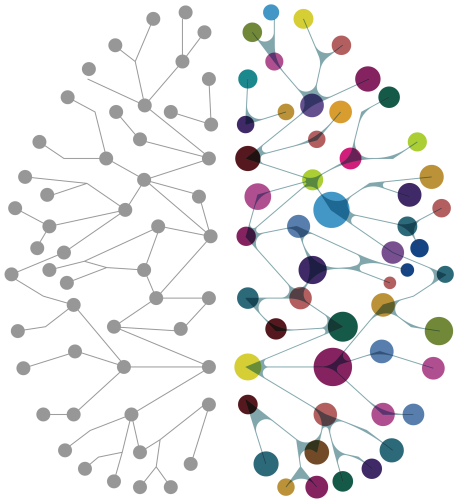
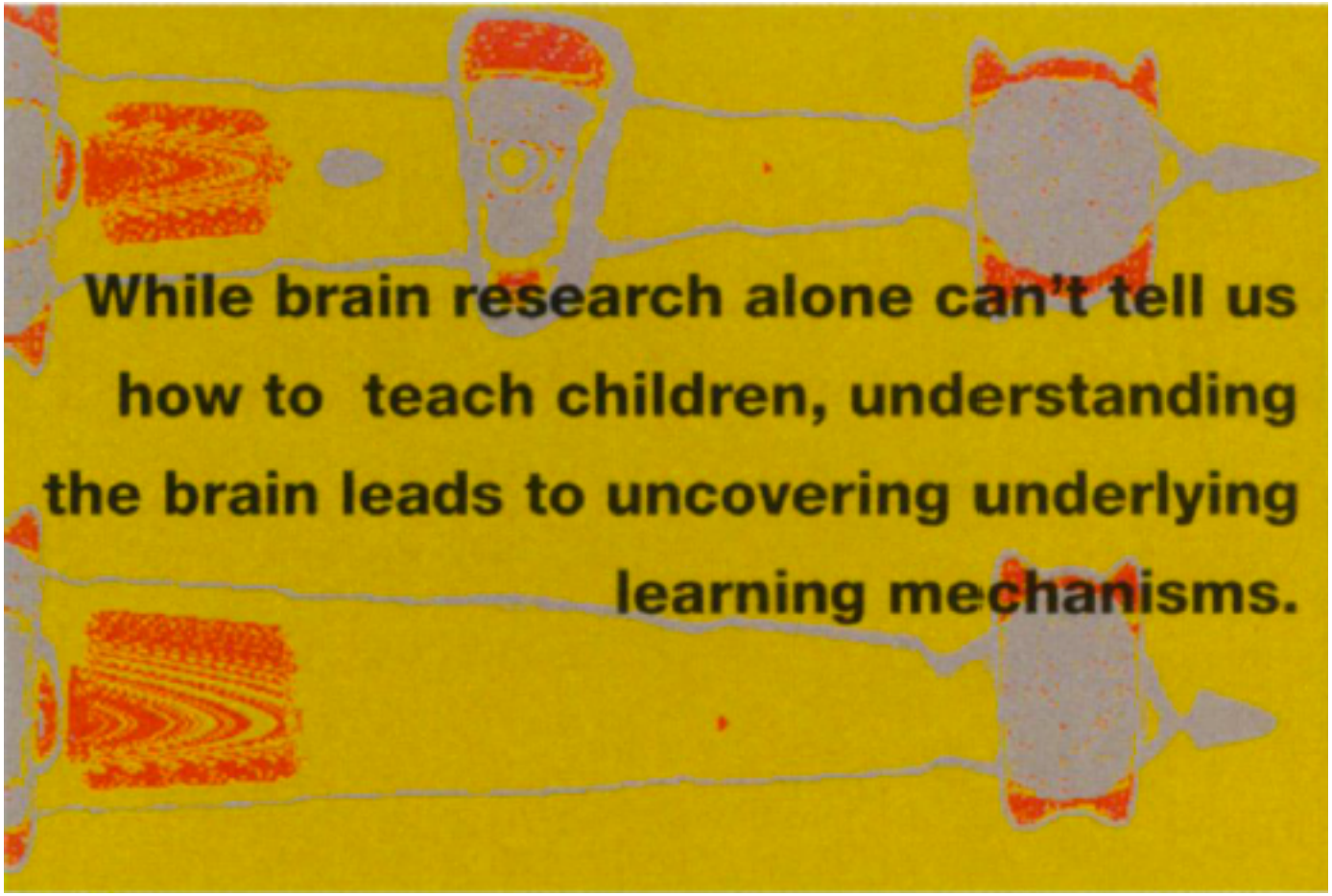
UNDERSTANDING BRAIN FUNCTIONING AND HOW IT APPLIES IN THE CLASSROOM

Cindy Hovington, Ph.D.

Founder Curious Neuron

www.curiousneuron.com



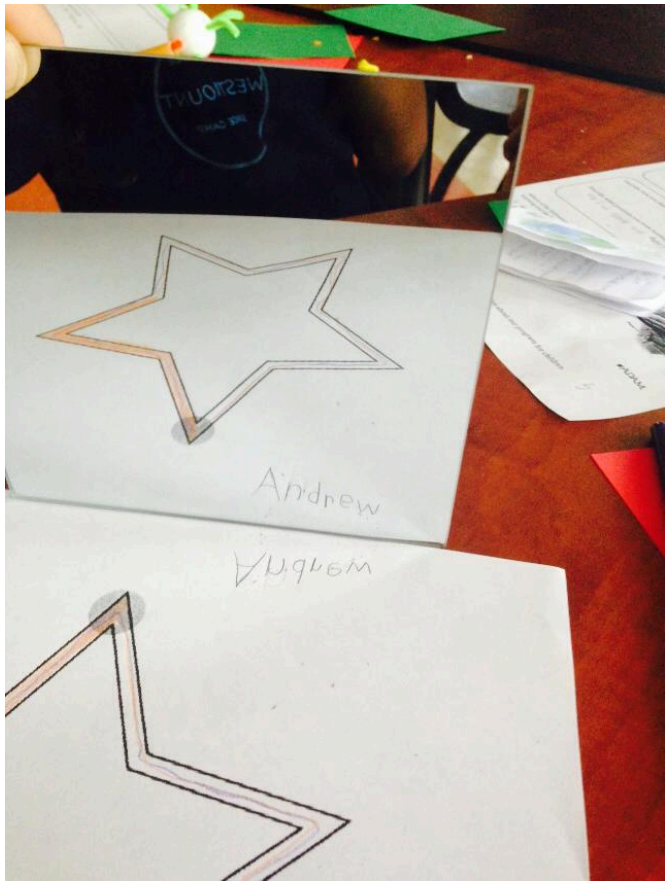


Worden et al. 2011

We only use 10% of our brain.

True or False?

HM's Story



https://en.wikipedia.org/wiki/Henry_Molaison

Fundamental principles of UDL:
Multiple Means of Representation, Expression and Engagement

"As students learn, these experiences shape the architecture of their brains.

Therefore, abilities are not fixed but rather continuously developing.

This ***plasticity*** enables students to overcome many learning challenges. "

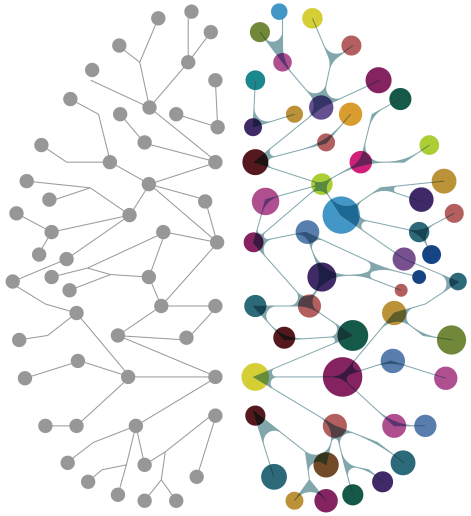
Hinton et al, 2012. Mind, Brain and Education

"A student's ***educational environment*** plays a crucial in shaping the brain's ability to learn and determining the students' academic achievement"

