Discoveries in the Adolescent Brain

Implications for Teaching & Learning:
Why the Old Methods Didn't Work

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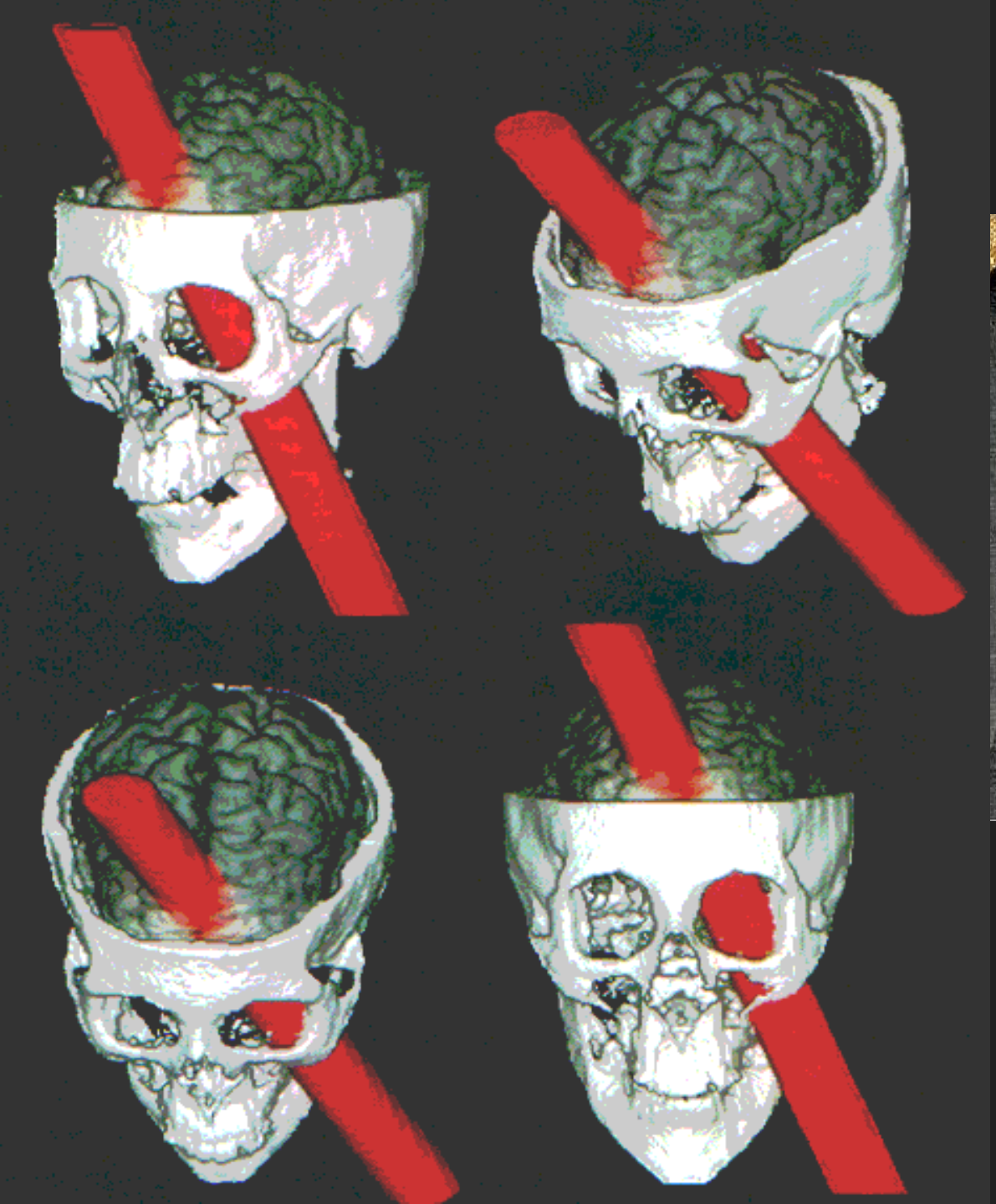
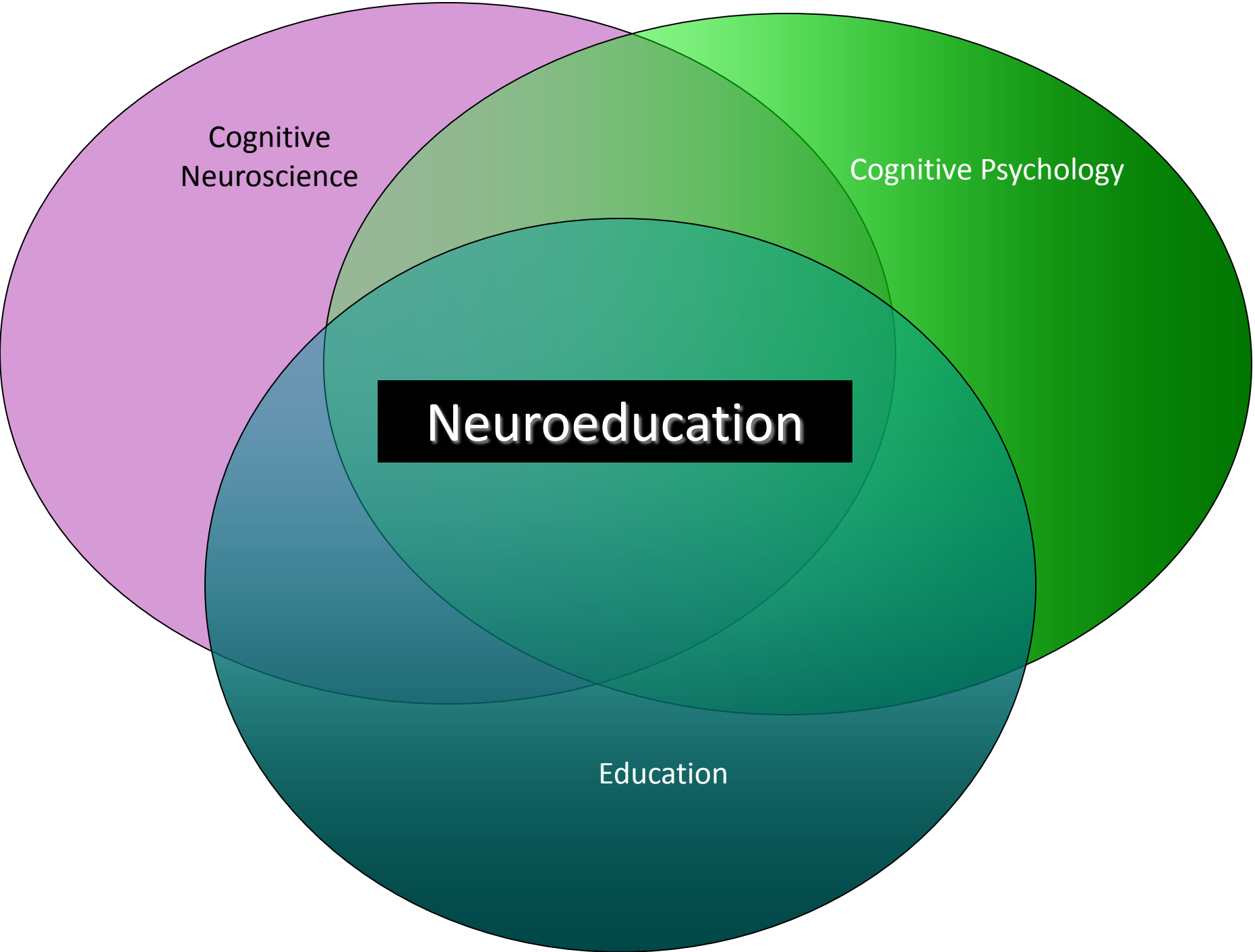
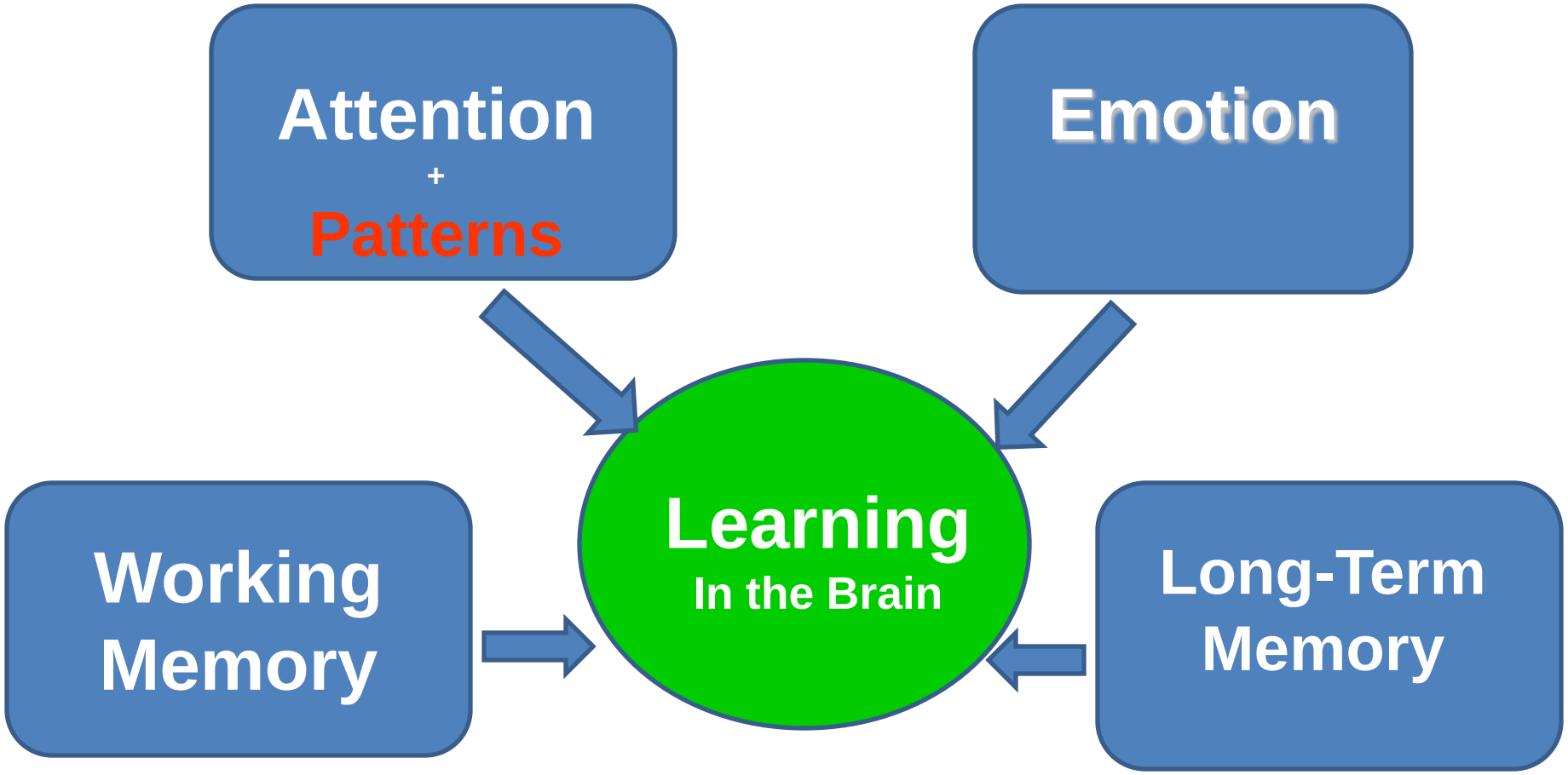
Modern Understanding Started With An Accident



