Emotion and Learning

Threat and anxiety in math: a case study

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www.affectacademics.com/pd

Universal Design for Learning

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Recognition Networks

The "what" of learning

How we gather facts and categorize what we see, hear, and read. Identifying letters, words, or an author's style are recognition tasks.

Strategic Networks

The "how" of learning

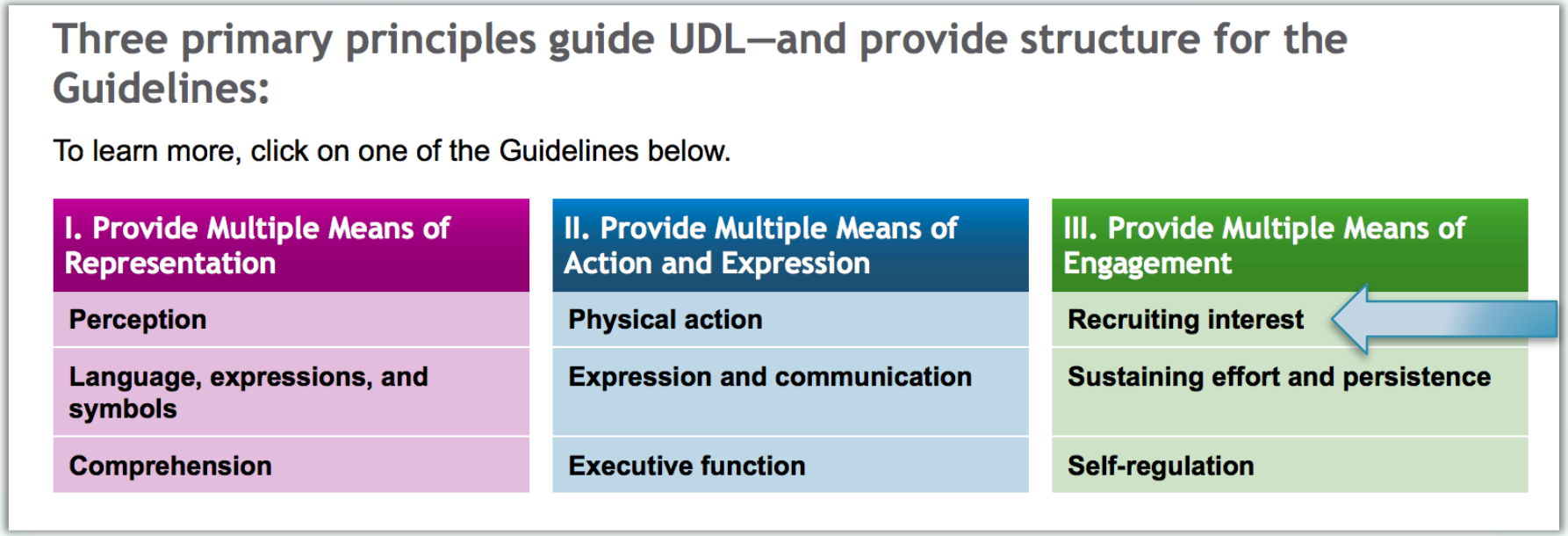
Planning and performing tasks. How we organize and express our ideas. Writing an essay or solving a math problem are strategic tasks.

Affective Networks

The "why" of learning

How learners get engaged and stay motivated. How they are challenged, excited, or interested. These are affective dimensions.

