

# Strategic Memory and Reasoning in Teens

Implications for Cognitive Efficiency, Brain Development and Learning Theory



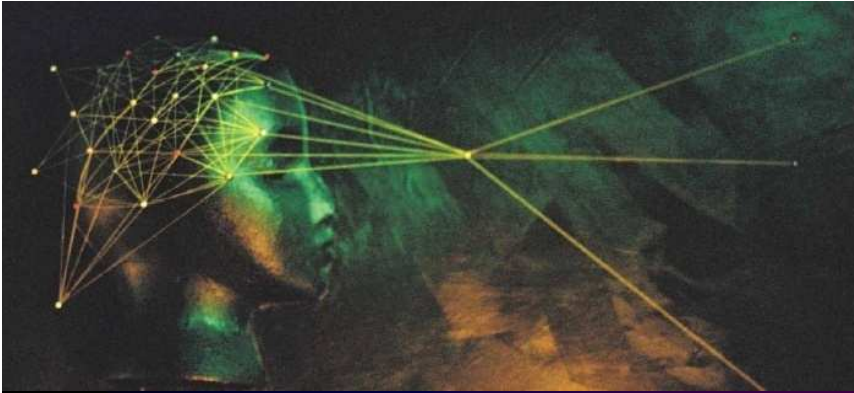
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**Raksha Anand, PhD**

**John Hart, Jr., MD**



## Key points

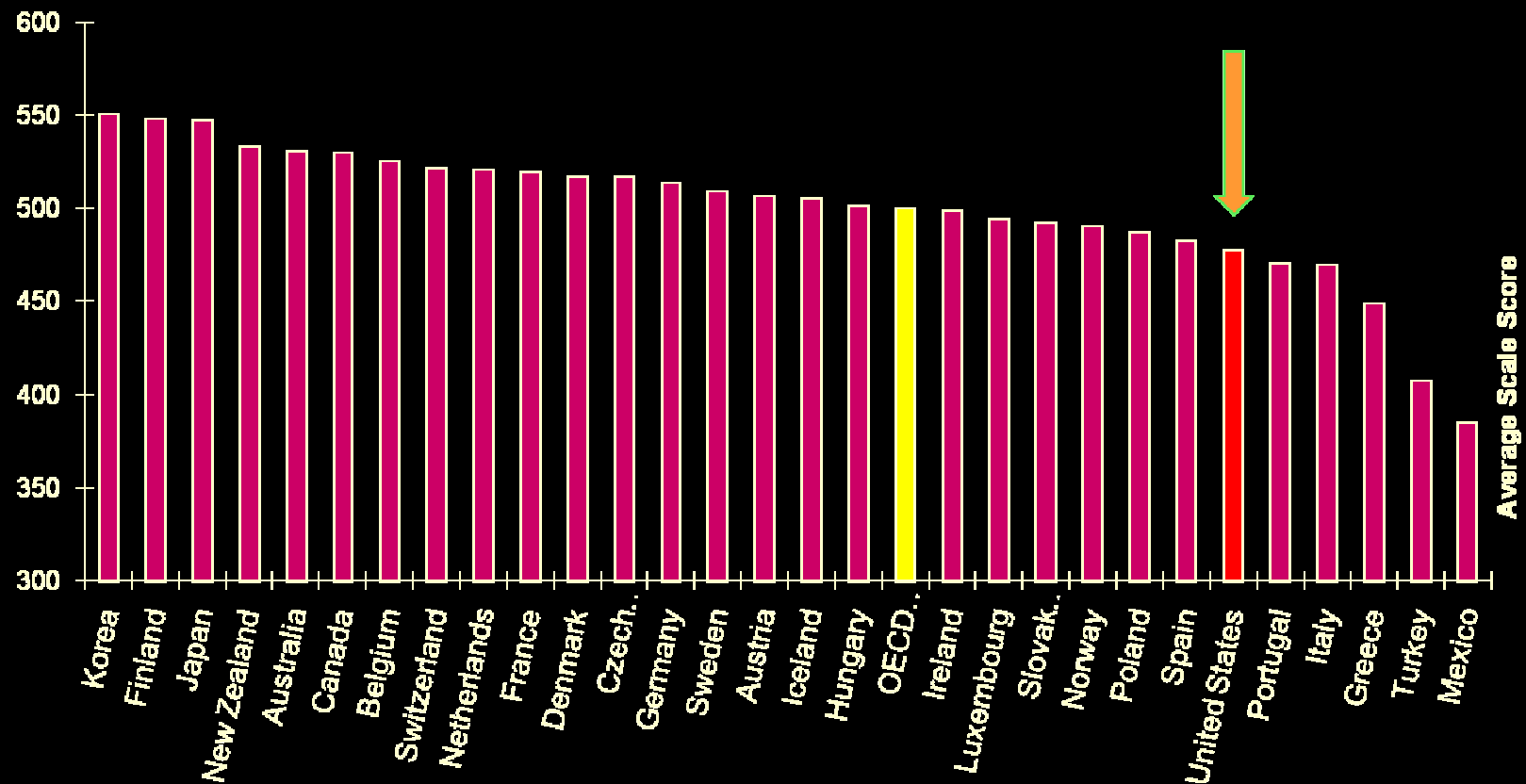
- 1. Scope of Problem**
- 2. Cognitive Efficiency: Construct of Strategic Reasoning**
- 3. Brain Development and Perturbation:  
Population studies of Strategic Reasoning**
- 4. Advance basic science in strategic reasoning as a  
construct of higher-order cognition**
  - **Framework for Strategic Reasoning**
  - **Tackling Strategic Memory and Reasoning Decline in Teens**

