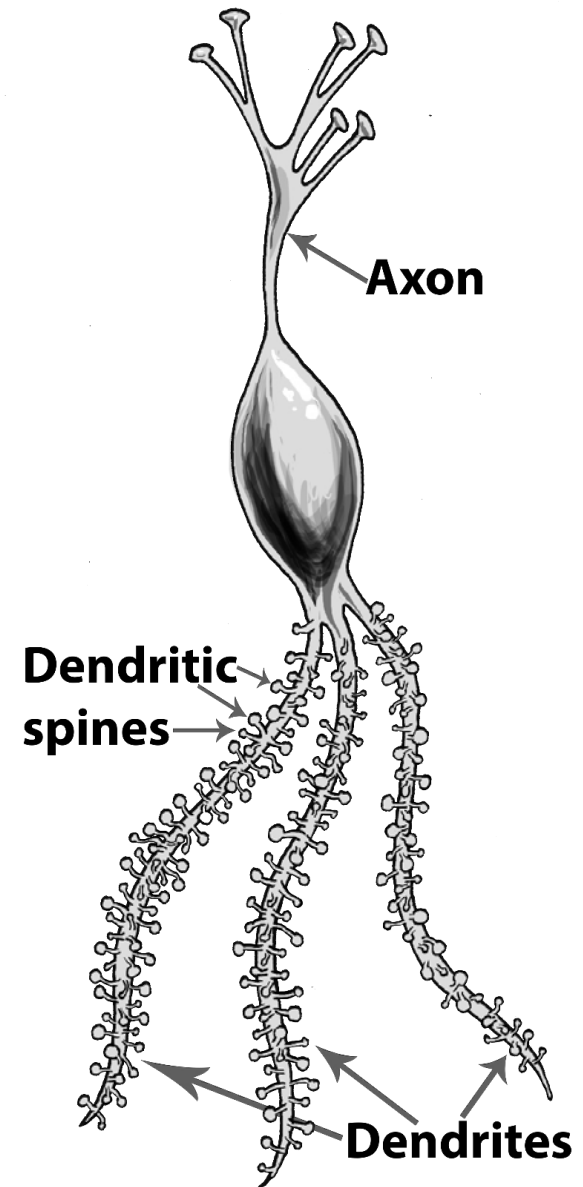
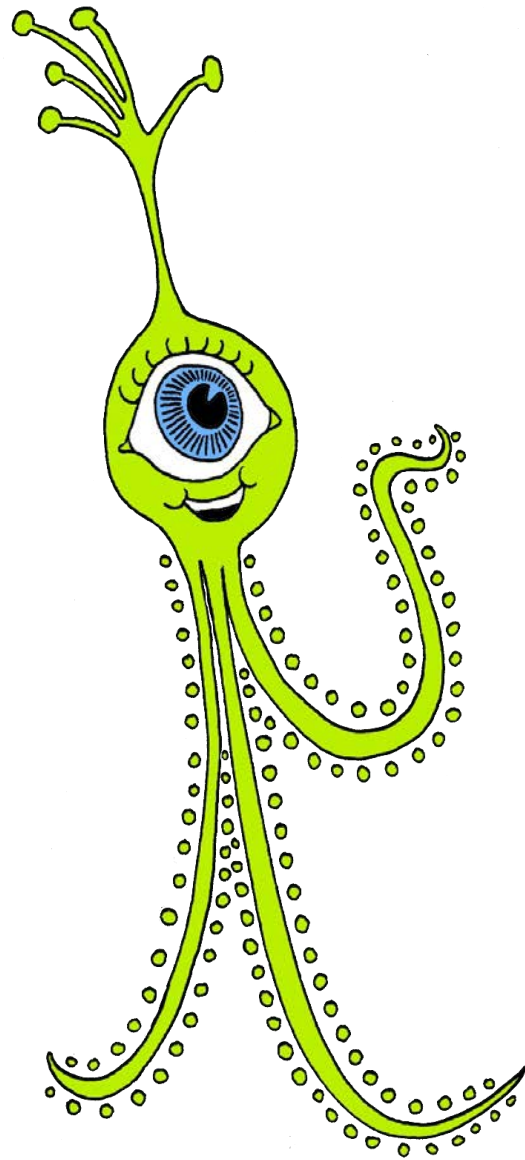


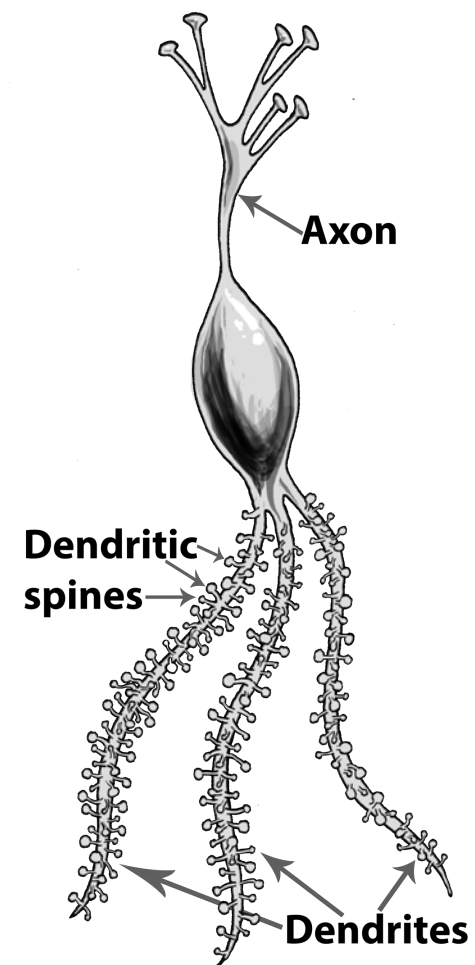
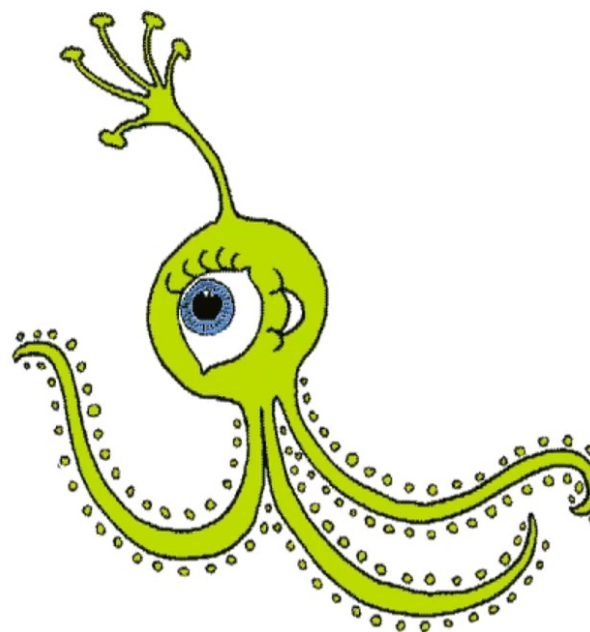
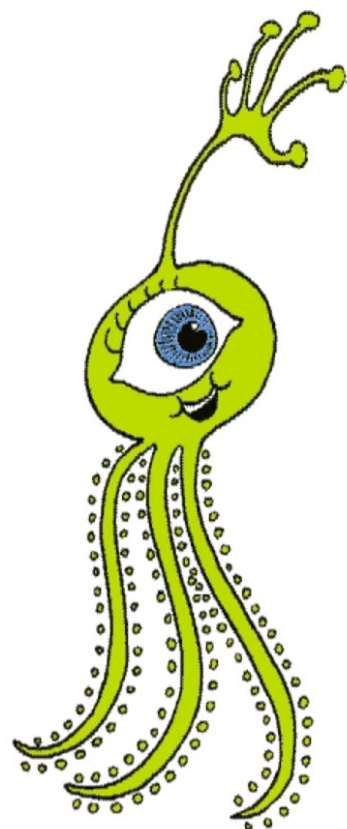