udlcenter.org, cast.org

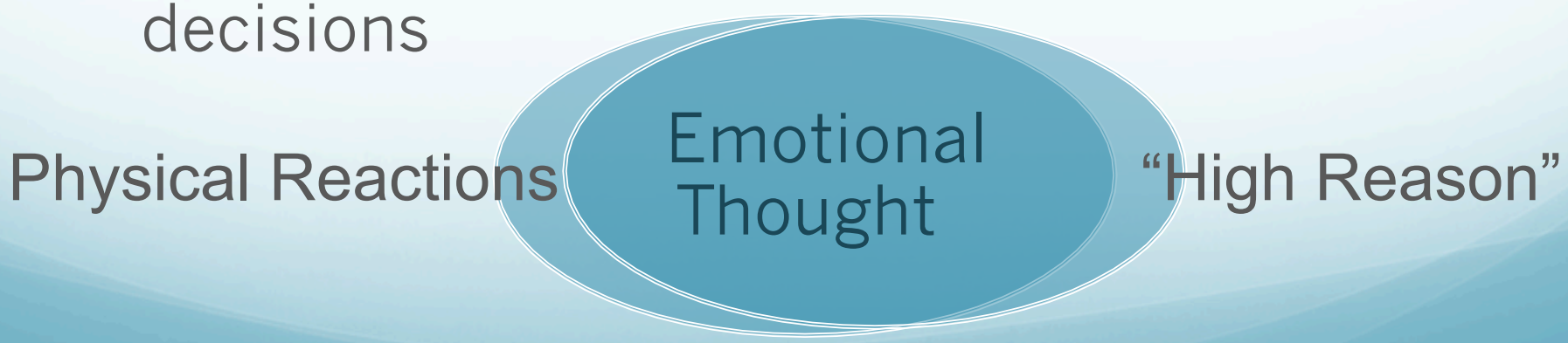


UDL Guidelines

http://www.udlcenter.org/aboutudl/udlguidelines

Research in Affective Neuroscience

- Learning, attention, memory, decision making, and social functioning are all controlled by emotion
- People whose emotional centers are damaged cannot make “rational” decisions



Immordino-Yang and Damasio, 2007

Recruiting interest
(Guideline 7)

- Optimize individual choice and autonomy
  - Giving students control over even a very small aspect of the assignment increases engagement
- Optimize relevance, value, and authenticity
  - Real world problems, as interdisciplinary as possible
- **Minimize threats and distractions**
  - Vary the level of risk, social demand, and sensory stimulation
  - Math anxiety and stereotype threat are significant

http://www.udlcenter.org/aboutudl/udlguidelines/principle3

What is Math Anxiety?

- State anxiety (vs. trait anxiety) only present when doing math
- Different components of math anxiety:
  - Affective - general fear of or dislike of math
  - Social/performance - board work in front of class, small group work with peers
  - Test anxiety
- Math Anxiety Rating Scales

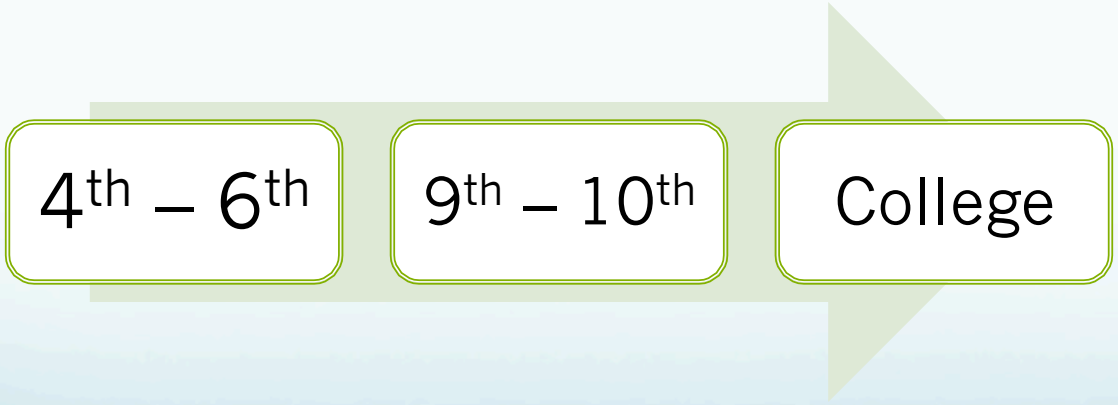
Anxiety vs. Threat

- Math Anxiety: Decreased performance stems from conscious worry over an expectation of high performance level

- Stereotype Threat: Decreased performance due to unconscious negative effects from an expectation of low performance level

Ages of Onset

- 93% of American adults self-identify as being bad at or disliking math
- Three major ages of anxiety onset (Hembree, 1990):