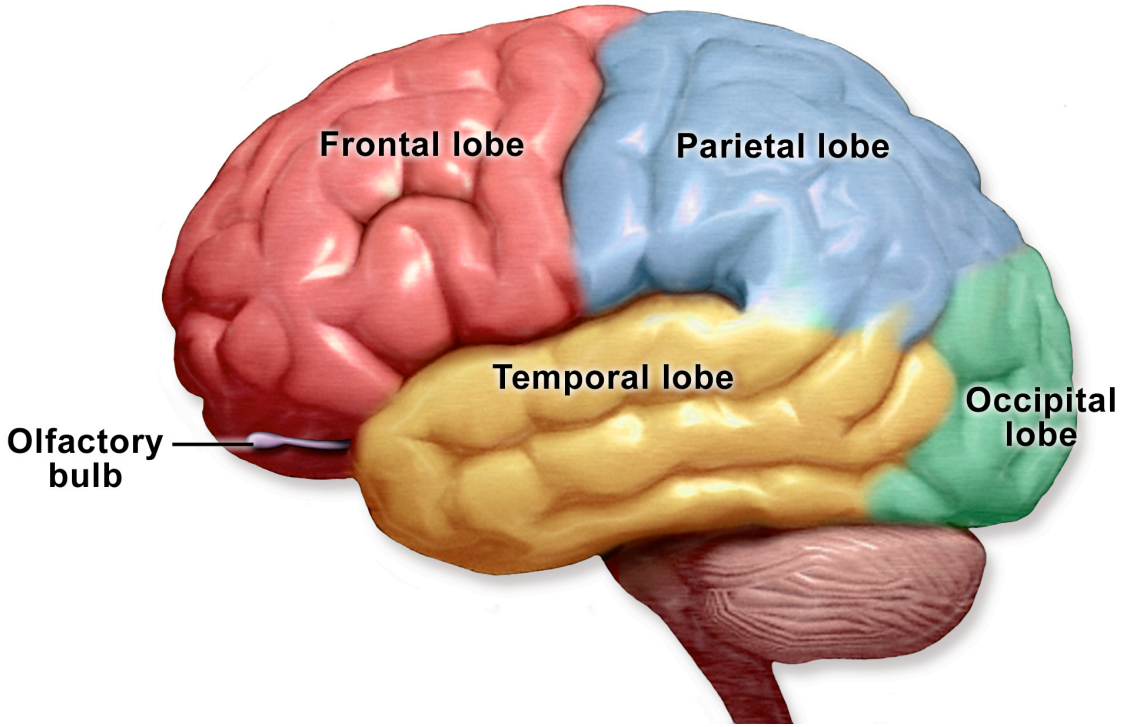
Hinton et al, 2012. Mind, Brain and Education

"Am I creating an **educational environment** that is conducive to learning for all students"

WHAT DOES LEARNING MEAN FROM A BIOLOGICAL PERSPECTIVE?



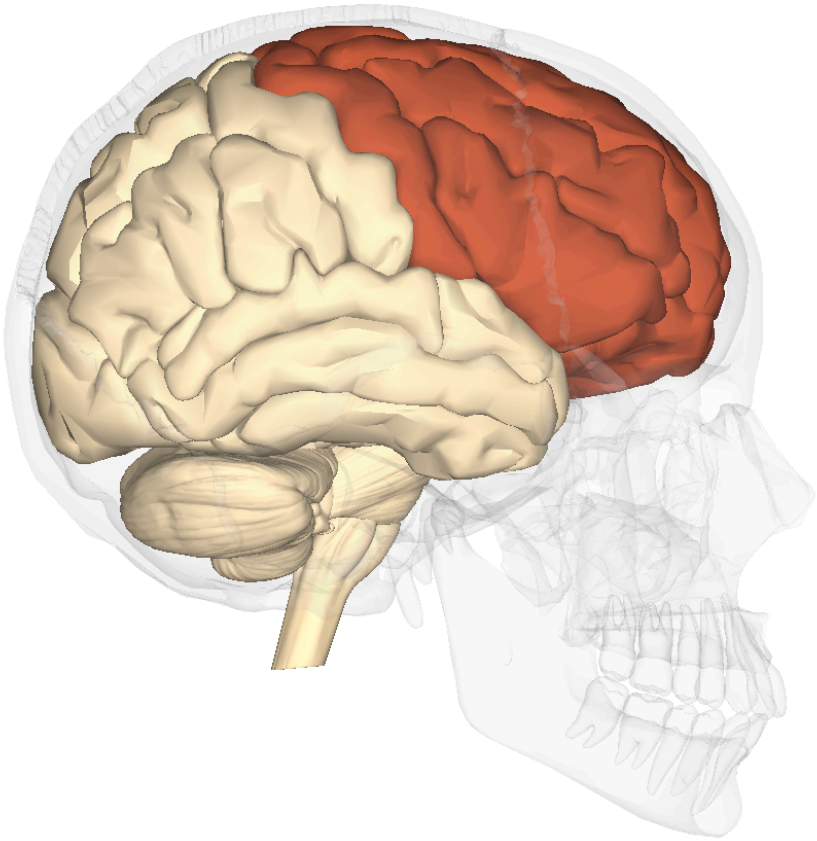
Networks working together



https://commons.wikimedia.org/wiki/File:Blausen_0111_BrainLobes.png

Learning involves several brain networks

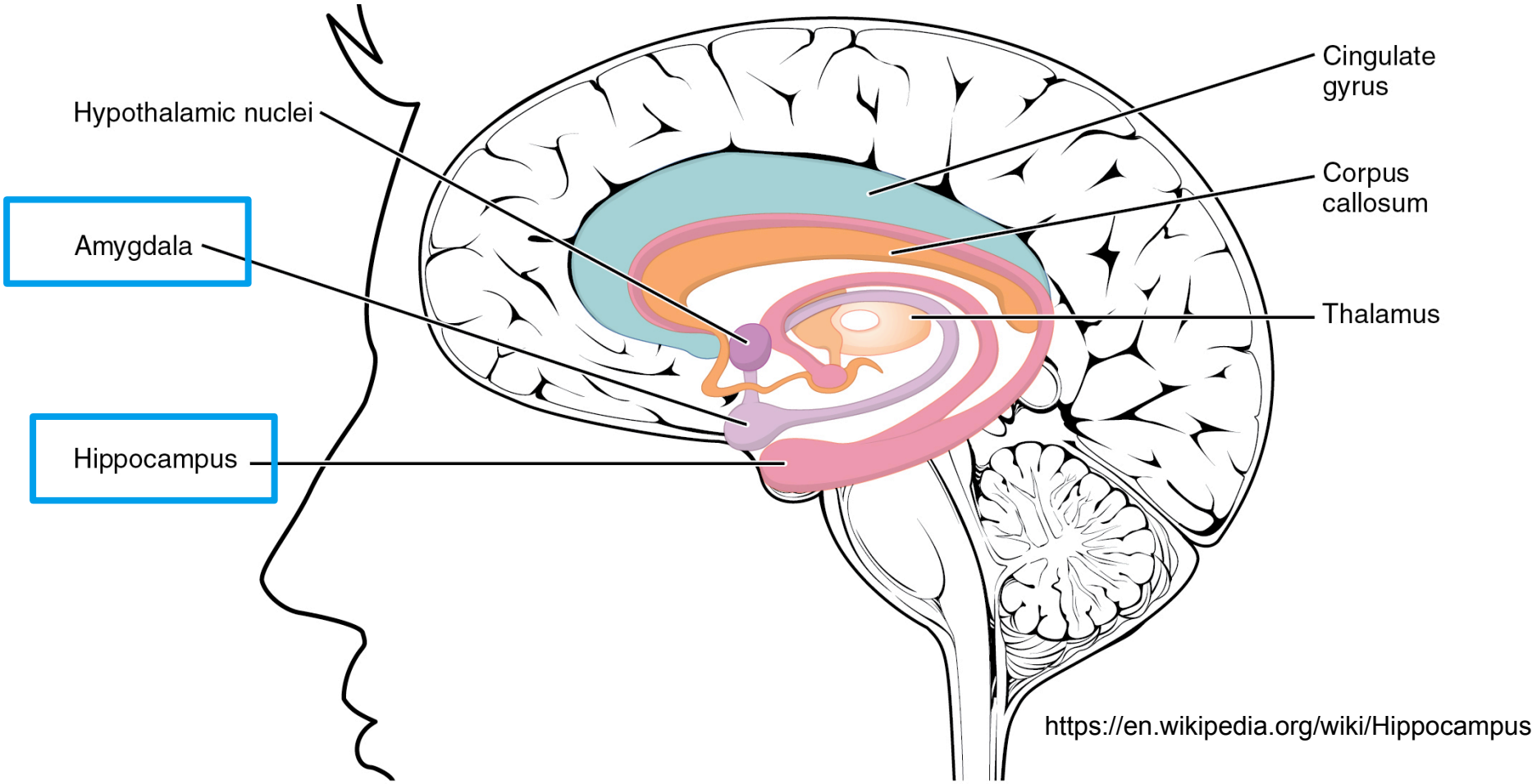
Frontal Cortex - Thinking



ROLE IN LEARNING:

- Working memory
- Establishing objectives
- Planning
- Executive functioning
- Decision making
- Motivation
- Concentration

