The New Science of Learning

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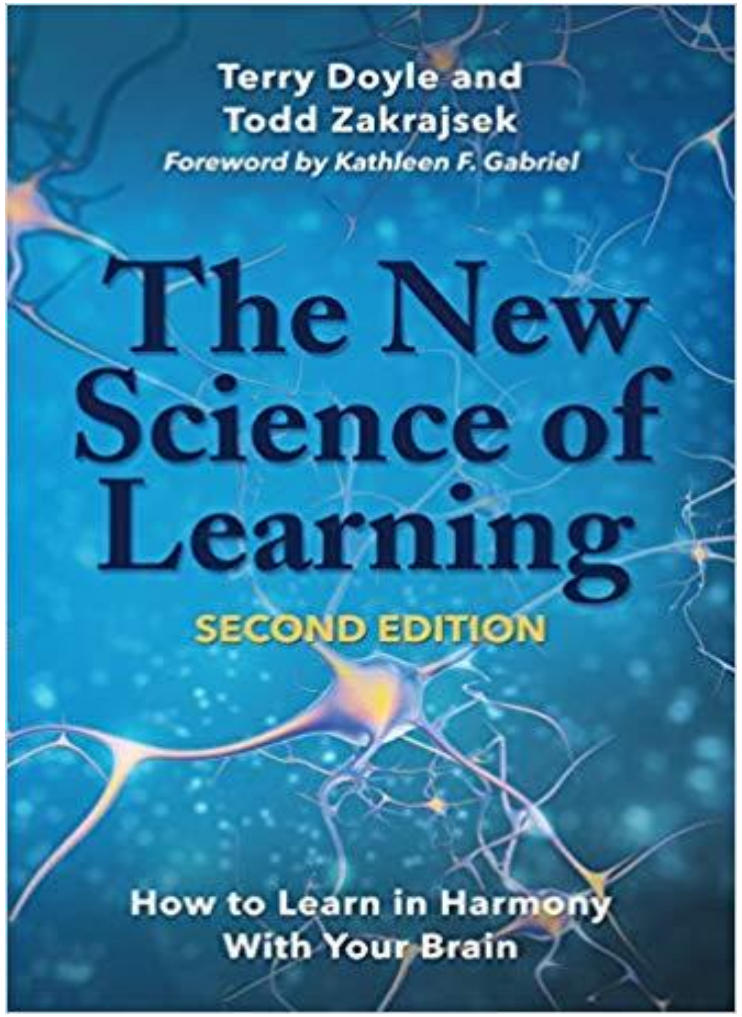
Designing Learning Activities in Harmony with how the Brain Learns



Slide Title

- A Quote from Derek Bok, Former President of Harvard University
- This quote comes from the recognition of the inconsistent behavior of faculty with regard to the research on teaching.

- “In fact, it is somewhat perplexing that we as scientists are resistant to such change. We are well trained in how to approach problems analytically, collect data, make interpretations, form conclusions and then revise experimental hypotheses and protocols accordingly. If we are experts at making evidence–based decisions in our experimental laboratories, then what forces are at play that impede us from adopting equally iterative and evidence-based approaches to teaching in our classrooms.”

Follow The Research

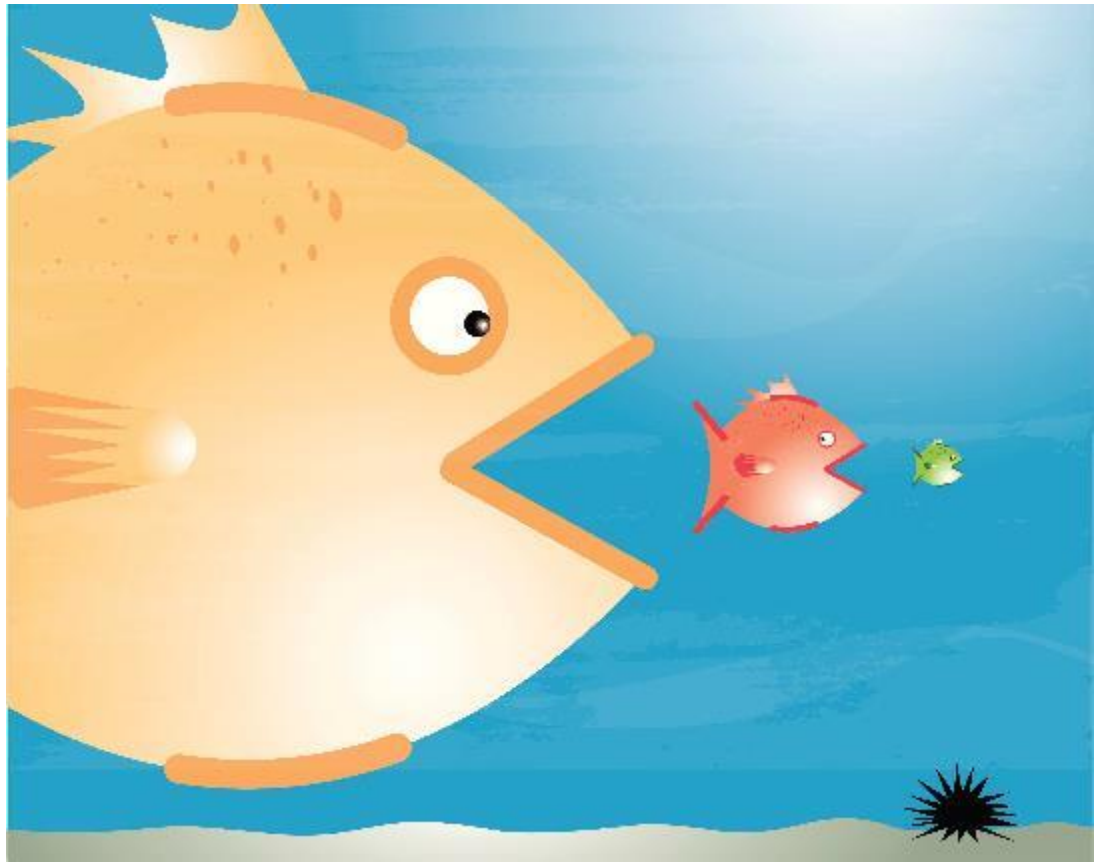
Here is our Professional Obligation

We must follow where the research leads us even if it makes us uncomfortable or results in major changes in our teaching practices.

Speed of Knowledge Production

According to Google--

2.5 billion gigabytes of data are produced each day.



Speed of Knowledge Production

Today's chip when compared to the 1971 Intel processor chip (4004)

- Has 3500 times more performance
- Is 90,000 times more energy efficient
- Is 60,000 times lower in cost

(Brian Krzanich Intel CEO)

Speed of Knowledge Production

Todays beetle would need to go
300,000 mph

It would need to get 2 million miles per gallon

It would cost 4 cents

(Brian Krzanich Intel CEO)

Speed of Knowledge Production

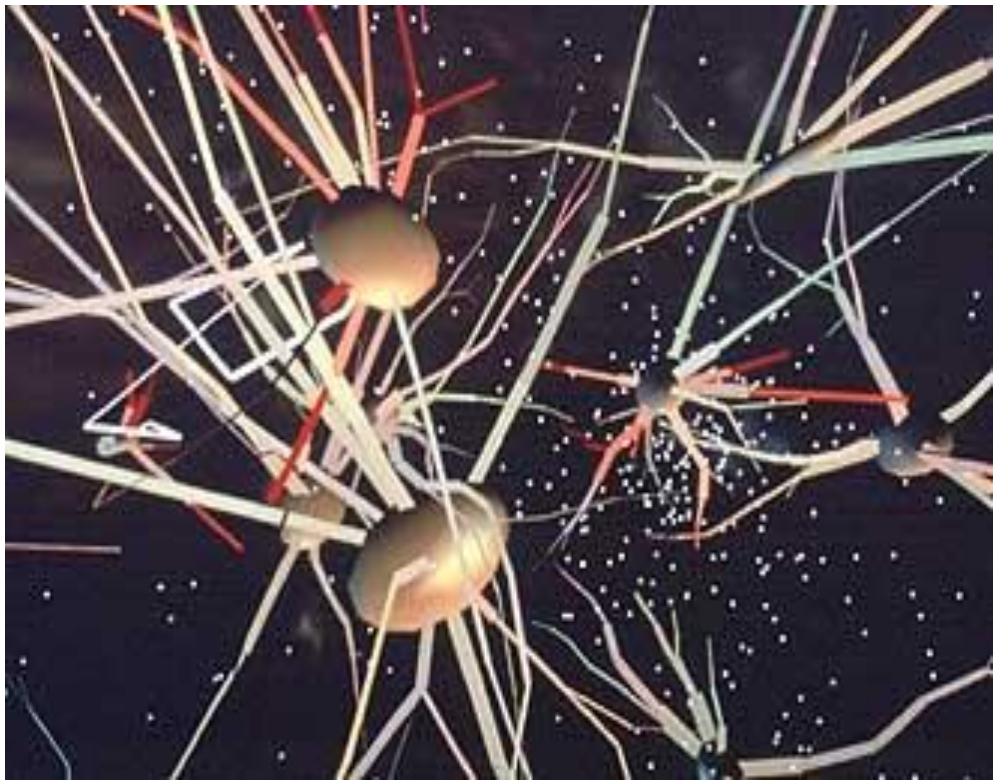
- In 2017 according to **United Nations Educational, Scientific and Cultural Organization** there were 2.5 million books published worldwide.

Initial Learning

Definition of Initial Learning

Learning is essentially a process of neurological change; as we absorb new skills and information, neurons form new connections and prune back others, and the brain as a whole recalibrates its networks and activity patterns.