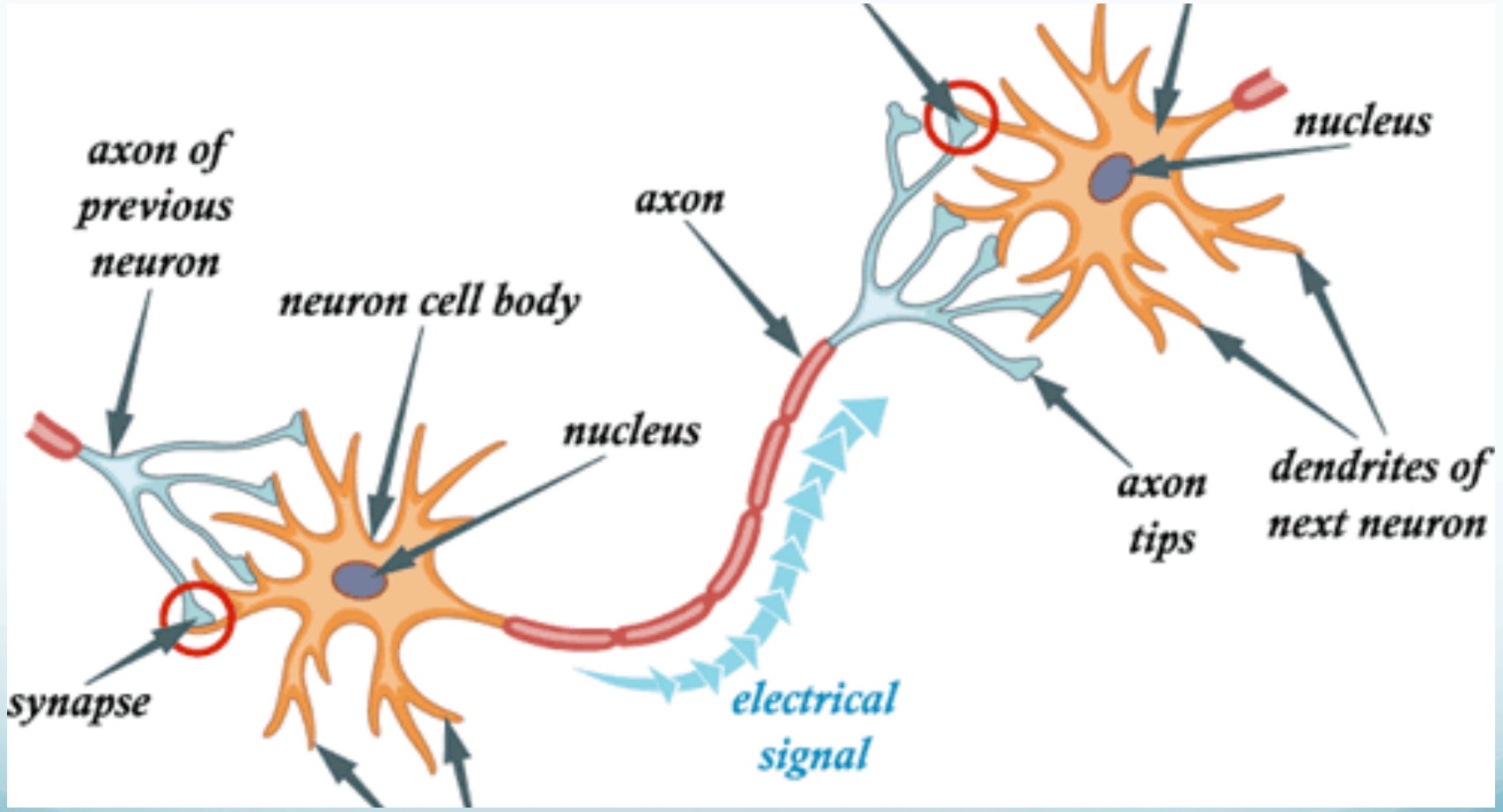


- Grades 1-3 are more likely to present with stereotype threat (Beilock et al, 2010)