Limbic System – Emotions and Long-Term Memory

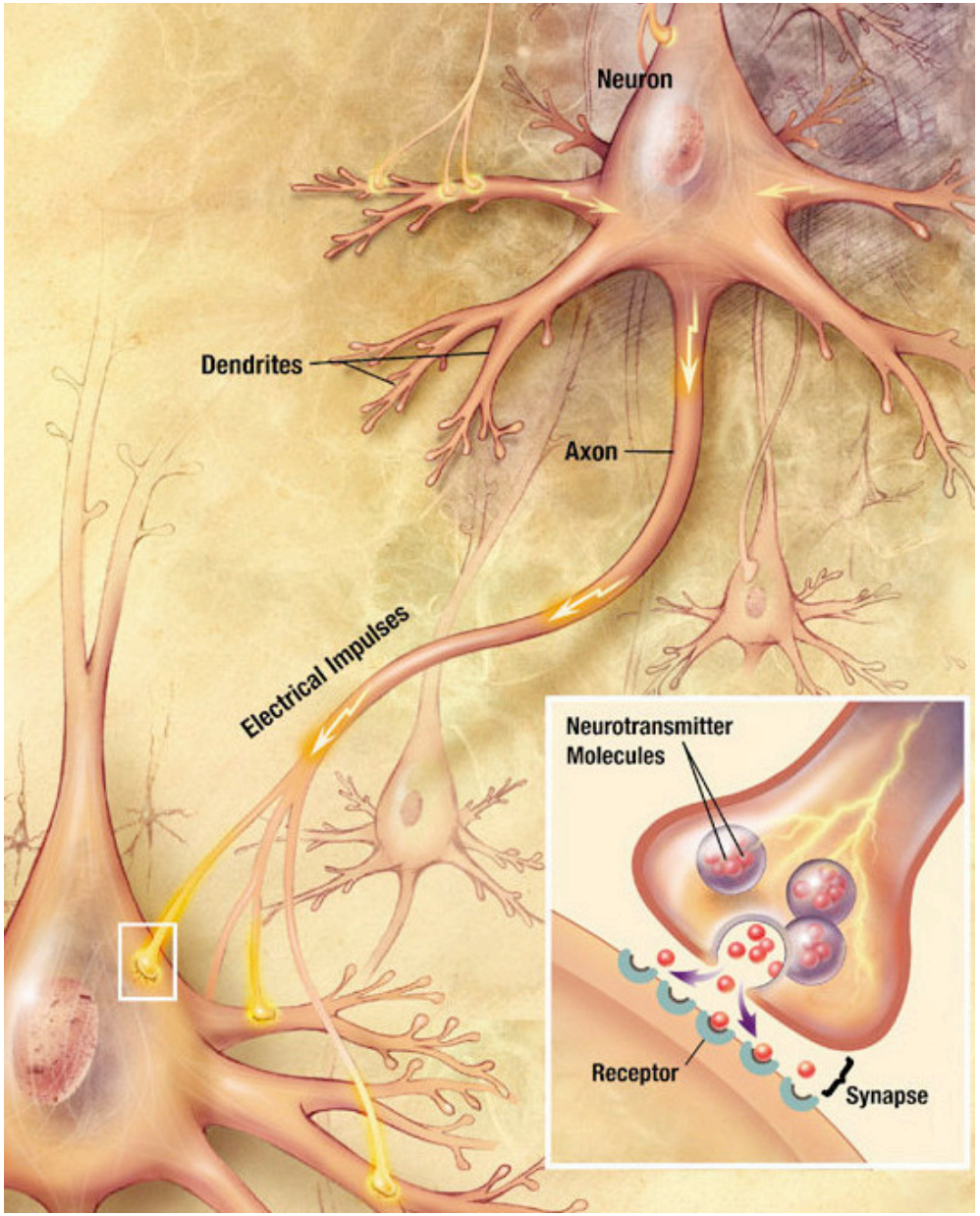


Neurons

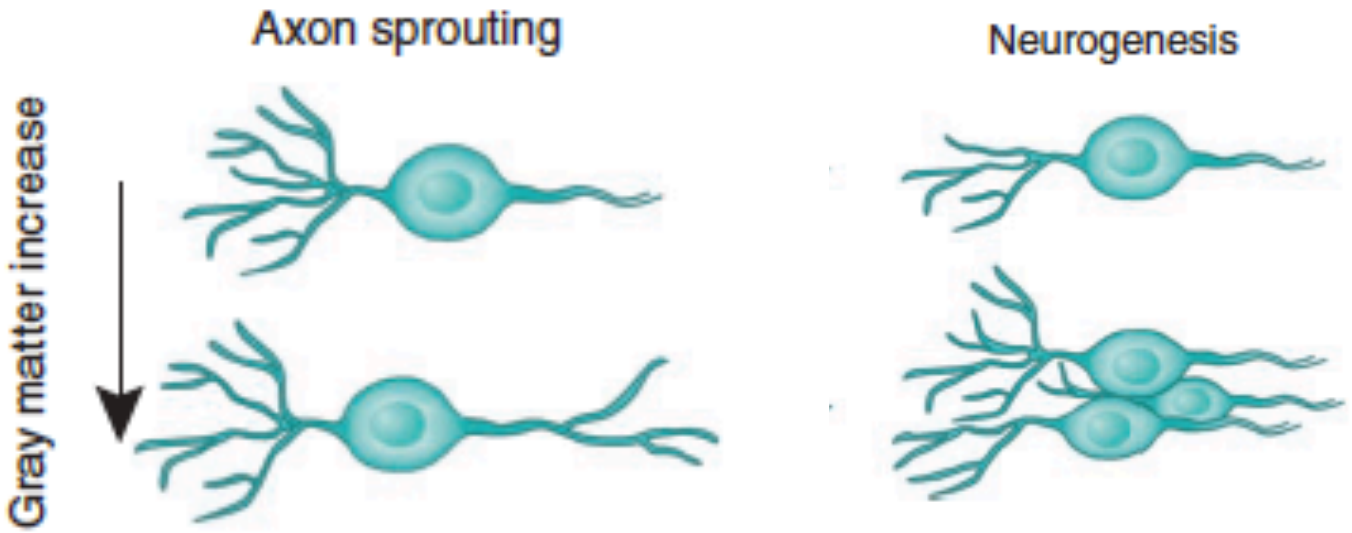
A learning experience activates chemical and electrical signals in the brain.

When specific signals are repeatedly activated, this modifies connections between neurons.

These modifications change the architecture of the brain.



What happens in the brain when we learn?



Learning new material generates new connections and new proteins in your brain (Kandel 2000; Zatorre et al 2012).

“Use it or lose it”

Networks that are used often strengthen

Networks that are not used are removed

Importance of repetition through group work, handouts and homework assignments

“Neurons that fire together, wire together”

Some students are left-brained, while others are right-brained

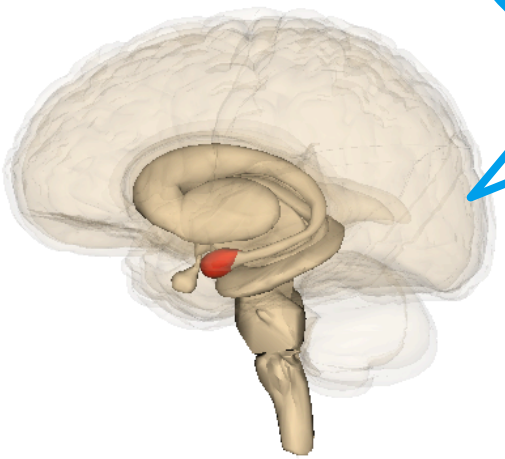
True or False?

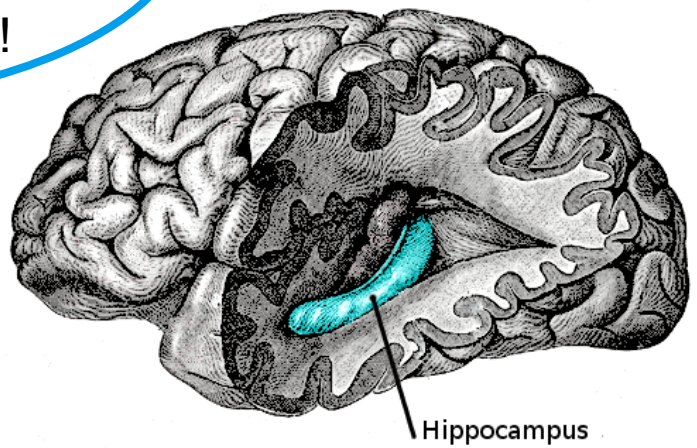
Emotions and Learning

1) Amygdala → 2) Hippocampus

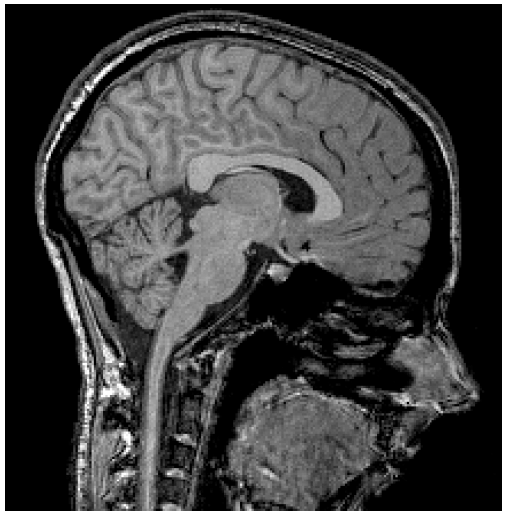
The "Boss"

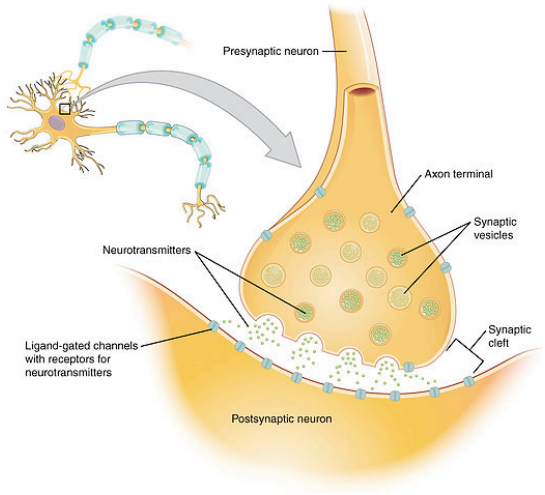
Why should I care?
Get me excited about learning and I will tell your hippocampus and frontal lobe to join me!