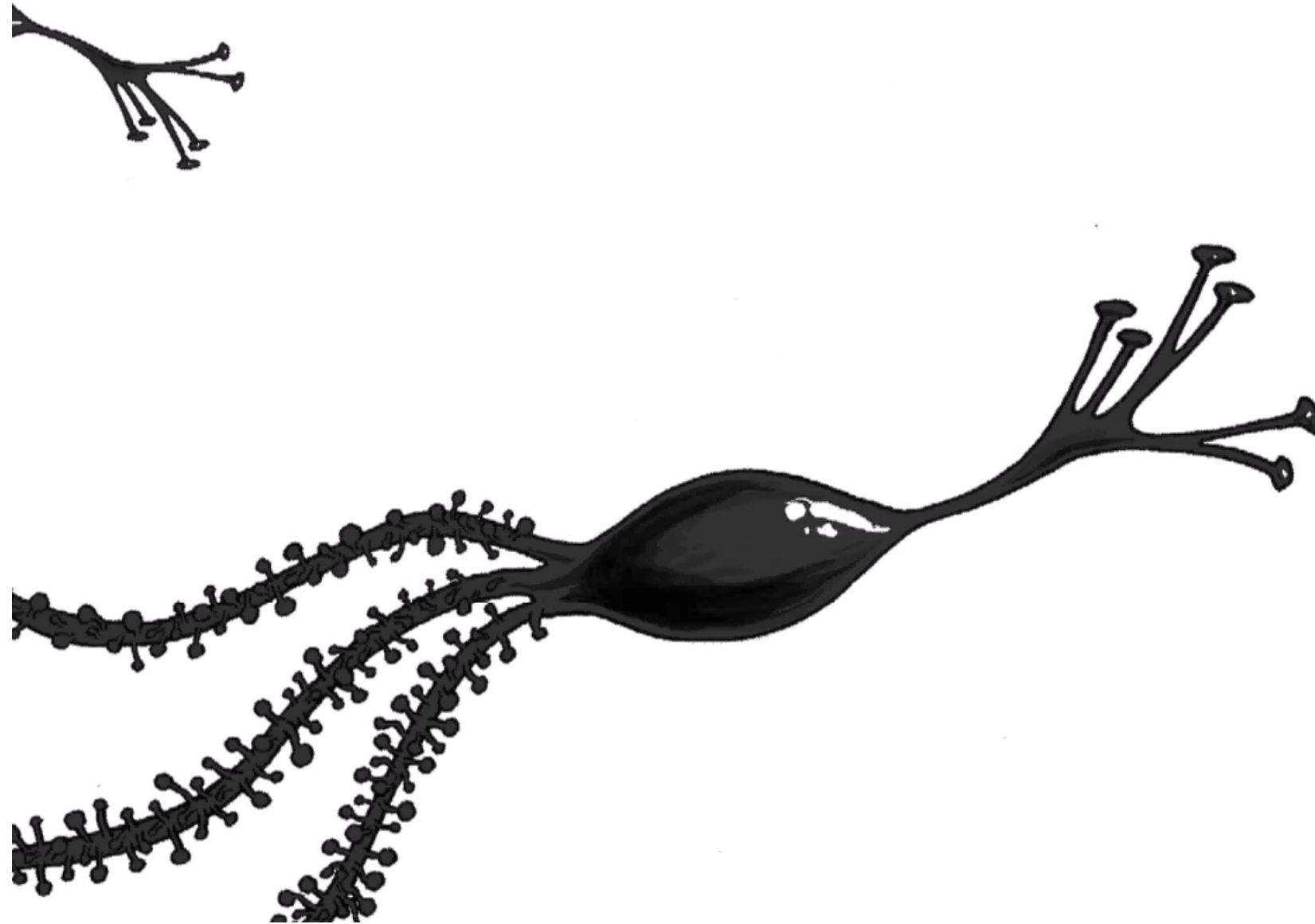
Philip Oakley





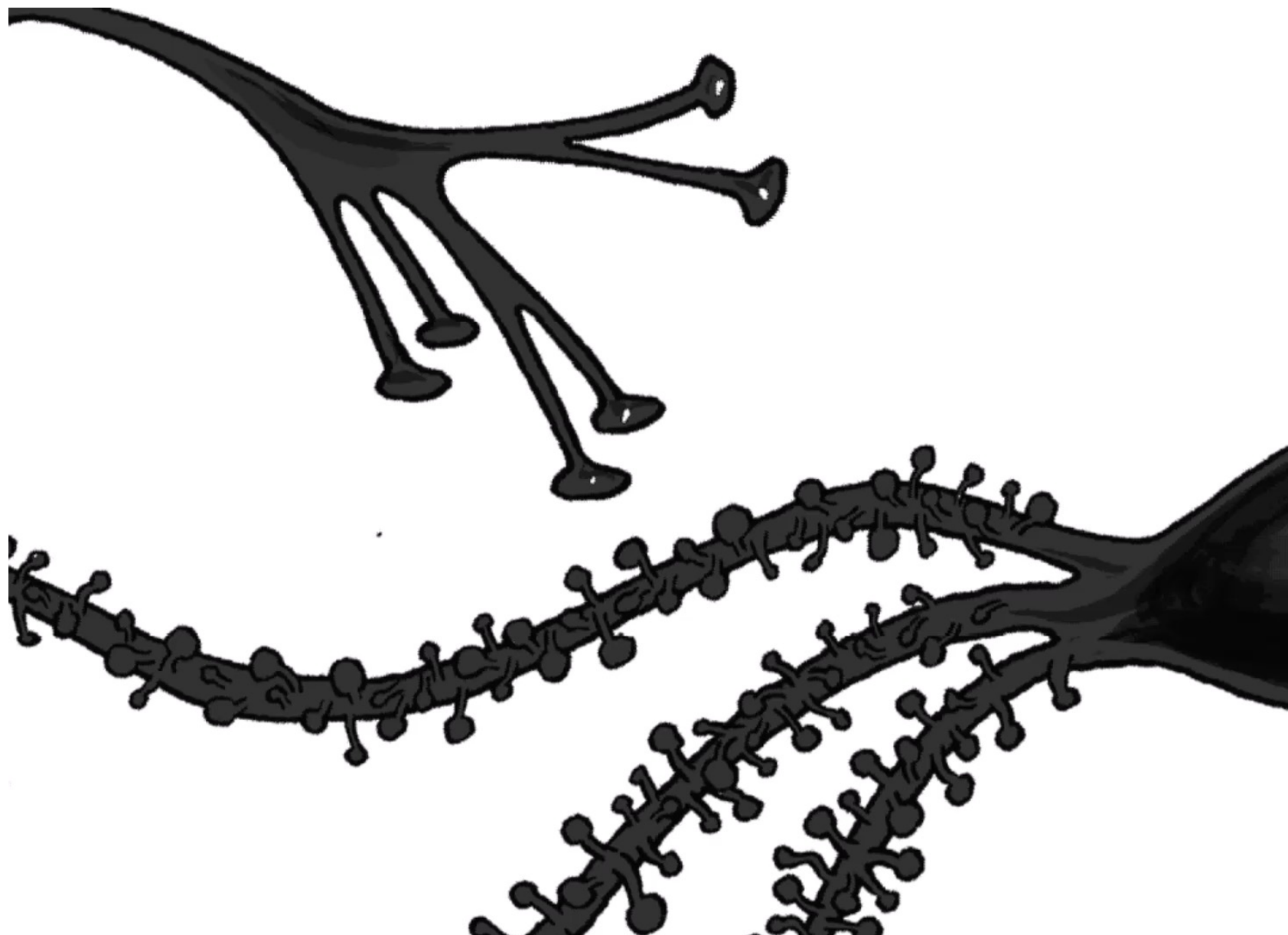




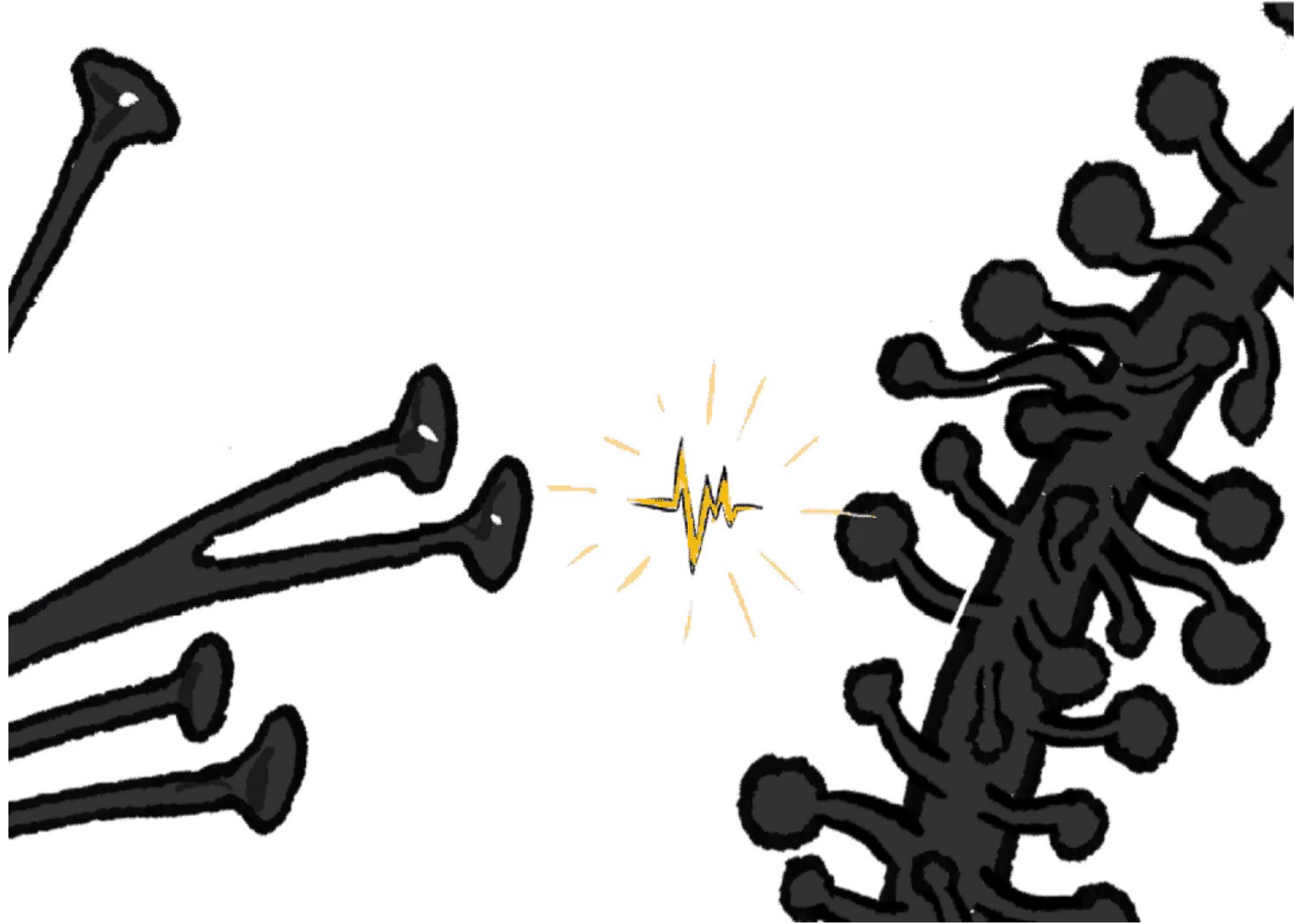


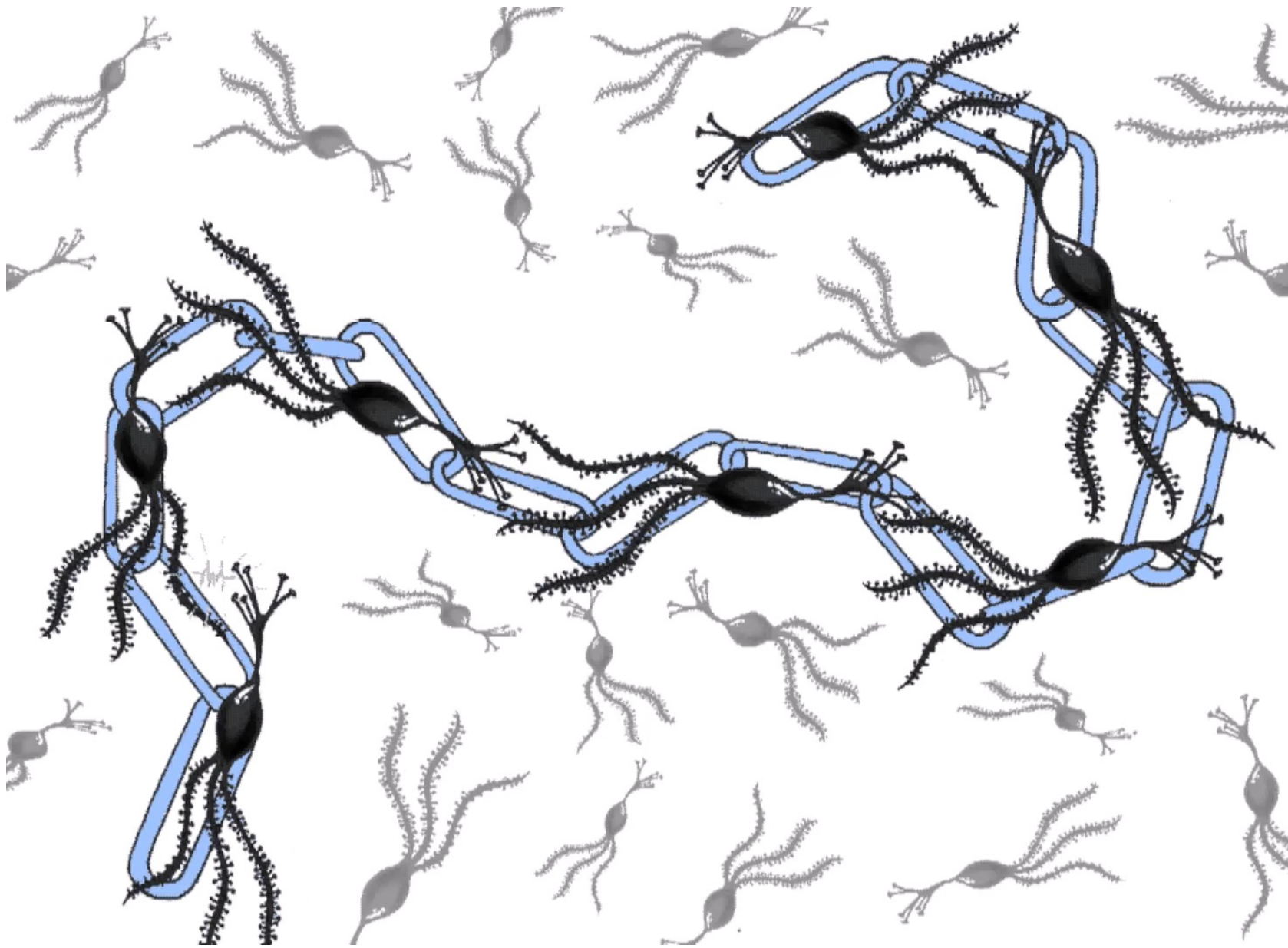
Neurons
send
signals

Neurons create
sets of links
when you learn
something.



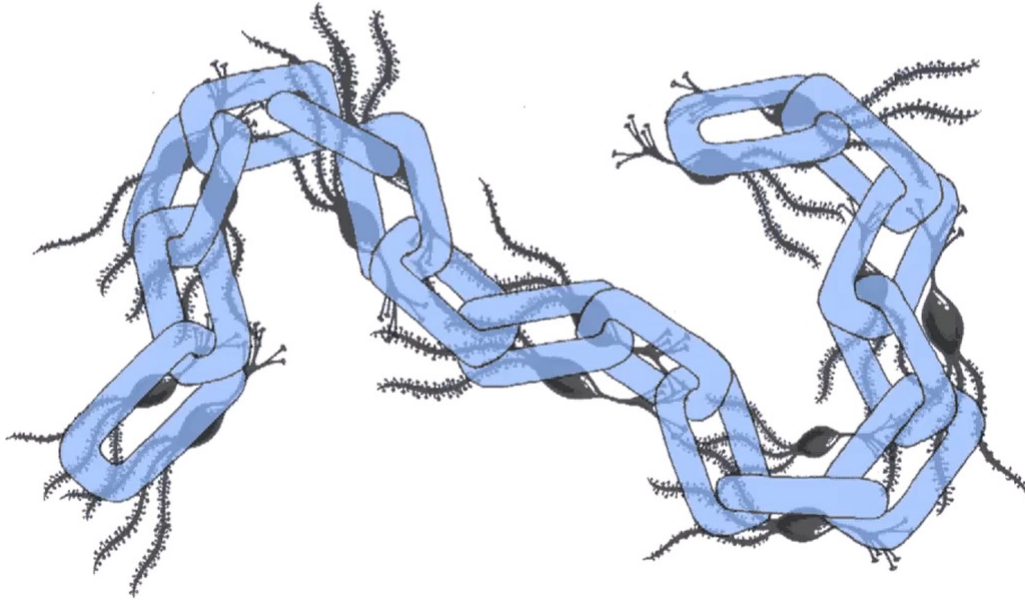
Connections
strengthen
with practice





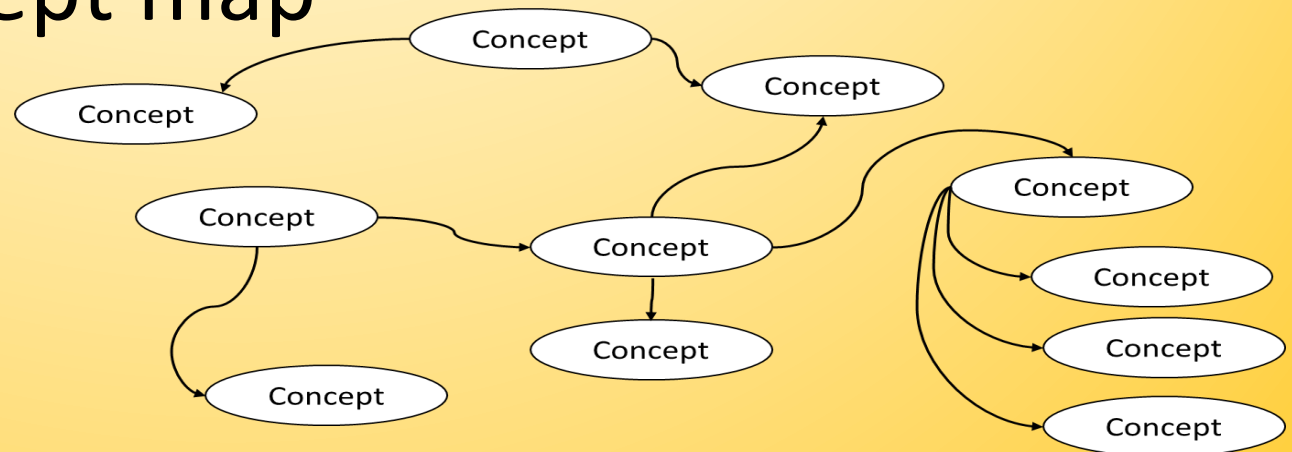
These are like
sets of links
in a chain.

The value of metaphor



What technique do you yourself use to learn most efficiently?

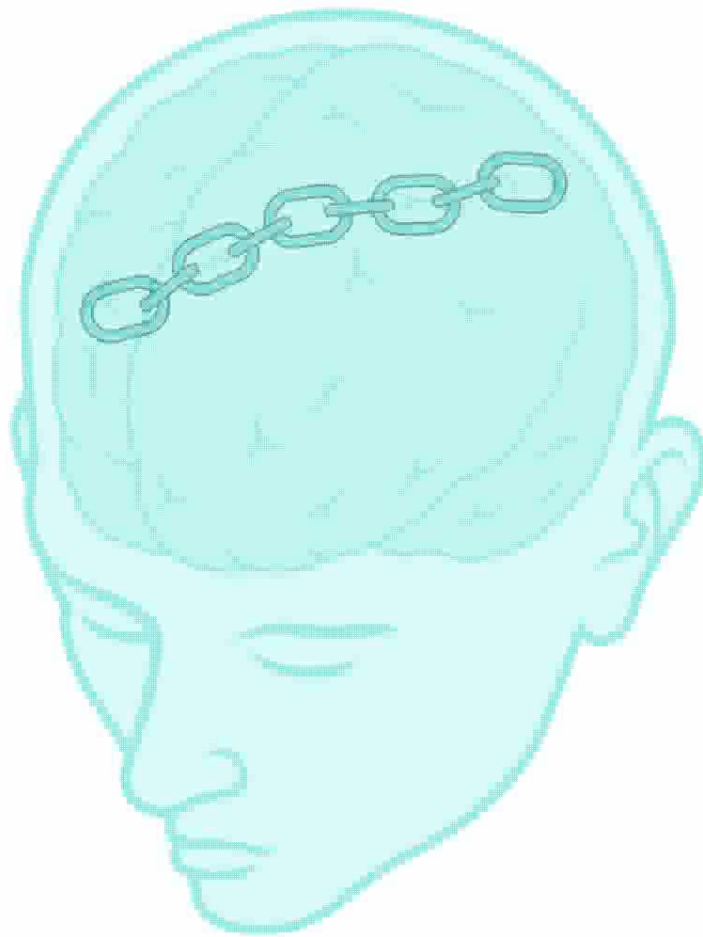
- Reread
- Highlight or underline
- Retrieval practice (“recall”)
- Create a concept map



Retrieval Practice

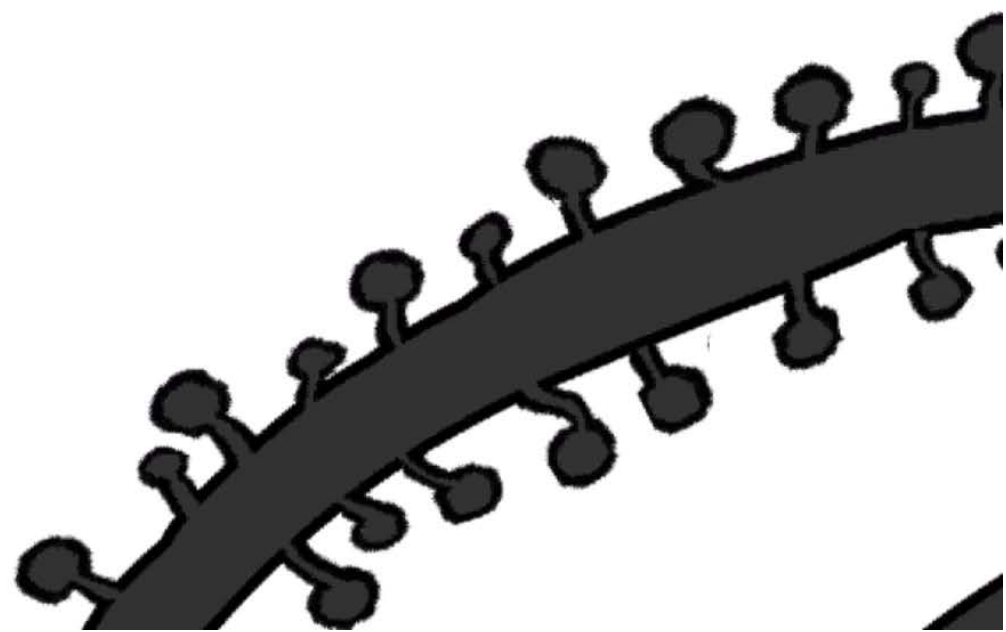


Retrieval Practice



← **Initial learning**





Before learning and before sleep



Images courtesy Guang Yang, NYU Langone

Before learning and before sleep



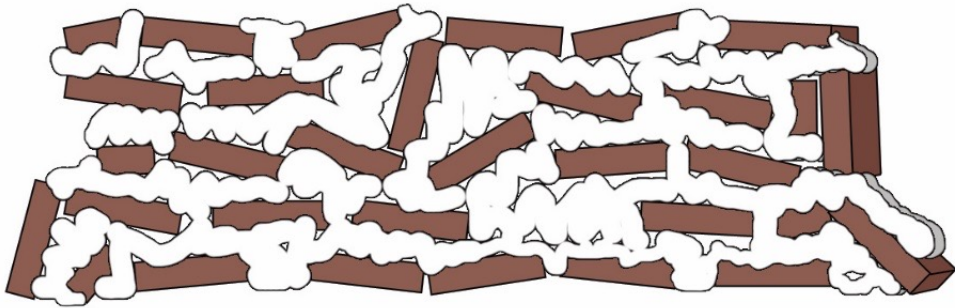
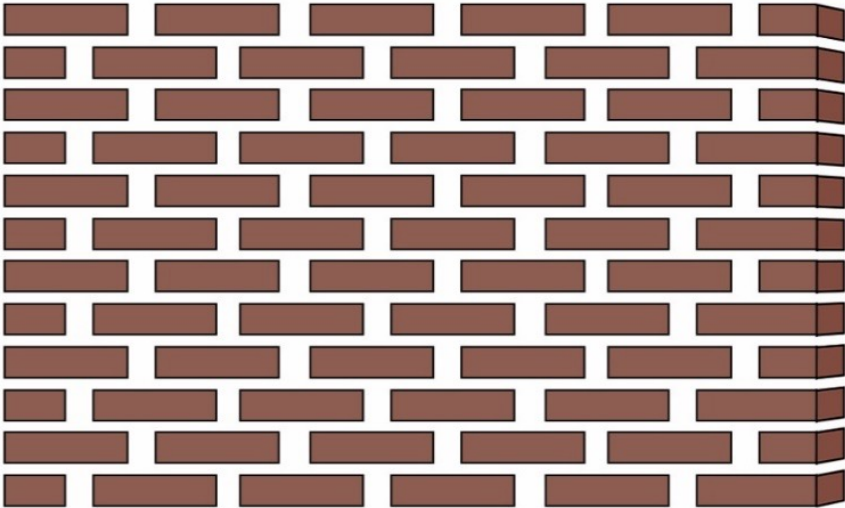
After learning and after sleep