NY Academy Of Science



Definition of Long-term Learning

Learning is the ability to use information after significant periods of disuse

and

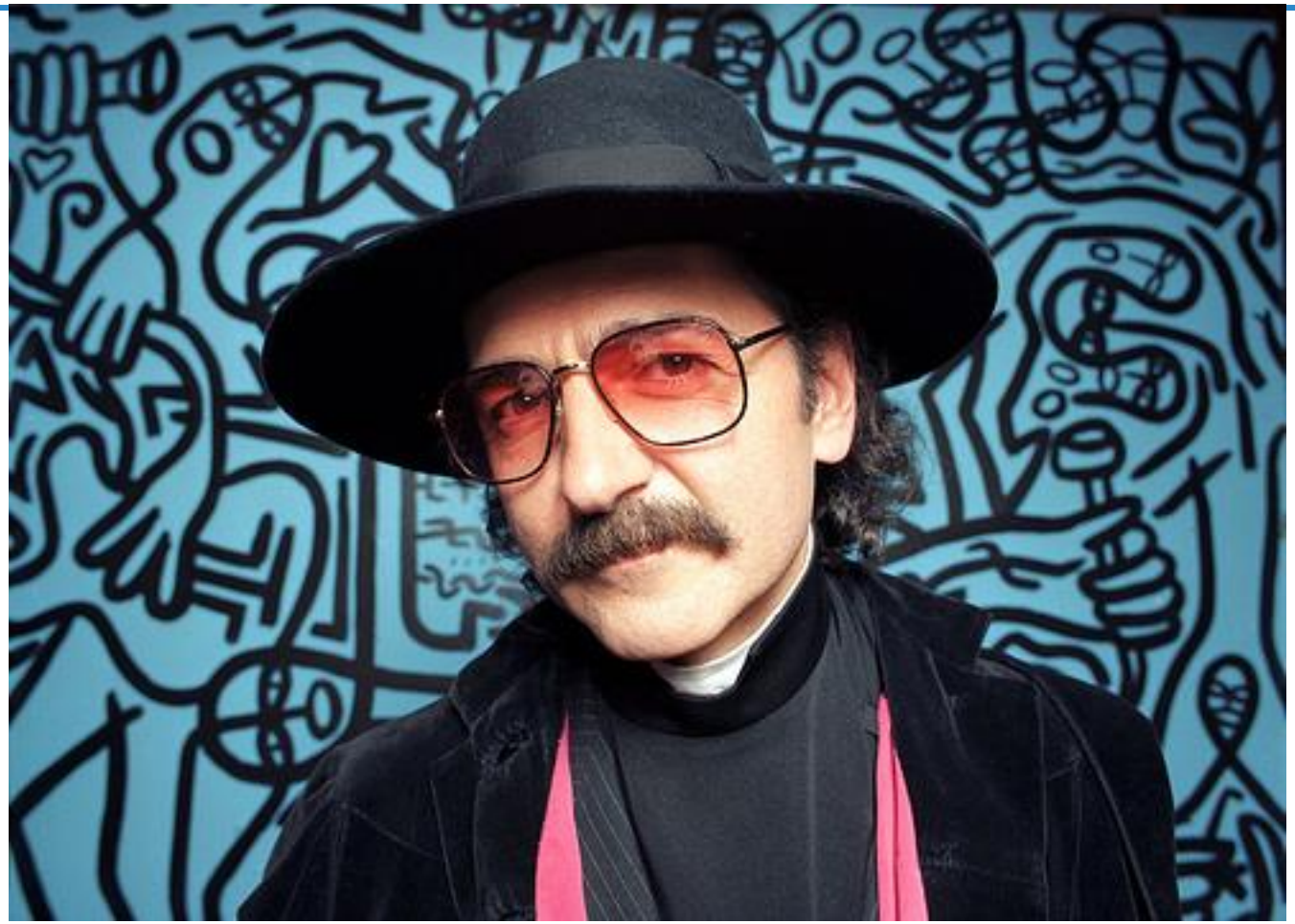
it is the ability to use the information to solve problems that arise in a context different (if only slightly) from the context in which the information was originally taught.

(Robert Bjork, *Memories and Metamemories,* 1994)

Slide Title

It is the one who does the work who does the learning (Doyle, 2008).

Slide Title



Slide Title

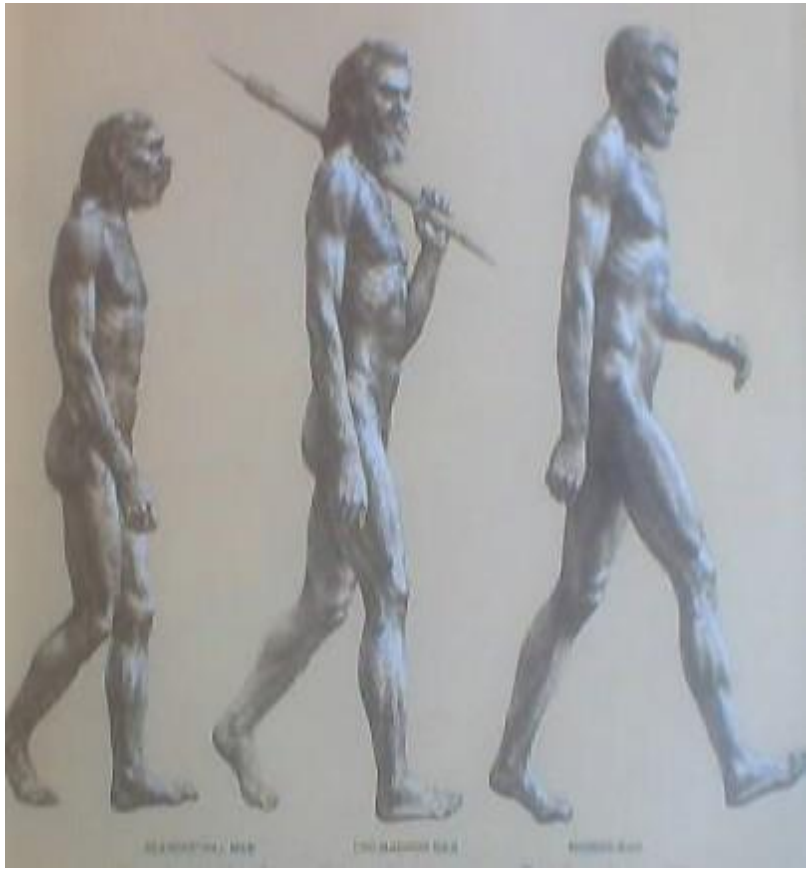
How to Design Learning Activities that Work in Harmony with the Brain

Movement and Learning

Natural selection developed a human brain to solve problems of survival in outdoor, unstable environments while in almost constant motion.

A brain in motion is a brain better able to learn.

(Medina, 2008)



- Walking is great for learning but even mild movement, like sitting on balance balls or working a stationary bike all improve learning.

- Try walking discussion groups!

Ratey, 2013

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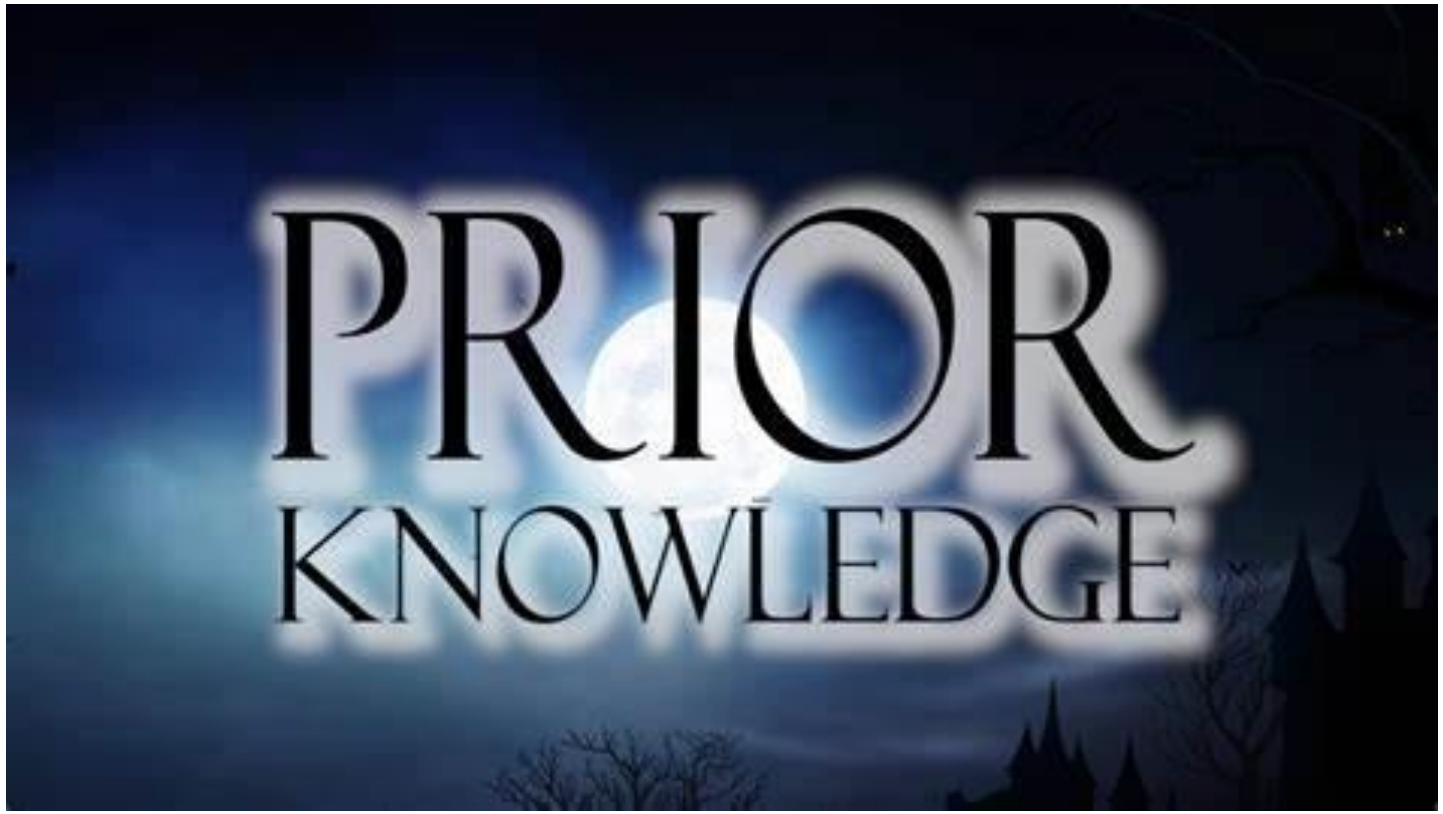
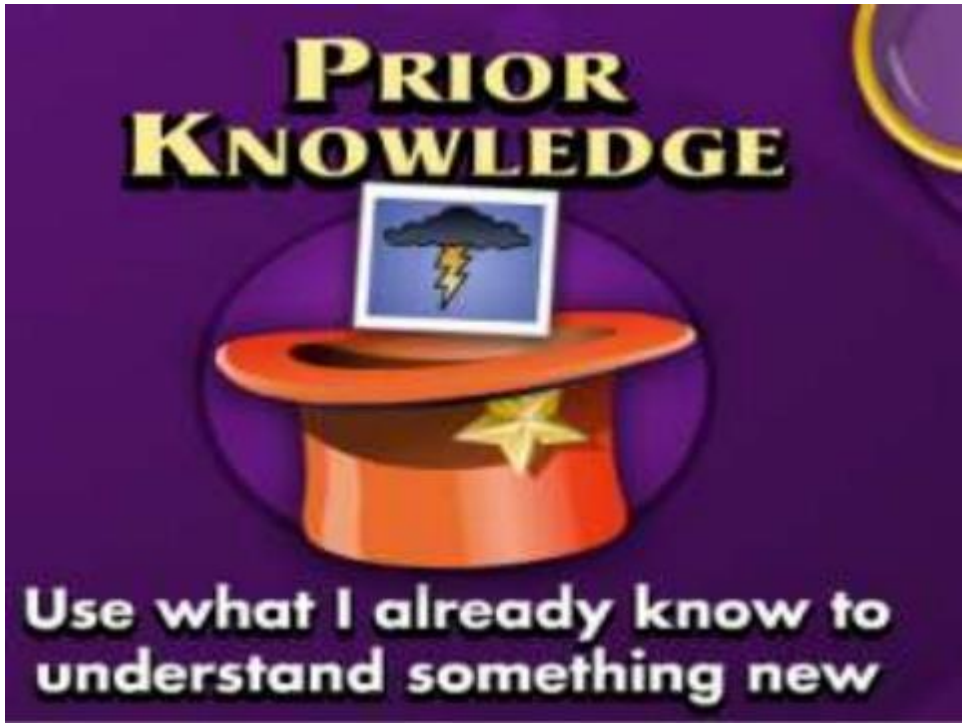
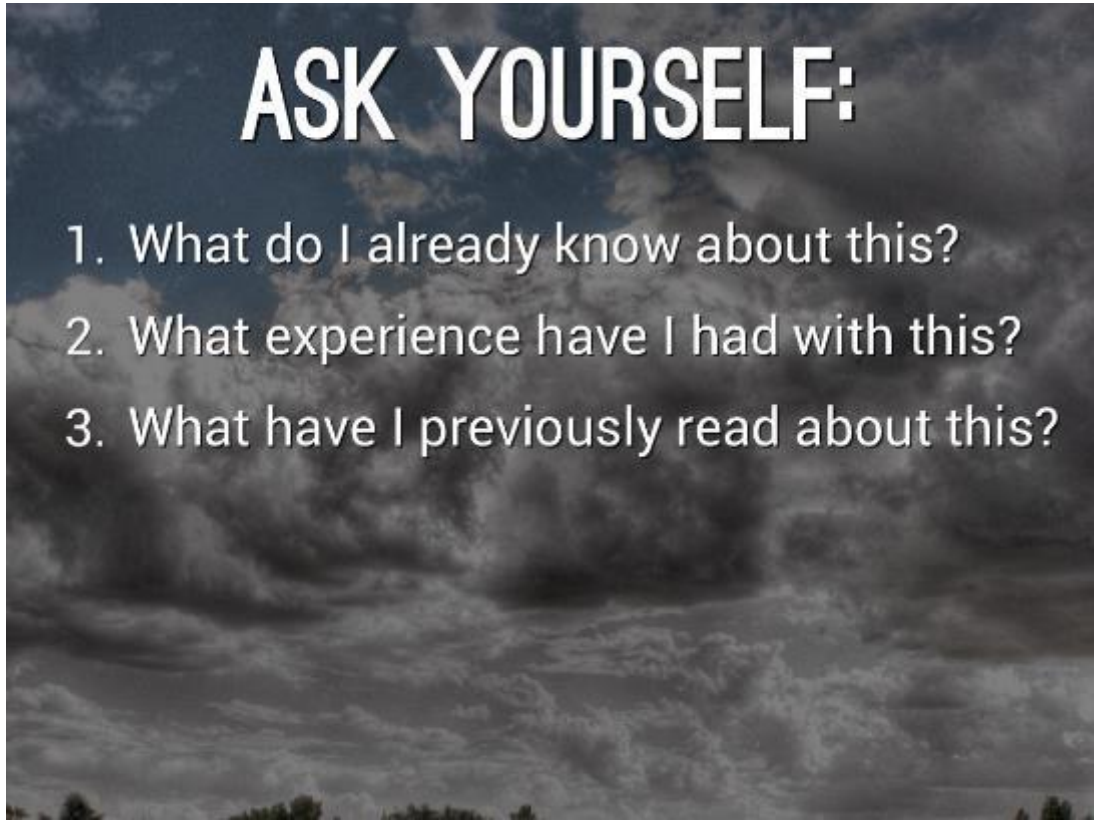