Learning is a Biological Process!





How is learning defined from a neuroscience perspective?

"Learning is defined as our ability to acquire new ideas from experience and to retain these ideas over time in memory."

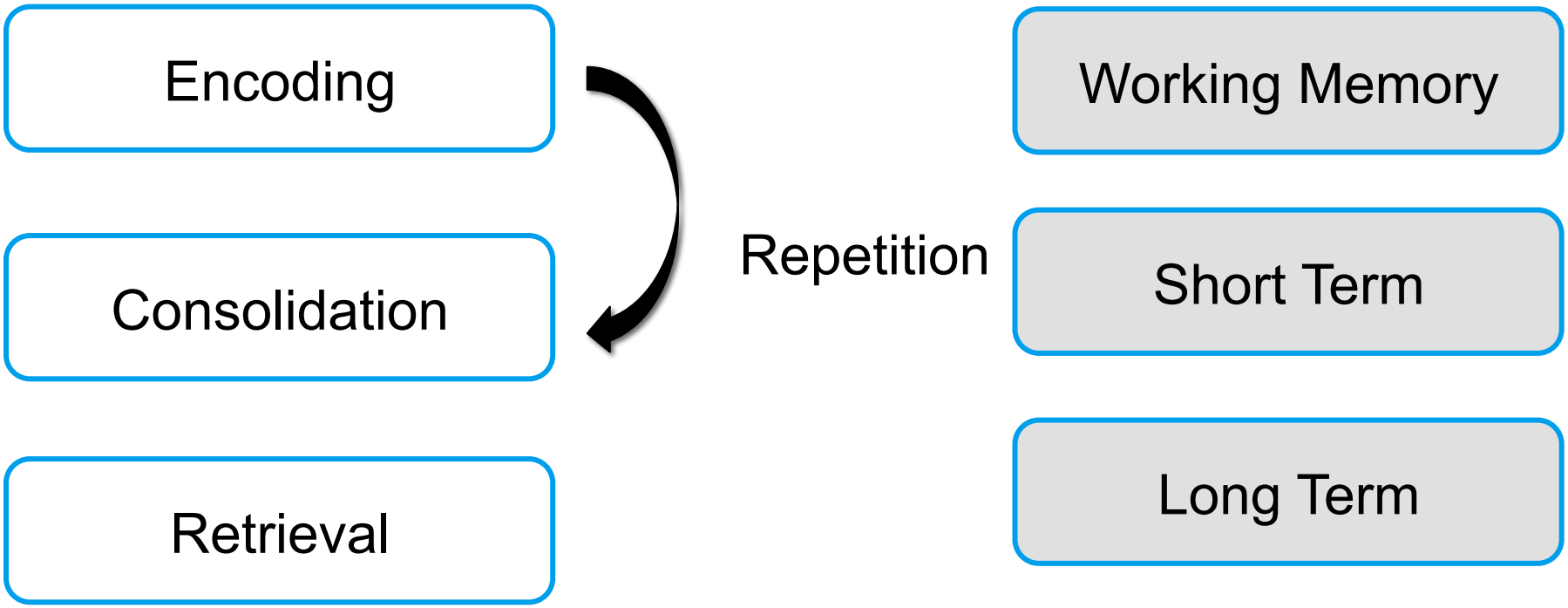
Dr. Eric Kandel

Learning has 2 components:

1) Understanding
2) Remembering

Robert Leamnson, Learning (Your First Job)

Memory



Creating the Optimal Learning Environment

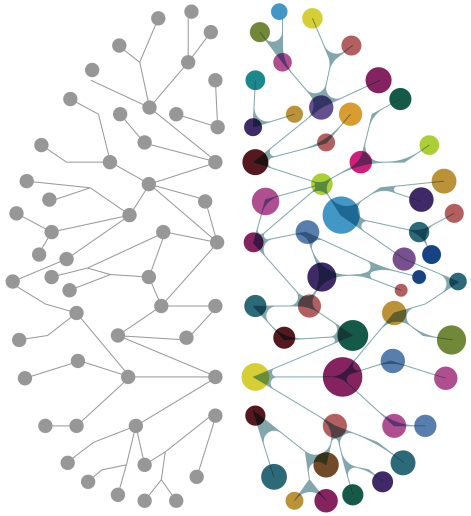
Postive Impact on Learning

- Feeling motivated
- Active learning
- Strong metacognitive strategies

Negative Impact on Learning

- Anxiety
- Lower executive functioning skills
- Decreased attention
- Misconceptions

WHAT CAN HAVE A POSITIVE IMPACT ON LEARNING?



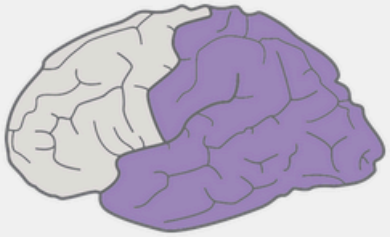
Universal Design For Learning Guidelines

AFFECTIVE NETWORKS:
THE **WHY** OF LEARNING

Engagement

For purposeful, motivated learners, stimulate interest and motivation for learning.

RECOGNITION NETWORKS:
THE **WHAT** OF LEARNING



Representation

For resourceful, knowledgeable learners, present information and content in different ways.

STRATEGIC NETWORKS:
THE **HOW** OF LEARNING

Action & Expression

For strategic, goal-directed learners, differentiate the ways that students can express what they know.

Motivation – Ability vs Effort

Entity Attitude: A student believes they were born either "smart" or "not smart"

Incremental Attitude: A student believes they can become more intelligent by working hard to learn

Carol Dweck, Mindsets

Motivation: Importance of Meaningful Feedback

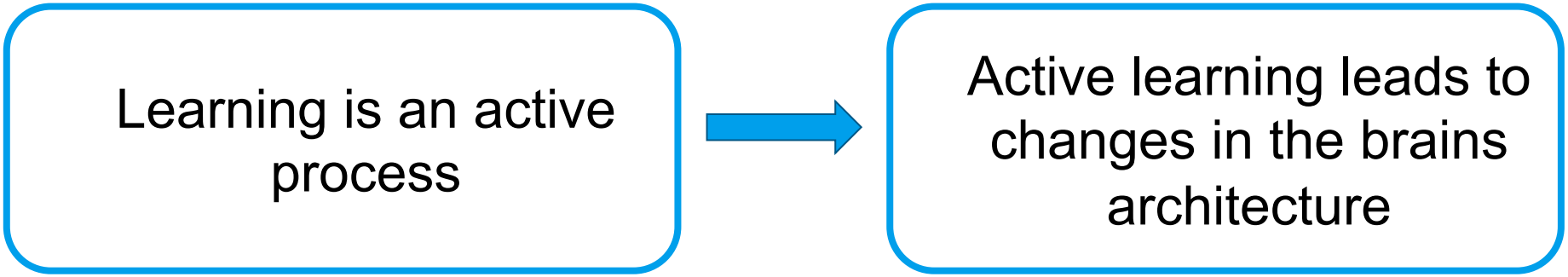
Teachers are able to enhance students' level of motivation by evaluating them on **effort and improvement** rather than ability.

Koka and Hein 2003

Students who received an enthusiastically delivered lecture subsequently reported greater intrinsic motivation regarding the lecture material.