Phineas Gage

The Brain is the most complex system in the universe

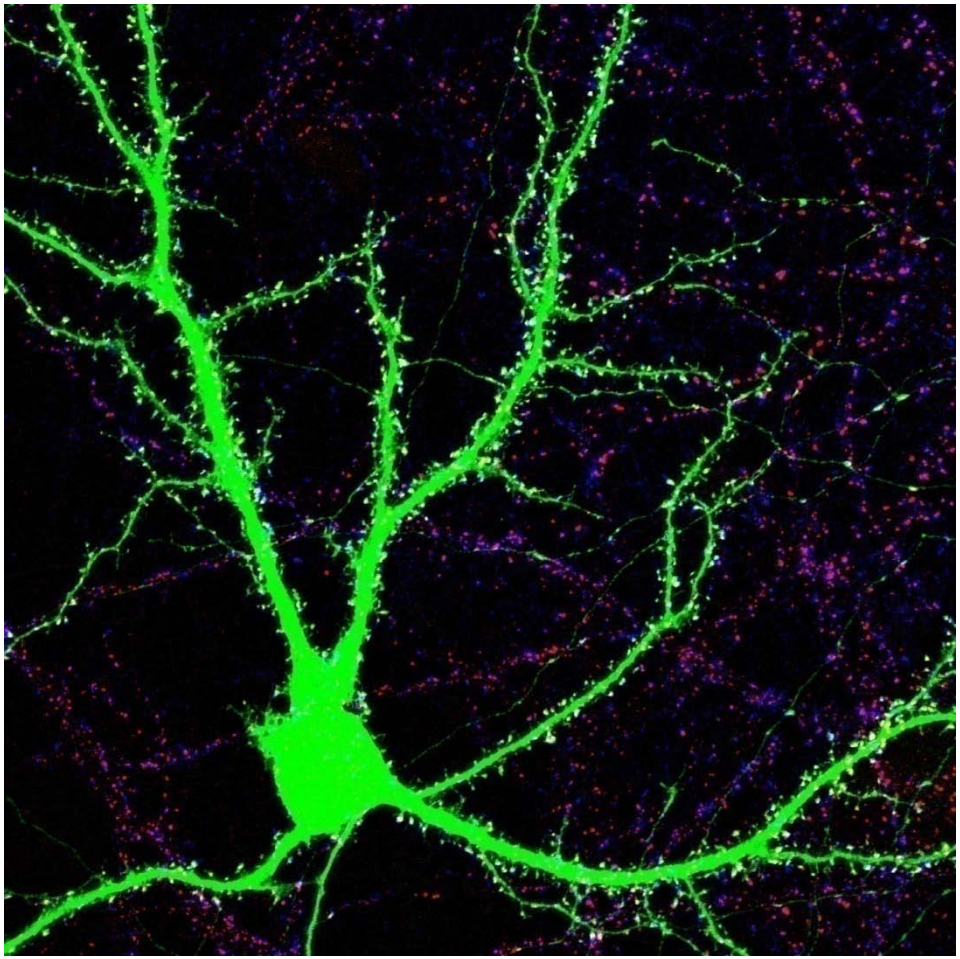

Cognitive
Neuroscience
Cognitive Psychology
Neuroeducation
Education


Attention
+
Patterns
Emotion
Learning
In the Brain
Working Memory
Long-Term Memory

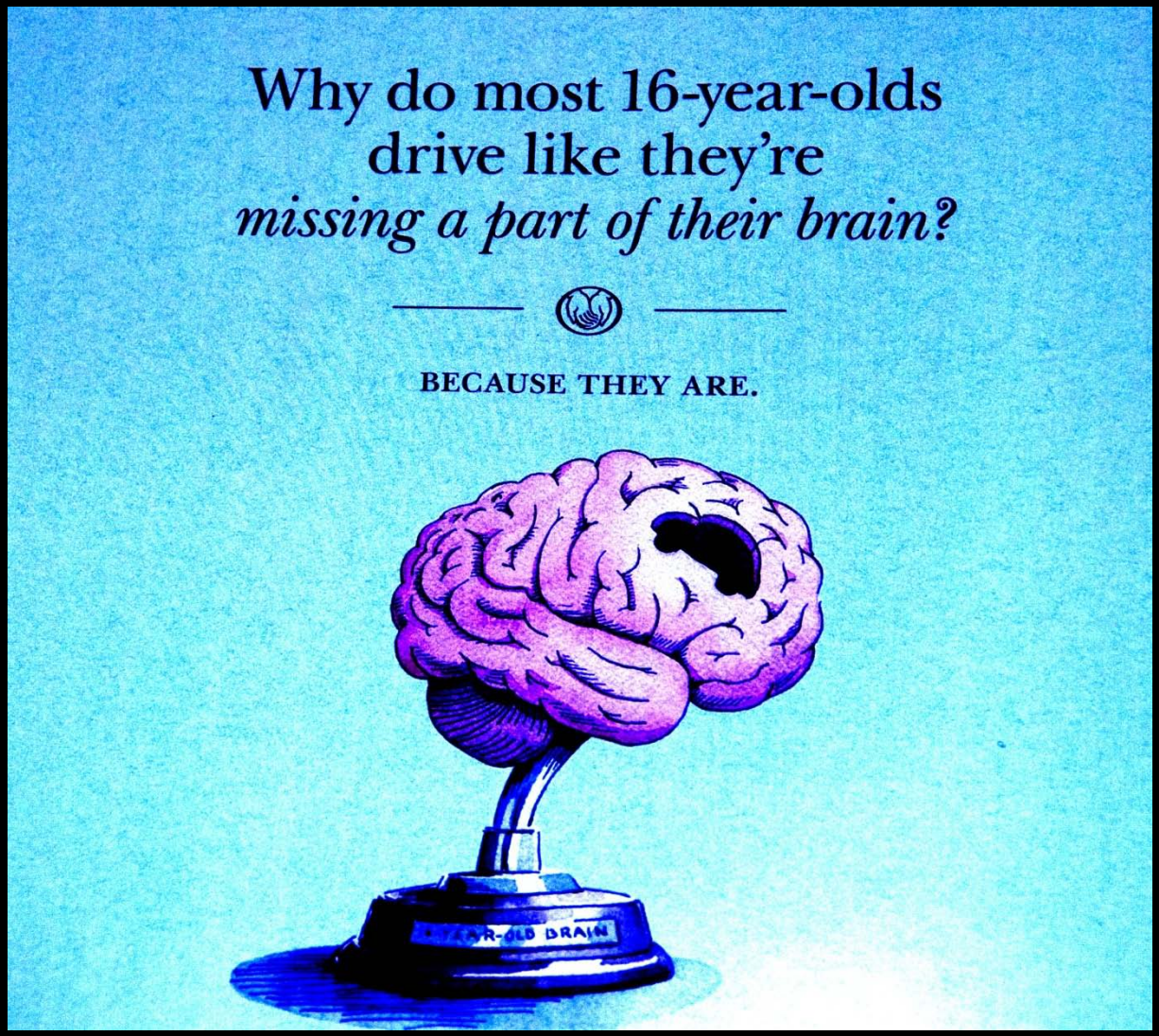
The Context:

How The Brain Grows

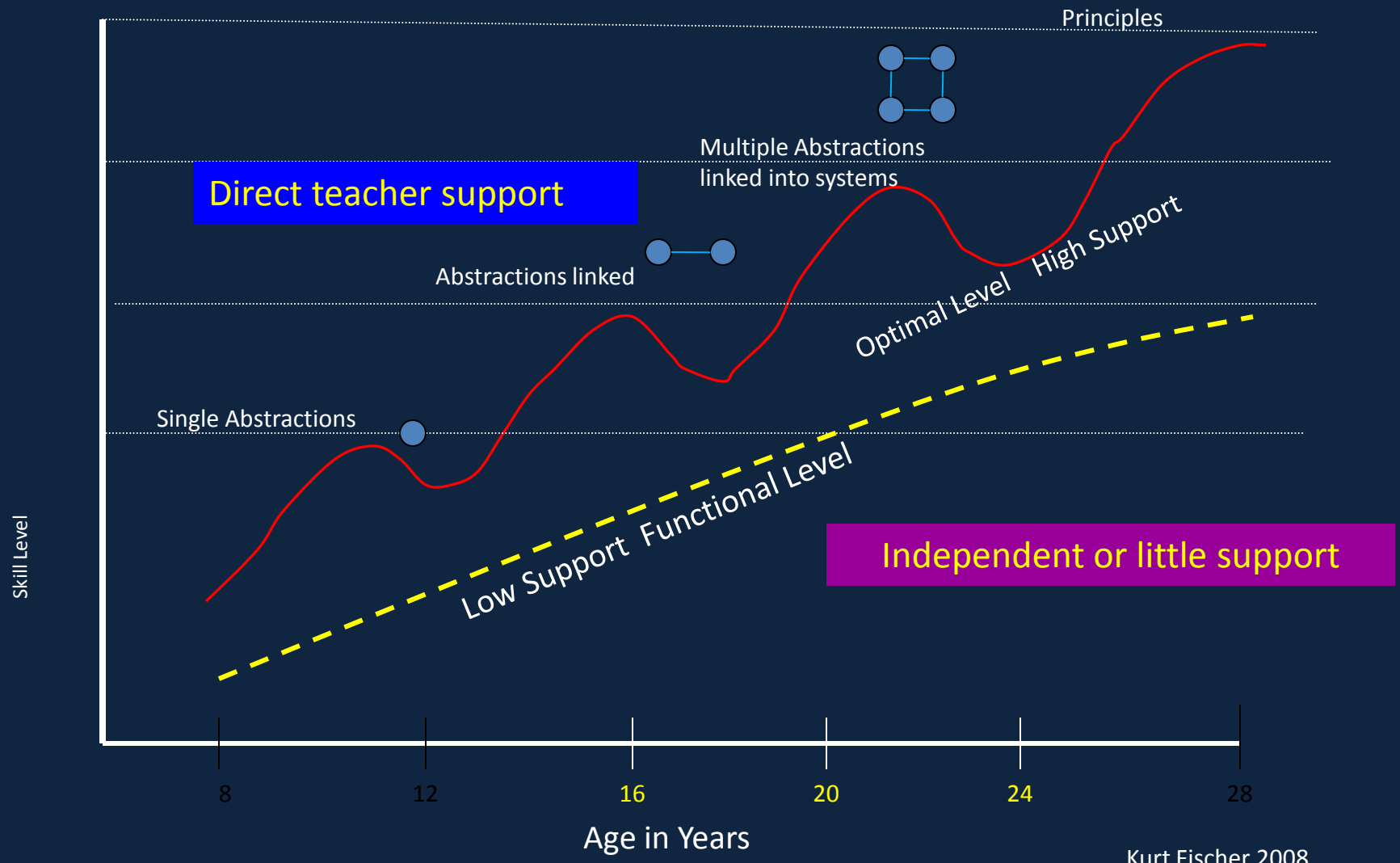
Pruning & Growing Dendritic Spines



Some knowledge about the brain is becoming common



Cycles in Cognitive Development



Kurt Fischer 2008

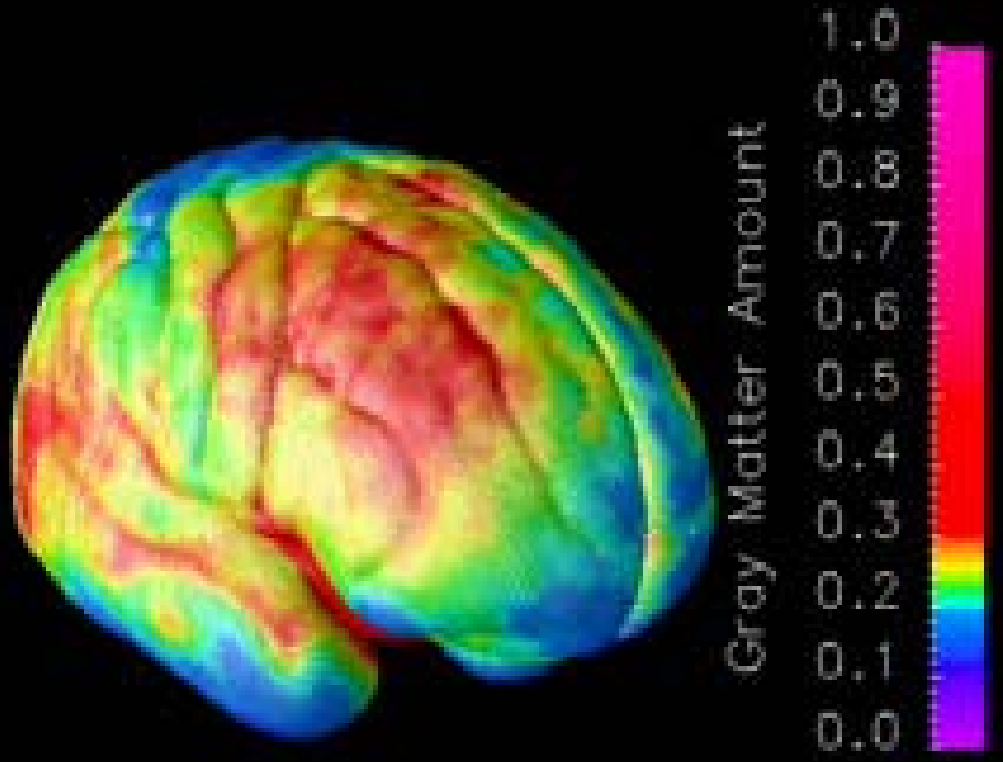
Cycles of Brain Growth

- 3 Cycles during adolescence, NOT STAGES
- 10-12 Years (middle school)
- 14-16 Years (Frosh-Soph)
- 18-20 Years (Seniors +)
- Cycles have chaos-fractal patterns

(From K. Fischer, 2000)

Inhibitory Controls Among Last to Mature:

- Implusivity
- Distractibility
- Higher Reasoning-Logic



Adolescence:
(not yet fully adult brain)

Age 10-11 to 25/30 years

- Have difficulty recognizing patterns
- Less impulse control
- Less planning/anticipating consequences
- Less emotional control

Skill Acquisition

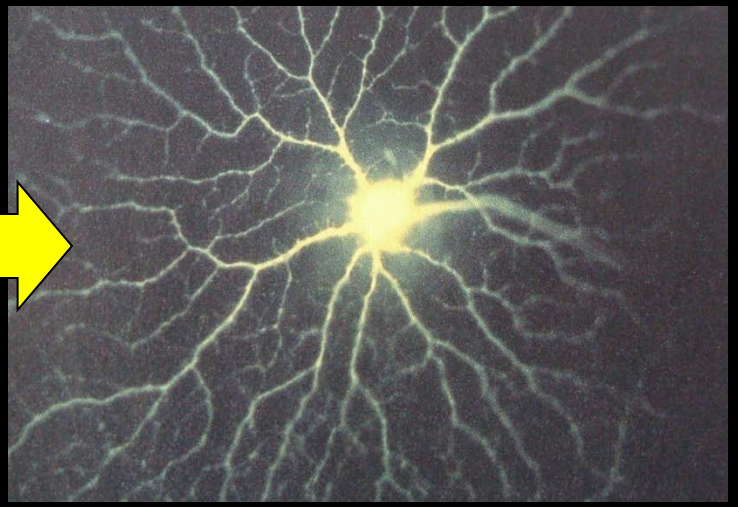
Adapted from:
Ruhland, R., & van Geert, P., (1998).