Images courtesy Guang Yang, NYU Langone

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
						

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
						



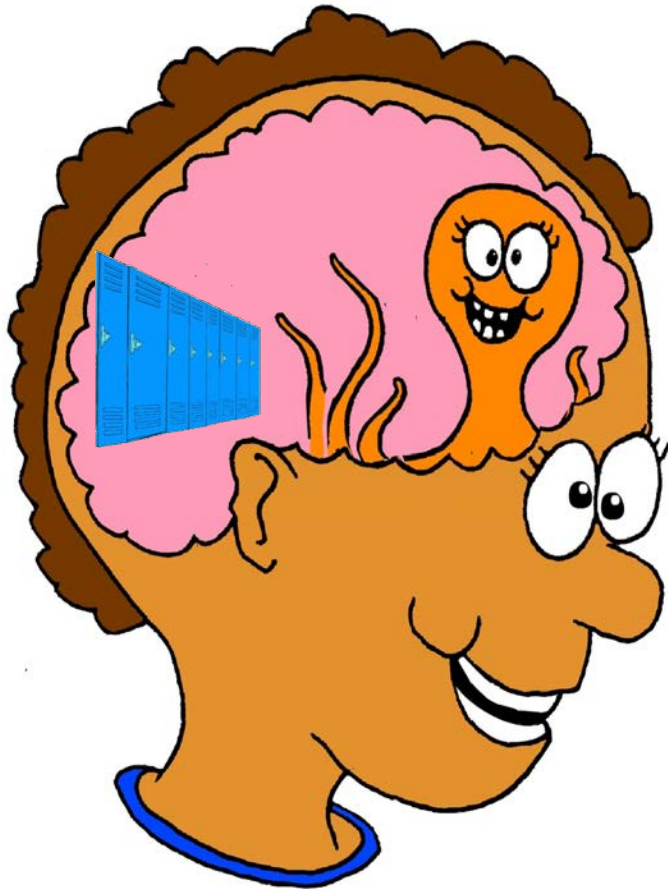
It takes time



Weight lifter Sultan Rakhmanov, RIA Novosti

Working memory

Long-term memory

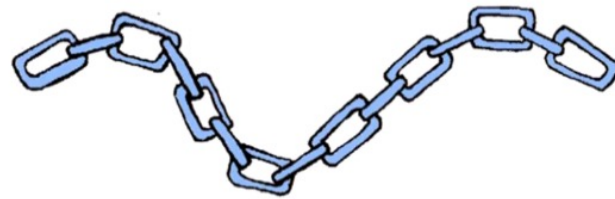
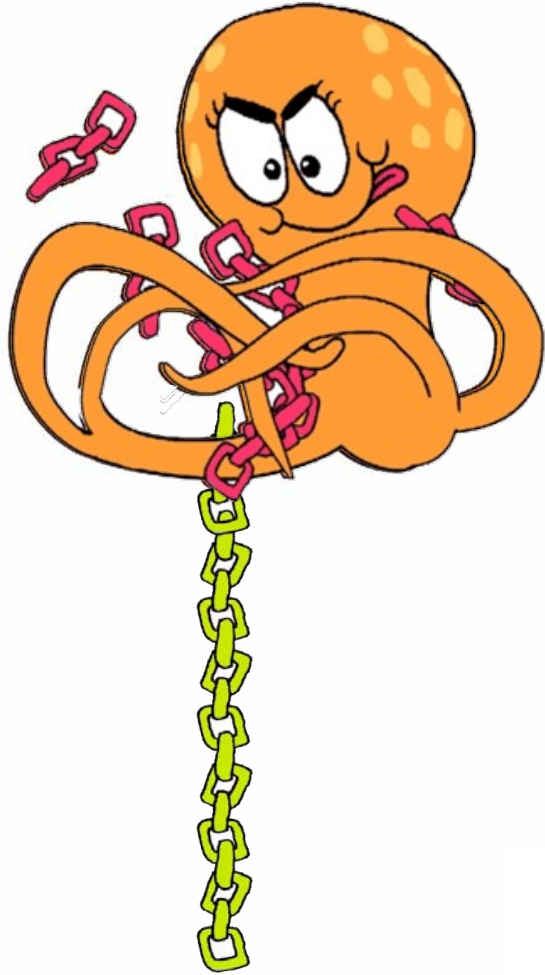


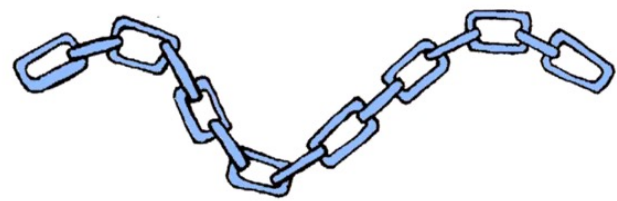
Working memory



Long-term memory







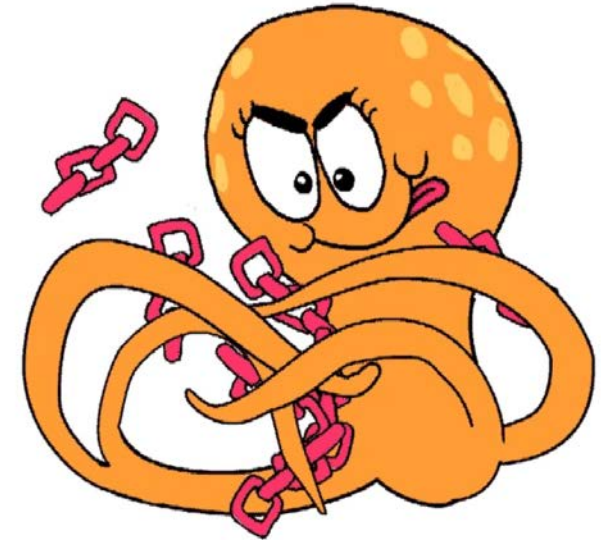


25 focused tangled octopus-20180922T134857Z-001.zip

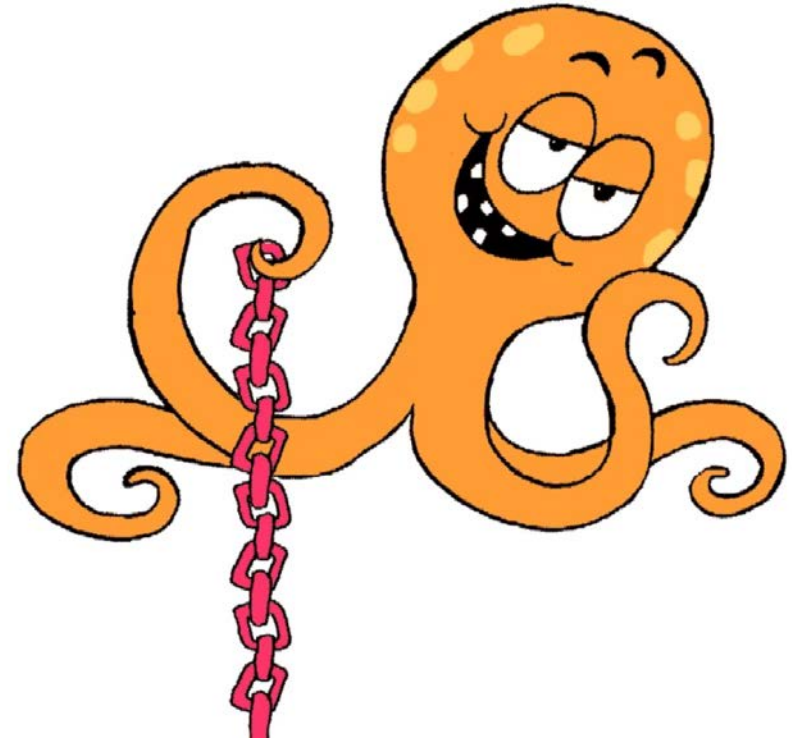


25 focused tangled octopus-20180922T134857Z-001.zip



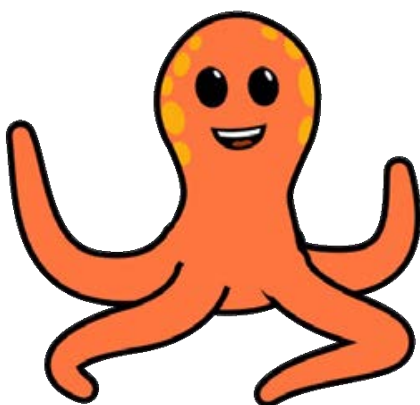


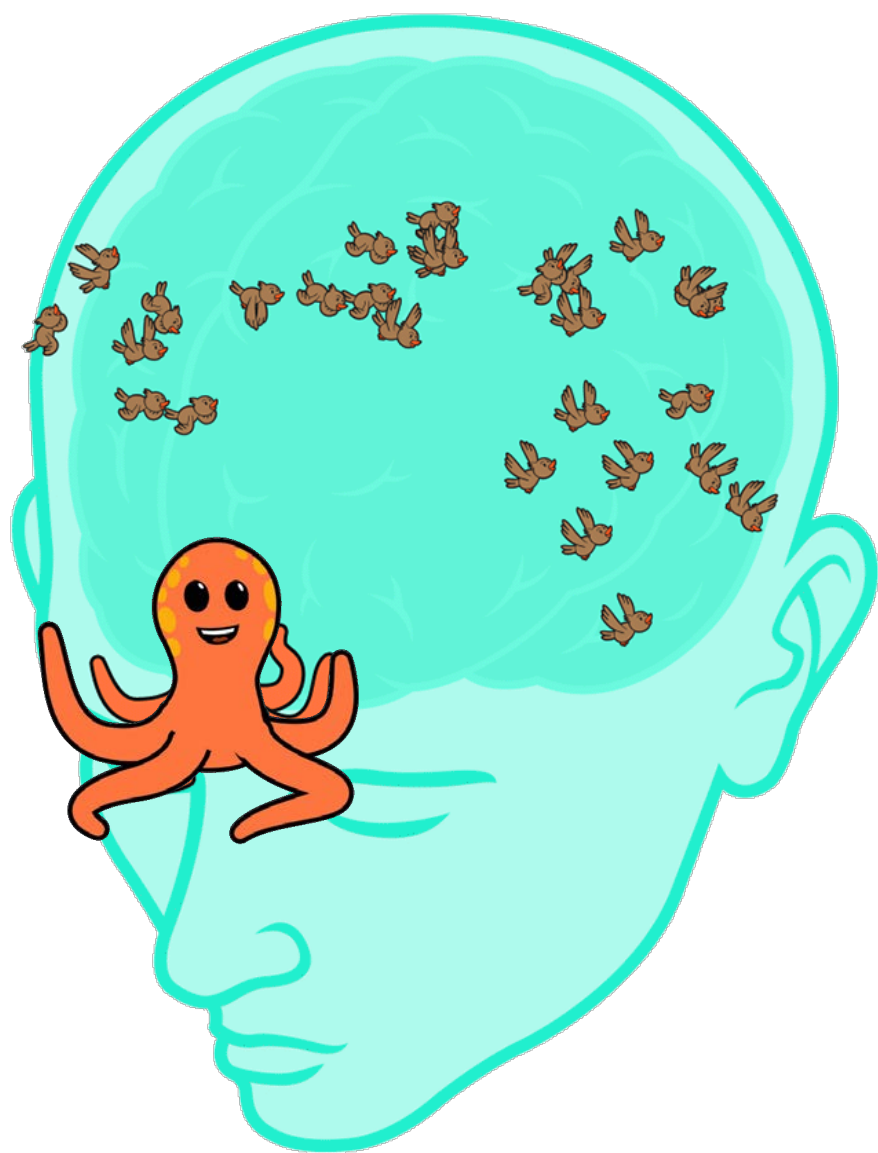
- Heavy cognitive load
- No working memory is available for anything else



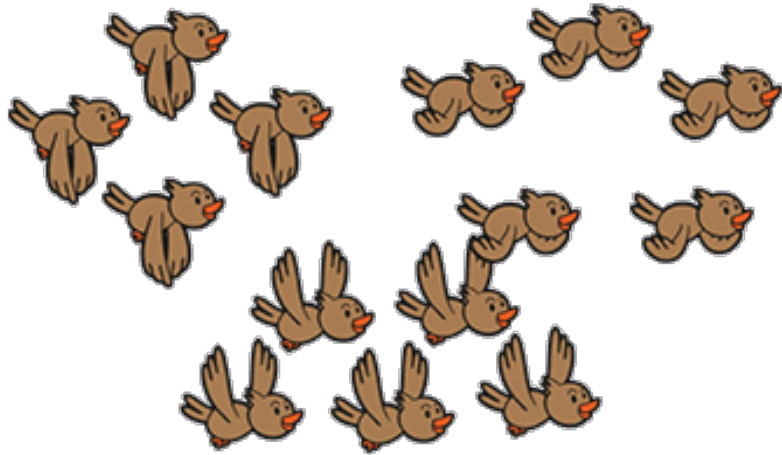
- Light cognitive load!
- Working memory is available for more complex thinking