Patrick et al. 2000

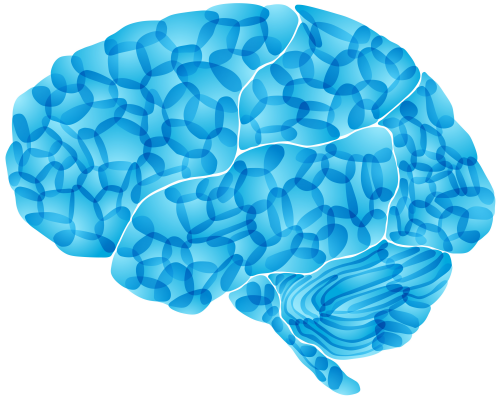
Motivation: Making material relevant



Neuroscience research suggests that active engagement is necessary for learning

Hinton et al, 2012. Mind, Brain and Education

“Children are naturally curious… until they begin school”

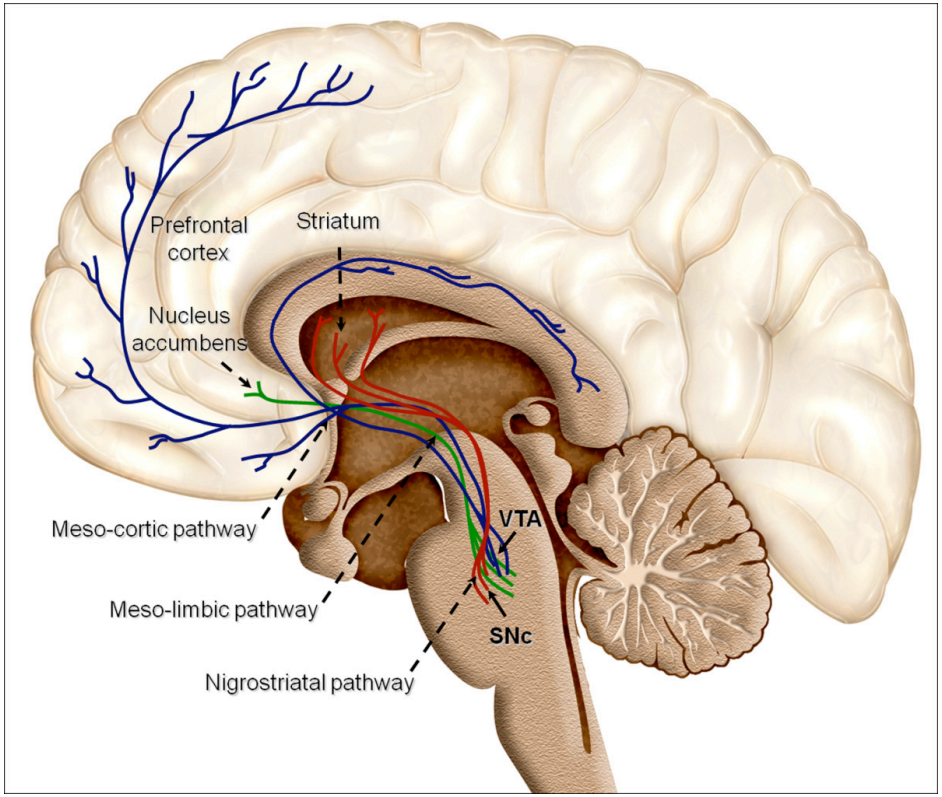


Avoiding “lecture-and-memorize classes”

Curiosity and the Brain

Learning is often self-motivated, driven by intrinsic curiosity in a particular topic.

Students don't learn, they discover. (Plato)



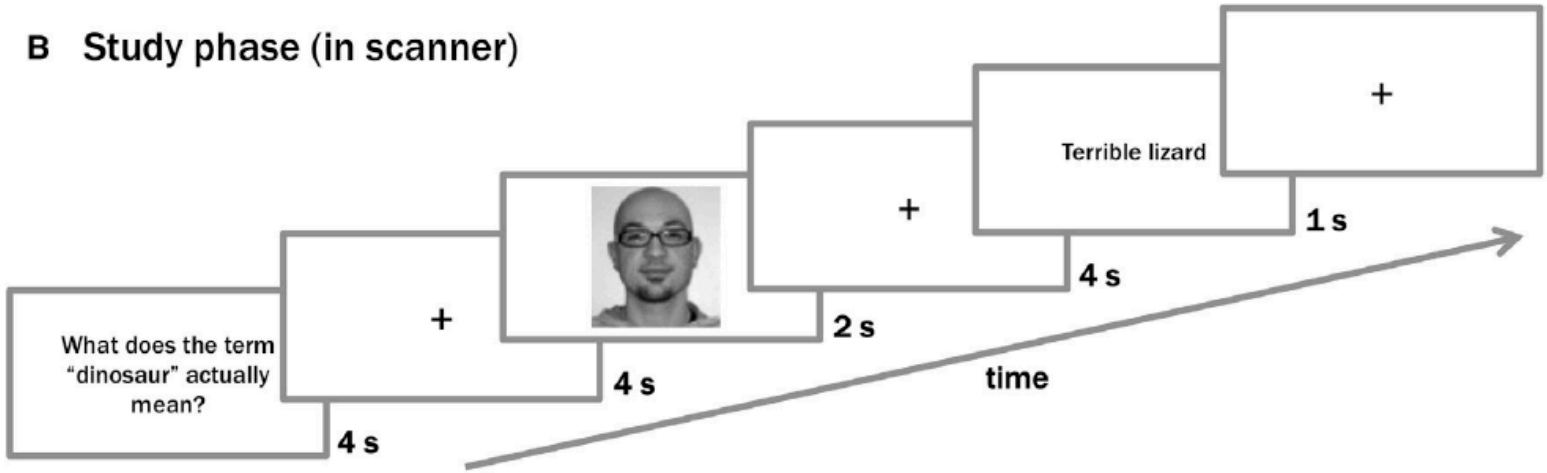
https://commons.wikimedia.org/wiki/File:Overview_of_reward_structures_in_the_human_brain.jpg

Curiosity-driven memory

Gruber et al, 2014. Neuron.

Trivia Questions → Curious → Activation of reward pathway → Boost memory

Curiosity can influence memory consolidation



Student Metacognition

We learn more from reflecting on our experiences than from the actual experiences themselves (Dewey, 1933)

Student Metacognition
Example: Exam

Planning

- What strategies will I use to study?
- Which aspects of the course material should I spend more or less time on, based on my current understanding?

Monitoring

- To what extent am I taking advantage of all the learning supports available to me?
- Which of my confusions have I clarified?

Evaluating

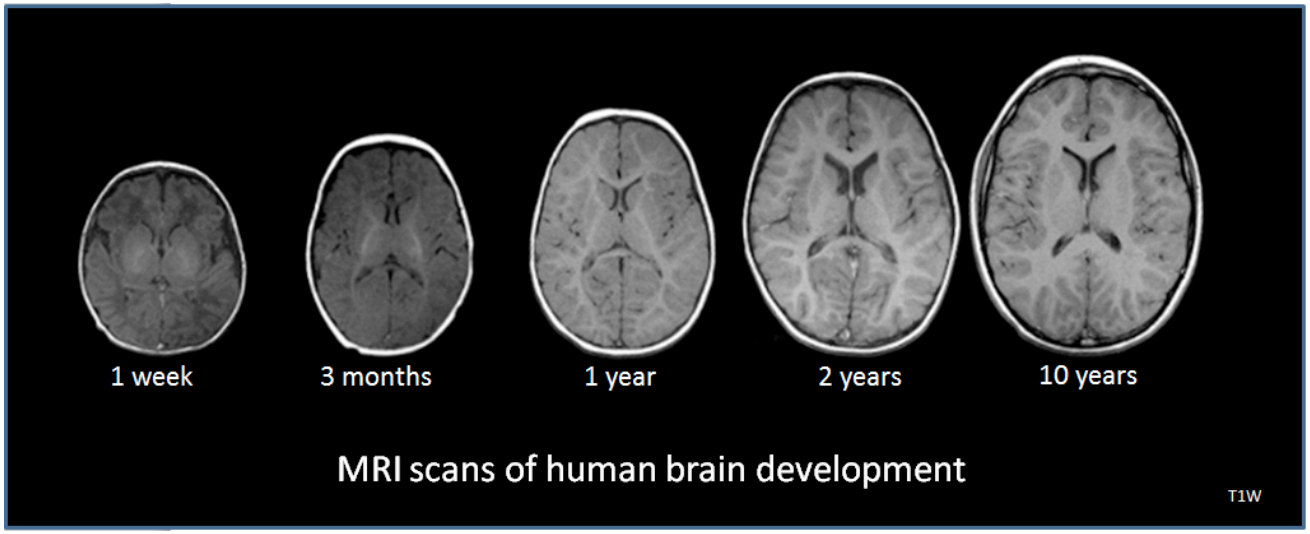
- What did not work so well that I should not do next time or that I should change?
- What questions did I not answer correctly?

Tanner, CBE—Life Sciences Education, 2012

Keep in mind…

- Metacognitive skills need to be developed
- Students need guidance
- Metacognition = frontal lobe
- Frontal lobe continues to develop until the age of 25

Hence, students needs lots of support for these skills!!!



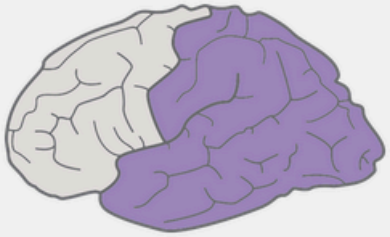
Universal Design For Learning Guidelines

AFFECTIVE NETWORKS:
THE **WHY** OF LEARNING

Engagement

For purposeful, motivated learners, stimulate interest and motivation for learning.