# Teen Brain Years: Scope of Problem

## Age of Greatest Vulnerability and Potential



# Critical Thinking: US Ranks 24<sup>th</sup> out of 29 Developed Countries



Source: NCES, 2005, International Outcomes of Learning in Mathematics, Literacy and Problem Solving  
2003 PISA Results. (Program for International Student Assessment)



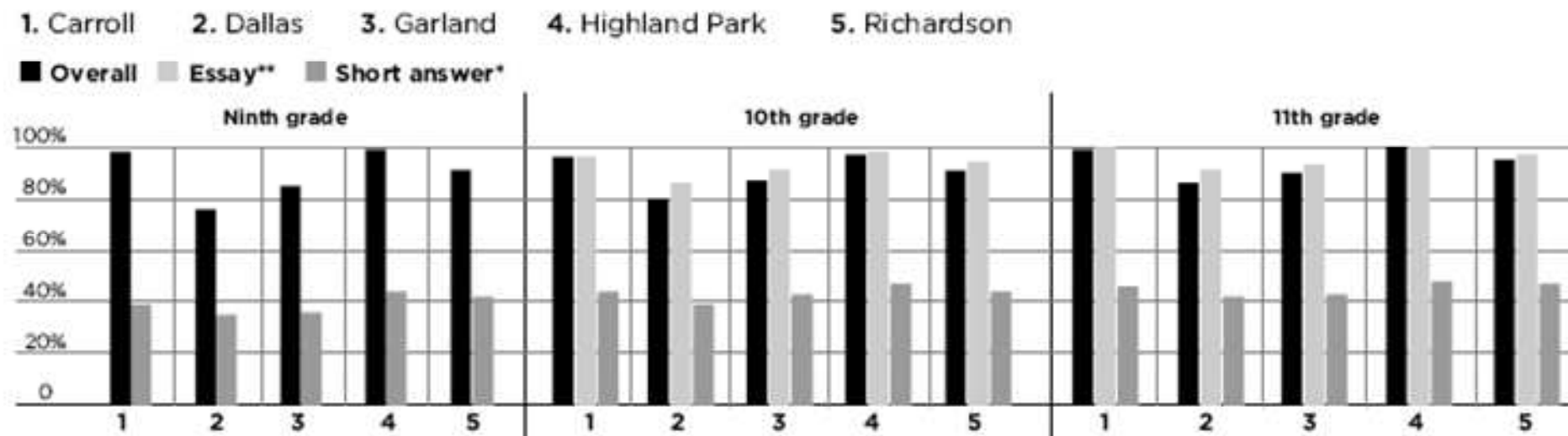
# Dallas-Fort Worth students struggle with TAKS' short-response written