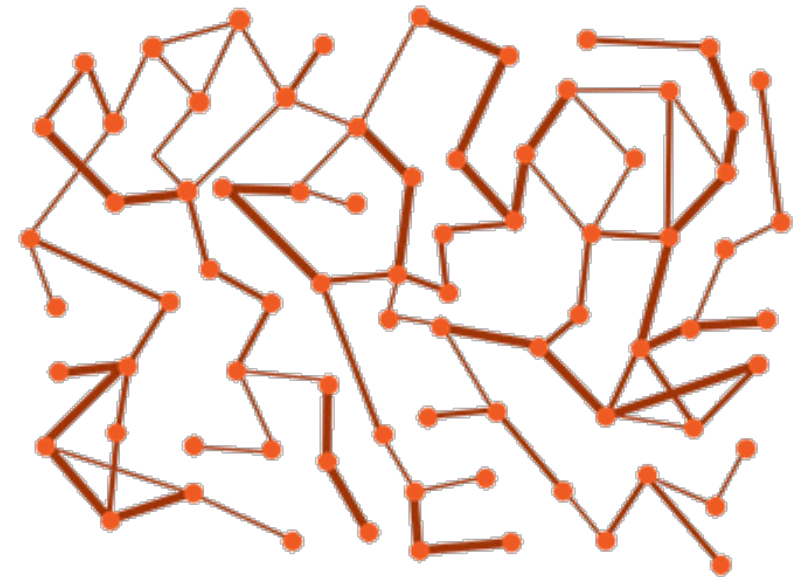


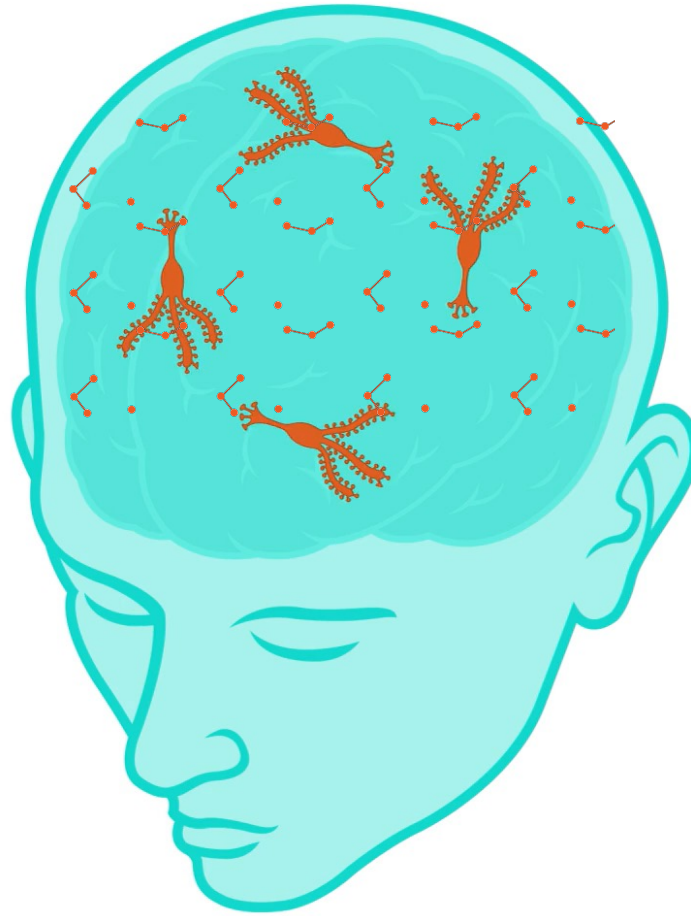


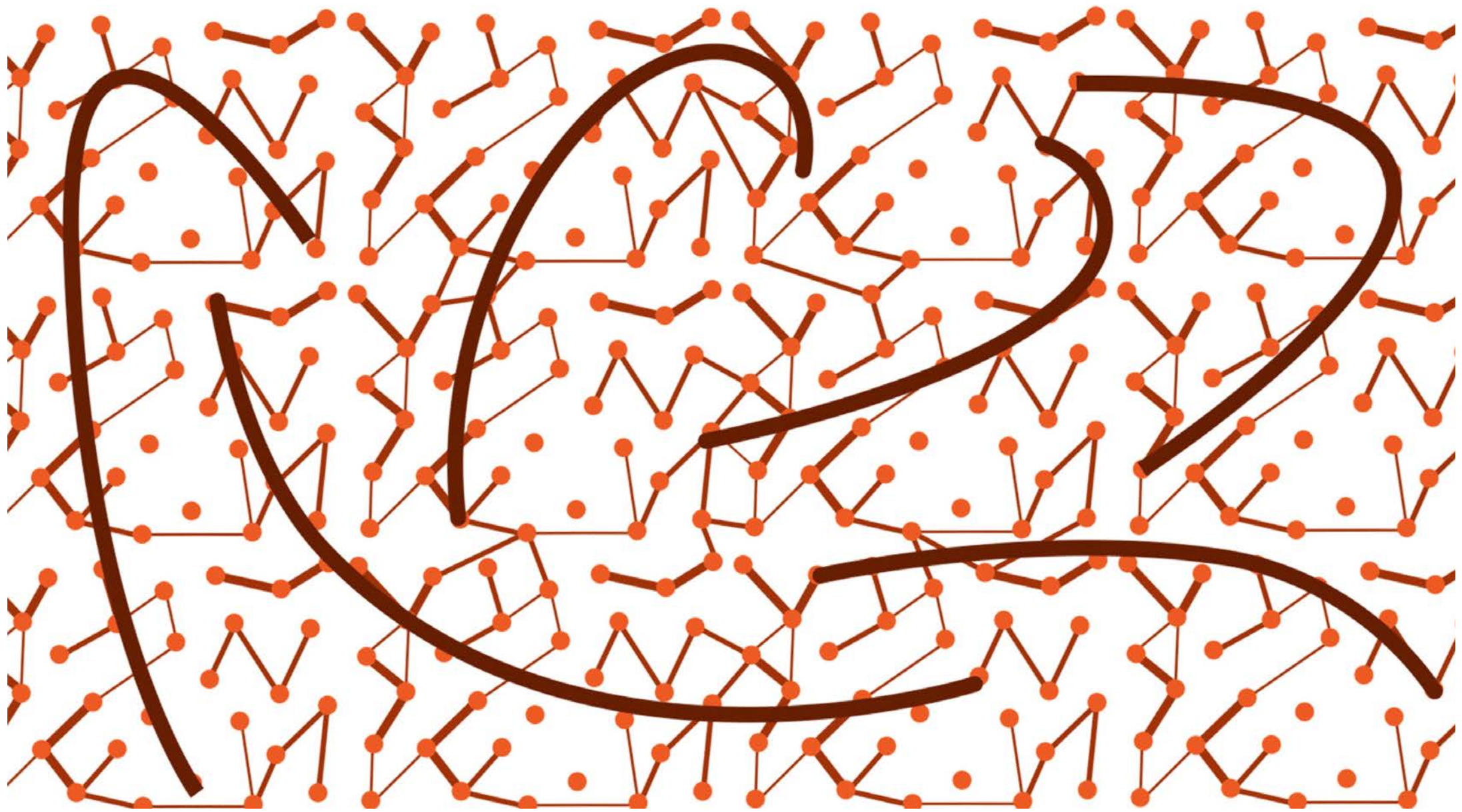
Mental models



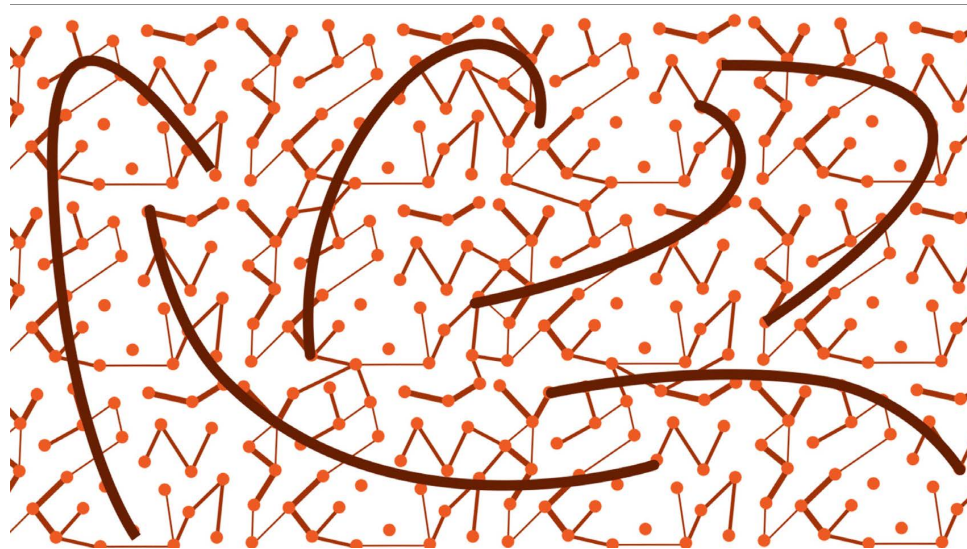
Schema







Schemas



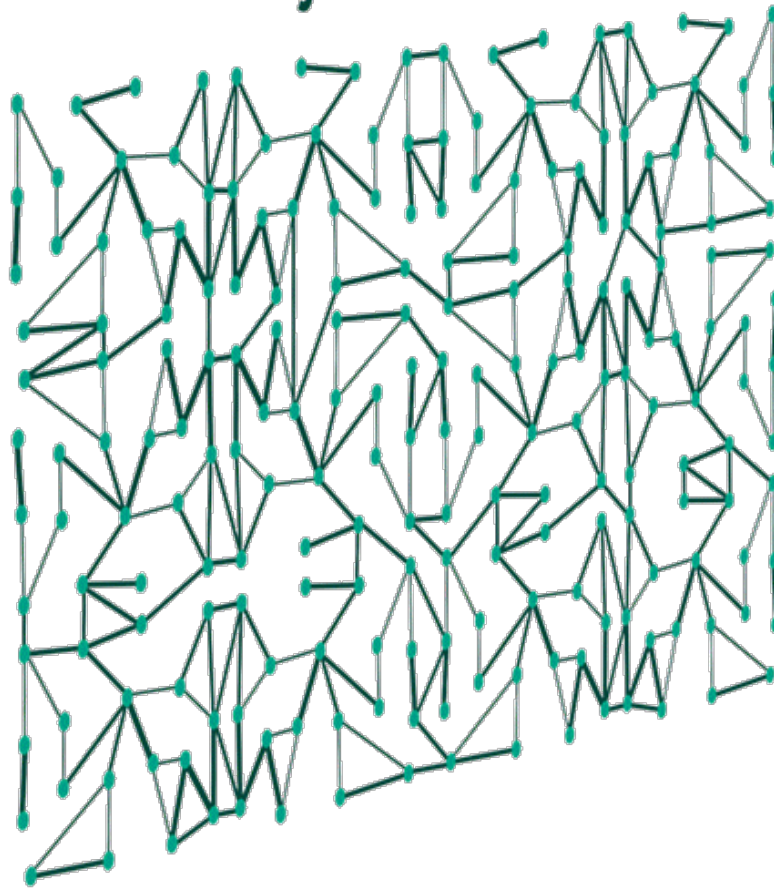
Schemas

Classroom Management

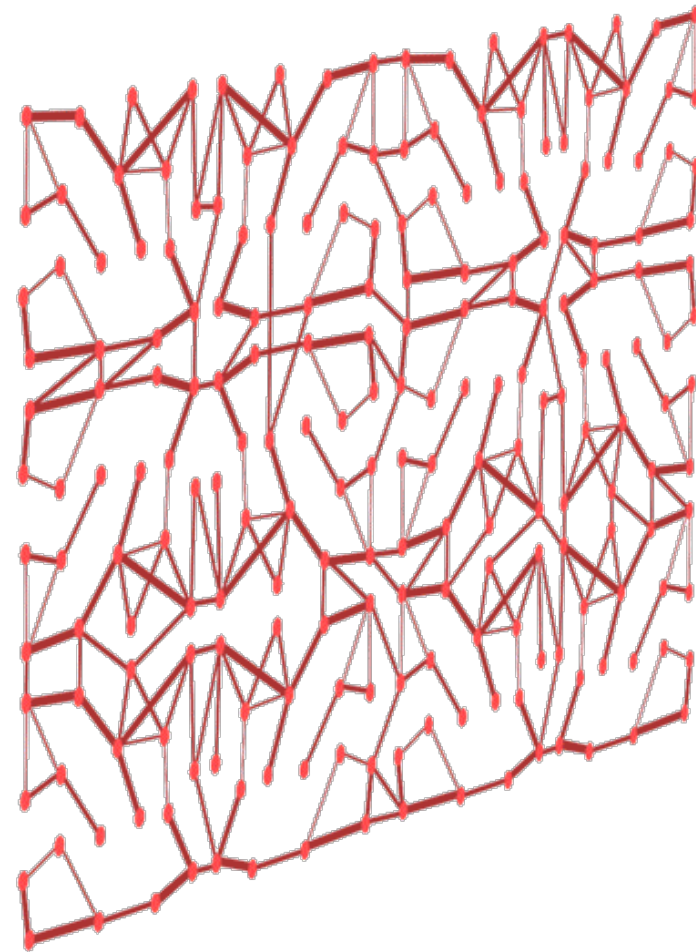
Japanese



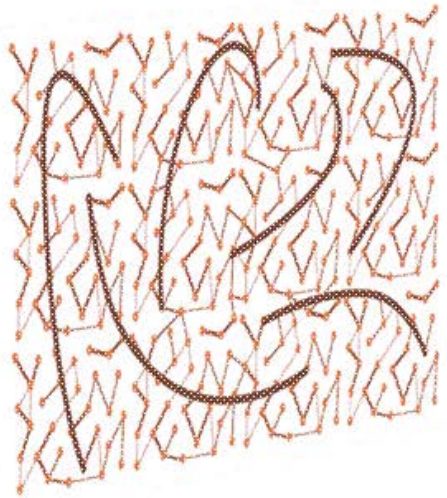
Physics



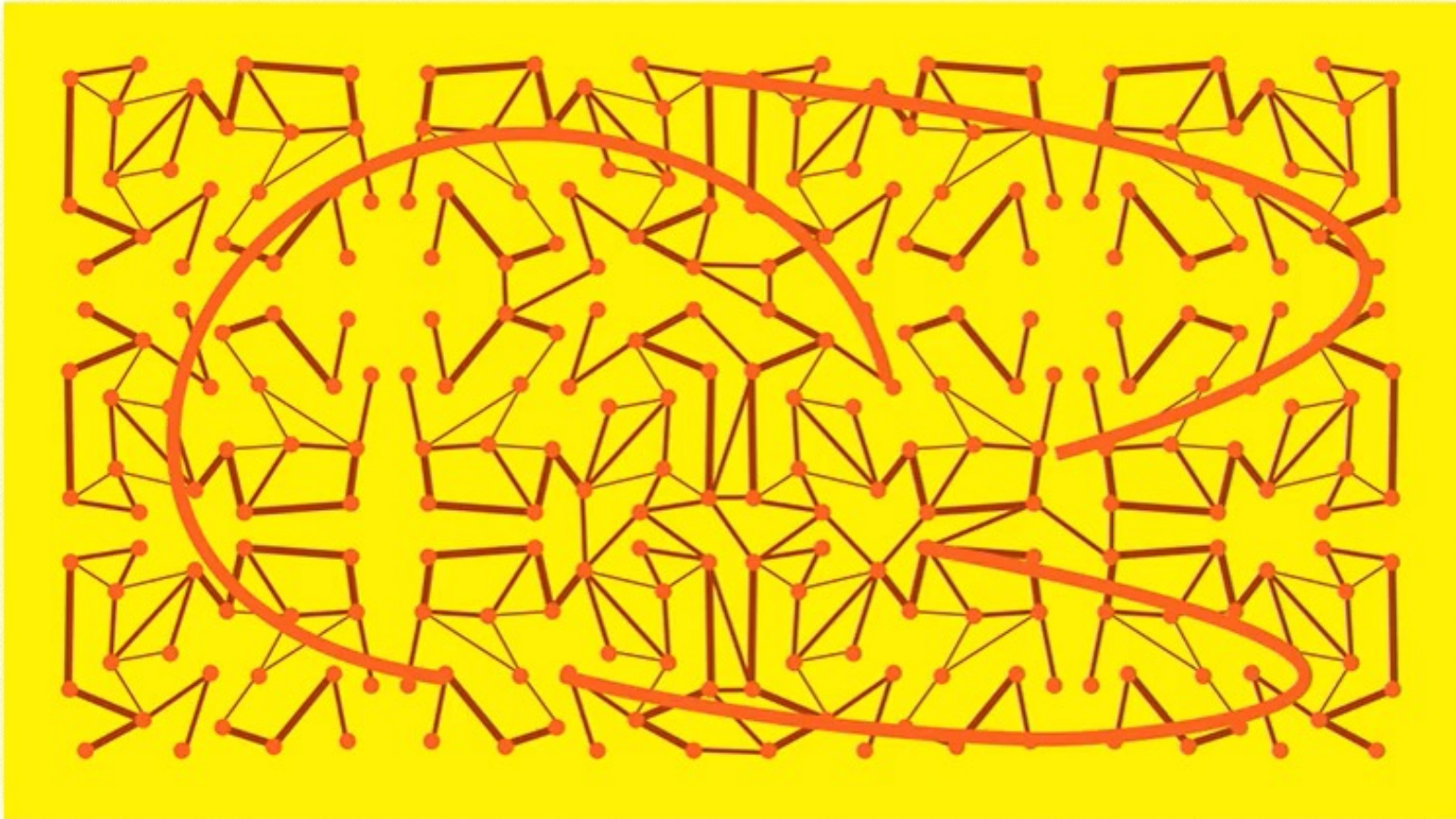
Math

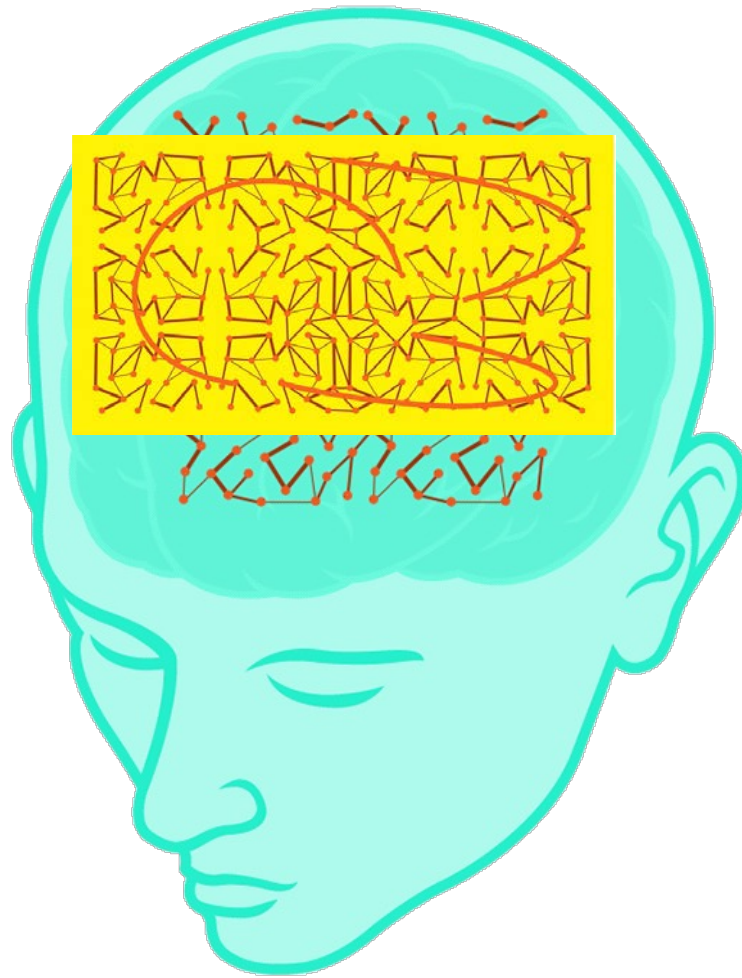


Identity Schema



Identity Schema





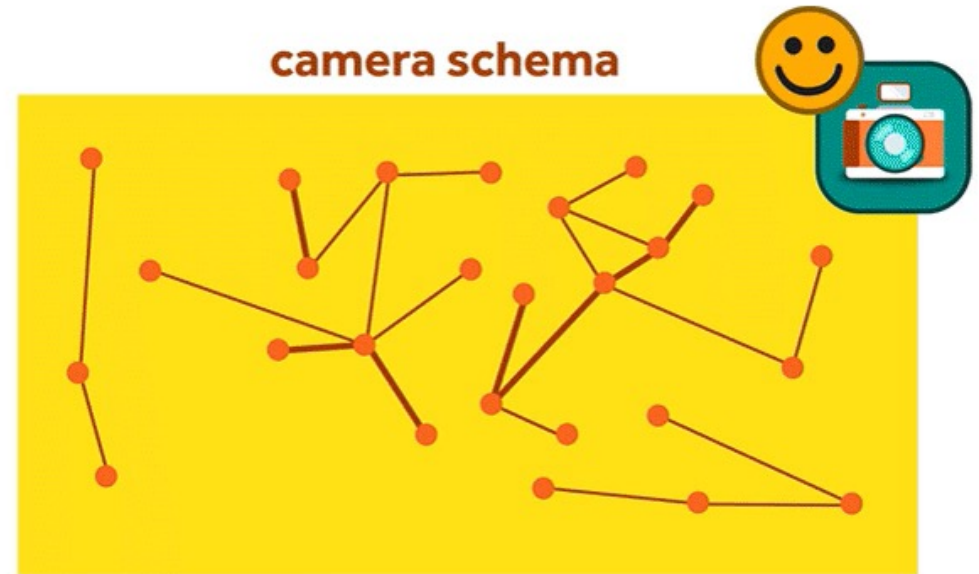


Audrey Lawrence

Growth mindset

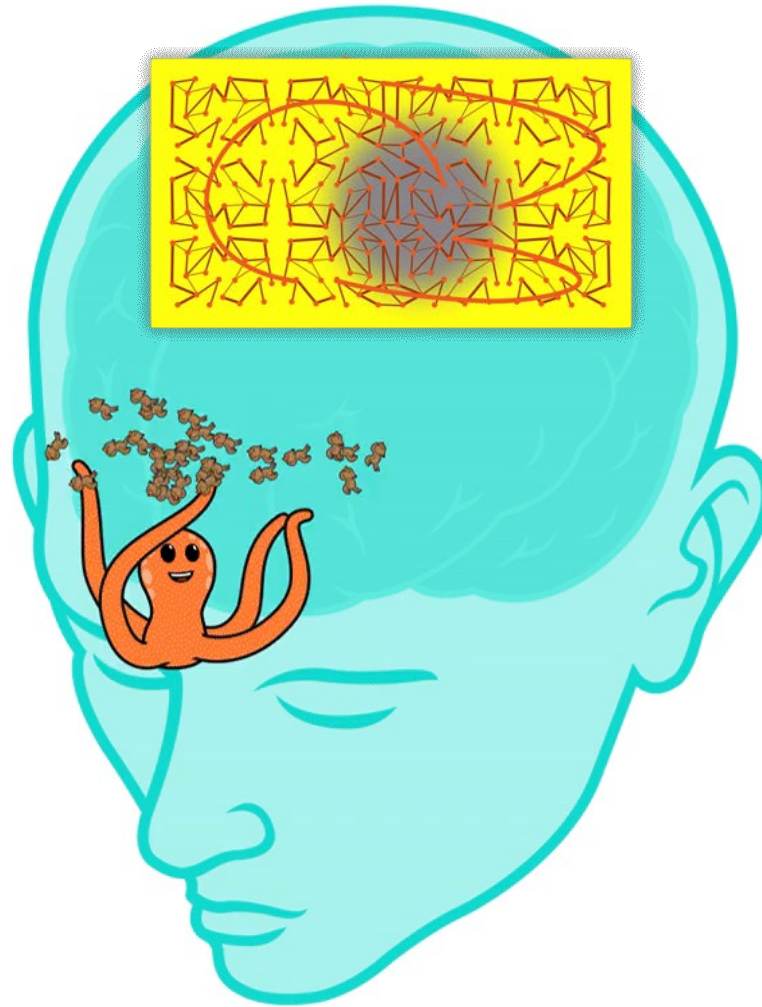


camera schema





Student

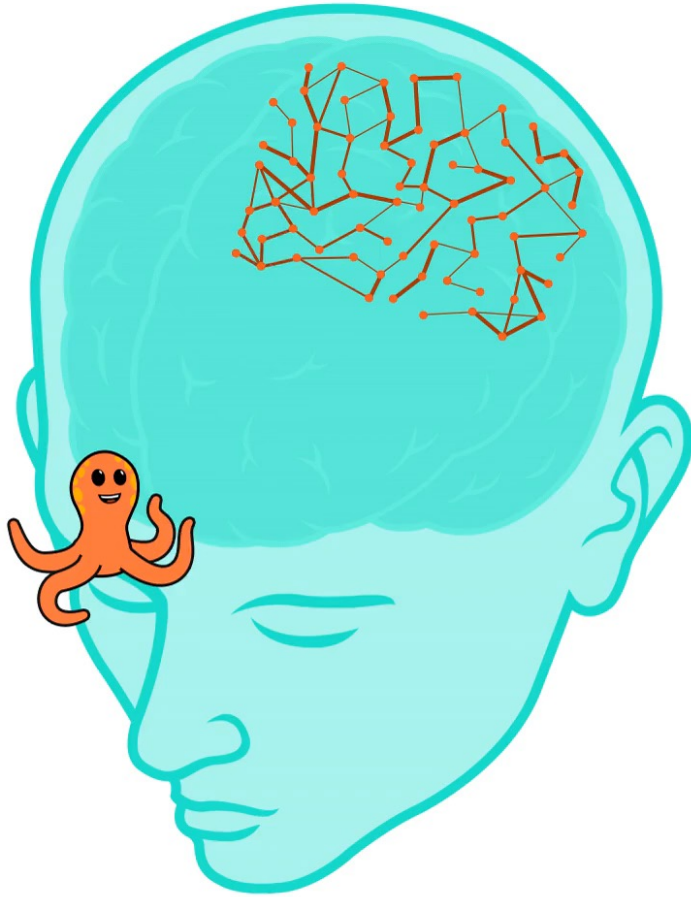




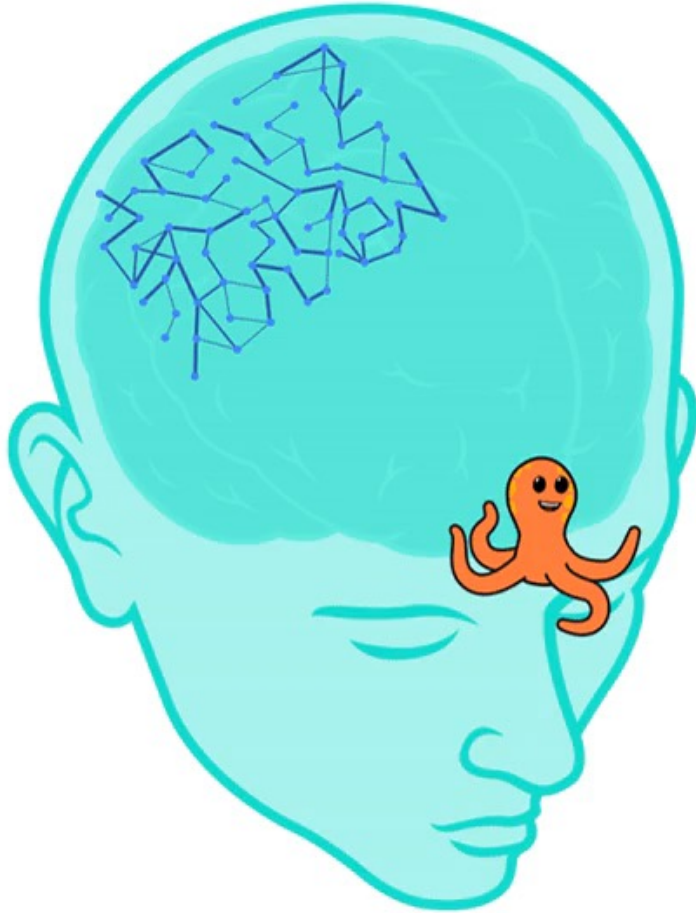


**Practice putting the
mental model into