Skill Acquisition

Errors with emotional valence & salience, BDNF probably generated

Use It or Lose It

Under Stimulated
Neuron



A neuron that has be
“used” or Stimulated

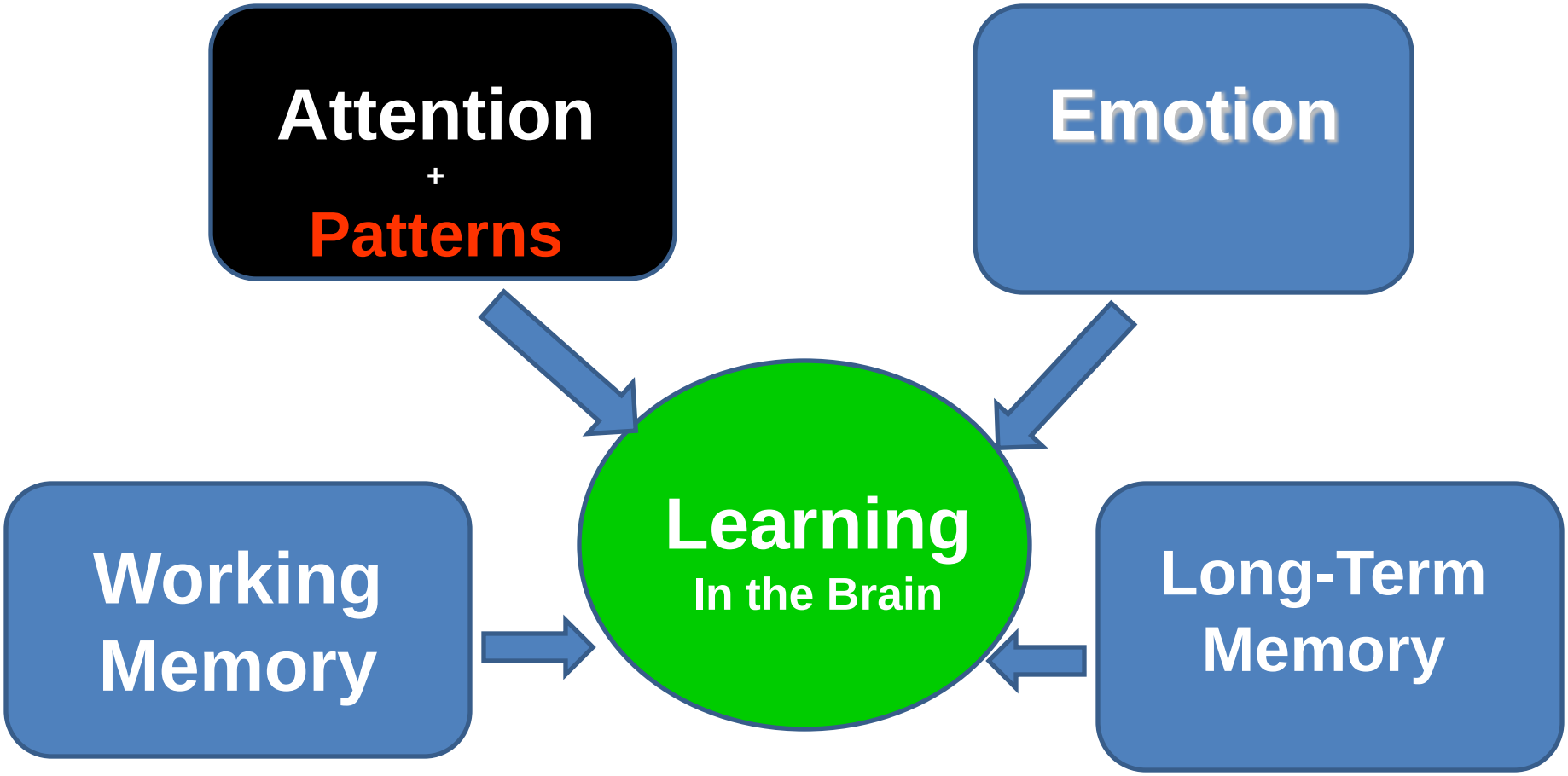
Implications

- Trained teachers elicit higher performances
- No errors = little or no learning
- w/ea new skill, performance initially drops

OLD School

Non-expert trainers (just as patient is not a expert just because they've experienced medicine, a parent is not an expert just because they drive)

Few controlled mistakes?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Attention
+
Patterns

PATTERNS

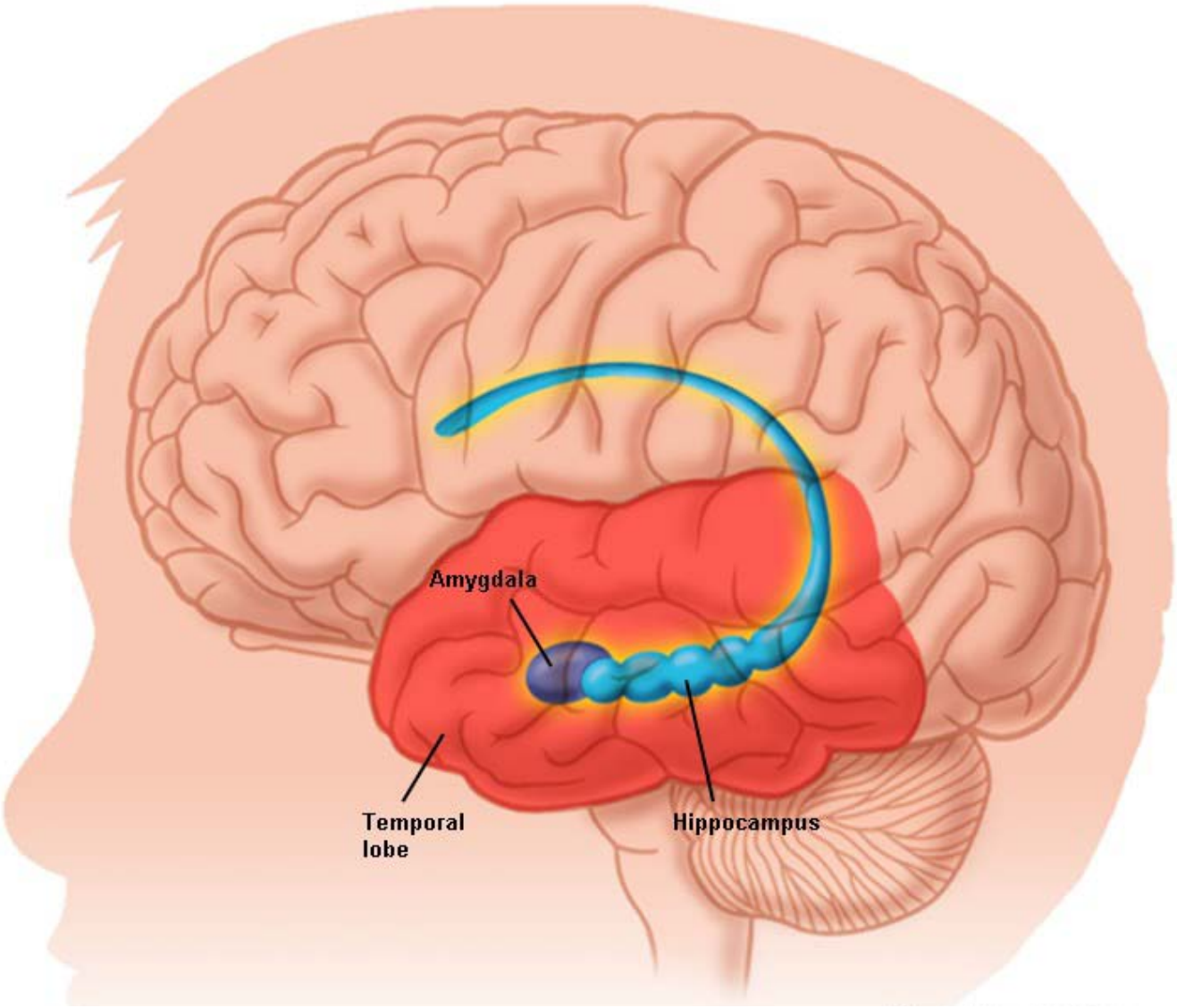
We process information
to find Patterns

Patterns

- Some have Emotional Significance
- Certain Patterns Change our Attention

Patterns → Recognition → Attention

Patterns → Recognition → Attention

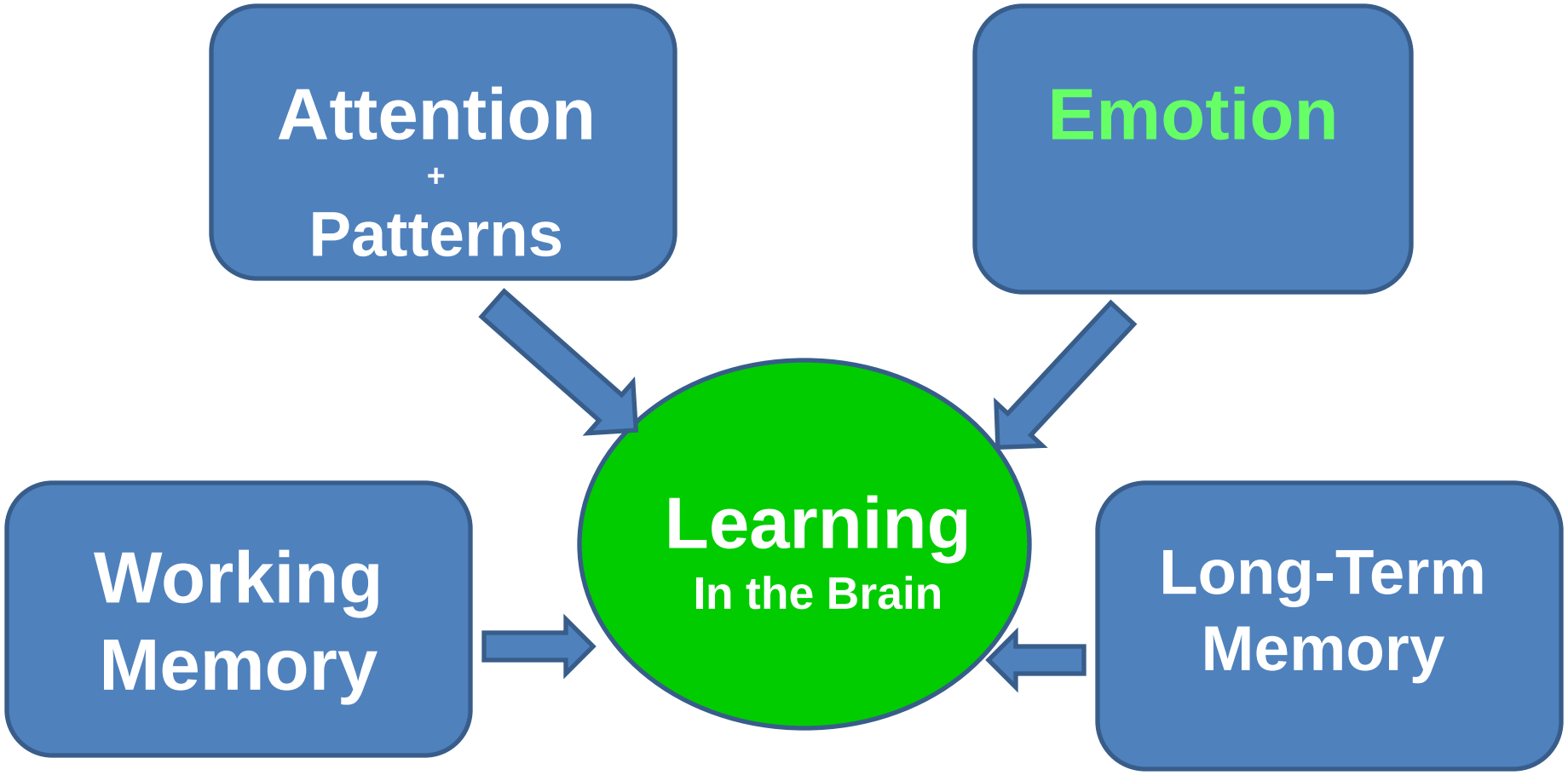

Amygdala
Temporal lobe
Hippocampus

Implications

- Students must first recognize patterns
- Brain recognizes ***large*** differences first, then smaller ones…(The snake body easier to spot than head)
- Suggests teaching subtleties ***after*** teaching initial large differences.