Friday, July 25, 2008

By LAURIE FOX and HOLLY K. HACKER / The Dallas Morning News

## Assessing language arts skills

High school students do well overall on the English language arts TAKS, which is mostly multiple-choice, and the essay portion. But when they're asked to read a short passage and write critically about it, they do much worse. The overall passing rate is calculated from scores on three parts: multiple-choice questions, which carry the most weight, the short-response questions and an essay. The passing rate for an individual section can be higher than the overall rate. Critics argue that the short-answer portions are graded on a tougher scale than the essay portion. Here's a sampling of local district passing rates on the 2008 exam:



\*Passing rates are based on the average scores of three short-answer questions that are asked.

\*\*Passing rates are based on the percentage of students giving "somewhat," "generally" or "highly" effective answers.

NOTE: The essay portion does not apply to the ninth grade.

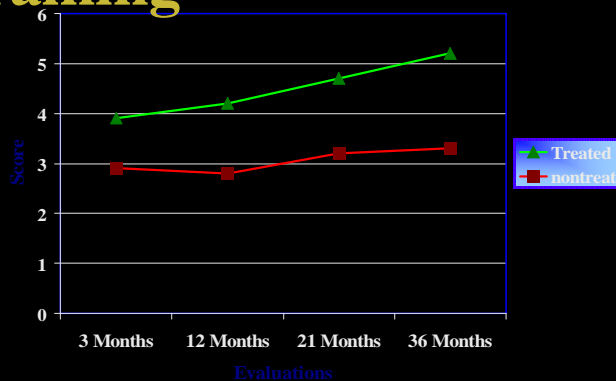
SOURCE: Dallas Morning News analysis of testing data from Pearson Educational Measurement

TOM SETZER/Staff Artist

# Translational Approach



**Multi-dimensional  
Assessment and  
training**



**Chart response over time**



**Identify Risk Genes**



**Impact on Real life**

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AT DALLAS**

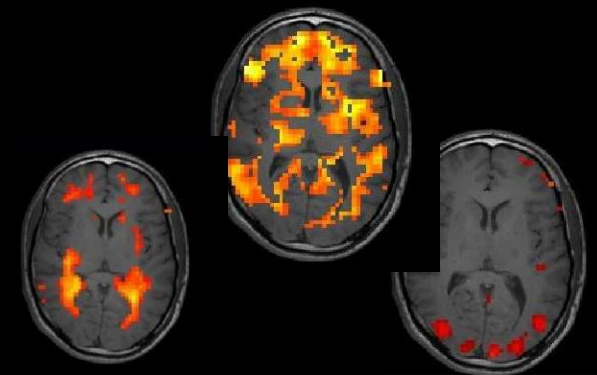


**EEG**



**Establish  
Brain Baseline**

**fMRI**



**Brain Response to  
Training +/- Drug**

# Abstract versus Detail meaning



- **One of brain's most robust functions is capacity to extract generalizations** (Gabrieli, 2004)
  - Verbatim details fade rapidly
  - Abstracted meaning persists over longer intervals (Radvansky et al., 2001)
- **Tasks eliciting abstract meaning of complex verbal content**
  - Summaries – Main ideas-Interpretive statements