- In a 2014 study by Psychologist Danielle McNamara she found when it comes to new learning it is not effort, intelligence or attention that reign supreme but what a student already knew about the topic that had the biggest effect on learning.



- The brain's goal is to find established patterns of learning with which to connect new learning. (Ratey, 2013)

- A course design needs to include a list of content and skills students are expected to already have so the instructor can check.



Prior Knowledge

Course designers also need to provide ways for teachers to:

1. Assess prior knowledge
   a. Questionnaires
   b. Pretests
   c. Discussion questions

•

Prior Knowledge

2. Tools to help students fill in missing knowledge/skills
    a. Readings
    b. Videos
    c. Online tutorials

Slide Title

Attention and Learning

Attention and Learning

Attention is almost magical in its ability to physically alter the brain and enlarge functional circuits.

When we attend to something, we are readying various cognitive process we may need for learning.

(Merzenich and colleagues, UCSF, 2011)

Attention Capacity

Attention capacity refers to the extent that one can allocate their processing resources.

One's arousal level
meaningfulness/relevance/interest

Type of task
new vs. automatic

How people allocate attention
guided by previous experiences

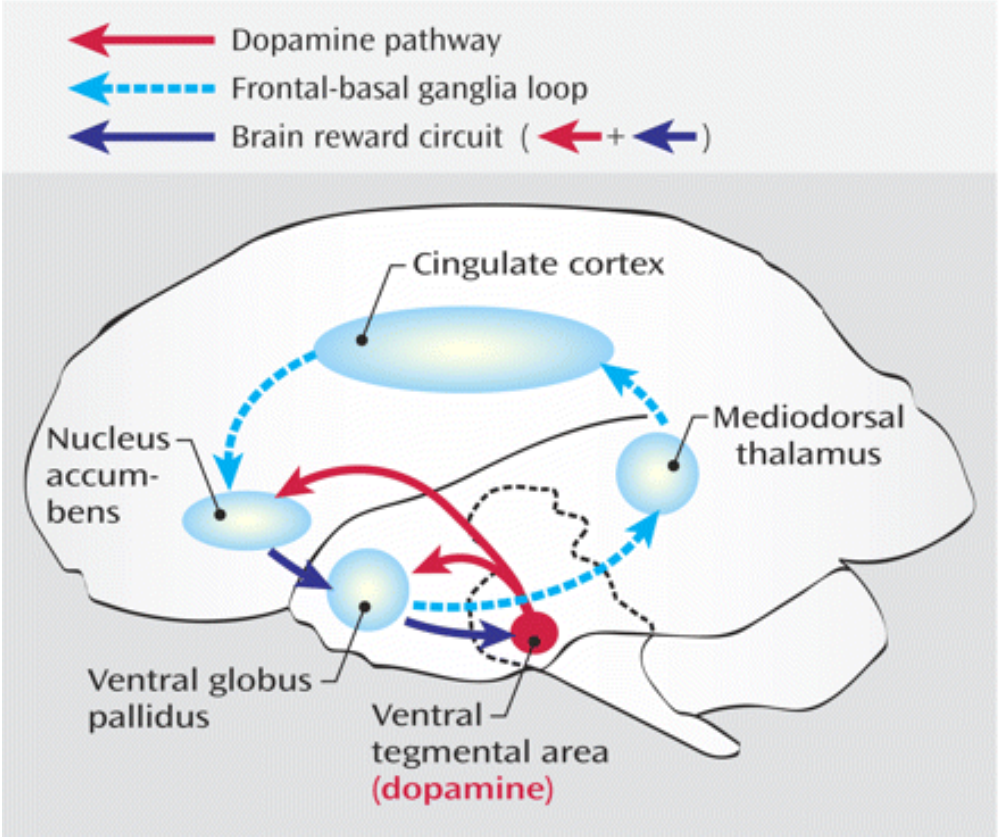
Attention and Emotion

The brain's emotional engagement pathway (dopamine pathway) is effective in capturing and sustaining attention.

Dopamine is there to motivate the brain to learn new information or engage in new experiences.

Without dopamine, you would not be interested in learning or trying new things.

(LeDoux, 2003)

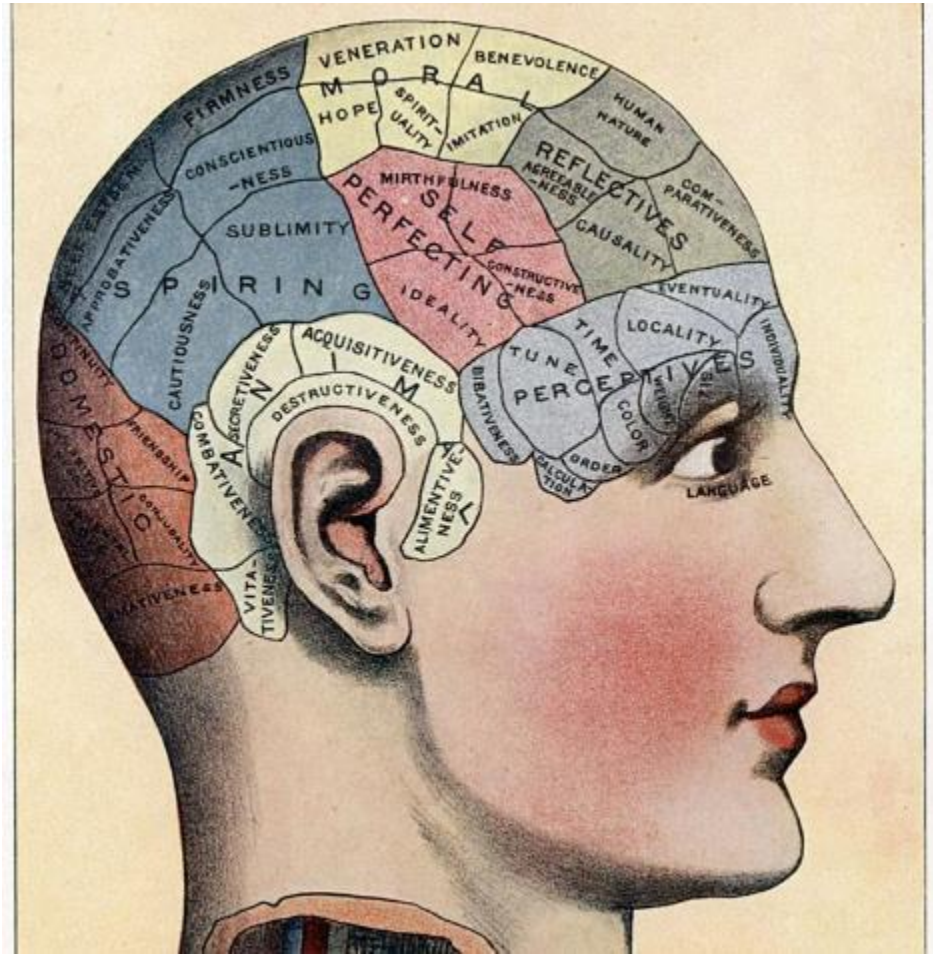


Attention and Memory

- The more elaborately you encode new information at the moment of learning the stronger the memory.

- Learners need to make it detailed, multifaceted and emotional.