OLD School:

- We did not directly and repeatedly work on pattern recognition
- Students became confused trying to recognize small differences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Emotion

Emotions

- Powerful learning tool
- Experiences are emotion laden
- ***Rarely forgotten when there are personal consequences***

Emotions Affect Learning

If it's emotionally important, the brain pays attention

Incomplete Frontal Lobe Development In A Group

- What happens to judgment?
- What happens to anticipating how *others* will feel?
- What happens to anticipating how *they* will feel?

Their Perception Is Their Reality

Perception of threat

affects the ability to THINK & LEARN

Implications

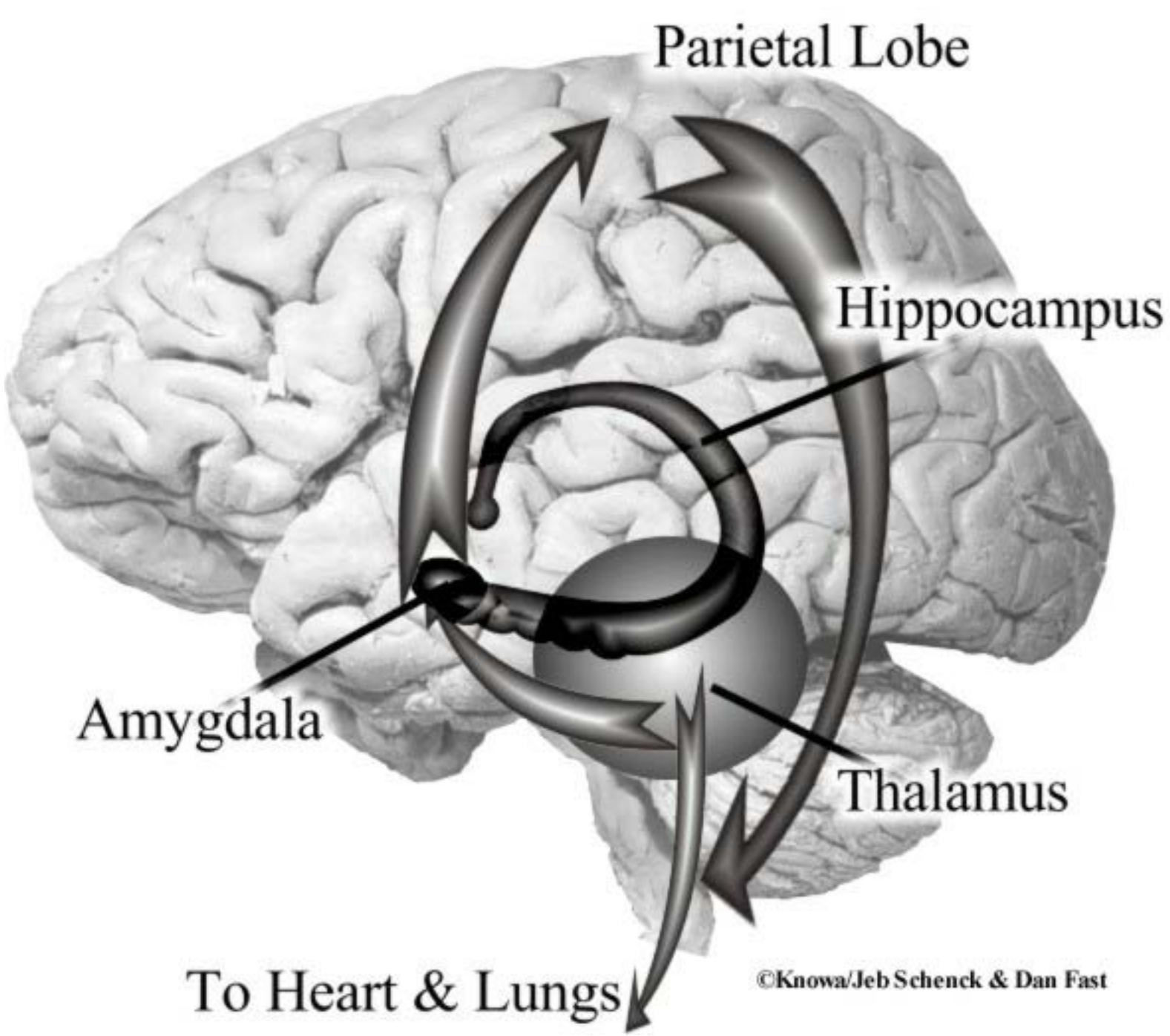
- Learning events with high personal *significance* are better remembered (High valence and salience)
- Learning events with personal *consequence* are better remembered*
- Suggests actual practice (simulated or closed course learning with errors..) better remembered

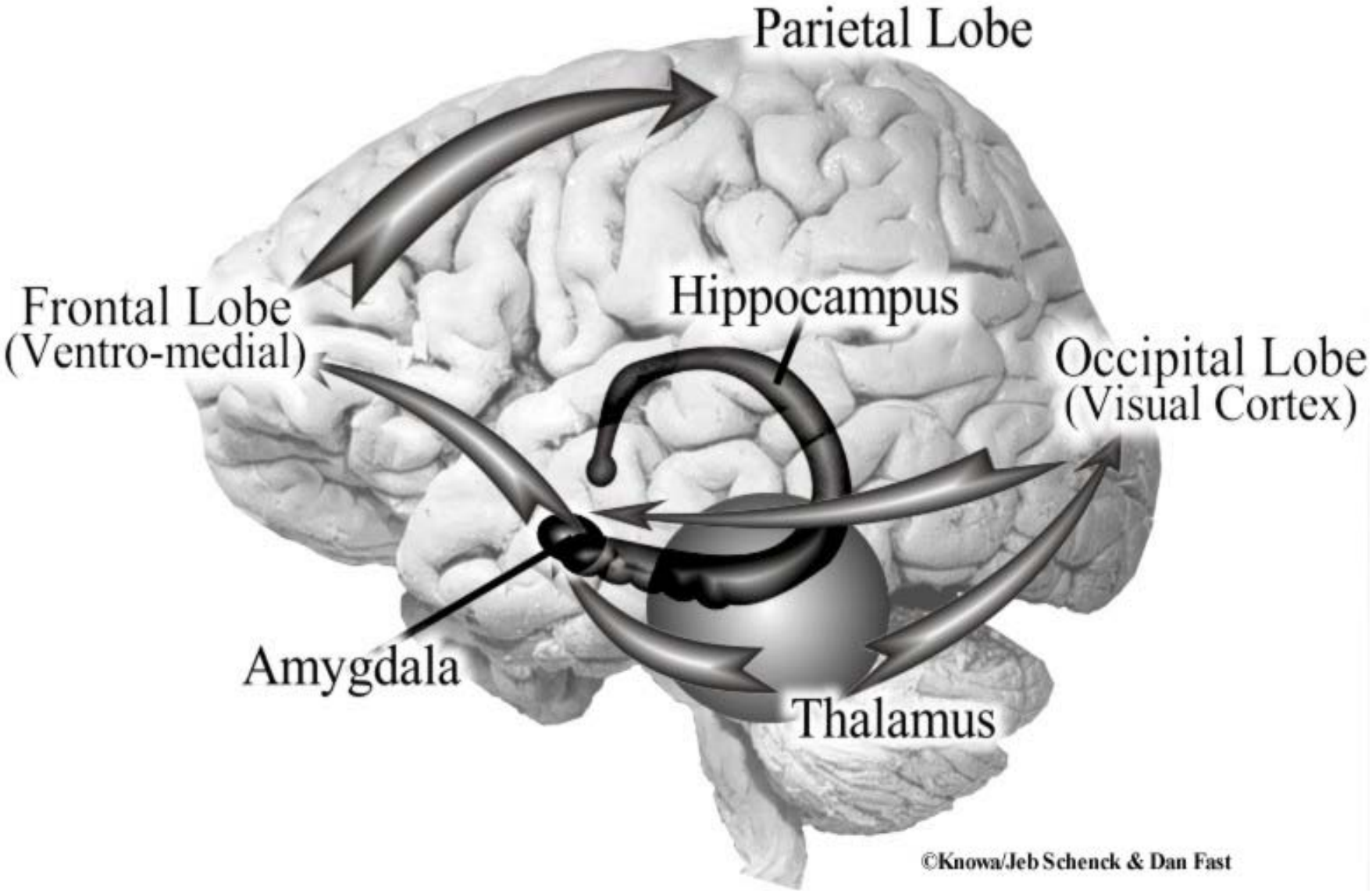
Old School

We talked, but students did not experience

They did not experience significant failure in controlled conditions

*There is a genetic deficit for about 30% of drivers;
BDNF Val^{66}Met Polymorphism Influences Motor System Function in the Human Brain by **McHughen, Cramer, et al. Cerebral Cortex, 2009,** doi:10.1093/cercor/bhp189


