



Emotion and Learning

Threat and anxiety in math: a case study

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# Universal Design for Learning

## Universal Design for Learning

### 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.

## Three primary principles guide UDL—and provide structure for the Guidelines:

To learn more, click on one of the Guidelines below.

### I. Provide Multiple Means of Representation

Perception

Language, expressions, and symbols

Comprehension

### II. Provide Multiple Means of Action and Expression

Physical action

Expression and communication

Executive function

### III. Provide Multiple Means of Engagement

Recruiting interest

Sustaining effort and persistence

Self-regulation

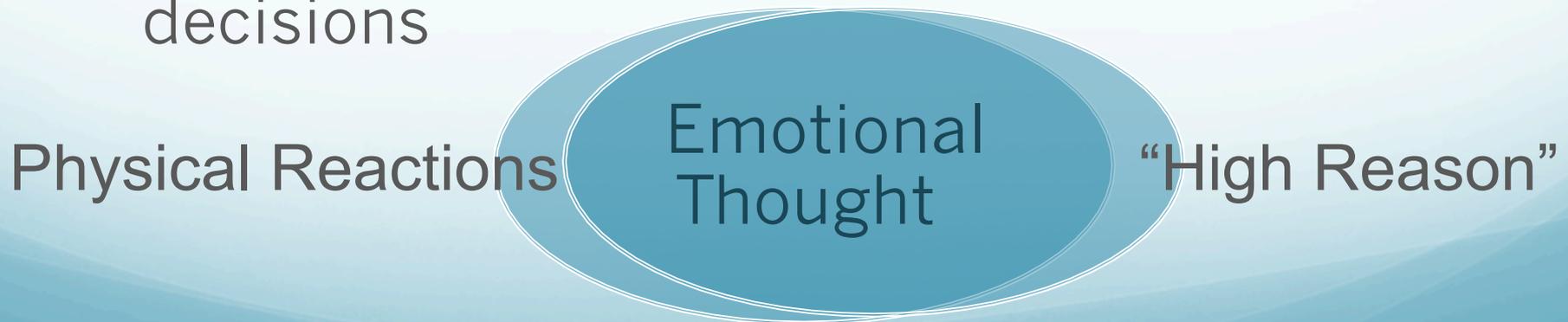


# UDL Guidelines

<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



# 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

# What is Math Anxiety?

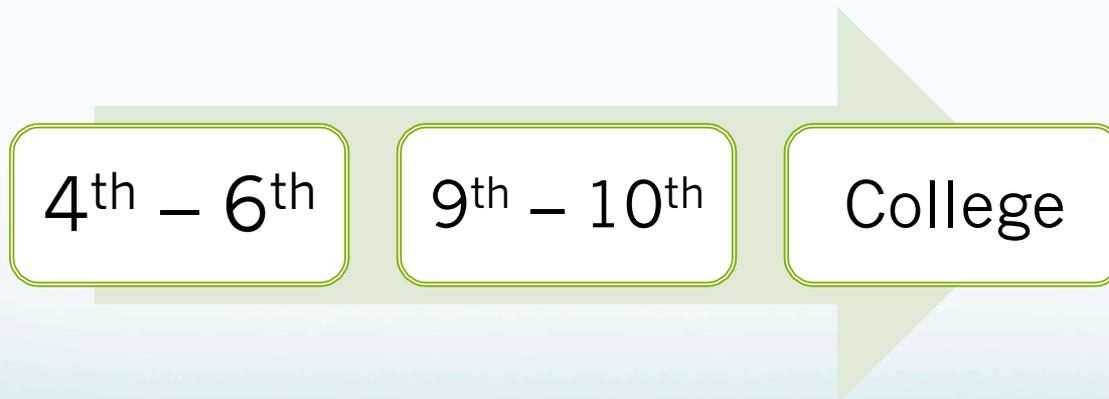
- State anxiety (vs. trait anxiety) only present when doing math
- Different components of math anxiety:
  - Affective - general fear of or dislike of math
  - Social/performance - board work in front of class, small group work with peers
  - Test anxiety
- Math Anxiety Rating Scales