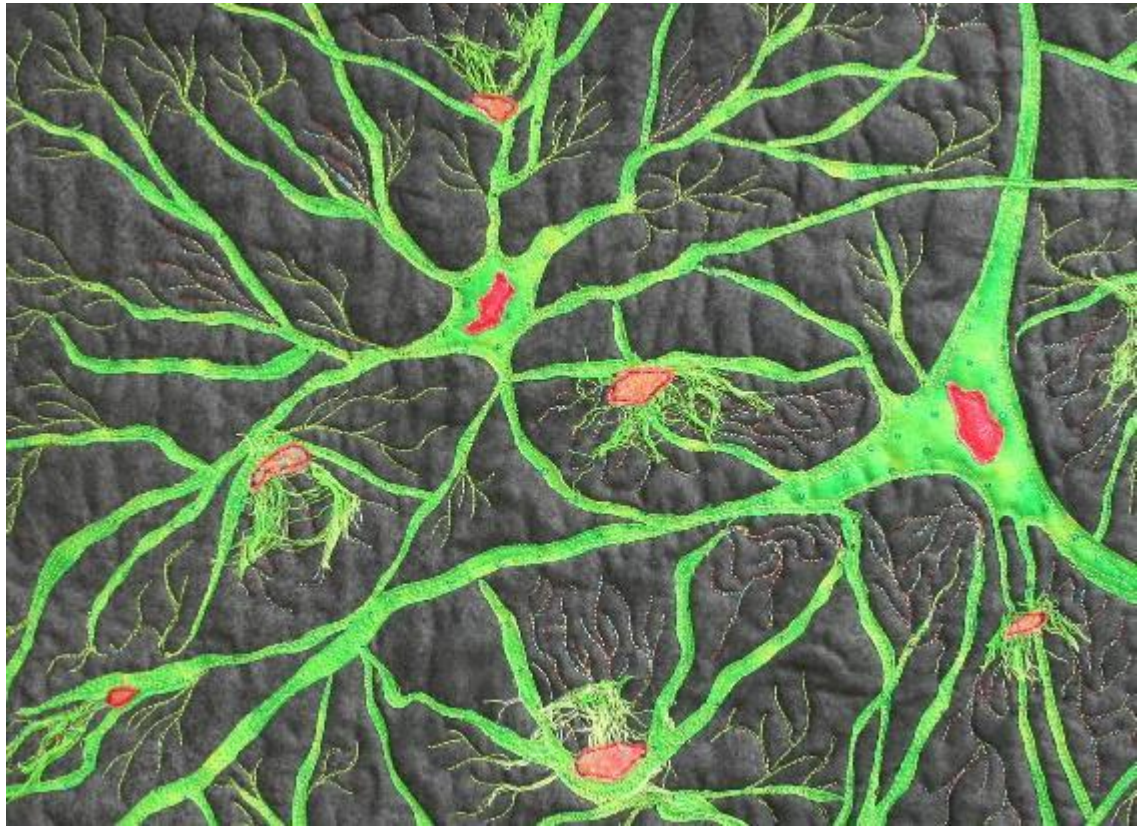
(Squire and Kandel, 2000)



Attention and Memory

- The same neural pathways used to process new learning are the same ones used to store it.
- So the initial moments of learning are crucial to helping us to recall what we learned.

(Squire and Kandel, 2000)



A Clear Rationale for Learning

- A learner's brain is constantly prioritizing.
- Students are less likely to be bored or prioritize other learning when they understand how the new learning matters to them.

(Brown, Roediger and McDaniel 2014)

A Clear Rationale for Learning

- Designers need to include clear rationales for why the content and skills are important to the learner including how the content and skills are used in authentic situations

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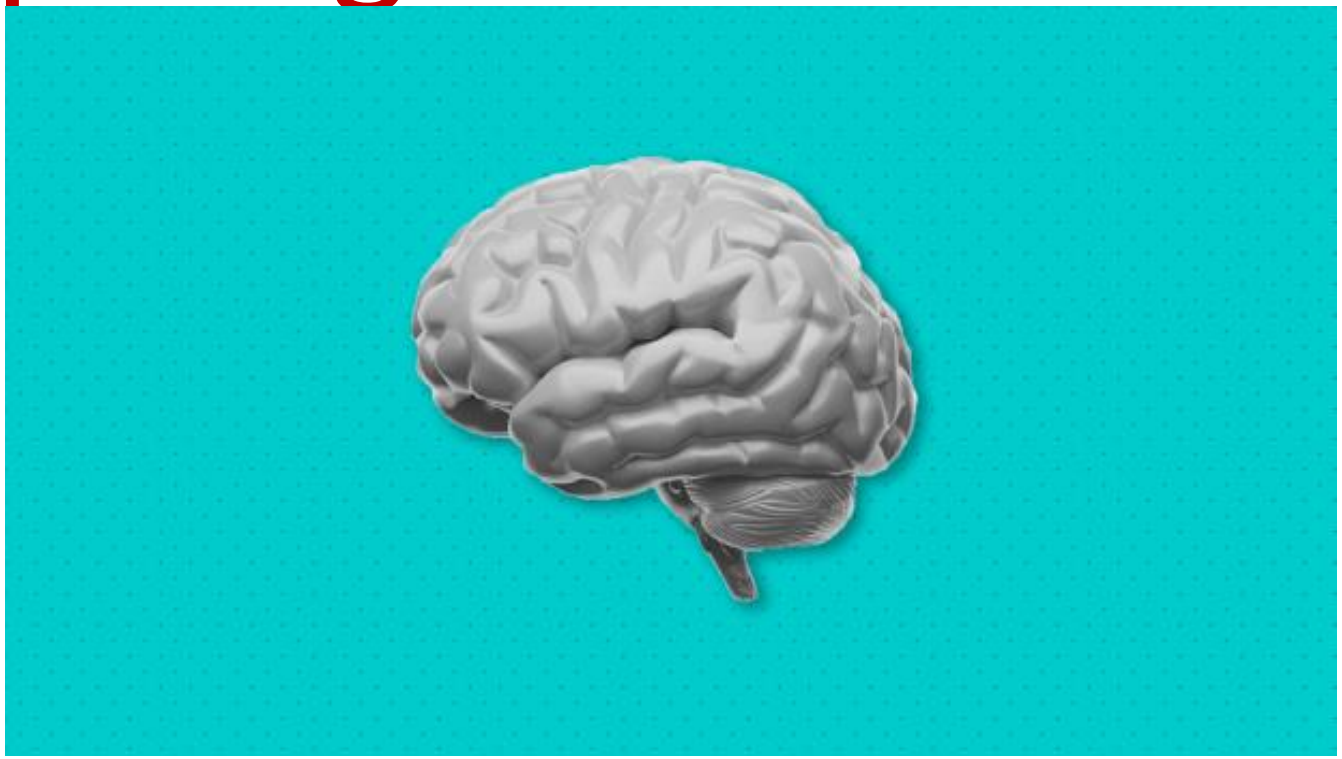
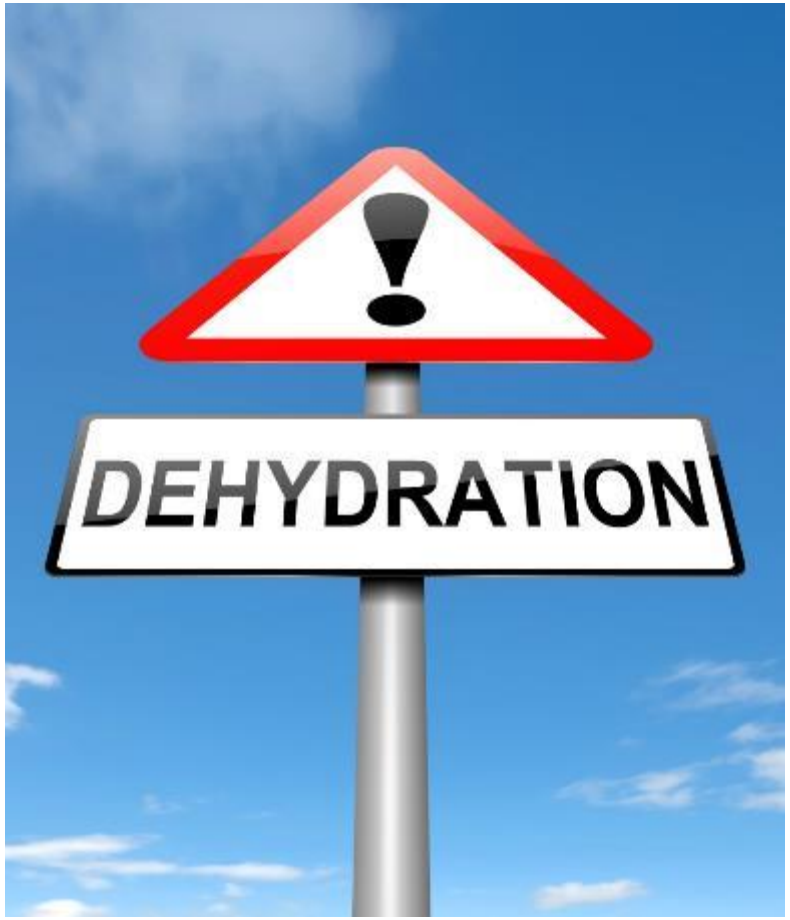
Preparing the Brain to Learn



Four Keys to Improving Learning

1. Staying Hydrated

- Even mild dehydration can alter a person's mood, energy level, and ability to think clearly.
- Mild dehydration is defined as an approximately 1.5 percent loss in normal water volume in the body. (Armstrong & Lieberman, 2011)



Four Keys to Improving Learning

Hydration

We can lose as much as 2 pounds of water while we sleep.

Drink water or other beverages first thing in the morning is key to staying hydrated.

Men an average of 125 ounces of fluids per day

Women 91 ounces per day.

Drink when thirsty/no 8 glasses a day

2. Diet

The brains energy source is glucose and glucose comes from the food we eat.

Learners need a balanced diet and need to eat before learning.

Four Keys to Improving Learning

For learners, the research on diet implies that the contents and timing of meals may need to be coordinated to have the most beneficial cognitive effects that enhance learning.

Four Keys to Improving Learning

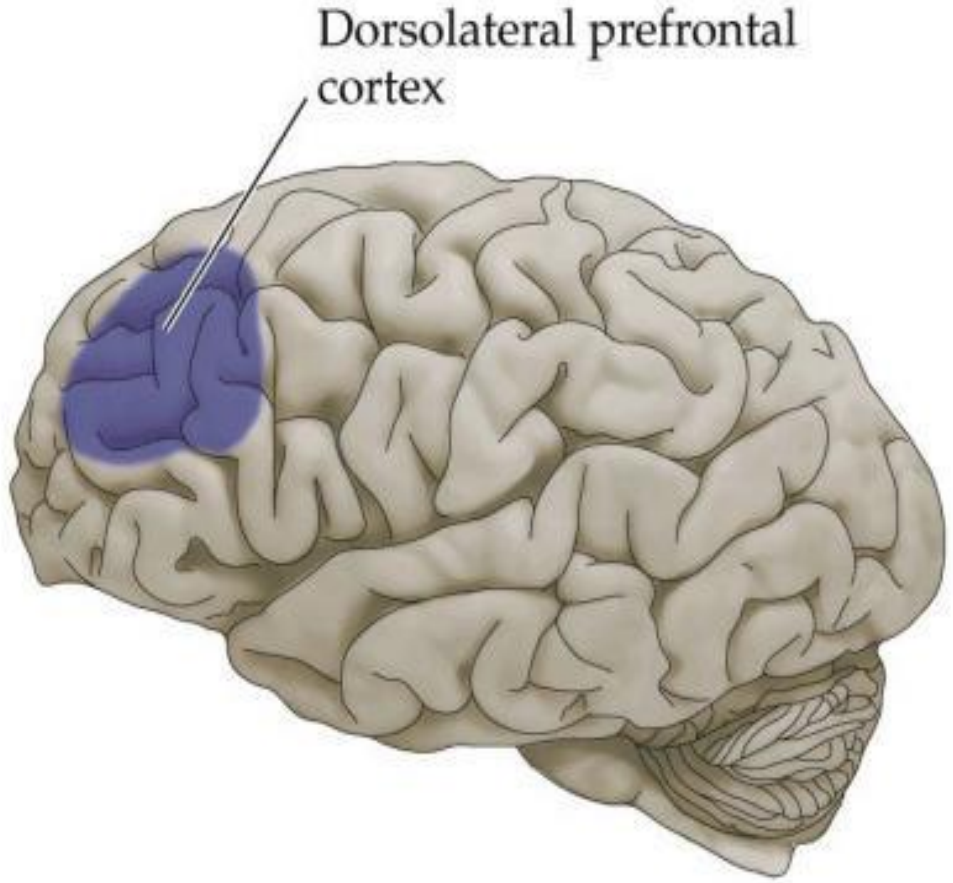
3. Exercise

Exercise is the single most important thing a person can do to improve their learning.