long-term memory
(schema)**

**Practice pulling the
mental model OUT of
long-term memory**



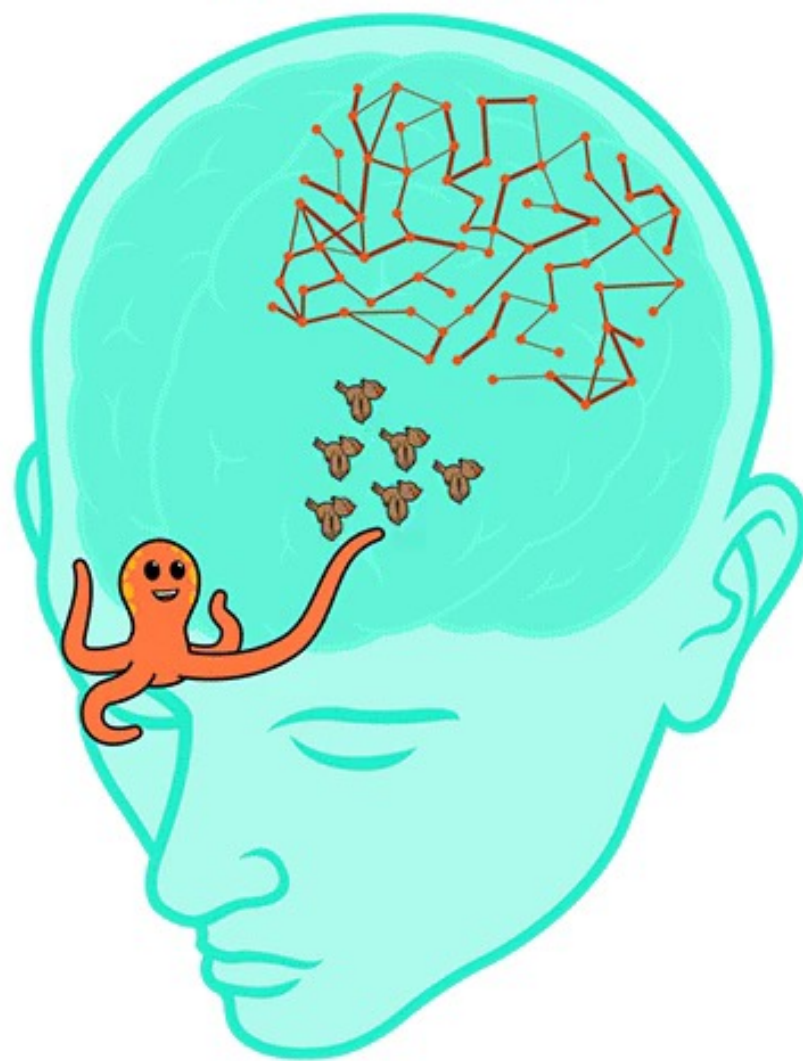
Student



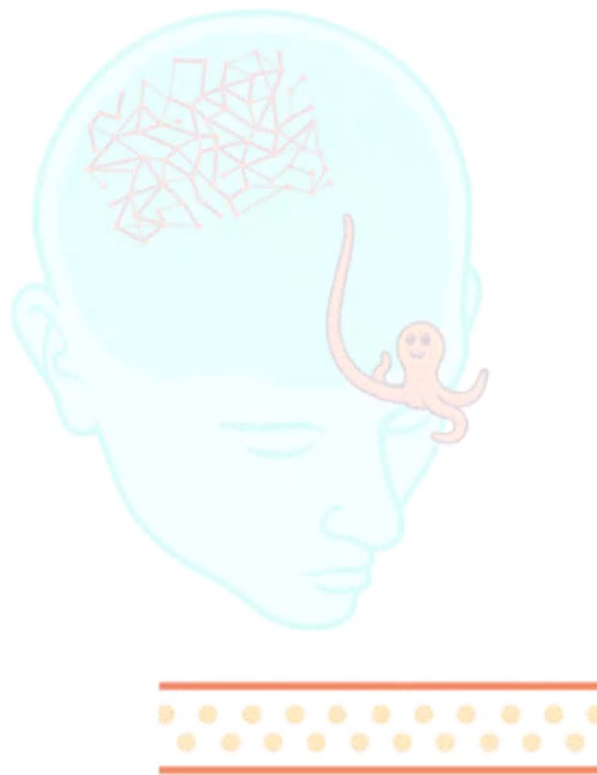
Teacher



Teacher



Teacher



Teacher



Teacher

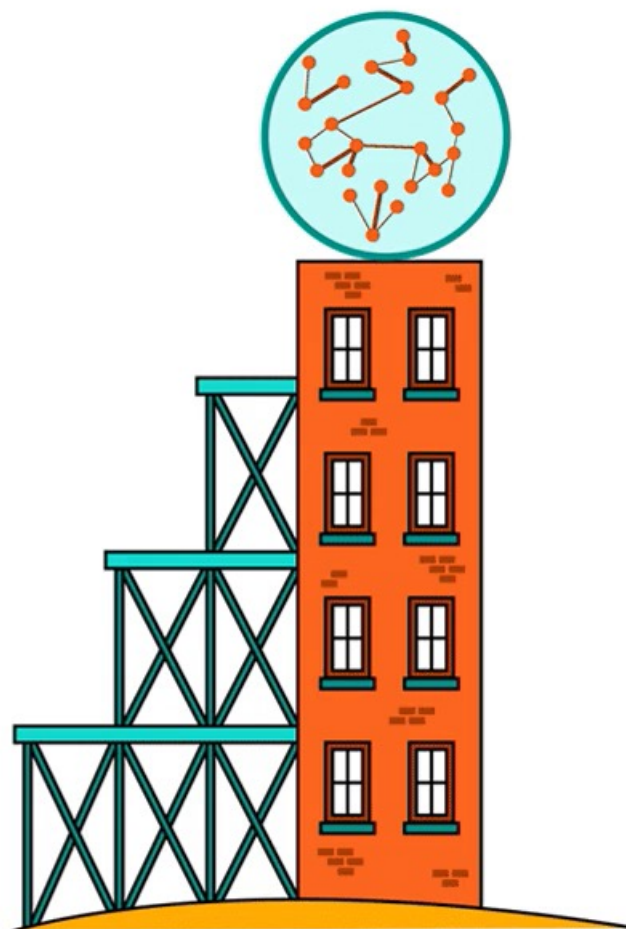
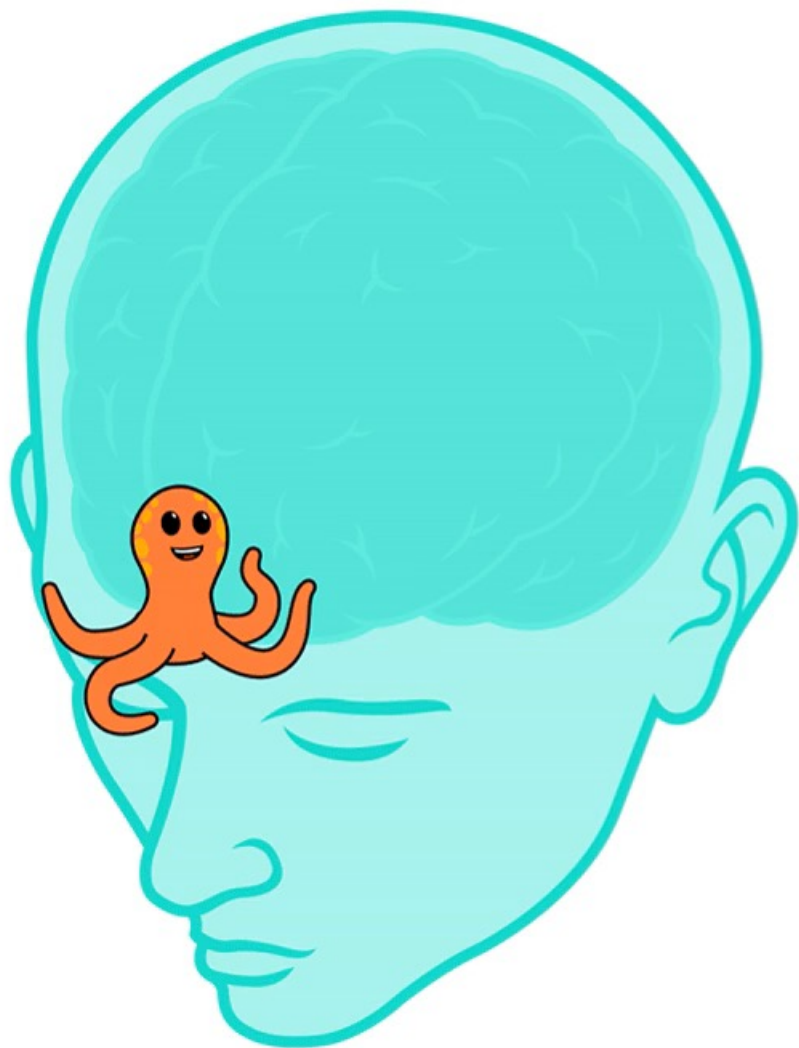


Student 1



Social learning







Week 4 - Lesson 1: Attention, Partnership and Teleprompters



Humor



Comedian

**Humor Does
NOT Mean
Being a Comedian**

Go



Entertain






Diffuse
Mode

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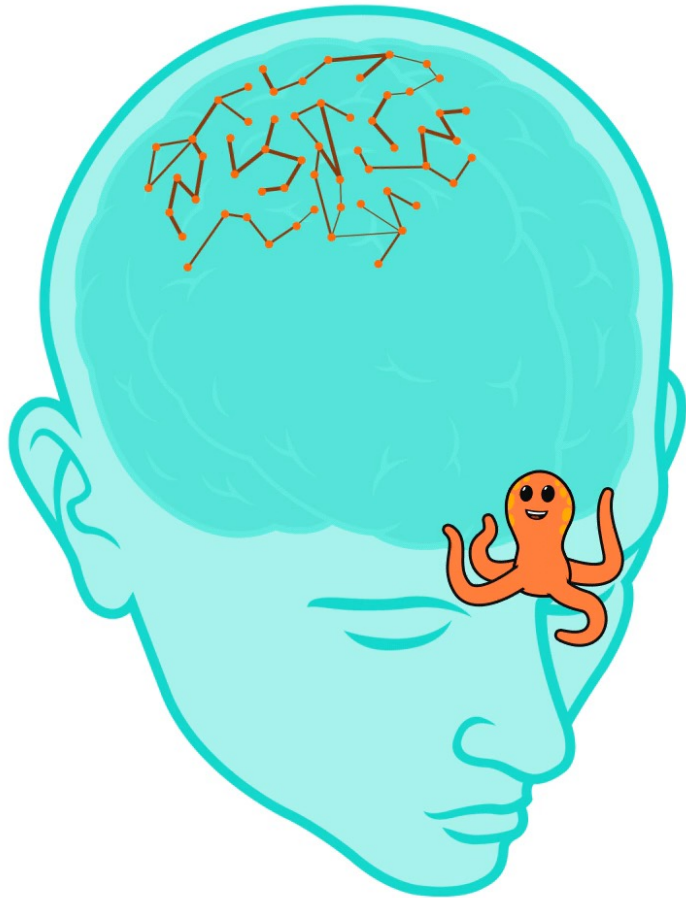
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TWEAKING *YOUR* SCHEMAS



- Add retrieval practice apps to your teaching repertoire!