# 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):

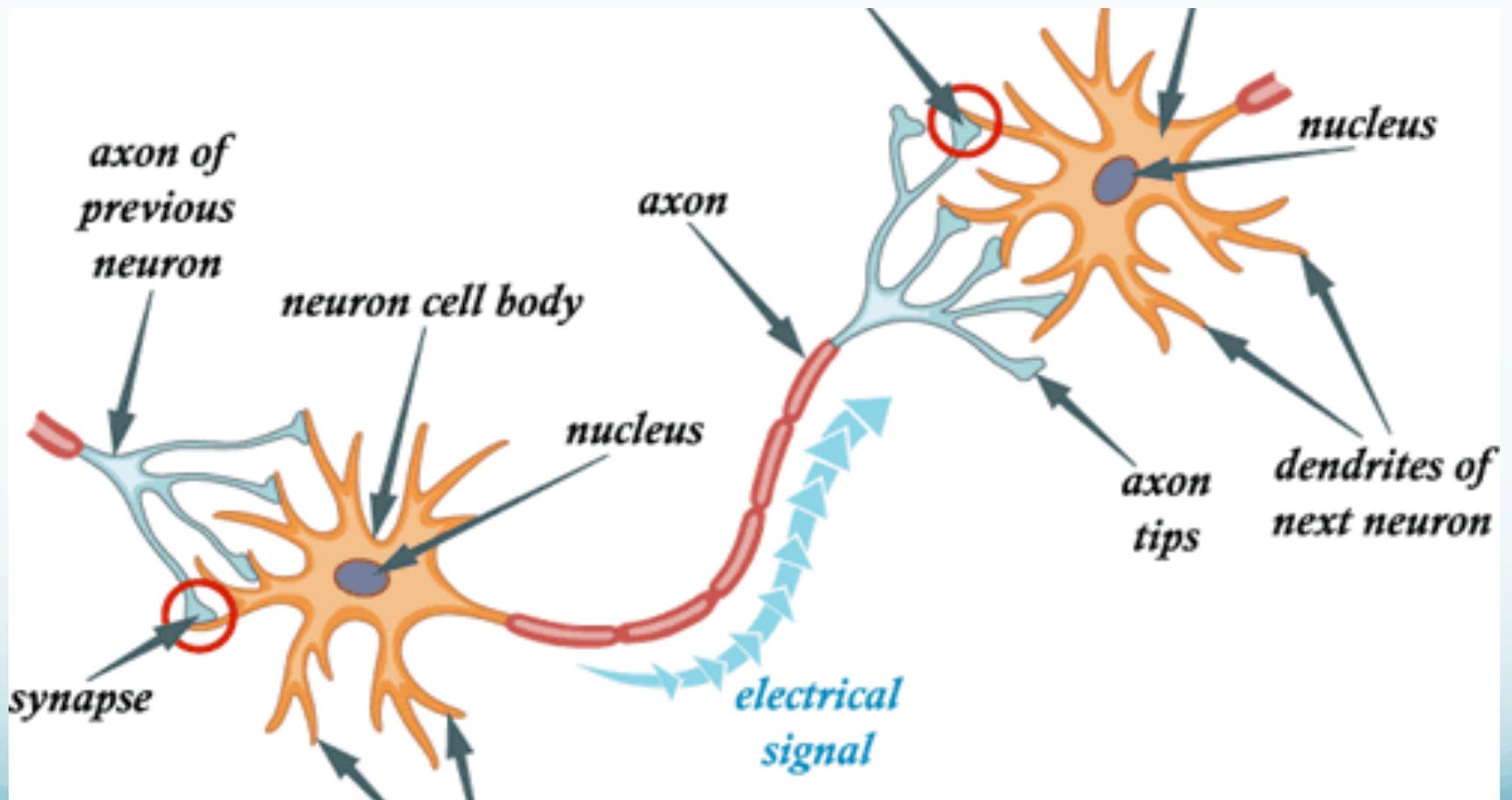


- Grades 1-3 are more likely to present with stereotype threat (Beilock et al, 2010)