(John Ratey, 2013, Spark, The Revolutionary New Science of Exercise and the Brain)

Four Keys to Improving Learning

- The reason is exercise directly stimulates the dorsolateral prefrontal cortices- the brain regions responsible for:
- focus
- concentration
- organization
- planning



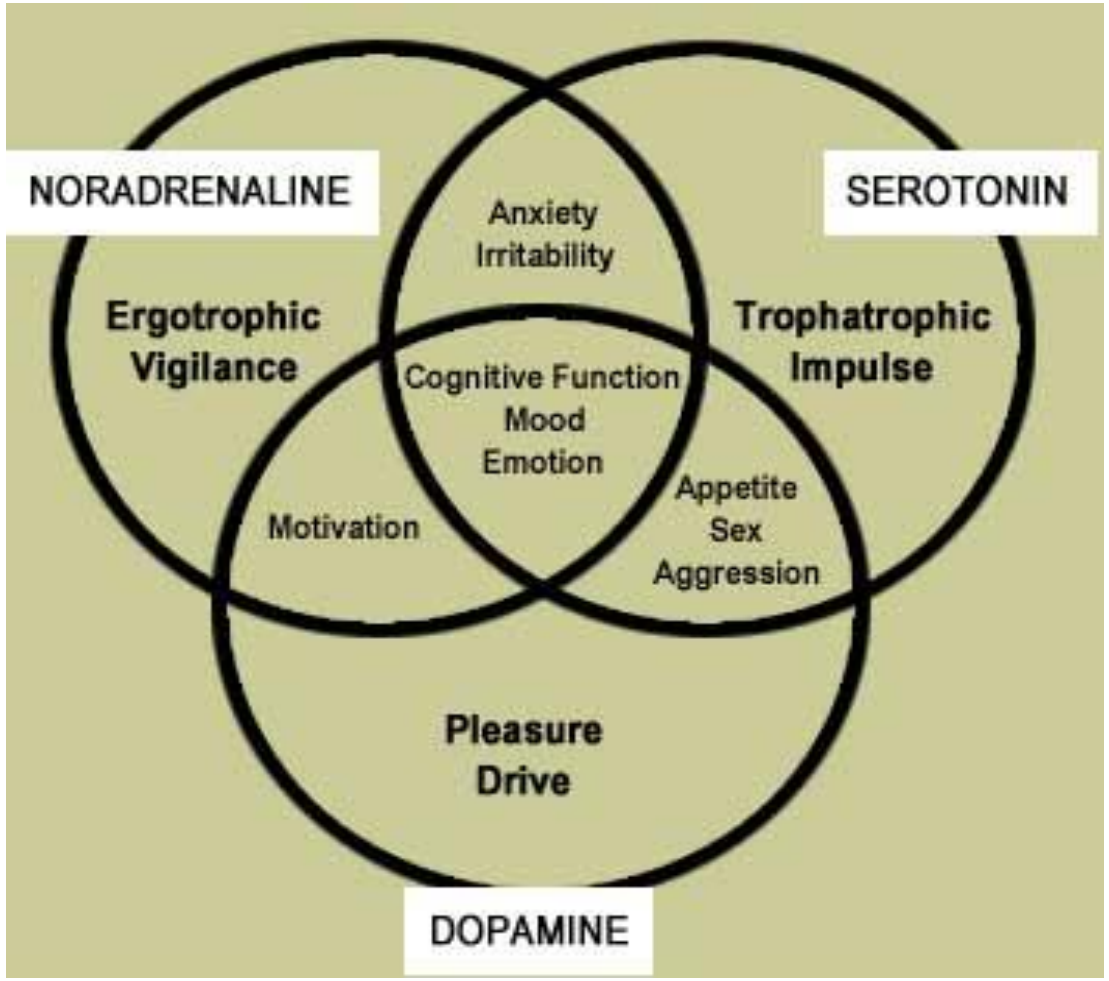
(Postal, 2015)

Four Keys to Improving Learning

Exercise also increases production of neurotransmitters that help:

1. Motivation
2. Patience
3. Mood (more optimistic)
4. Attention

(Ratey, 2013)



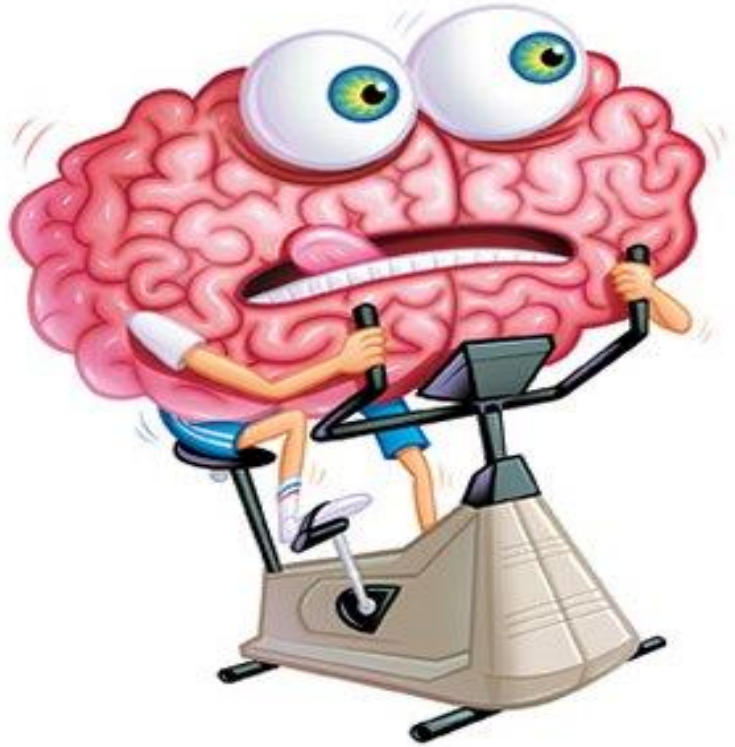
Four Keys to Improving Learning

Exercise Increases Production of BDNF

(Brain-derived neurotrophic factor)

Enhances the wiring of neurons which underlies all human learning.

BDNF makes new learning easier.



Miracle Gro for the Brain

Slide Title

ATTENTION PLEASE

"Scientists have discovered a revolutionary new treatment that makes you live longer. It enhances your memory and makes you more creative. It makes you look more attractive. It keeps you slim and lowers your food cravings. It protects you from cancer and dementia. It wards off colds and flu. It lowers your risk of heart attack and stroke, not to mention diabetes. You'll even feel happier, less depressed, and less anxious. Are you interested?"

(Matthew Walker, 2017)

Four Keys to Improving Learning

- Adults need 7 to 9 hours
- Teens 9-10
- Preschoolers 10-13

(National Sleep Foundation 2016, Dement, 2005)

Four Keys to Improving Learning

Immediate Effects of Sleep Deprivation

Poor attention

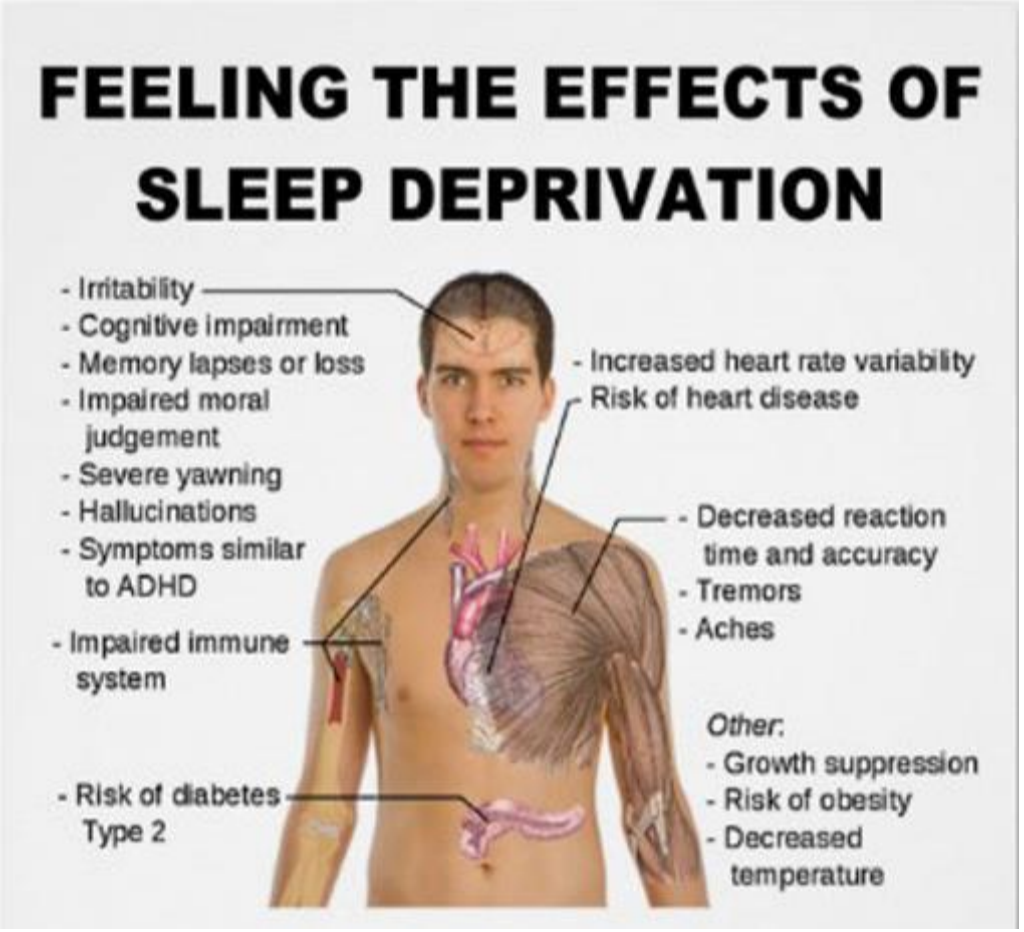
Irritability

Difficulty with memory

Increased risk taking and impulsivity

Slowed reaction time

Depressed Immune system



Four Keys to Improving Learning

Sleeps Impact on Learning and Memory

- Scientists have fortified evidence that a key purpose of sleep is to recalibrate the brain cells responsible for learning and memory

- So the lessons can be “solidified” and used when awake.

(Diering,2017)

Caffeine and Alcohol's Effects on Sleep

- Caffeine blocks the release of adenosine the chemical that puts us to sleep and keeps us asleep. It has a half-life of 5-6 hours.

- Alcohol prevents the brain from producing REM sleep—REM sleep integrates the new information with all past experiences building an ever more accurate model of how the world works including innovative insights and problem-solving abilities.