Retrieval Practice Apps

**Teacher can facilitate creation
of decks in classes**

- iDoRecall
- Quizlet
- Kahoot!
- Anki

Live, in-class

- PearDeck
- NearPod



GROUPS
Shared Content



RECALLS
Flashcards



LIBRARY
Your materials



PRACTICE
Today's recalls



ALL RECALLS 160



Sort By: Date Created

+ New



litera

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 between 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.



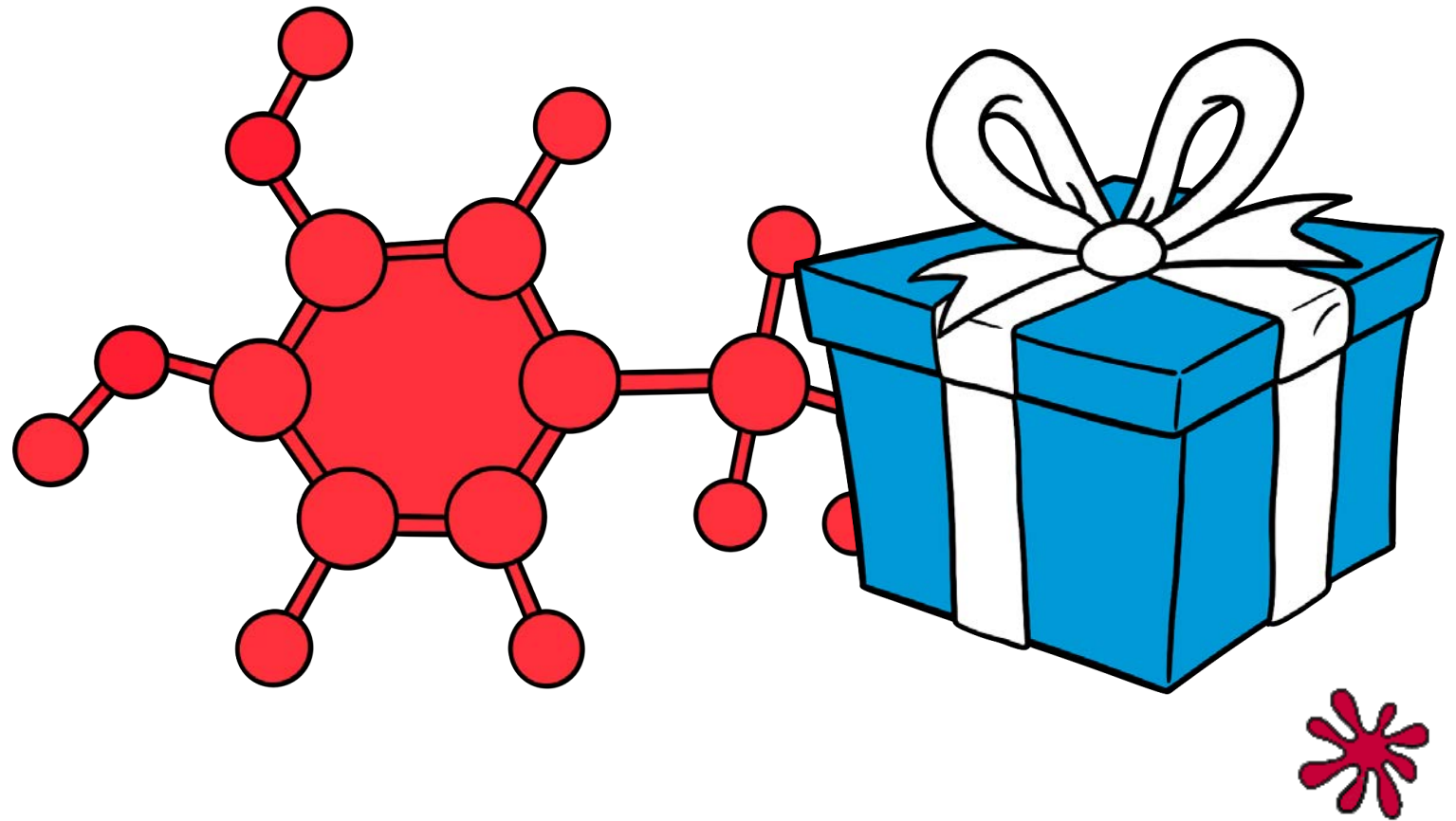
Explain the neurological model of language



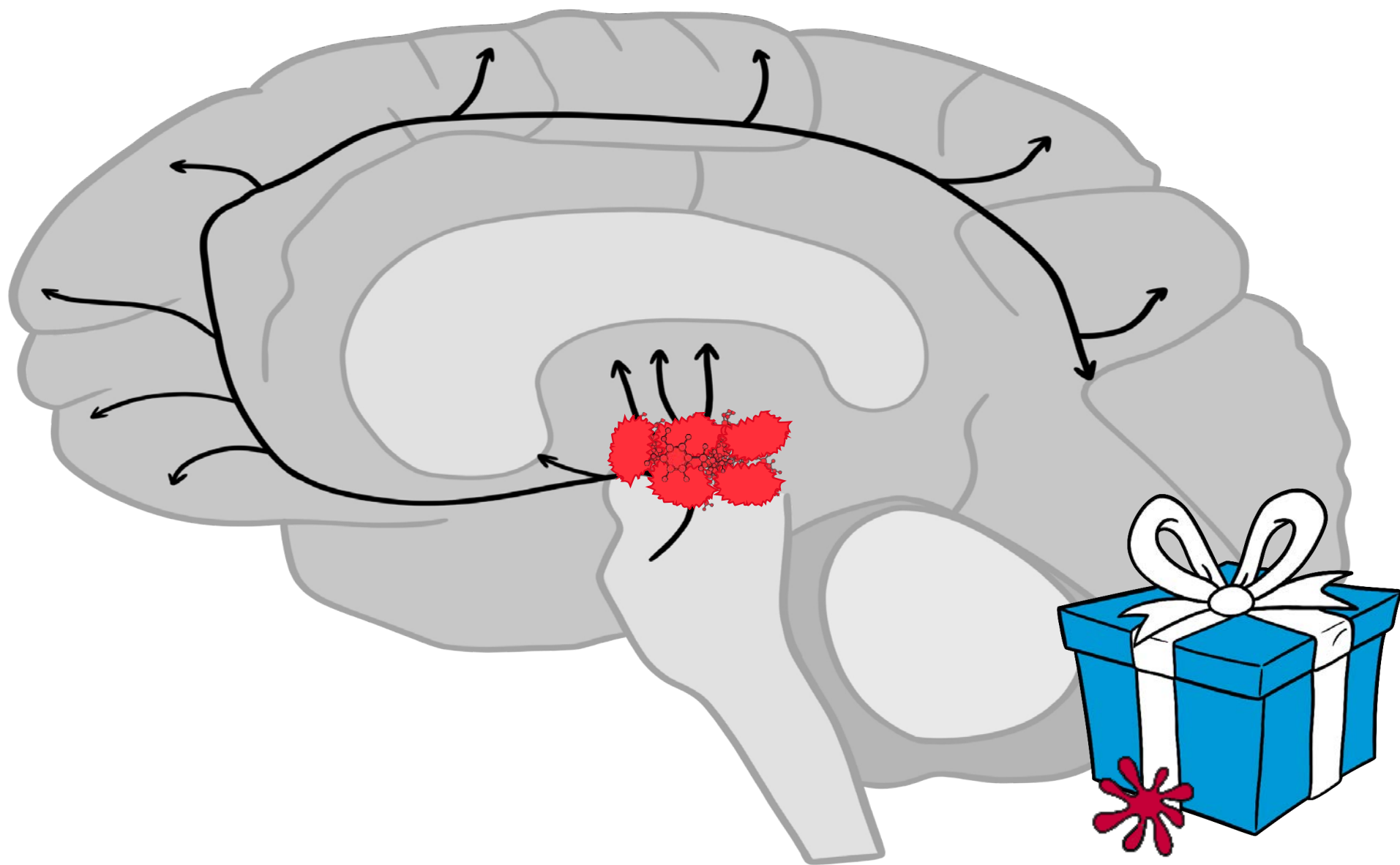
General intelligence predicts memory change across sleep Kimberly M. Fenn & David Z. Hambrick



high-level mathematical expertise and basic number sense share common roots in



Dopamine—the “feel good molecule”