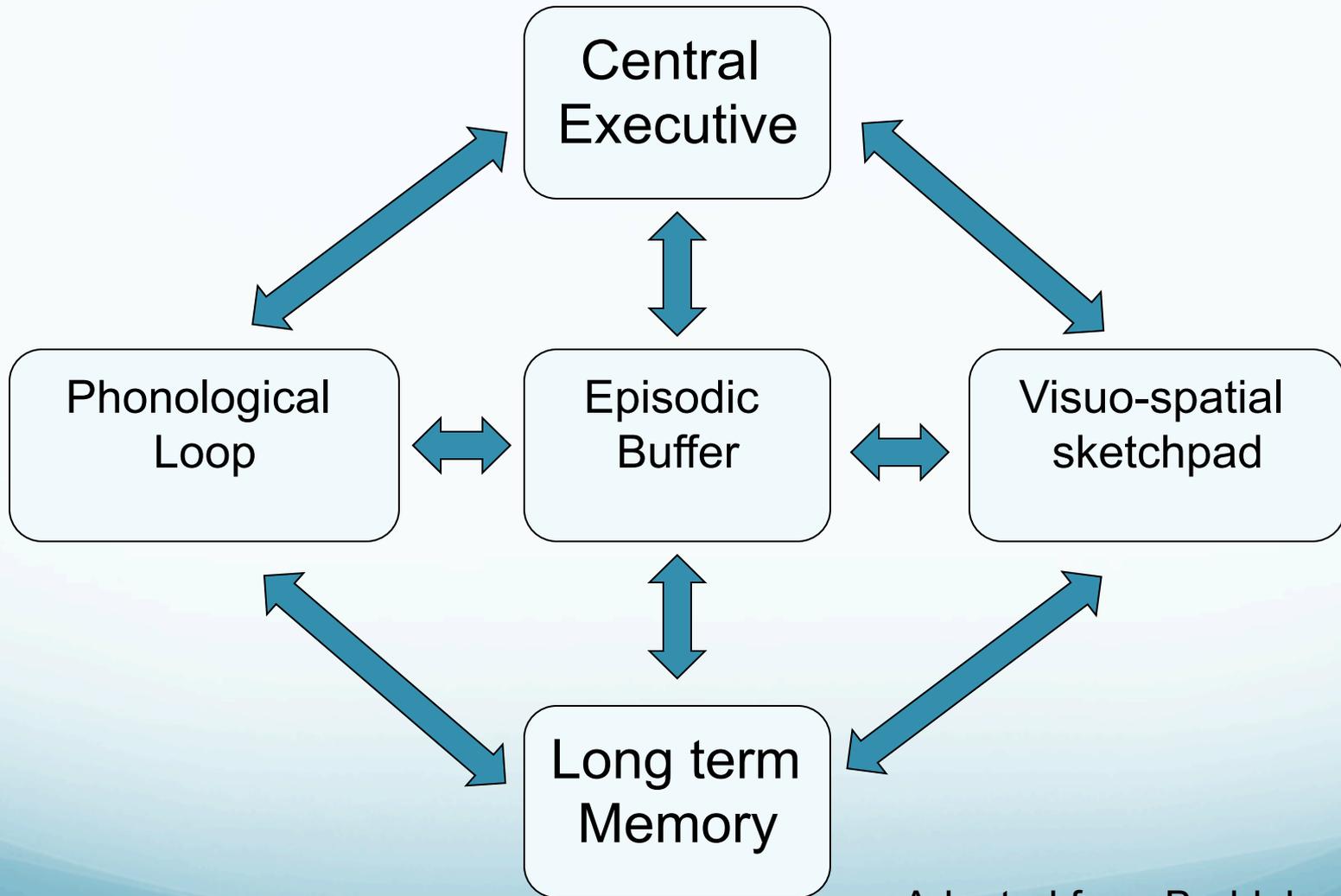
# Mirror Neurons and Math

- 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

# Prevention and Intervention

## Grades 4 – 12

- Mindfulness training
  - Two seconds of silence to clear working memory
  - Recognizing emotions 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”
- 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](http://affectacademics.com) under Resources tab
- <http://scpd.stanford.edu/ppc/how-learn-math-teachers>
- Tobias, S. (1993). Overcoming Math Anxiety. New York: Norton & Company.
- Zaslavsky, 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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