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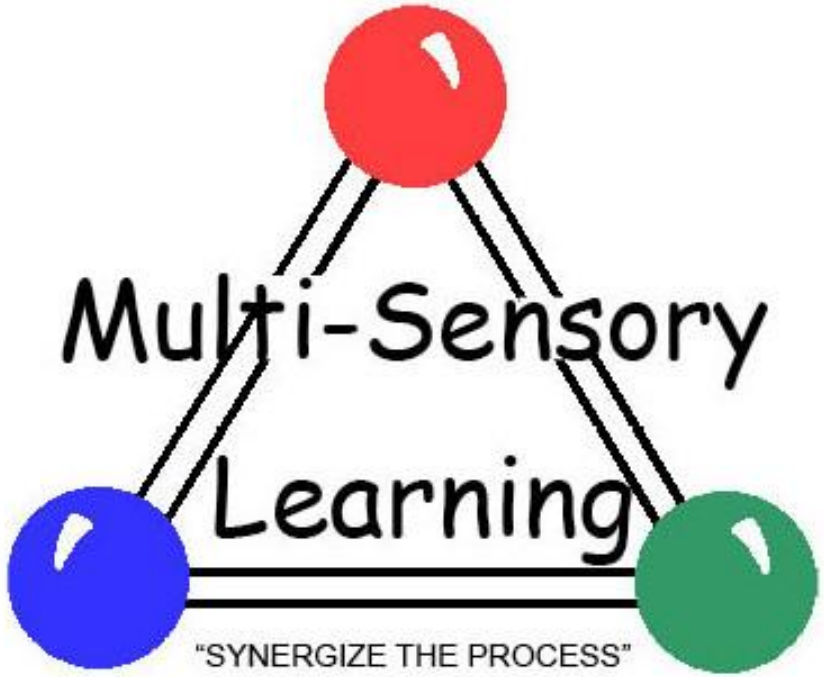
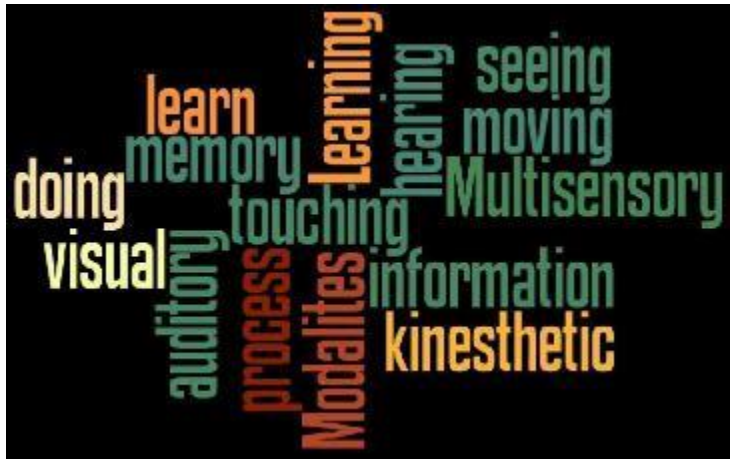


Learning and Memory are Enhanced when Multiple Senses are Engaged

- Humans are powerful visual and auditory learners—evolution made certain of it.



(www.human-memory.net/processes_encoding.html)

Each sensory pathway creates its own memory pathways — the more senses used in learning the more chances for understanding and recall.

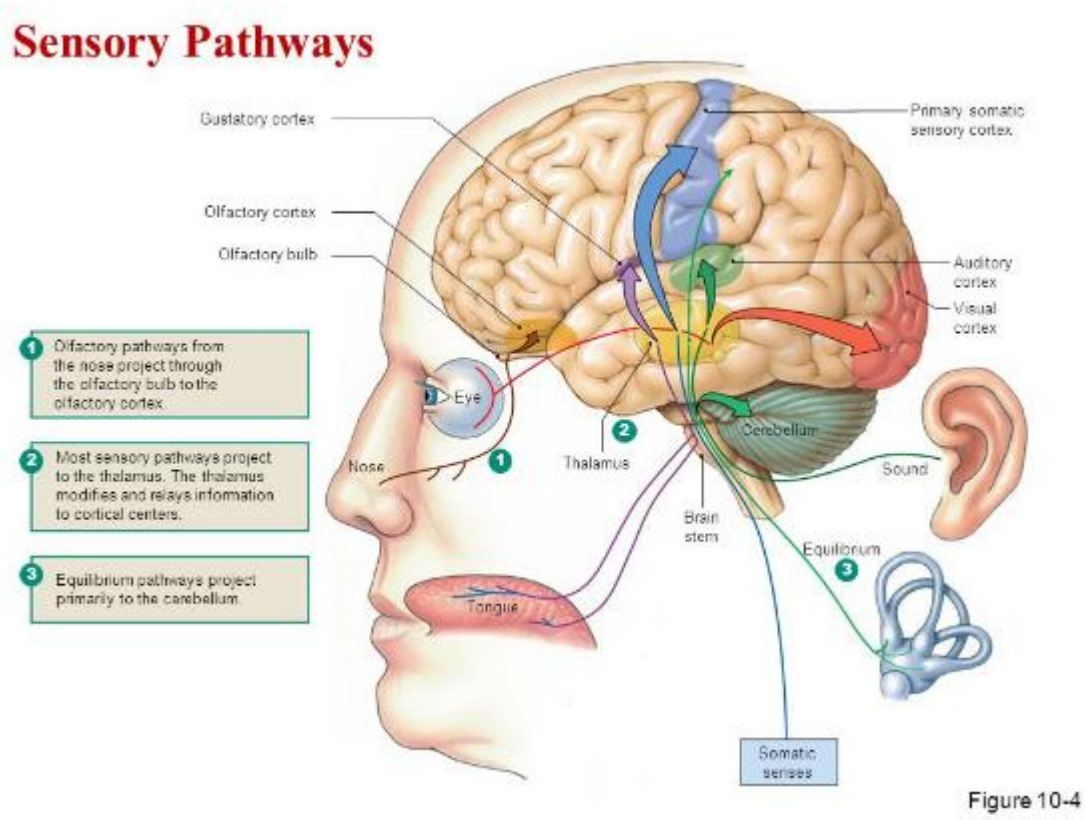


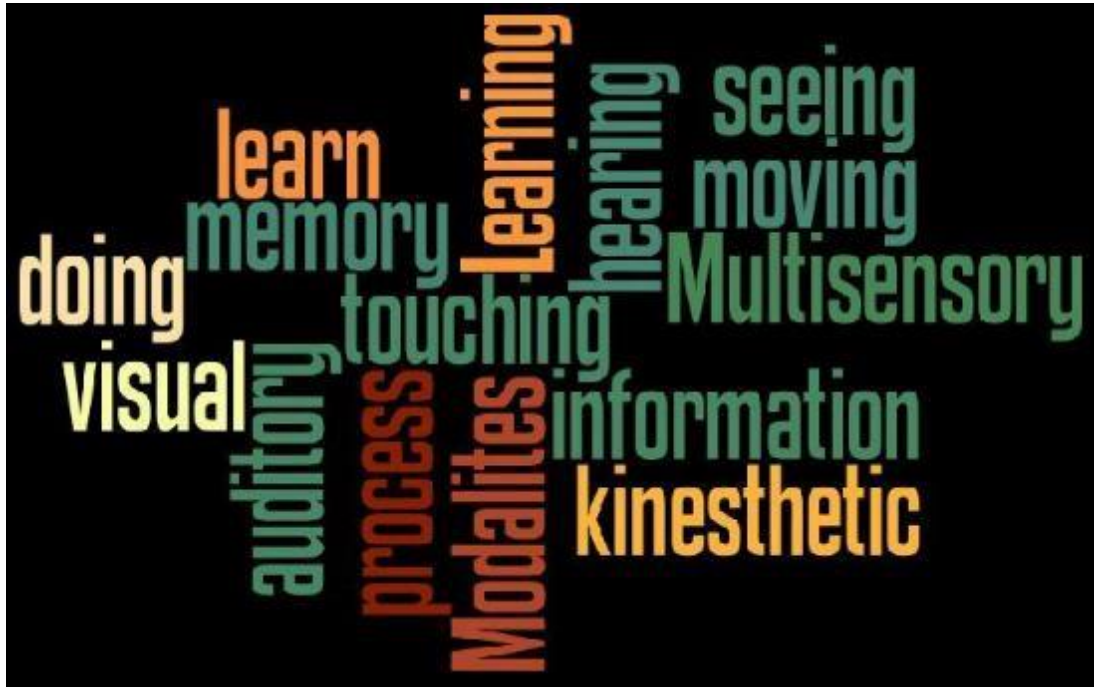
Figure 10-4

- By using a multisensory approach to teaching instructors increase the chances of learners making connections to their prior knowledge—thus optimizing new learning.

- Teach in a Multisensory Way

Multi-Sensory Learning and Teaching

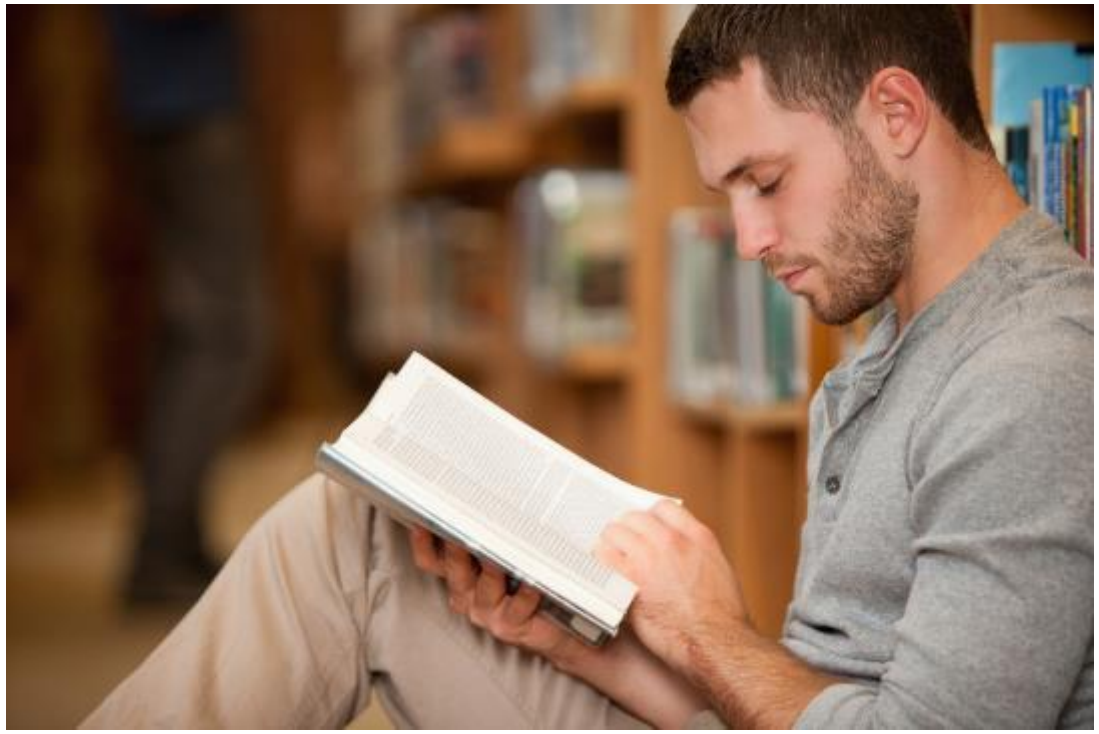
- The same is true for learners. By studying using a multi-sensory approach more connections to prior knowledge are strengthened creating a greater chance of recall when information is needed.