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

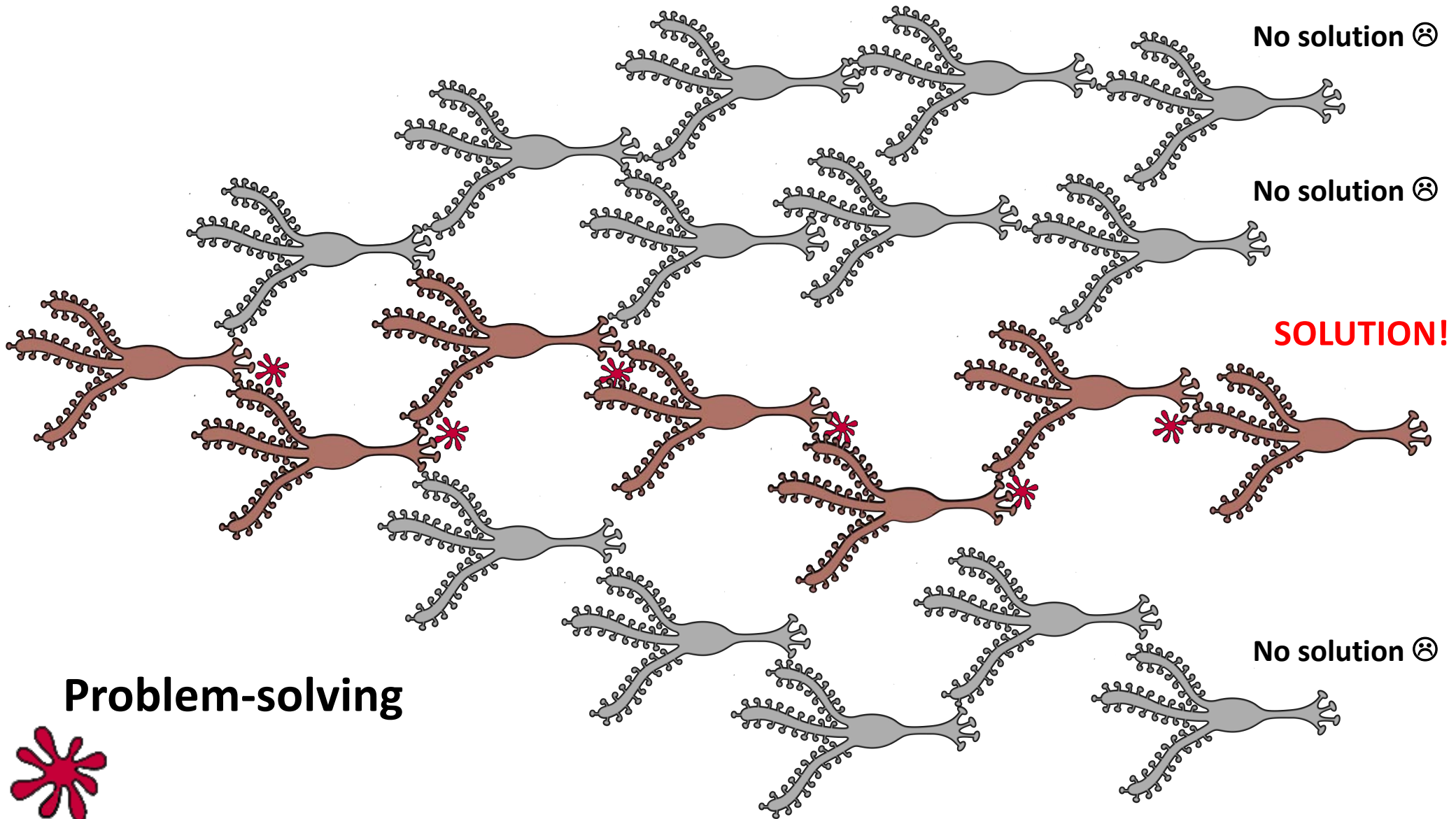
No solution ☹️

No solution ☹️

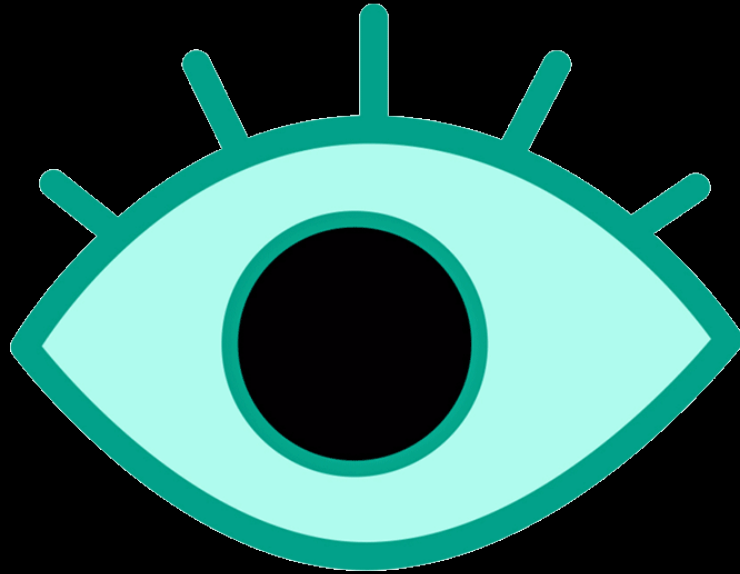
SOLUTION!

No solution ☹️

Problem-solving



Hooks & curiosity suppress
diffuse mode and enhance
focus



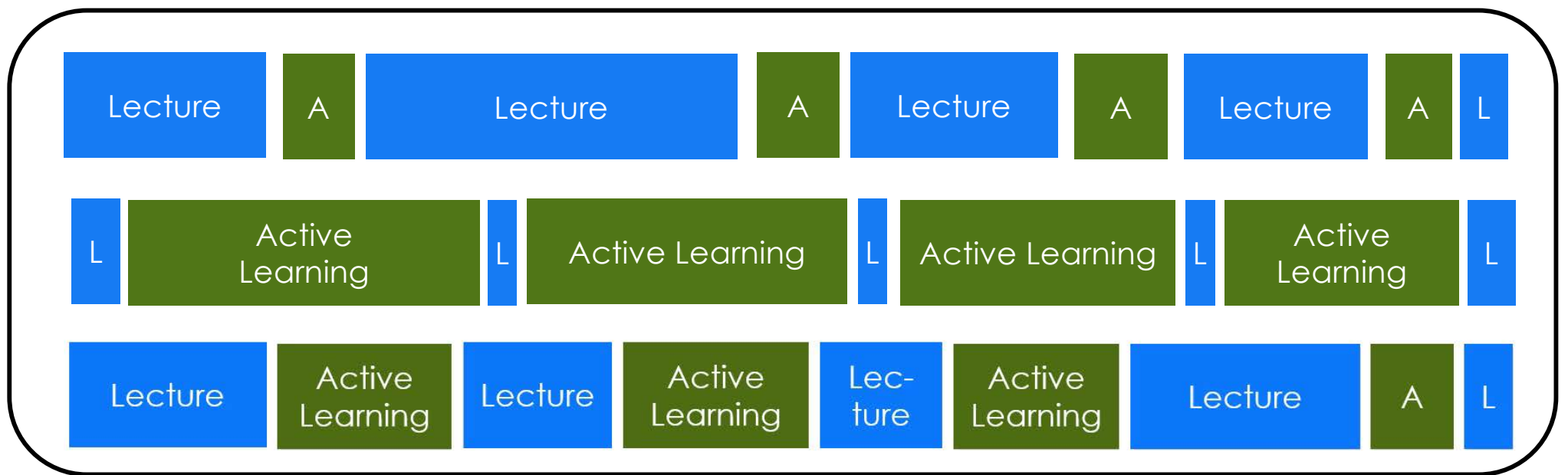
Project Follow Through, 1967 - 1977

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

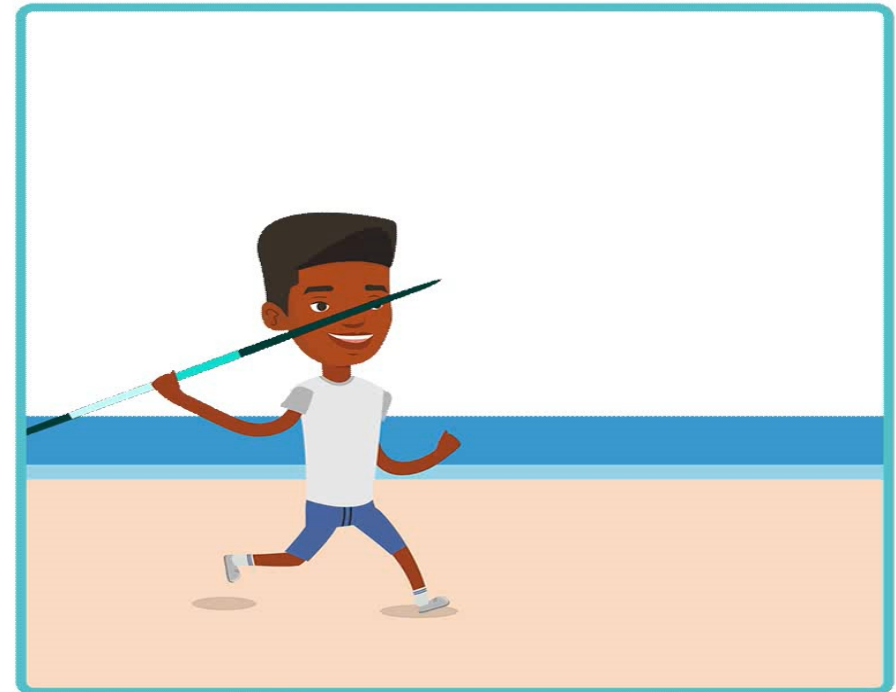
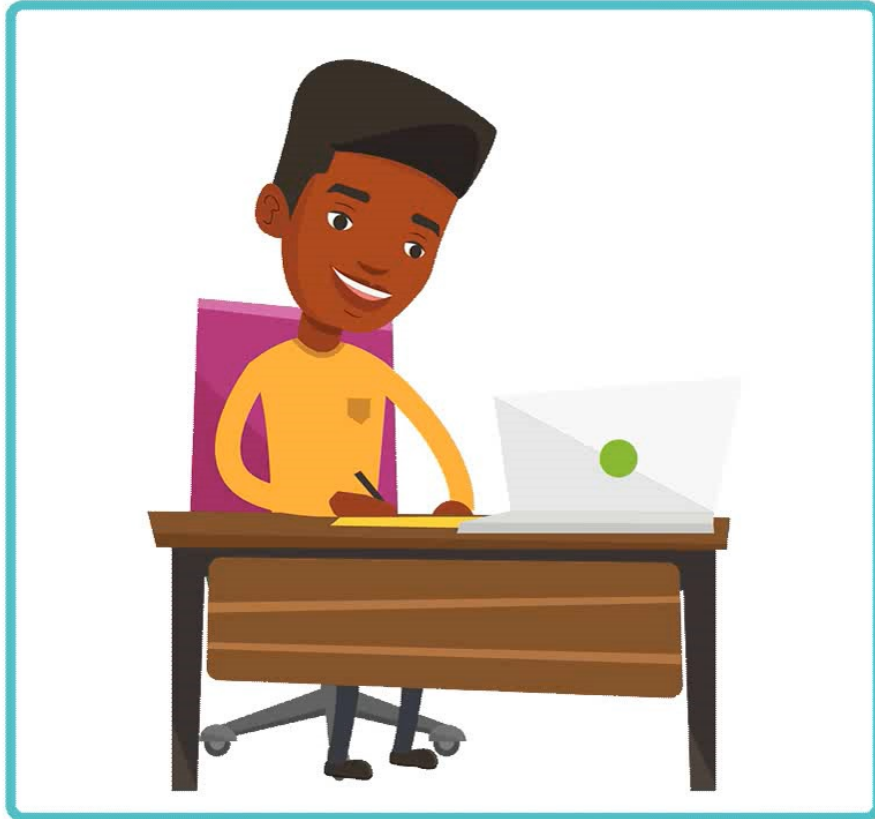


Lecture

Active Learning



Direct instruction



Lecture

Active
Learning

Lecture

Active
Learning

Lect-
ure

Active
Learning

Lecture

Lecture

Active
Learning

Lecture

Active
Learning

Lecture

Active
Learning

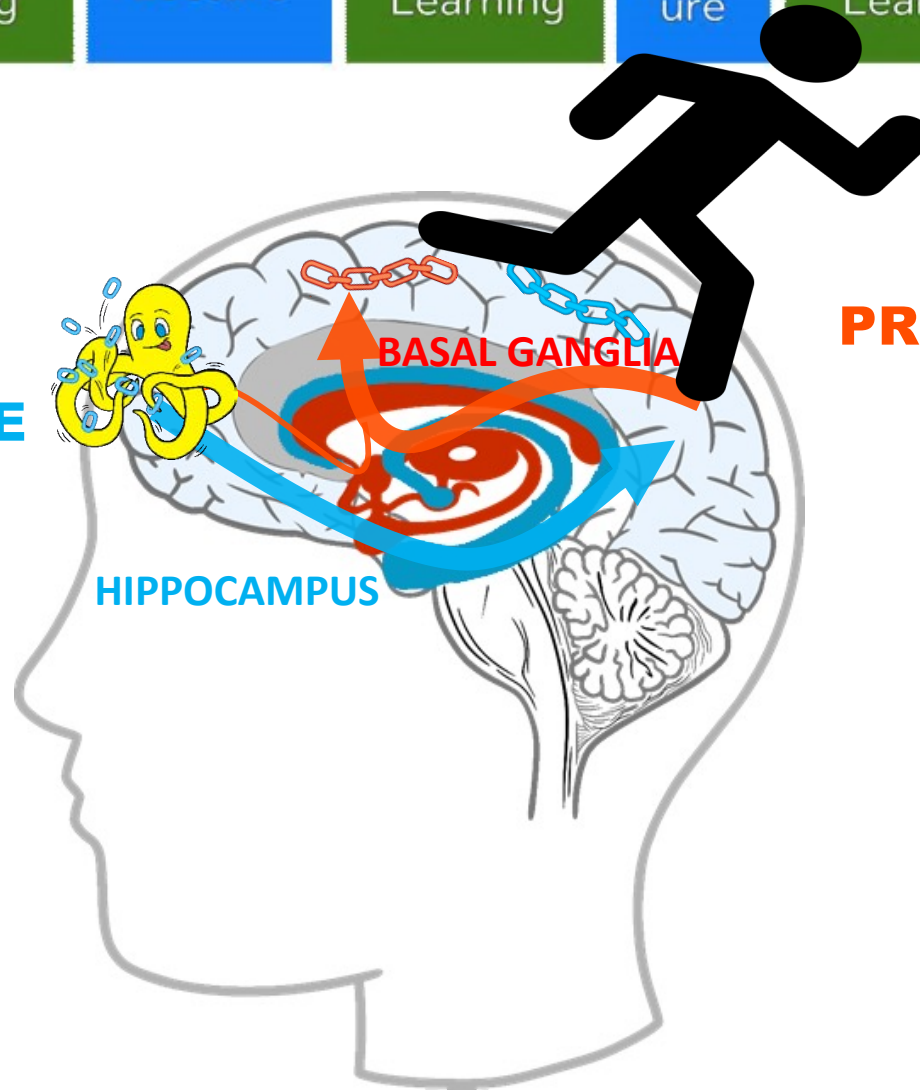
Lecture

DECLARATIVE

HIPPOCAMPUS

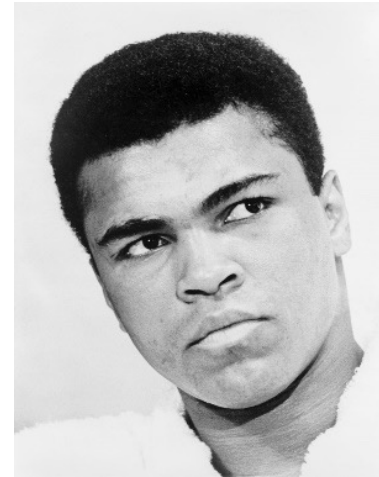
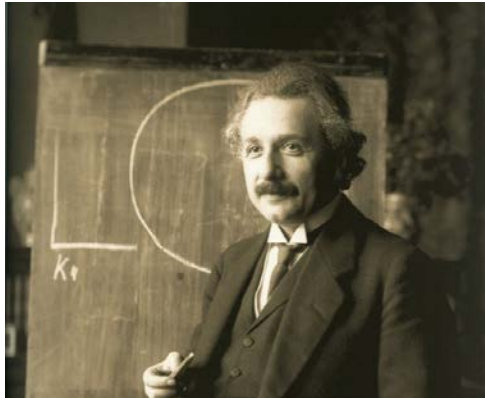
BASAL GANGLIA