RECOGNITION NETWORKS:
THE **WHAT** OF LEARNING



Representation

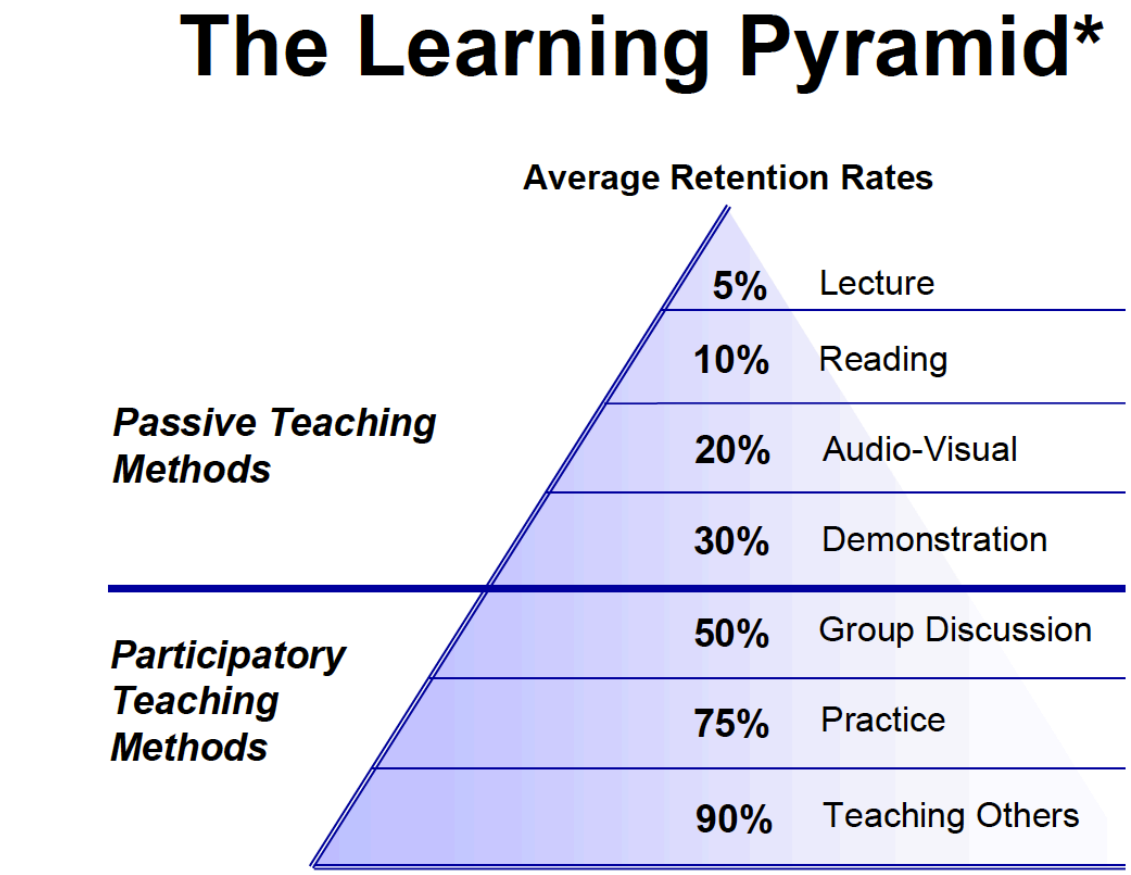
For resourceful, knowledgeable learners, present information and content in different ways.

STRATEGIC NETWORKS:
THE **HOW** OF LEARNING

Action & Expression

For strategic, goal-directed learners, differentiate the ways that students can express what they know.

Lecturing

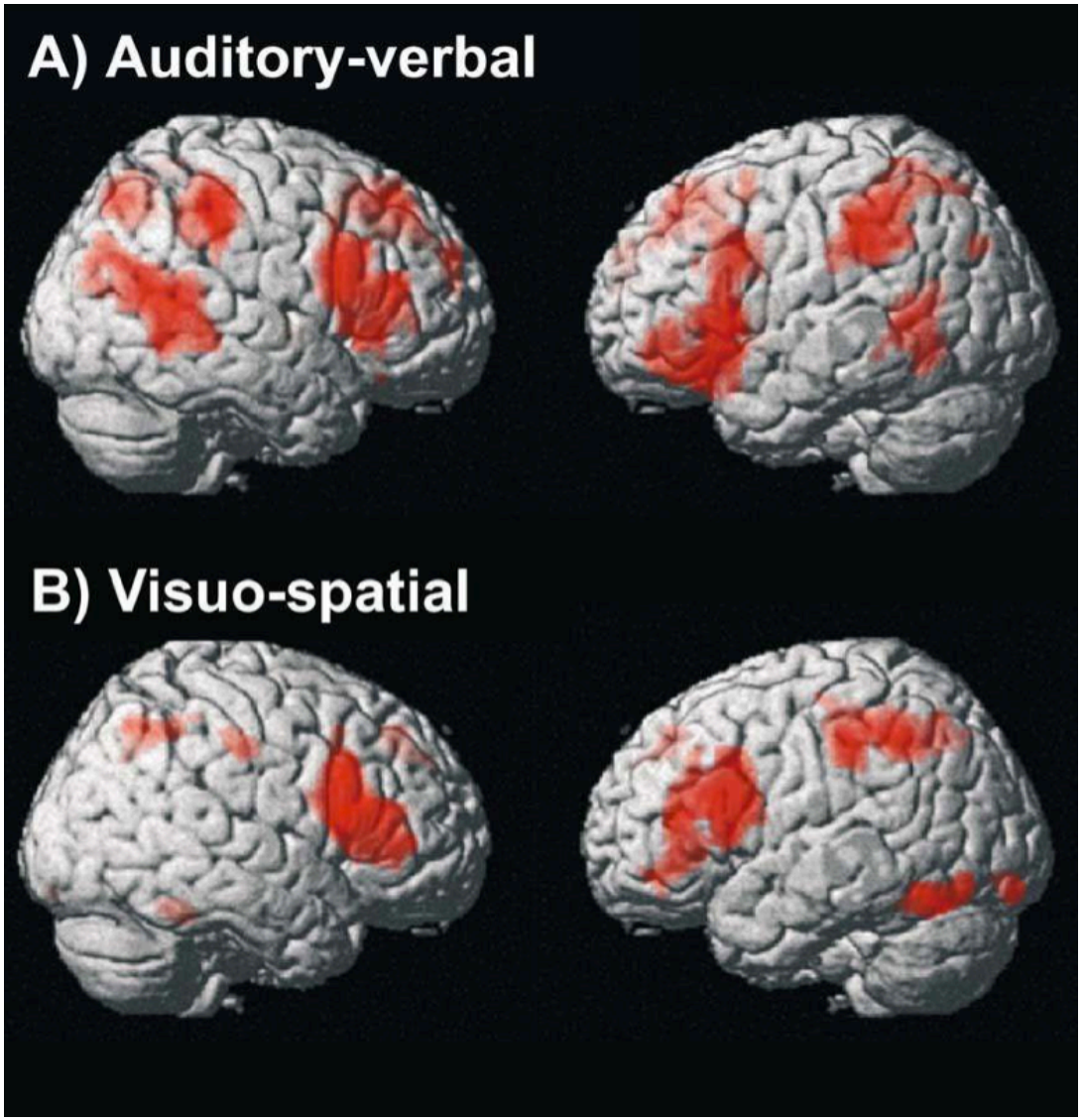


*Adapted from National Training Laboratories. Bethel, Maine

http://www.une.edu/sites/default/files/styles/une_content_large/public/shared/The-Learning-Pyramid2013.jpg?itok=TUDJm625

Encoding Strategies and Memory Retention

Delay is also important for retention and activation of the hippocampus



Bor et al. 2004

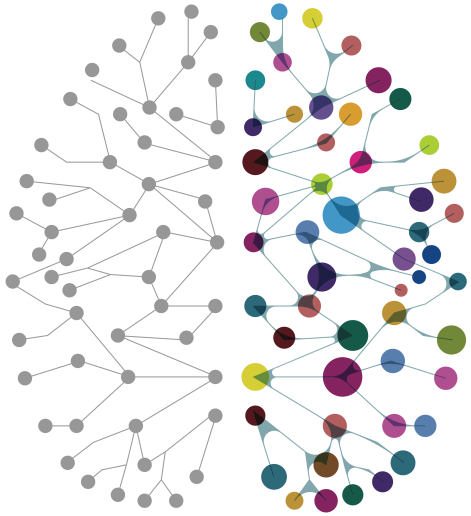
Active Learning or Active Engagement

- Rather than the traditional lecture, it is recommended to promote learning by student engagement

- Take periodic breaks and have students turn to their partner to:
  - Compare or complete notes (called Pause Procedure)
  - Think-Pair-Share
  - Summarize what they have learned
  - Ask for clarification

- Redish et al. show that the improved learning gains are due to the nature of active engagement and not to extra time spent on a given topic.