Multi-Sensory Learning and Teaching

- Reading, although vitally important to the learning process, is the slowest way humans enter information into their brains.

(Reading in the Brain, Dehaene)



Annotation when reading

Cognitive mapping

Using a smell as a memory cue

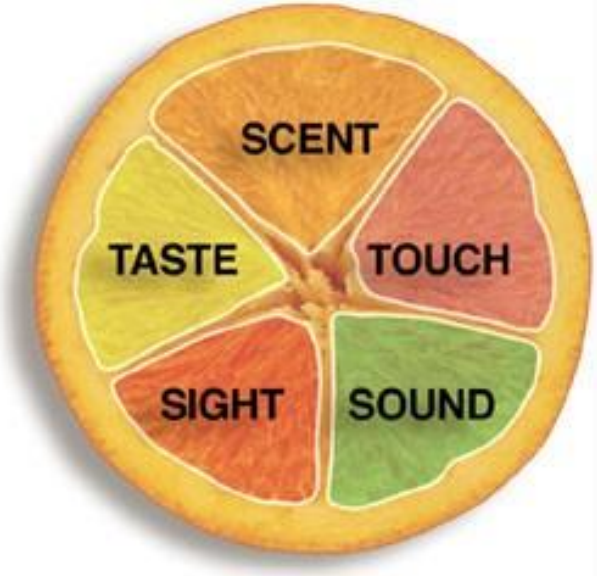
Drawing a picture/image/diagram

Listening while reading the same text (supportive reading)

Taking notes

Visualizing while listening

- Examples of Multisensory Learning



Patterns in Learning and Teaching

Patterns and Learning and Teaching

- The brain is a pattern seeking device. It seeks to connect new information to existing patterns of information.

(J. Ratey, 2001)

Patterns and Learning and Teaching

- When learners don't recognize the patterns, they can get lost, stressed, anxious or fearful.

Examples

- Reading your first research journal.
- Traveling to a foreign country for the first time.

Slide Title

Which of the following slides is easier to remember and WHY?

Slide Title

Slide One

4915802979

Slide Title

Slide Two

(491) 580-2979

Slide Title

What is the pattern in the next slide.

Slide Title

NRAFBINBCUSAMTV

Slide Title

NRA NBC FBI USA MTV

Patterns and Learning and Teaching

Clustering Information is One Key to Efficient
Teaching and Learning

Clustering is a type of patterning used to organize related information into groups.

Information that is categorized becomes easier to remember and recall.

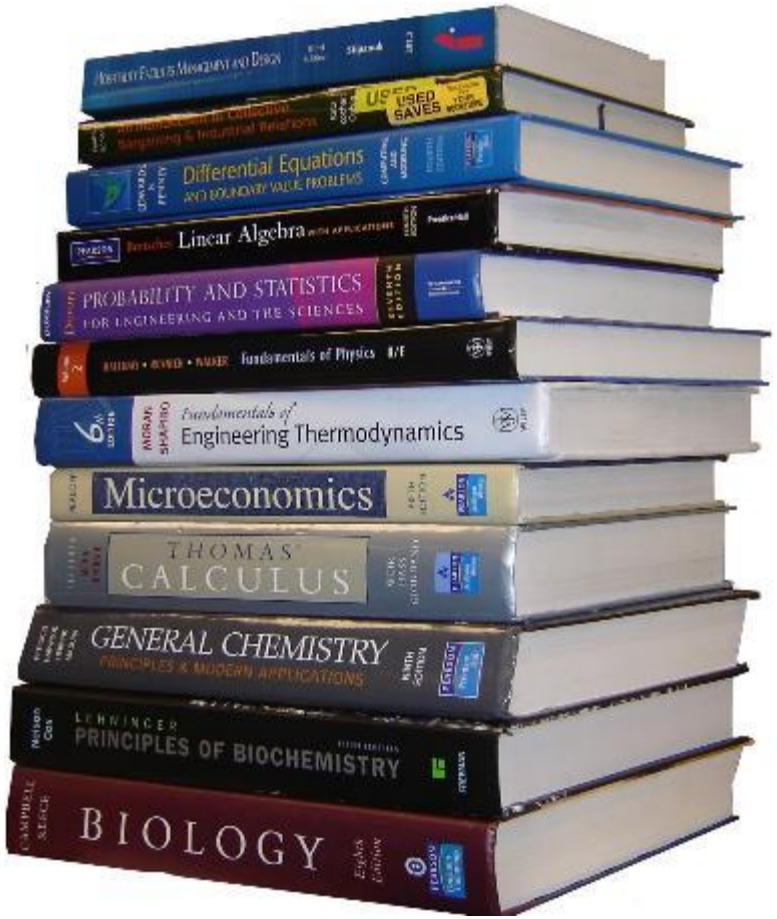
Patterns and Learning and Teaching

Patterns in Reading Textbooks

90 % of the time the first sentence of a paragraph is the Main Idea.

Main Ideas are almost always followed by significant details—details clarify or support MI's.

Examples make up ½ of all textbook material.



Patterns and Learning and Teaching

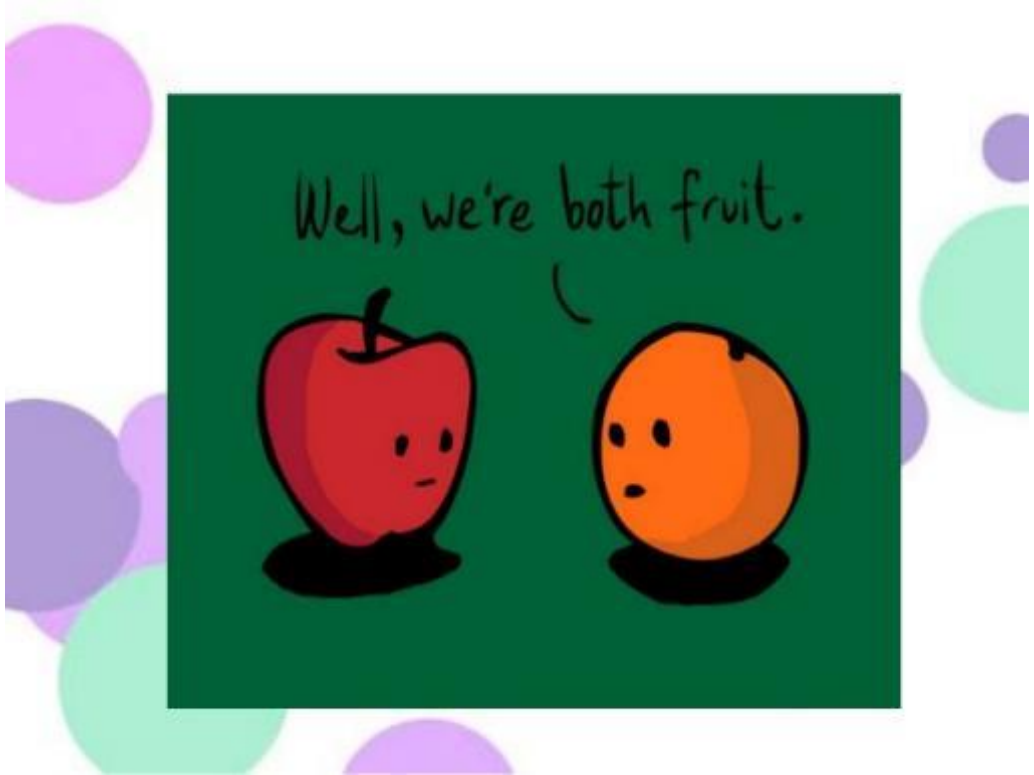
Similarity and Difference

Cause and Effect

Comparison and Contrast

In students' own words

Common Patterns for Learning



Patterns and Learning and Teaching

- Dunlosky and his colleagues investigated ten different learning strategies and one consistent finding was that anything that required learners to put things into their own words resulted in better learning

(Dunlosky, et al., 2013)

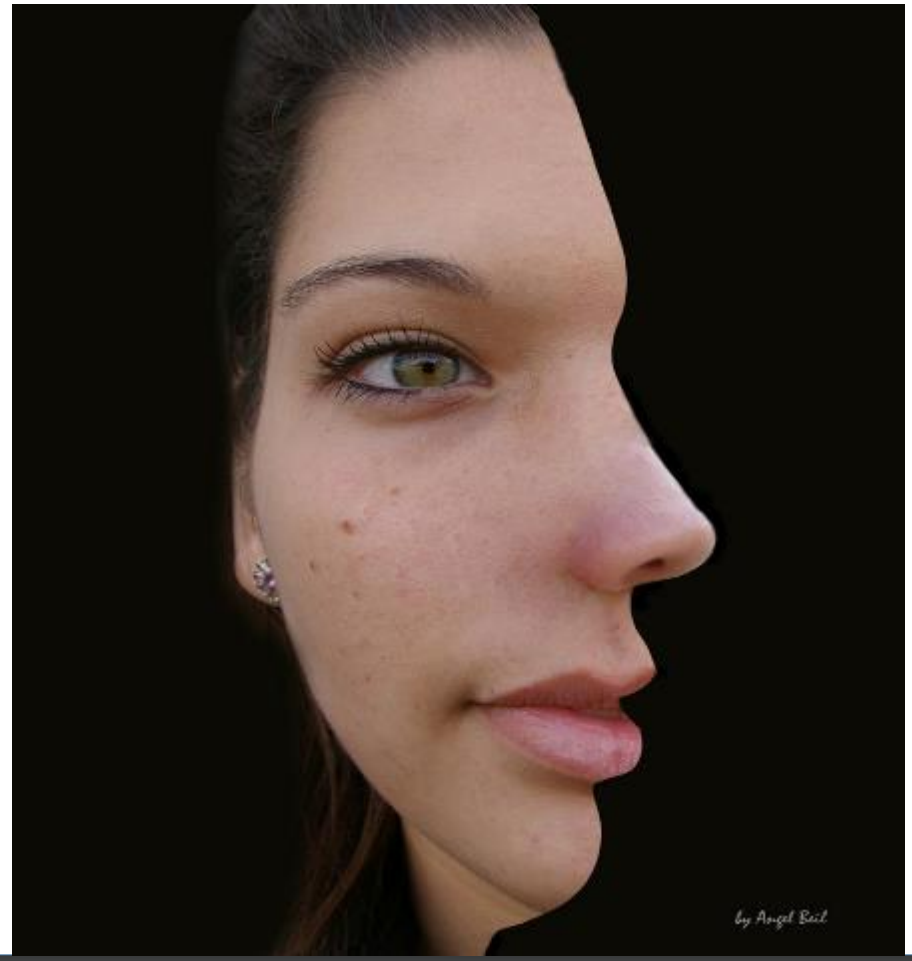
A learner's own words equals better learning

Prior Knowledge and Pattern Recognition

Expectations that certain patterns will exist can cause professionals to fail to see the actual patterns that exist.