Parietal Lobe
Hippocampus
Amygdala
Thalamus
To Heart & Lungs
©Knowa/Jeb Schenck & Dan Fast


Parietal Lobe
Frontal Lobe
(Ventro-medial)
Hippocampus
Occipital Lobe
(Visual Cortex)
Amygdala
Thalamus
©Knowa/Jeb Schenck & Dan Fast

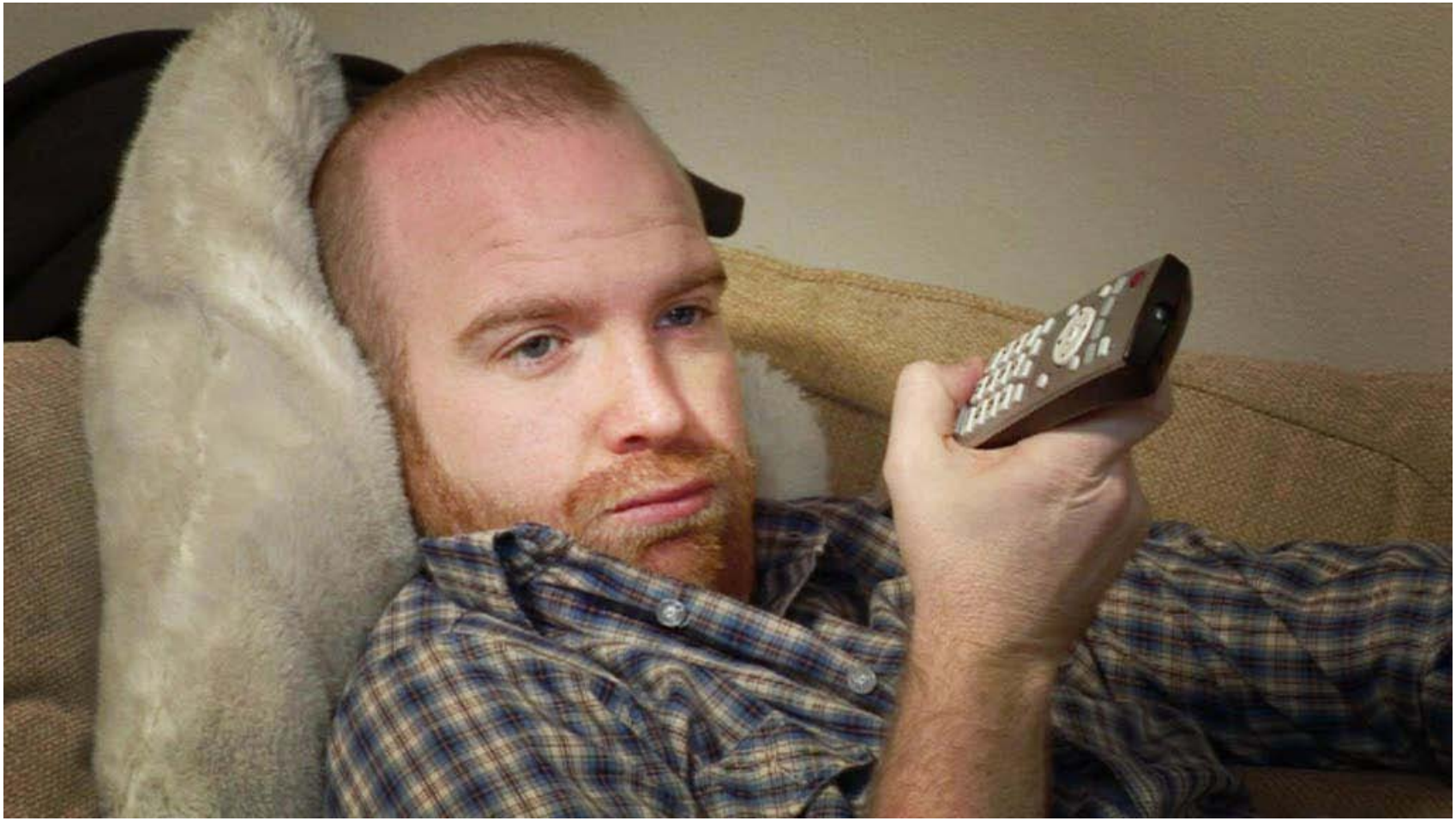
In effect, all animals are under stringent selection pressure to be as stupid as they can get away with.

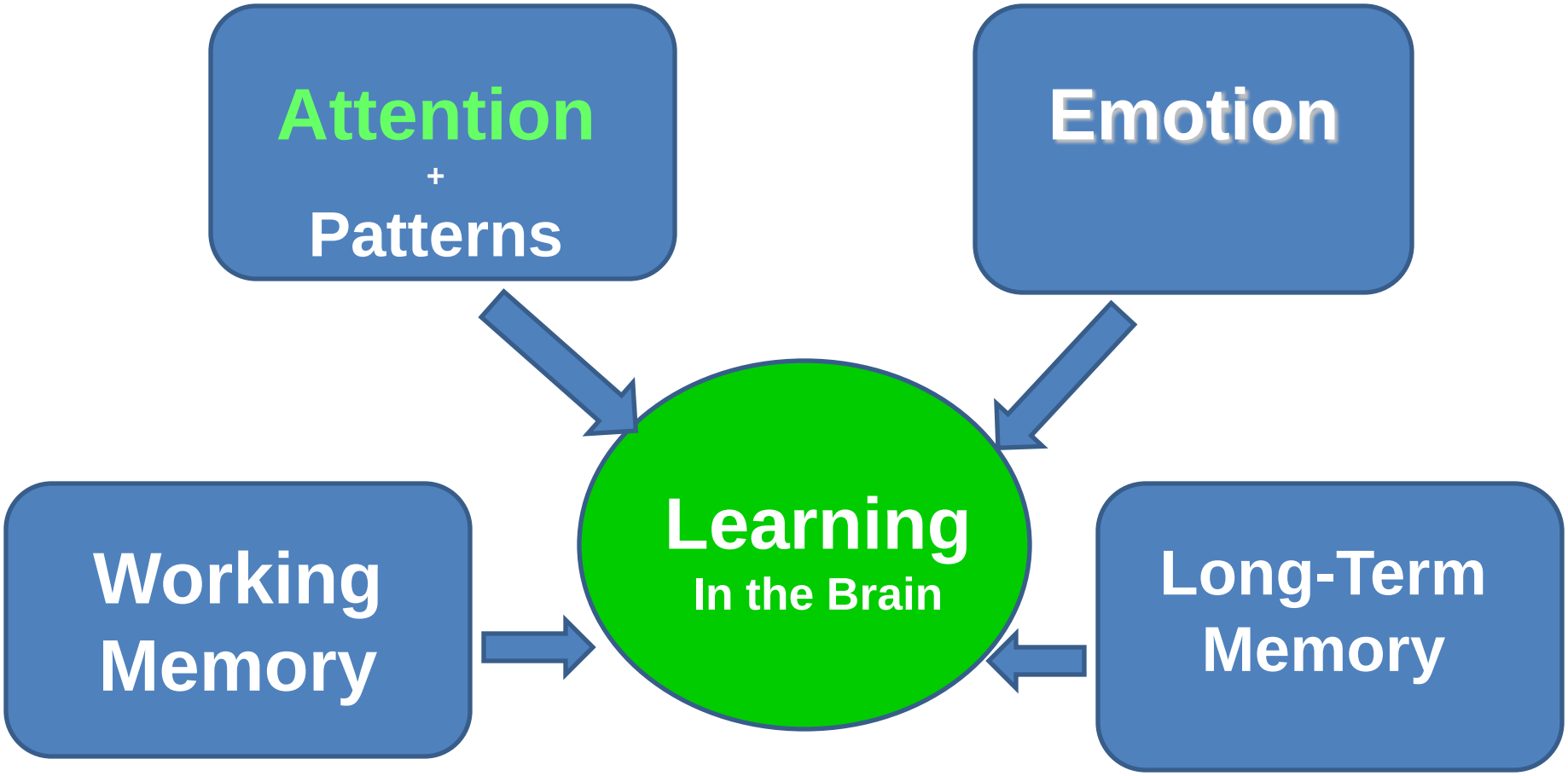
Richerson & Boyd,

Not By Genes Alone, 2005.

The default state in solving a problem is to do as little as possible.

Brain in default state

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Attention

Attention

Applied Cognitive Laboratory
University of Utah: David Strayer PI

Attention

- Mirror Systems & Modeling
- Divided Attention
- Limited Capacity (with Working Memory)
- It is NOT a matter of learning styles (EX. visual learner vs. auditory learner is a neuromyth*)

*Pashler, et al 2010 in press

Attention

Multitasking is a ***Myth***

Divided Attention

- Attention Systems are limited: What is it, Where is it?