WHAT CAN HAVE A NEGATIVE IMPACT ON LEARNING?



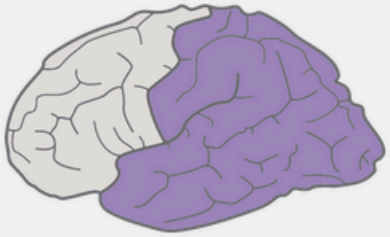
Universal Design For Learning Guidelines

AFFECTIVE NETWORKS:
THE **WHY** OF LEARNING

Engagement

For purposeful, motivated learners, stimulate interest and motivation for learning.

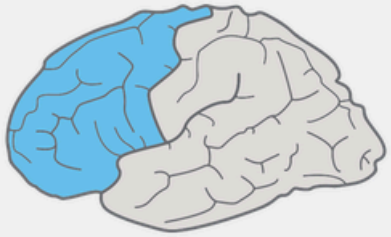
RECOGNITION NETWORKS:
THE **WHAT** OF LEARNING



Representation

For resourceful, knowledgeable learners, present information and content in different ways.

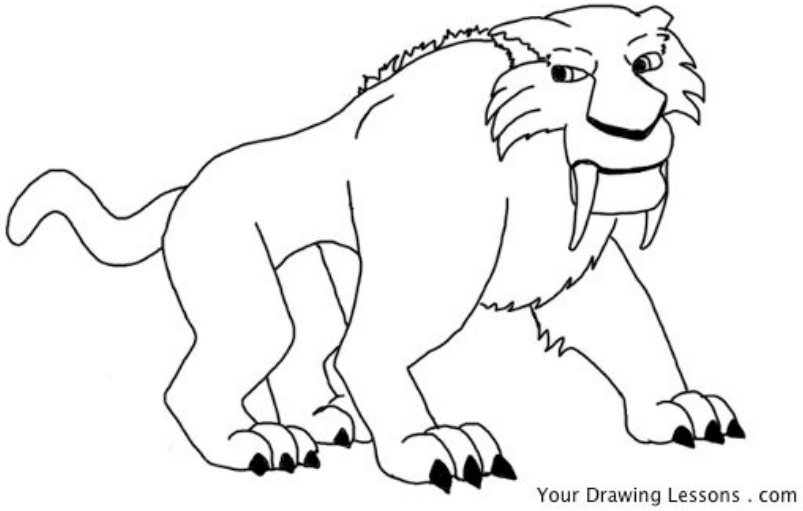
STRATEGIC NETWORKS:
THE **HOW** OF LEARNING



Action & Expression

For strategic, goal-directed learners, differentiate the ways that students can express what they know.

Anxiety and Learning



Vigilance, alertness, arousal, attention

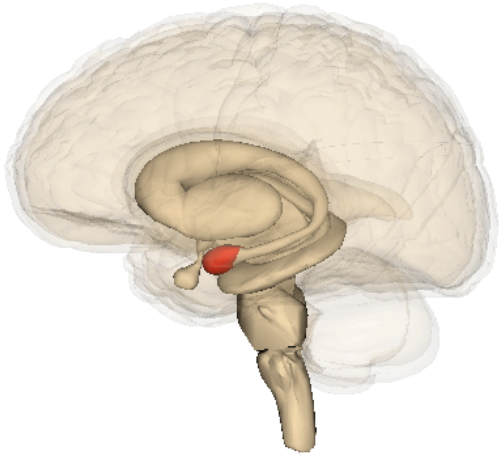
*Recent research shows that **supportive school environments** can buffer students' brains from the impacts of unhealthy levels of stress*
Hinton et al, 2012. Mind, Brain and Education

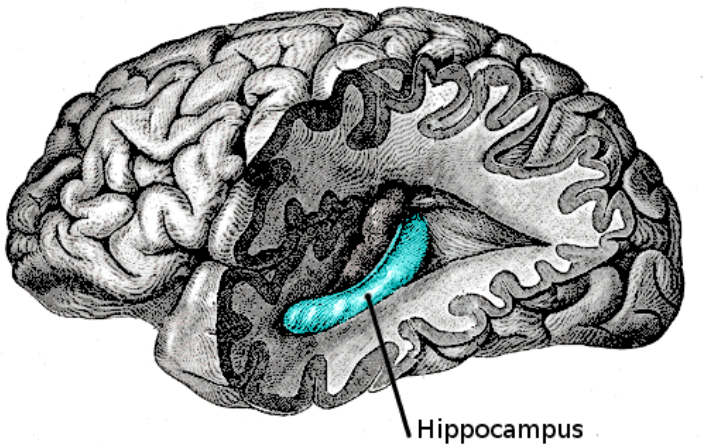
ADHD, is the most common mental illness in children.

True or False?

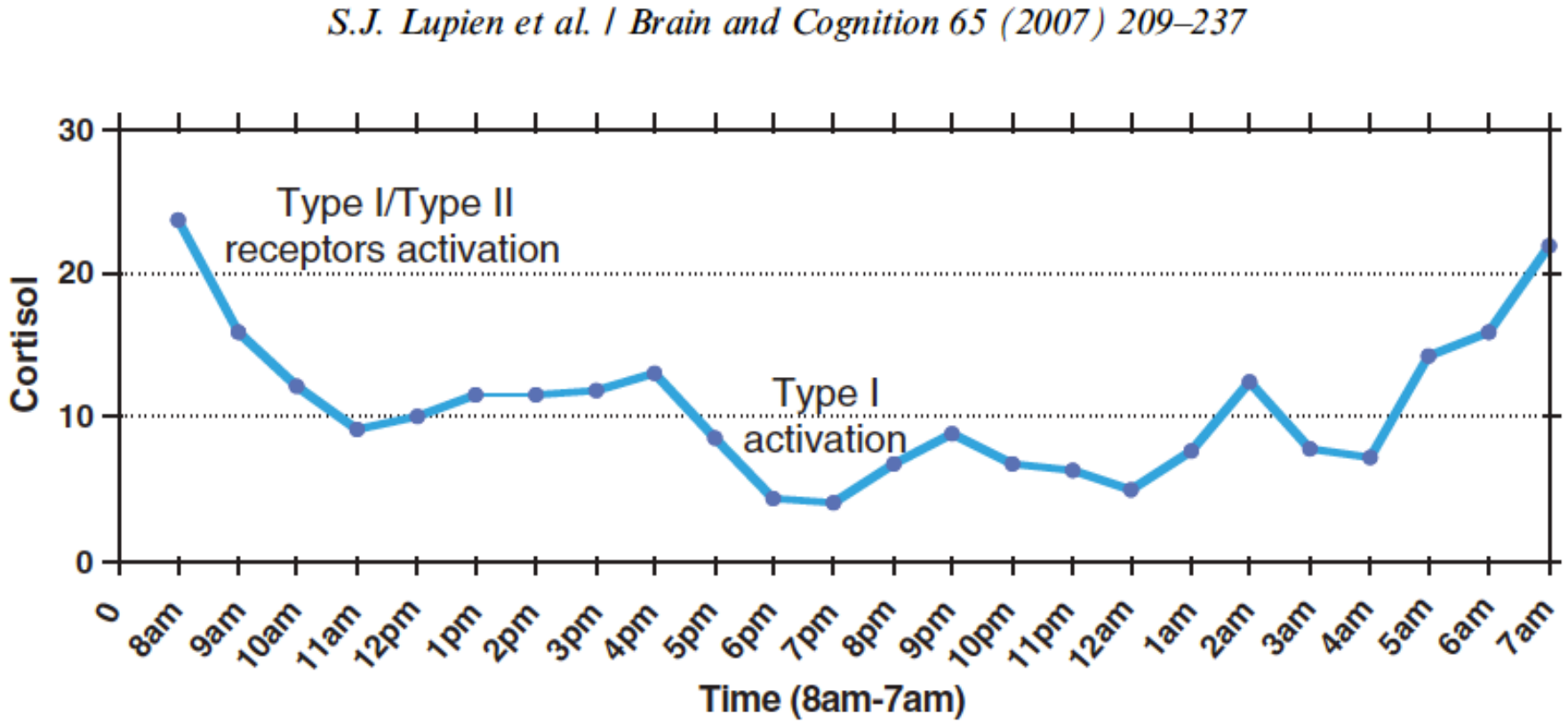
Emotions and Learning

1) Amygdala → 2) Hippocampus





Cortisol Levels Througout the Day



Stress

Positive Stress

Tolerable Stress

Toxic Stress

***Stress is a risk factor for depression*

Can cause architectural changes in brain

Stress and Memory

Encoding

Consolidation

Retrieval

Selective and divided attention

Repetition

Executive Function and Working Memory

I will read you a list of numbers…please repeat them in reverse order!