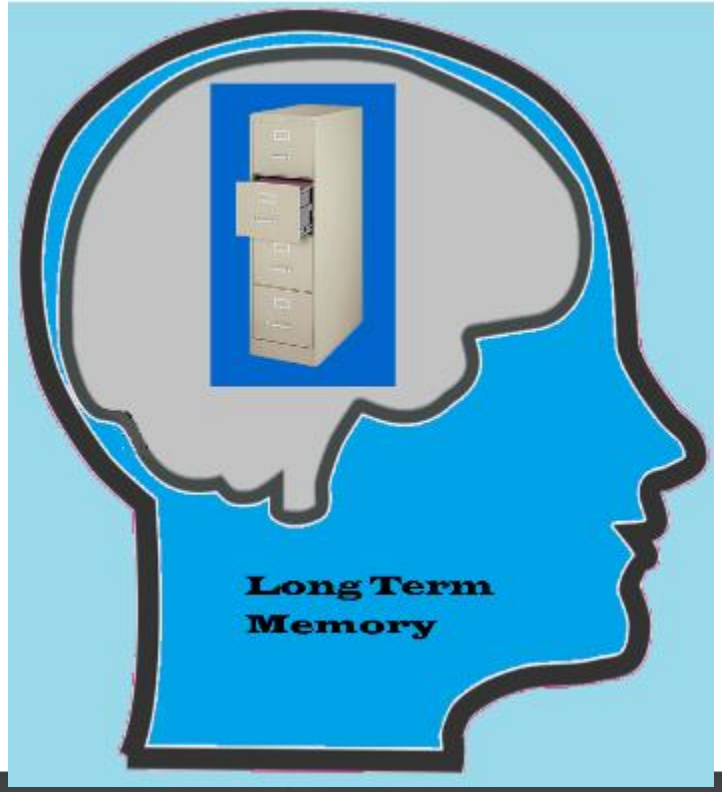
Example

Misdiagnosis of a patient



Slide Title

Long-term Recall of What We Learn



Long-term Recall

Factors Impacting Recall

1. Number of memory pathways

2. The number of senses used in the learning process

3. The strength of the memory

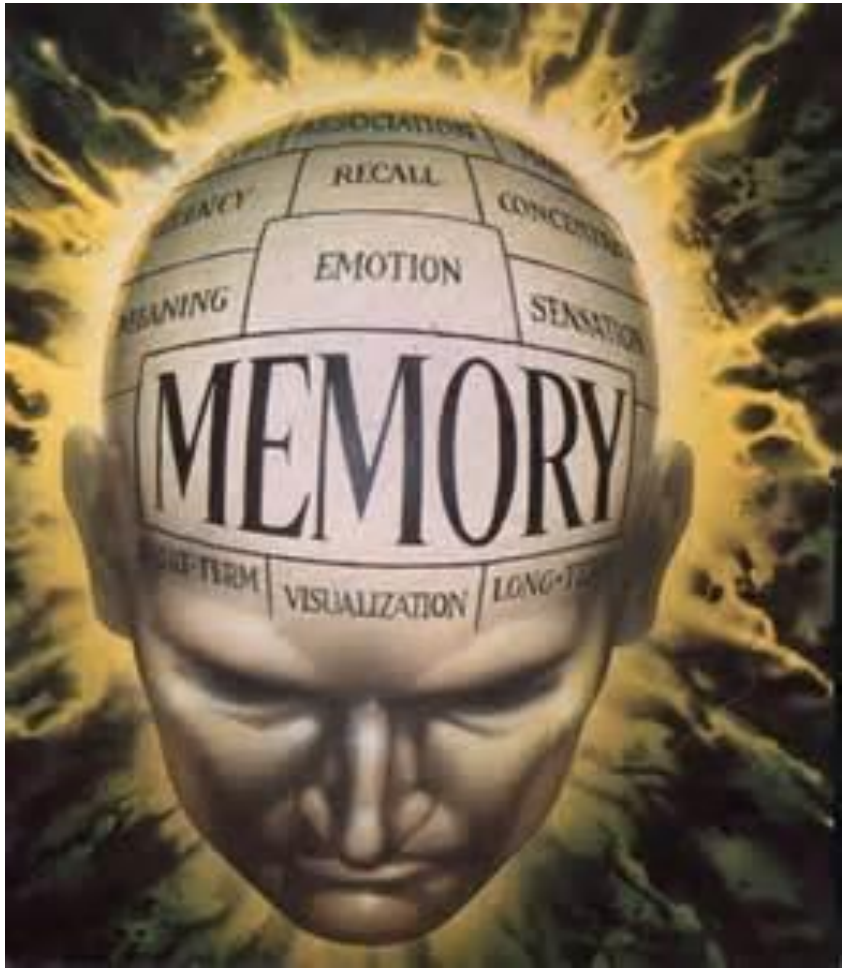
4. The cue that is given to spark the recall

5. Was the information learned as a part of a whole idea or concept

Long-term Recall

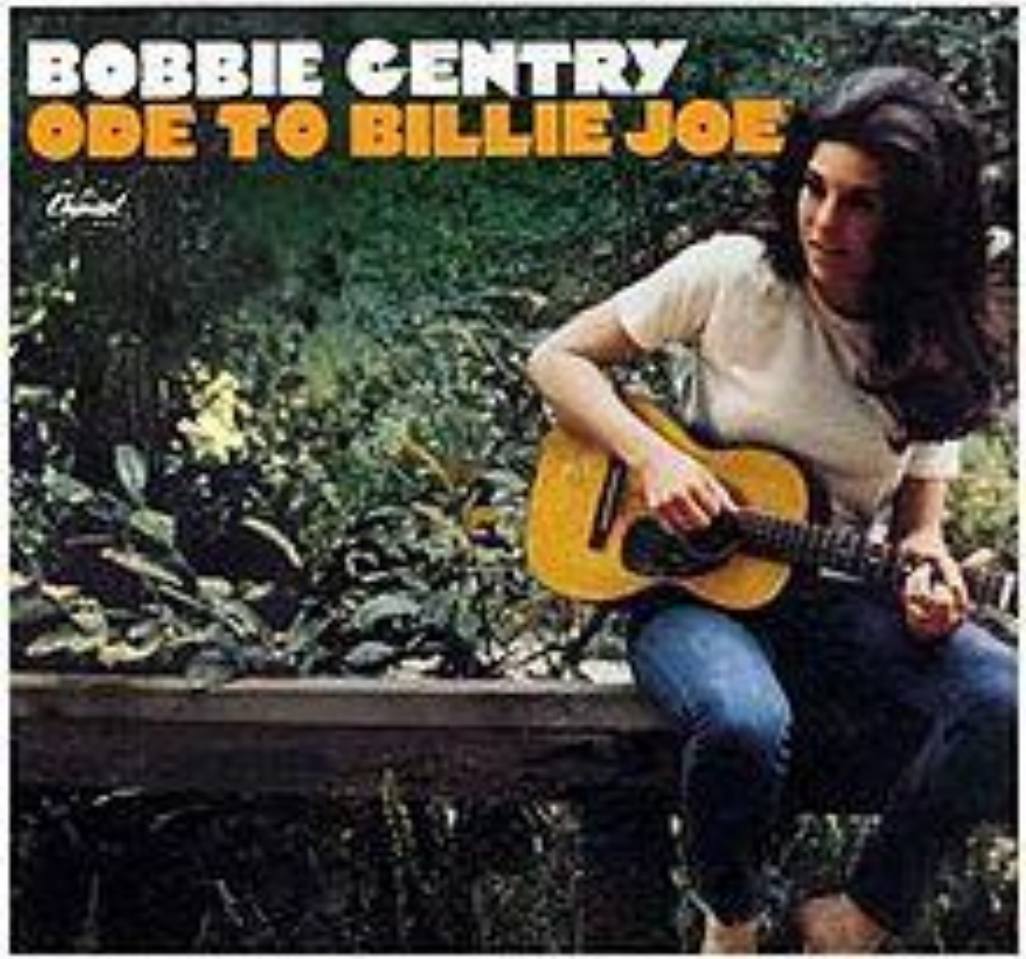
Learning Actions that Improve Memory
Formation and Recall

1. Wanting to remember
2. Distributive practice
3. Elaboration
4. Interest



Long-term Recall

- Repetition and Recall
- How many of you know the lyrics to songs that YOU DO NOT WANT TO KNOW THE LYRICS TO?



Long-term Recall

Distributive Practice

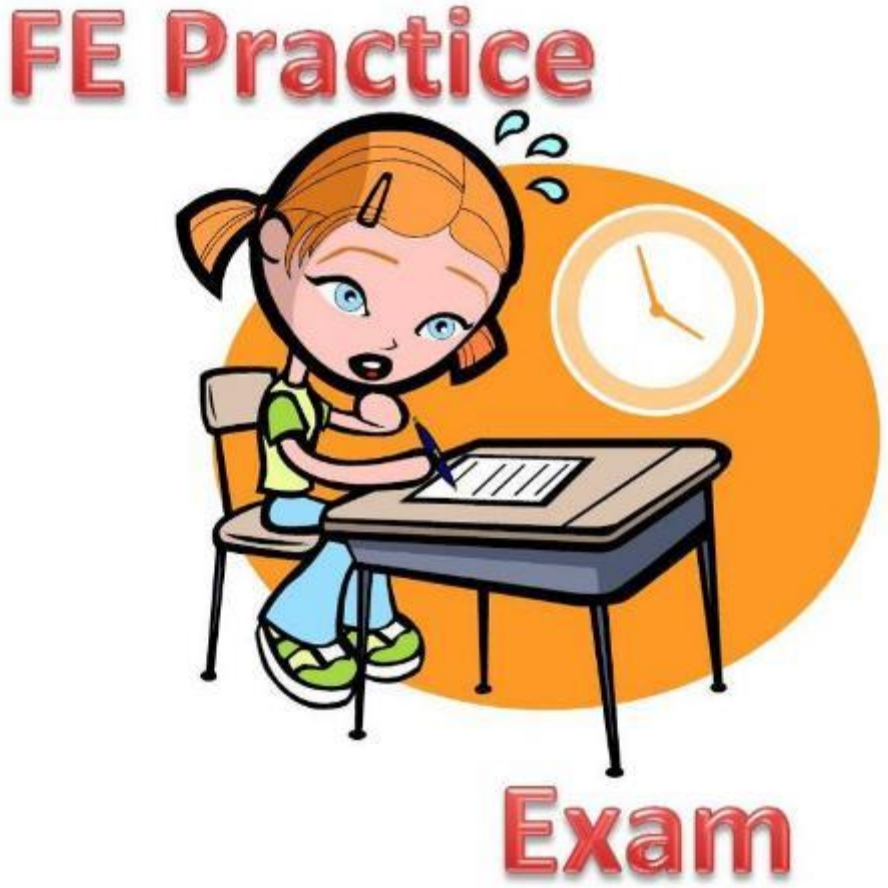
- To strengthen our memories it is vital to recall from memory what we have learned over time, rather than just looking/reading it over.

- Every time learning is recalled the memory gets stronger and faster (LTP).

(Schacter, Seven Sins of Memory, 2001)

Long-term Recall

- An excellent way to promote the recall of new learning is through the use of practice tests and quizzes.
- These can be put online so students can use them whenever they want.
- The key is that the tests/quizzes ask for recall from memory—so no multiple choice-true and false etc.



Resources

https://militarysimulation.training/

https://www.faac.com/training-simulators/military/

Military Simulation Training

Slide Title

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