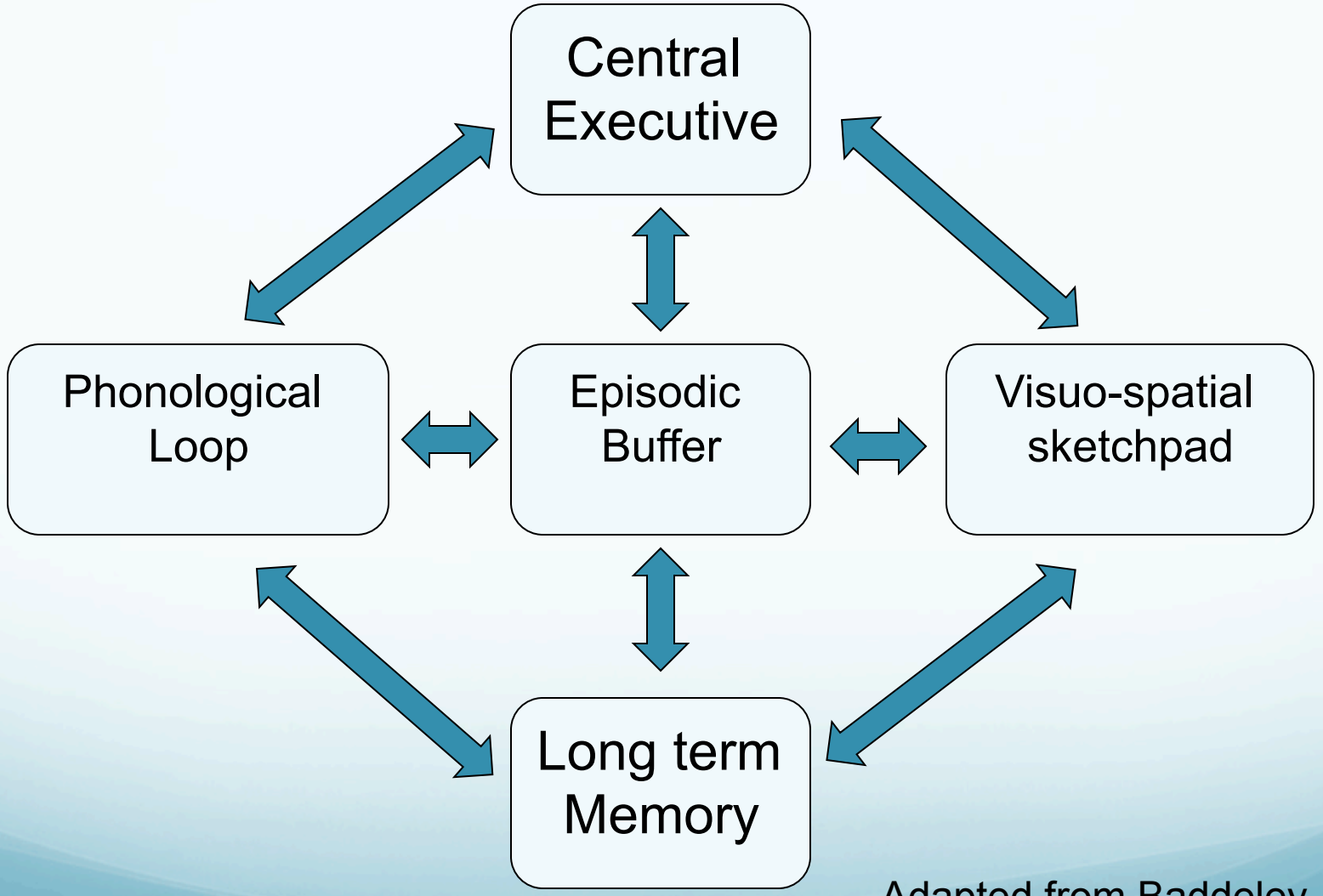
Mirror Neurons and Math

- Both math anxiety and stereotype threat are largely due to modeled behavior by parents and teachers
  - Mirror neurons and emotional alignment
    - Body posture, eye movements, facial expression
  - Not attributable to math content
- Math anxious teachers spend less time preparing for math classes, less time teaching it
  - Teach skills instead of concepts
  - Model math avoidance

The learning brain



Working Memory



Adapted from Baddeley, 2010

Working Memory and Math

- Working memory is taxed by mental arithmetic: carrying, borrowing
- Highly anxious people do worse on tasks that require working memory capacity
- Controlling for anxiety and taxing working memory reveals the same effect
- WM is NOT involved in rote memory tasks like retrieving simple math facts

(Ashcraft, 2002)

8 + 3

$$\begin{array}{r} 588 \\ +\ 749 \\ \hline \end{array}$$

269 + 573

6 + 7

478 + 635

Why intervene?