Implications

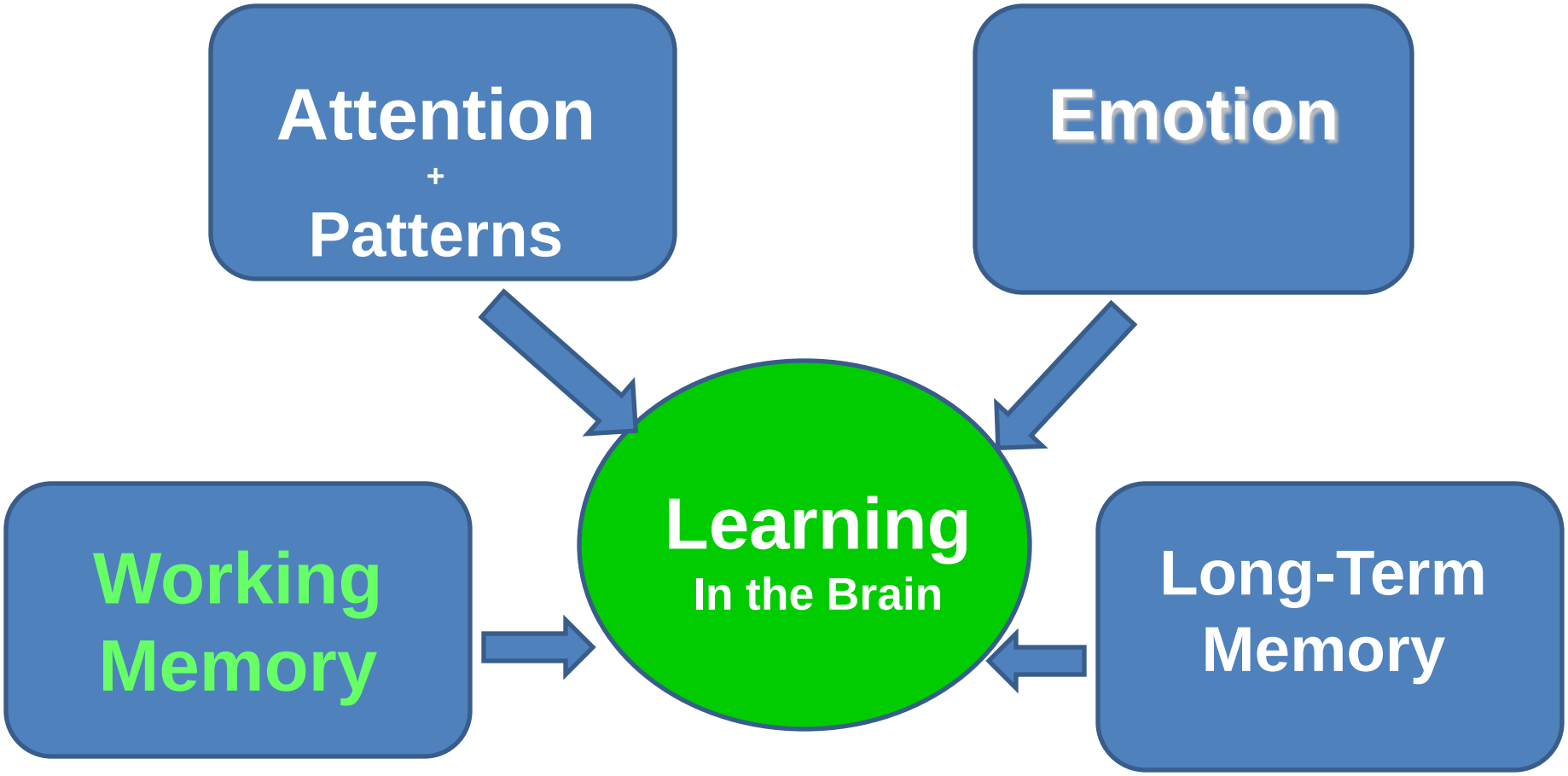
- The brain doesn't multitask (This applies to instruction as well as driving)
- The brain pays attention to modeling (both good & bad)
- Interspersed learning better than blocks of concentrated learning
- Weave between classroom-simulation-field

OLD School

Taking notes & listening

Blocks of classroom-simulation, followed by field experience

No field experience until well after "lecture"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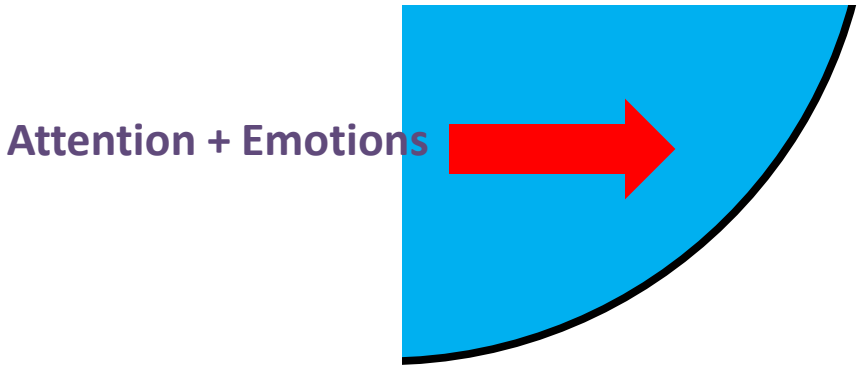
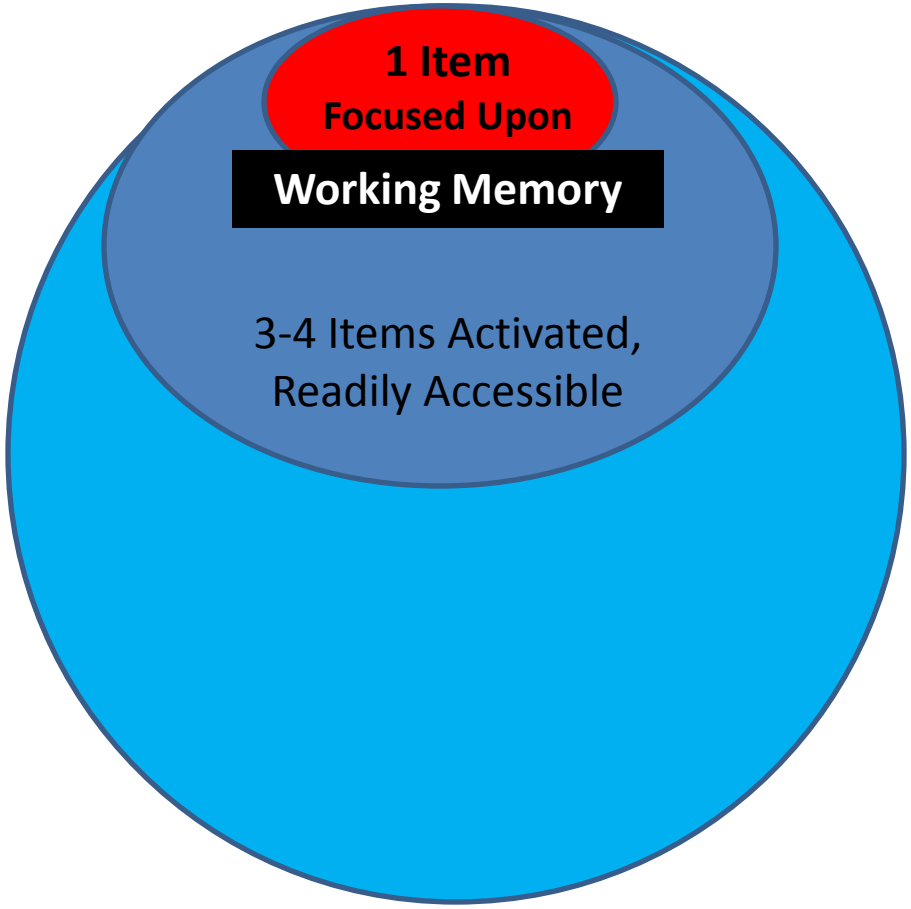
Working Memory

Working Memory

- It is what your are thinking about RIGHT NOW!



Cowan, 2005


1 Item
Focused Upon
Working Memory
3-4 Items Activated,
Readily Accessible

Decision Making:

Combines

Emotion +Attention +Memory

Schenck, 2010, In Press

Decision Making

- We *THINK* we're are making a conscious choice
- But the mind has already decided
- 1st Decision is made non-consciously
- 2nd Then we are consciously "let in on it"
- How do we train for this?
- Train for BOTH non-conscious & conscious levels

Decision
Making

Implications

- WM easily overloaded
- WM can be trained to have more information readily available (Cogmeg®)
- Skills moved up to automaticity frees more Working Memory & more Attention Reserves for processing current information
- Genetic deficits interfere, but may possibly be trained around
- Vigilance may last only 10-30 minutes… More accidents?