Anxiety impacts frontal lobe functioning

Working memory involves manipulating numbers in your head….this cognitive skill is impacted by stress

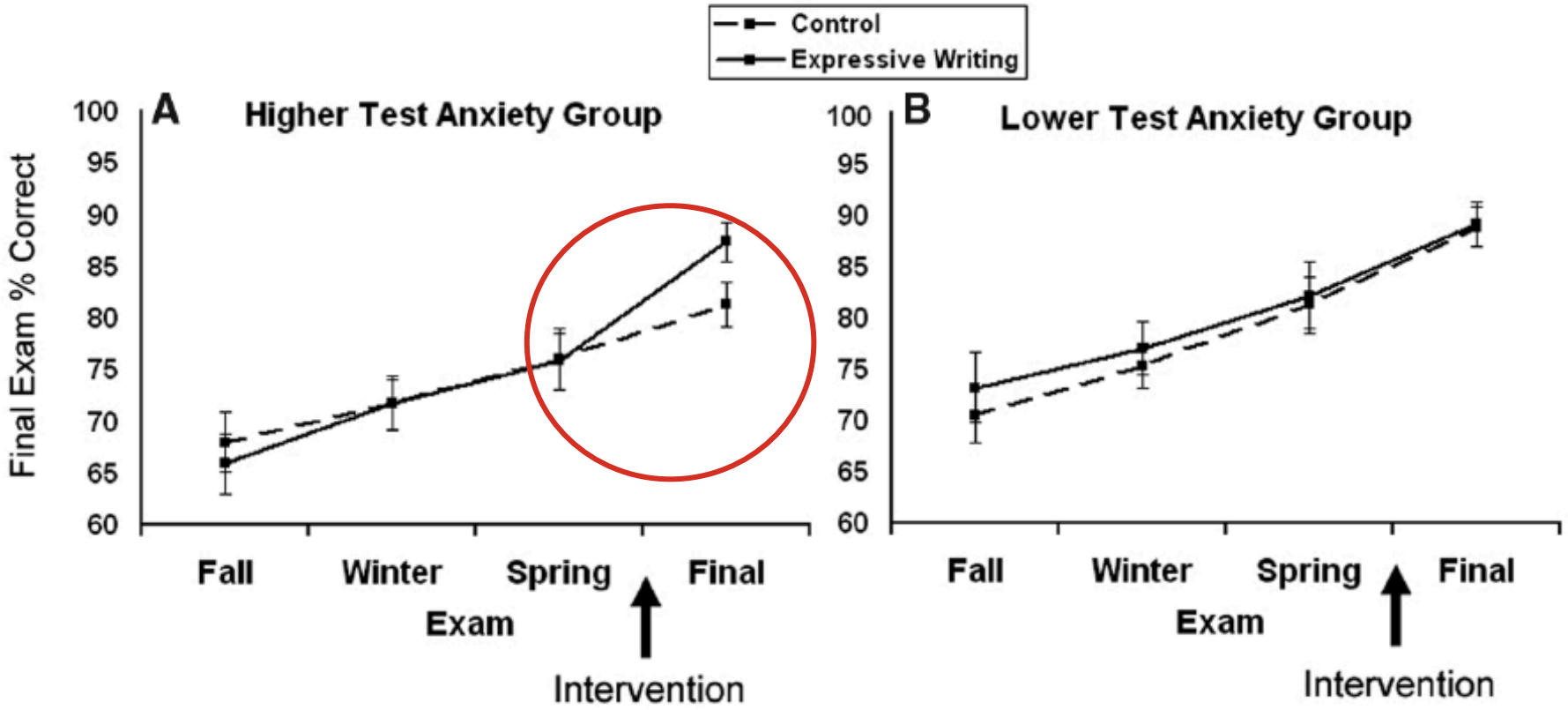
Student Attention Span

Passively listening more than 15 min can hinder learning

Immediately after a lecture, students recall 70% from the first 10min and 20% from the last 10min (Hartley and Davis, 1978)

https://www.flickr.com/photos/orvice/4410504377

Anxiety and Expressive Writing

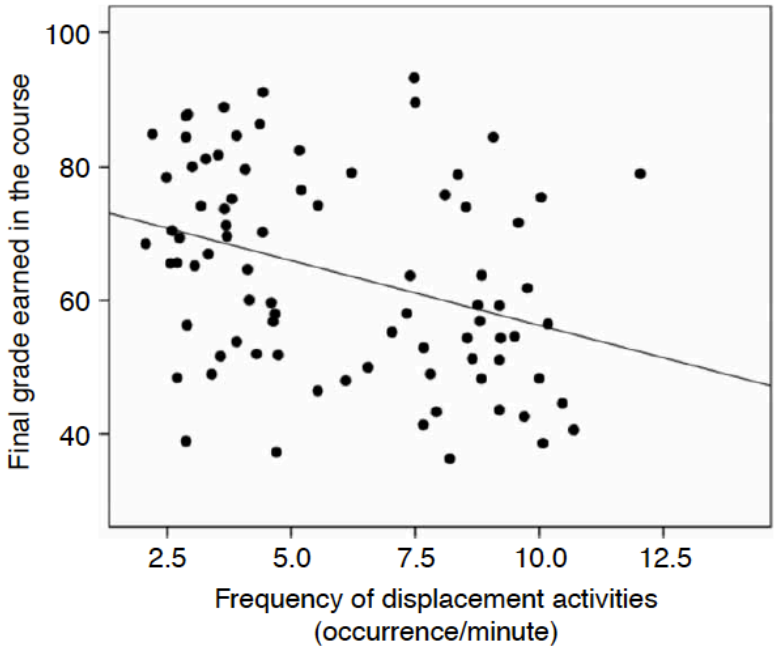


Measuring Stress in Students

(Bardi et al. 2011)

- Saliva samples (cortisol) and **displacement activities** (DA) were collected at major exams

- DAs were significantly higher during exams in students with lower grades compared to those who passed (cortisol did not differ)

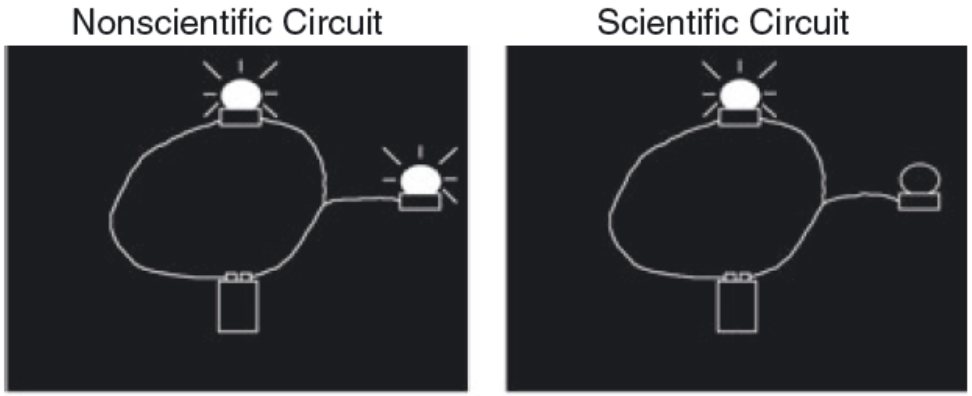


Testing **environment**

Beware of Student Misconceptions

- Students can have misconceptions about how nature works and this interferes with learning scientific concepts

- Results from this study showed that experts in electricity, more than novices, rely on brain areas related to inhibition when they evaluate the correctness of nonscientific electric circuits.

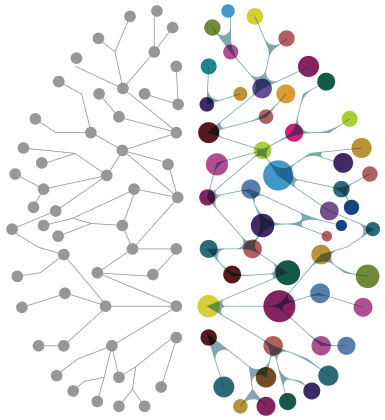


Masson et al. 2014

“Every man can, if he so desires, become the sculptor of his own brain”

— Santiago Ramon y Cajal (1852–1934)

Thank you!



For any brain-related questions, click on the contact page www.curiousneuron.com

References for Images

- http://blog.calicospanish.com/2015/09/28/keepin-it-real-in-every-mode-langchat-talks-authentic-classroom-experiences.html
- https://en.wikipedia.org/wiki/Chemical_synapse
- https://www.flickr.com/photos/dumfstar/8553474140
- https://www.flickr.com/photos/matthewleyva/11377431084
- https://he.wikipedia.org/wiki/%D7%94%D7%90%D7%95%D7%A0%D7%94_%D7%94%D7%9E%D7%A6%D7%97%D7%99%D7%AA
- https://en.wikipedia.org/wiki/Amygdalofugal_pathway
- https://commons.wikimedia.org/wiki/File:Human_brain_development_1wk-3mo-1yr-2yr-10yr-T1W-MRI.PNG