- 78% of job growth is in STEM fields
- Accountability (Ashcraft & Moore, 2009): after anxiety onset in 4-5th grade, standardized tests are no longer an accurate measure of math ability
- Remediation of math anxiety is associated with over a twenty percentile point gain on standardized tests (Ma, 1999)

Prevention
Pre-K – Grade 3

- Reduce math anxiety in teachers
  - Preservice teacher training – confidence and awareness
  - Mentoring and support from experienced teachers
- Teaching techniques for positive emotion
  - Storytelling
    - Schiro, M. (2004). Oral Storytelling & Teaching Mathematics. Thousand Oaks, CA: Sage Publications.
    - Zazkis, R. & Liljedahl, P. (2009). Teaching Mathematics as Storytelling. Rotterdam: Sense Publishers.
  - Games and Manipulatives
    - Kaye, P. (1987). Games for Math. New York: Pantheon Books
    - Number Worlds Curriculum
- Growth mindset language and mindfulness education as part of the school culture
  - Mindup Curriculum, ~$15 on Amazon, grades pK-8

Prevention and Intervention
Grades 4 – 12

- Mindfulness training
  - Ten seconds of mindful breathing to clear working memory
  - Recognizing emotions (anxiety, self-doubt) and letting them pass without judgment
- Start with traditional transmission style teaching before beginning more unfamiliar techniques
- Cognitive restructuring and growth mindset
  - Catch negative statements about math and rephrase them, have the student practice
    - The power of YET
  - Support post-exam appraisals: how to think about bad/good grades to support a growth mindset
  - Mistakes as positives

Prevention and Intervention
Grades 4 – 12

- Teachers as counselors and students as mentors
  - Be careful with consoling language!
  - Use growth mindset language
- Convert feelings of anxiety from threat to challenge
- Reduce the threat level
  - Untimed or alternative assessments whenever possible
  - "Imagine yourself as a white male" – proof that the performance difference is due to structural sexism
  - Power posing
- Educational therapy or CBT/talk therapy
- Values Affirmation intervention for stereotype threat
  - Opportunity for collaboration!

Opportunities for Collaboration

- Values Affirmation intervention is best launched by English teachers
- History classes can pose math problems in context
- Art teachers can dispel the “left-brained” myth and reveal the math hidden within art
- All humanities teachers can model positive language around math teaching
  - “not a math person”
- Elementary school teachers can model anxiety-free math learning
  - Relearn math from the ground up

UDL Math Techniques

- Harness positive emotion whenever and however possible
  - Personal connections with students, teaching through games
  - Growth Mindset Language!!!
- Allow for choice whenever possible
  - Two columns of math problems of equal difficulty
  - Choices between tasks (when appropriate)
- Scaffold the level of challenge for individual learning goals
  - Different rubrics for the same task
  - Different tasks depending on individual need
- Ensure that group work is cooperative, not competitive
  - Offer the choice of individual work
  - Guidelines with clear roles and responsibilities
  - Rubrics for social behavior as well as academic work

Math Anxiety Resources

- Post, C. (2010). Too Afraid to Learn: The role of math anxiety in learning and what you can do about it. Available online at affectacademics.com/pd
- http://scpd.stanford.edu/ppc/how-learn-math-teachers
- Tobias, S. (1993). Overcoming Math Anxiety. New York: Norton & Company.
- Zazlavsky, C. (1999). Fear of Math: How to Get Over It and Get On with Your Life. New Brunswick: Rutgers University Press.

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- Beilock, S., Gunderson, E., Ramirez, G., & Levine, S. (2010). Female teachers' math anxiety affects girls' math achievement. Proceedings of the National Academy of Sciences, 107(5), 1860-1863.
- Chiu, L., & Henry, L. (1990). Development and validation of the mathematics anxiety scale for children. *Measurement and Evaluation in Counseling and Development, 23*(3), 121.
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