Old School

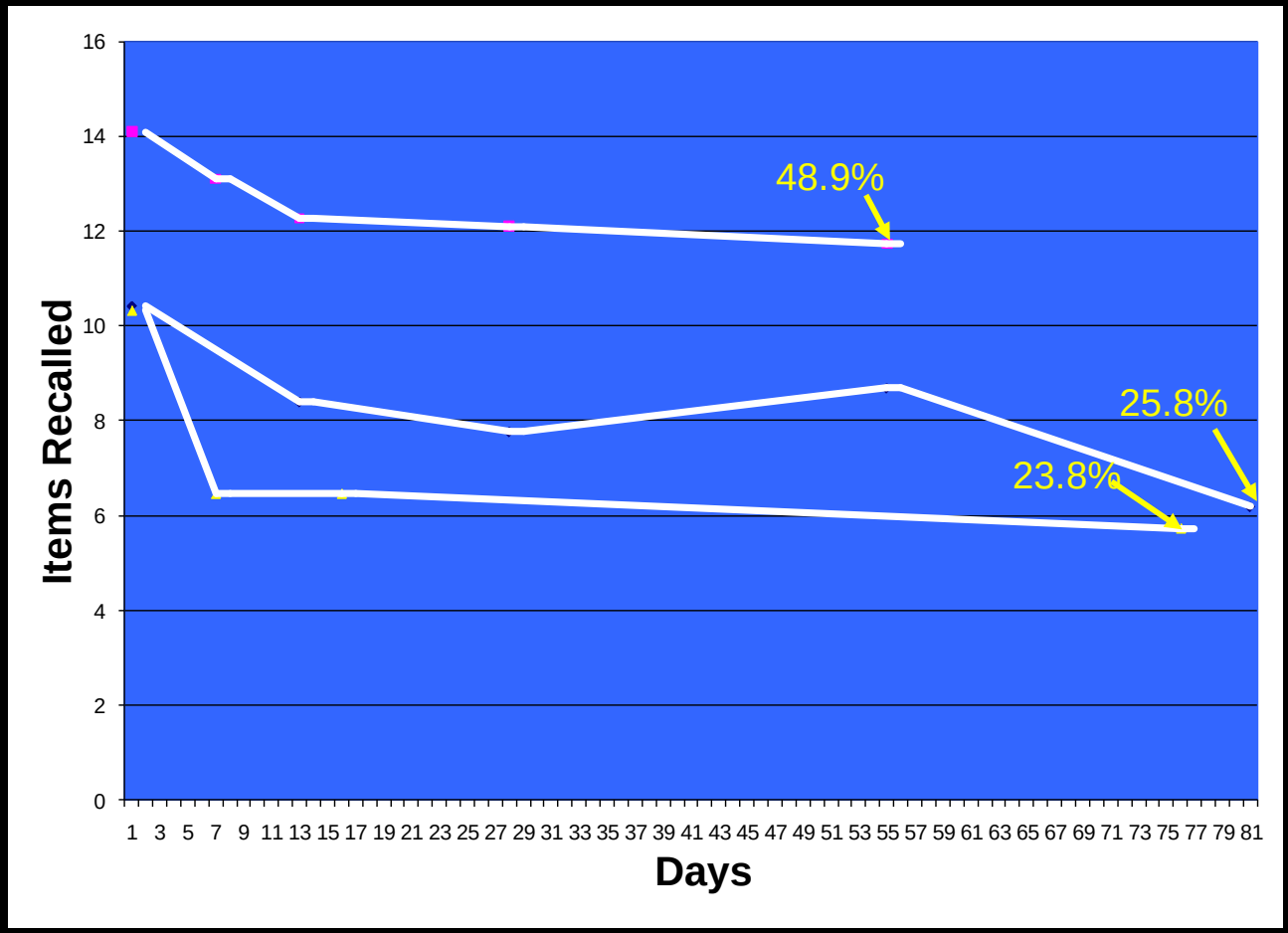
Lots of information, few or no pauses,

Passive initial learning (student is the “receiver” of information)

Students play catch up

Long-Term Memory

Stabilizes in about 10-14 days



Long-Term Memory

- Memory stabilizes after about 10-14 days[1]
- **Distributed Practice Effect**, Practice events further apart are harder, but produce longer lasting memory[2]
- **Test Effect,** Repeated Practice under real conditions is better than only a few real practices.[3]
- Suggests Behind the Wheel in ***subtle-threshold conditions*** can be very important

1. Schenck, J. (2003)
2. Rohrer, D. & Pashler, H. (2007).
3. Roediger, H.L., & Karpicke, J. D. (2006).

Implications

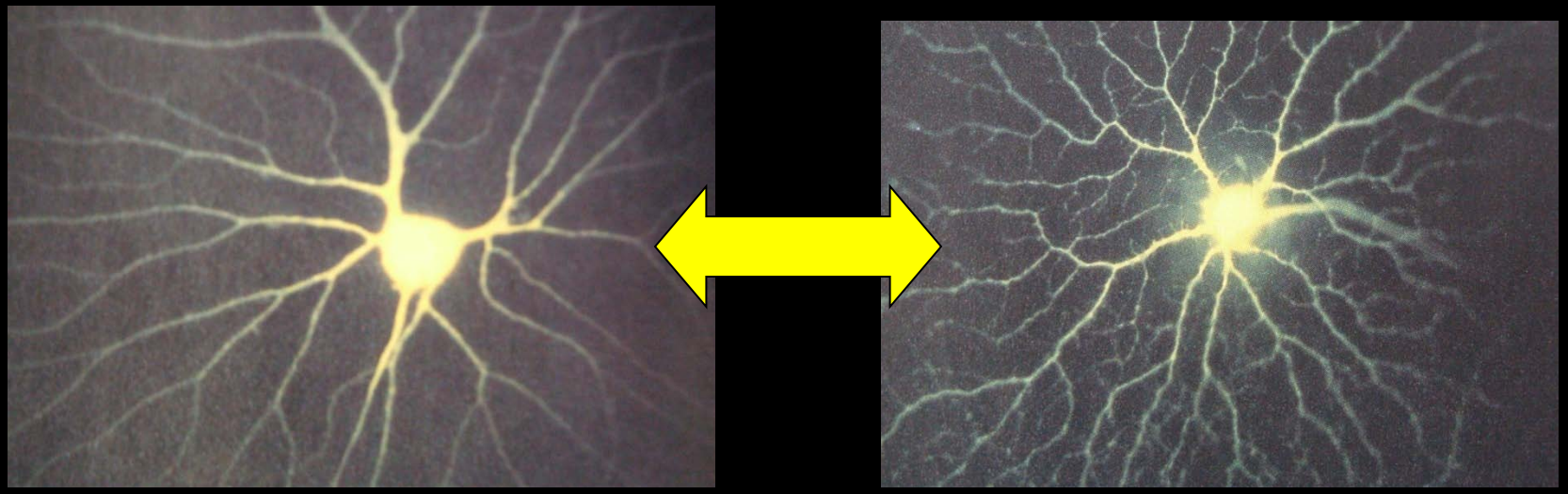
- Experiential learning better remembered than classroom lecture
- Practices/tests spaced
- ACTION + creates BDNF & strong memories

Old School

Testing typically within a day or two of classroom lecture

Assessments lacked authentic/simulated conditions

BDNF (Brain Derived NeuroFactor)
promotes dendrite growth & connections,

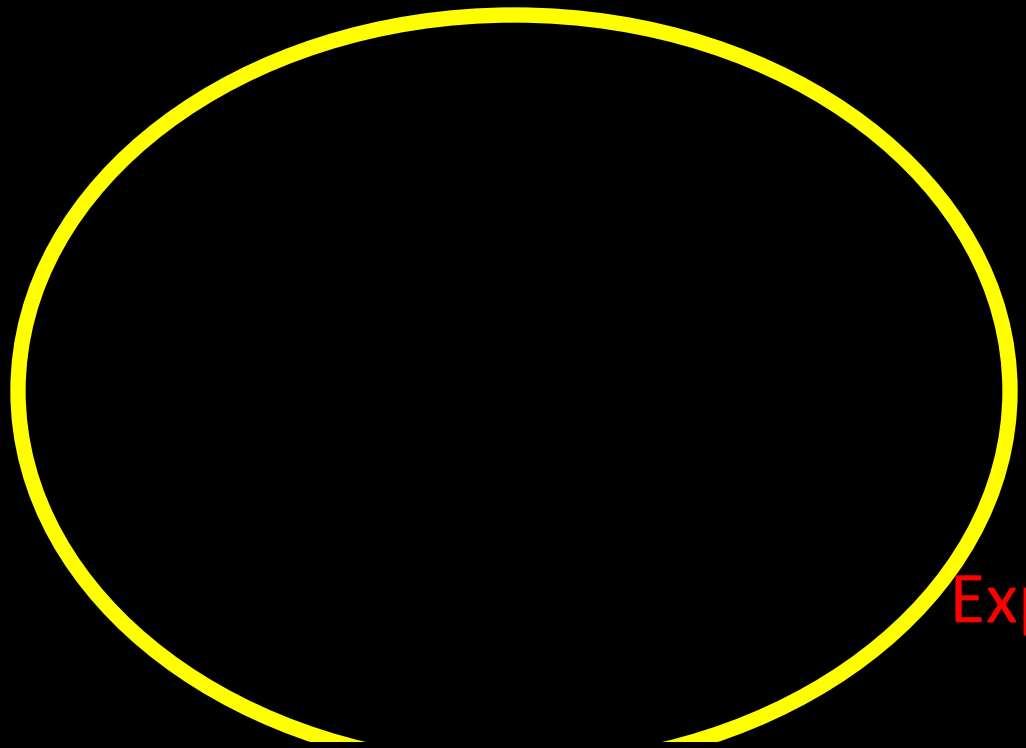


Generated by experience & physical activity

Genetic Issues

- 30% may be have a mutation reduces/prevents traditional experiential learning* (Clearly procedural memories are made—why the difference in procedural memory?)
- Apparently several possible procedural memories
- Alternative training may be needed, possibly different developmental learning curve
- RNA silencing protein? Dopamine role?

* **BDNF Val^{66}Met Polymorphism Influences Motor System Function in the Human Brain** by **McHughen, Cramer, et al. Cerebral Cortex, 2009,** doi:10.1093/cercor/bhp189


Experiential E

Considerations

- Trained teachers elicit higher performances
- No errors = little or no learning
- w/ea new skill, performance initially drops
- directly and repeatedly work on pattern recognition
- Students become confused trying to recognize small differences
- Brain recognizes large differences first, then smaller ones…
- Suggests teaching subtleties ***after*** initial large differences.
- Learning events with high personal significance are better remembered (High valence and salience)
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- Weave between classroom-simulation-field
- Train for BOTH non-conscious & conscious levels (automaticity)
- WM easily overloaded
- WM can be trained to have more information readily available (Cogmed®)
- Neuroerognomics of attention & vigilance
- Vigilance may be trained? Monitor with Doppler Sonography—TDS Transcranial Doppler Sonography- portable
- Experiential learning better remembered than classroom lecture
- Practices/tests spaced
- ACTION + creates BDNF & strong memories
- 30% with genetic variation reduces experiential learning, possible alternative training needed

References

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