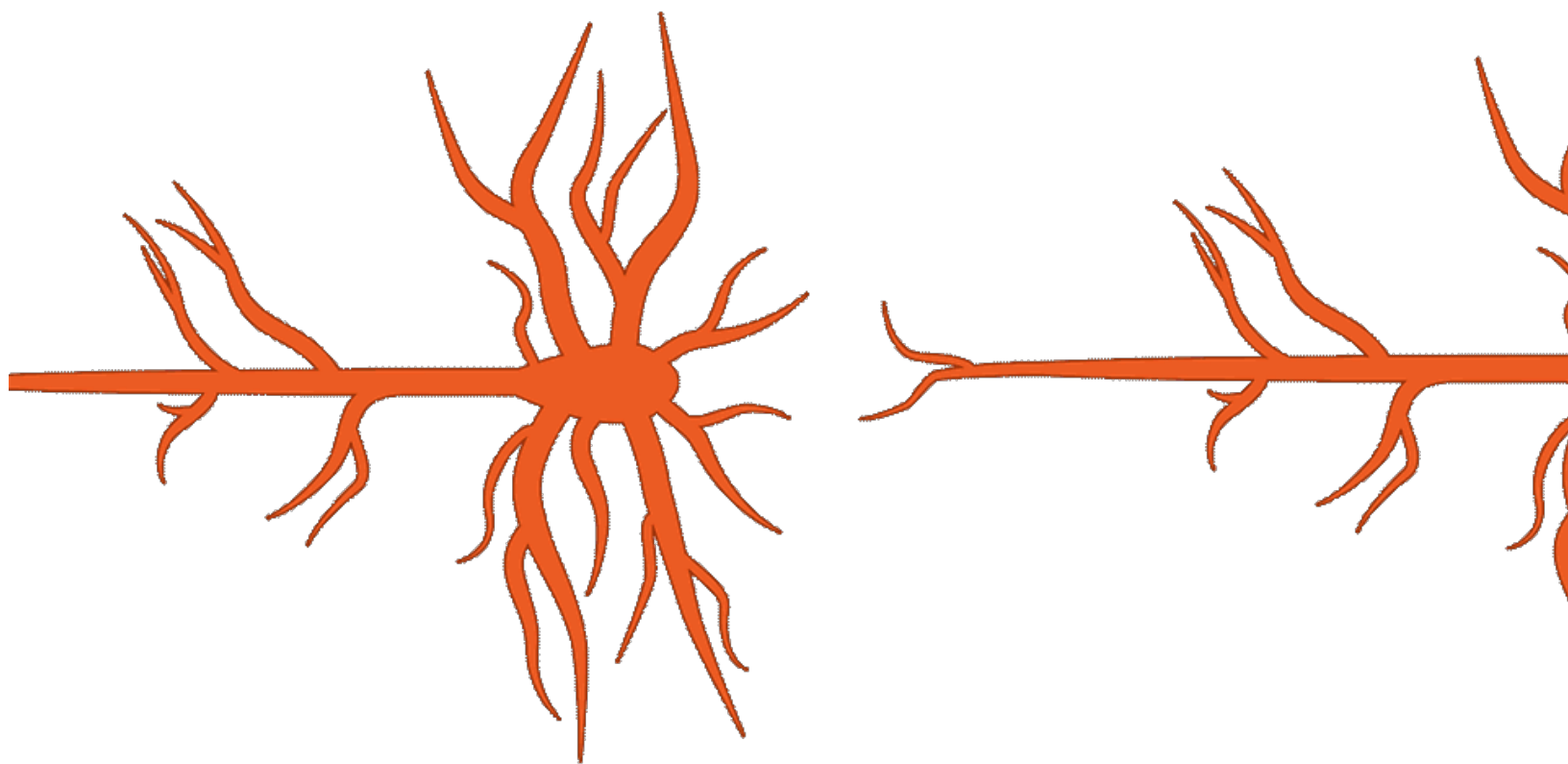
PROCEDURAL

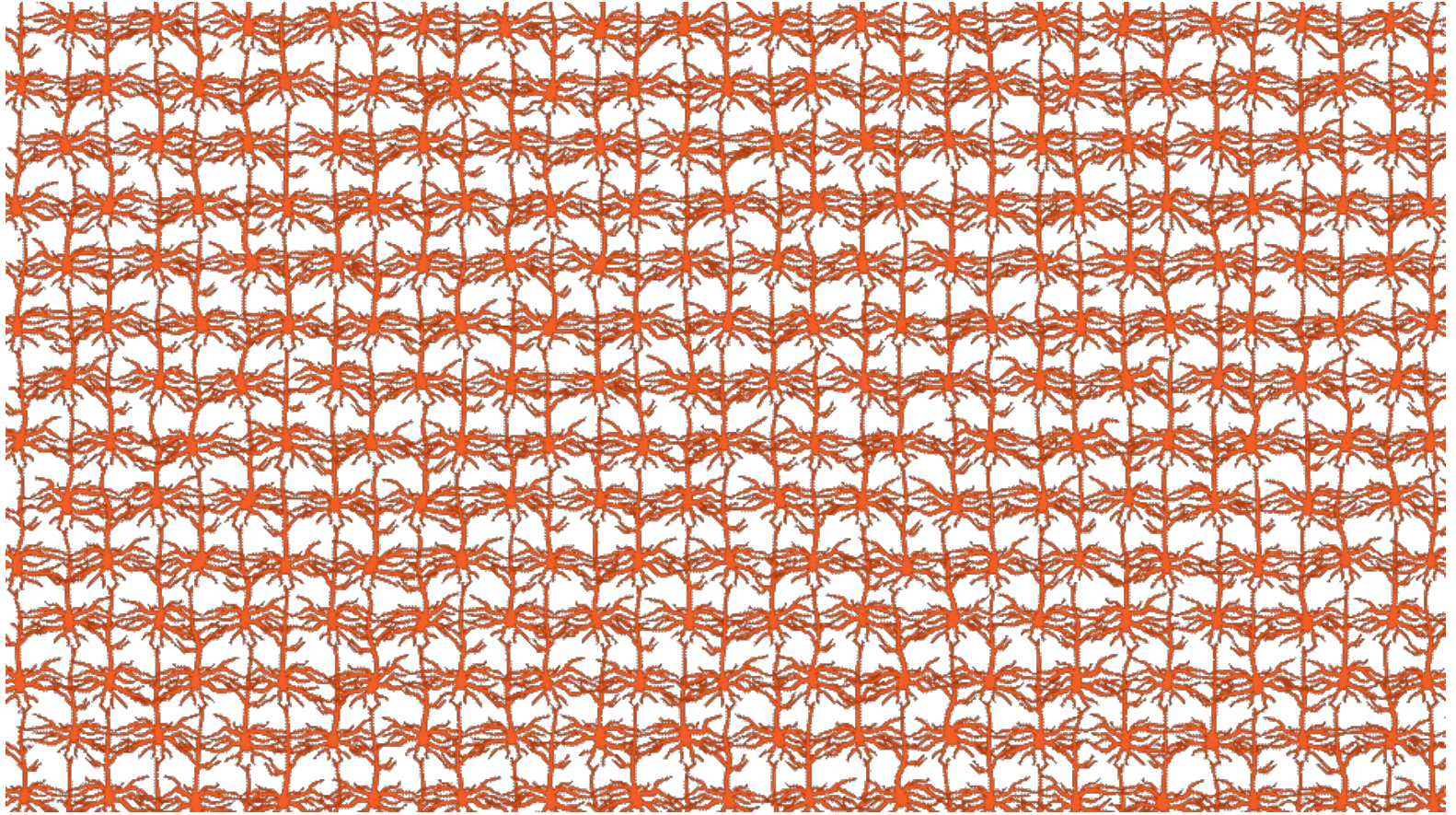


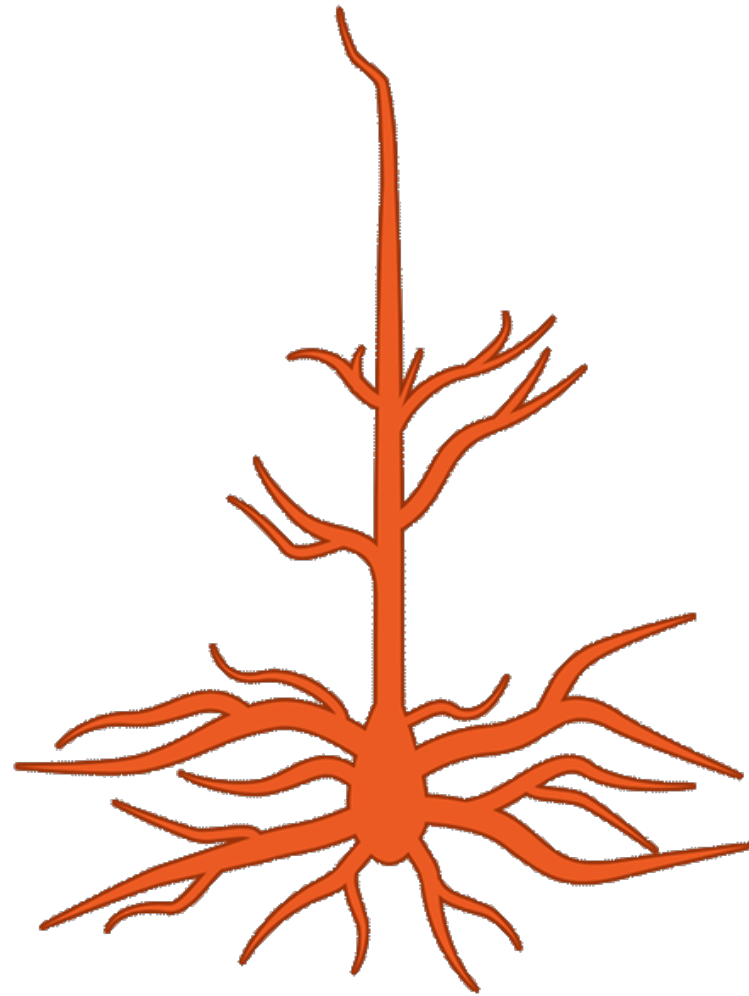
Nature loves heterogeneity

—Terrence Sejnowski

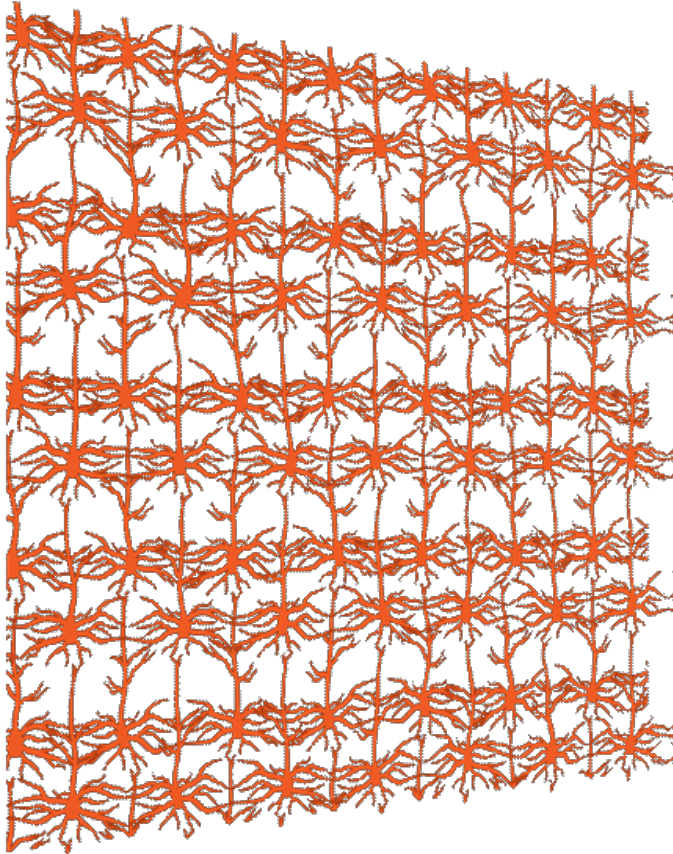


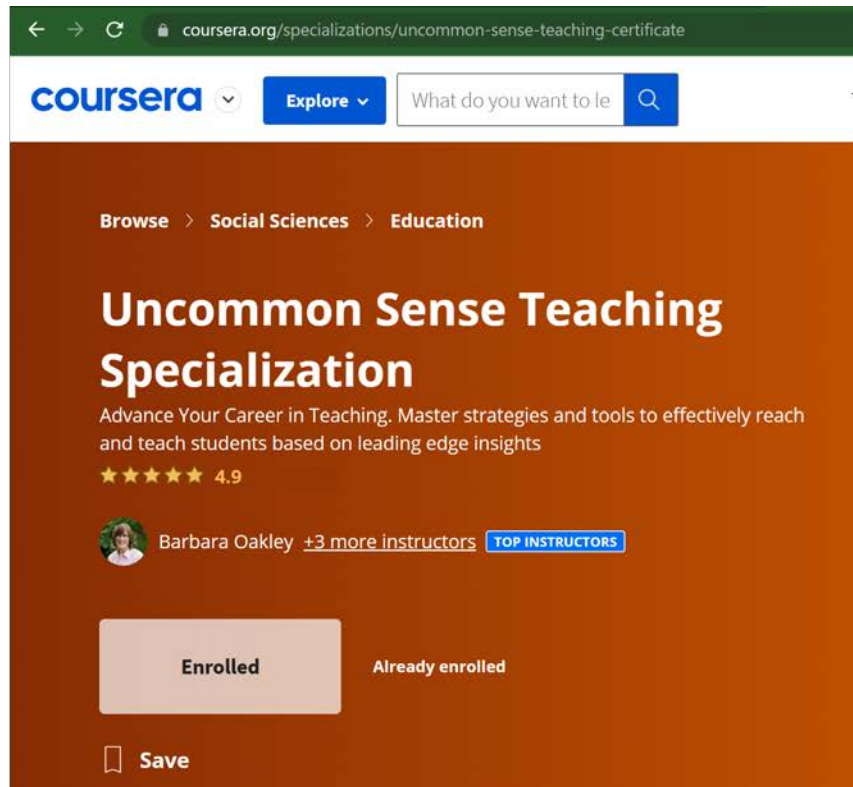






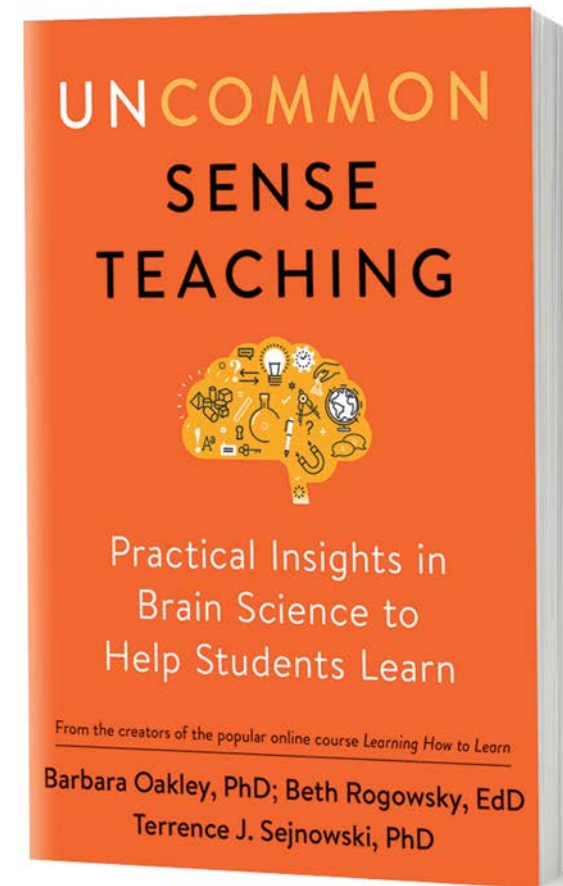
New learning boosts spirits





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- [MOOC 1: Uncommon Sense Teaching](#)
- [MOOC 2: Uncommon Sense Teaching, Part 2](#)






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