# Cognitive Operations Pivotal to Strategic Reasoning

- Strategic Filtering

Function: Filtering of relevant from irrelevant

- Abstracting coherent meaning from detail component meaning

Function: Dynamic process of updating abstracted meaning from the details

- Innovative Questioning

Function: Using information to generate novel questions/issues/solutions

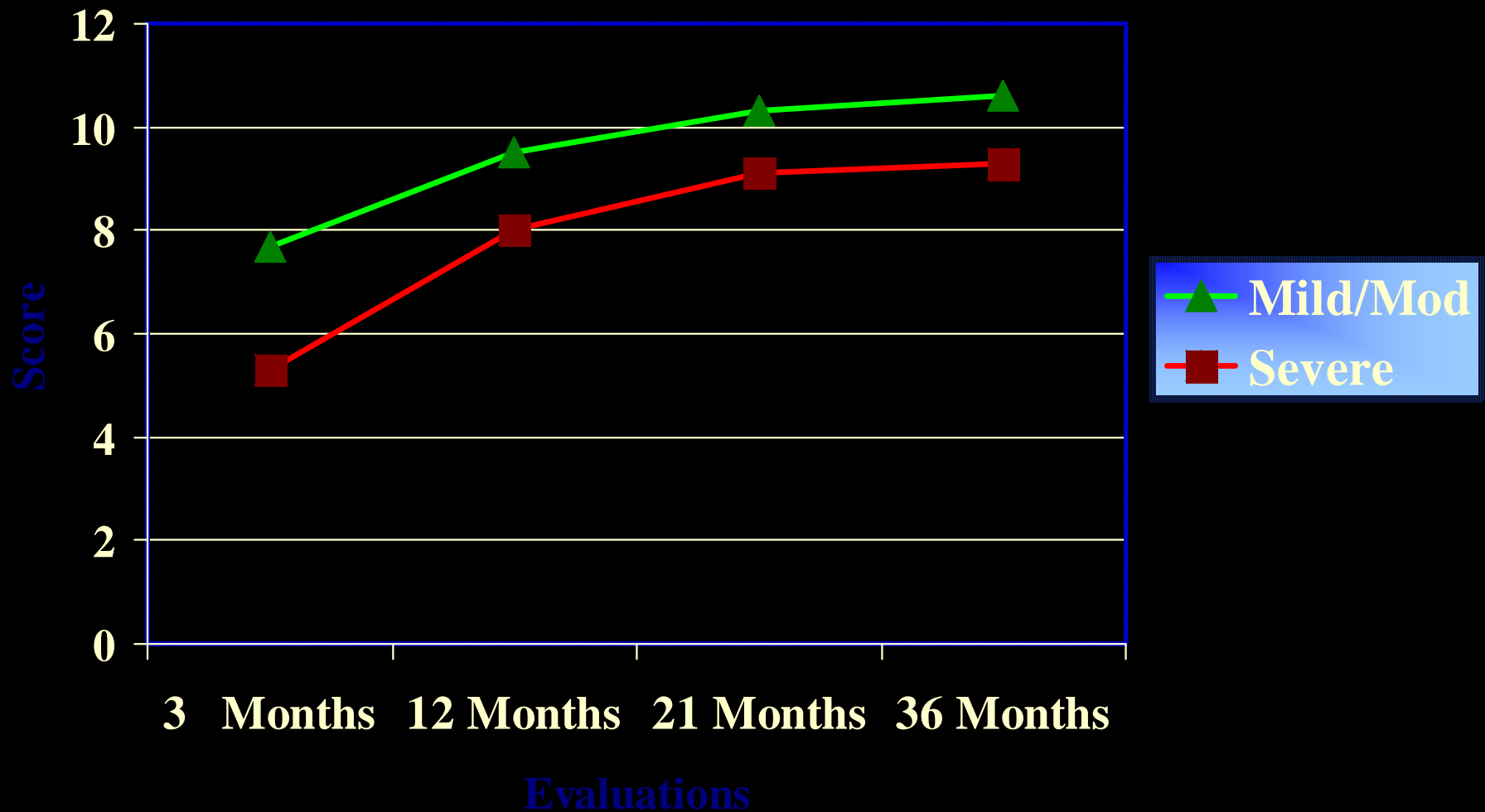


# Empirical Studies

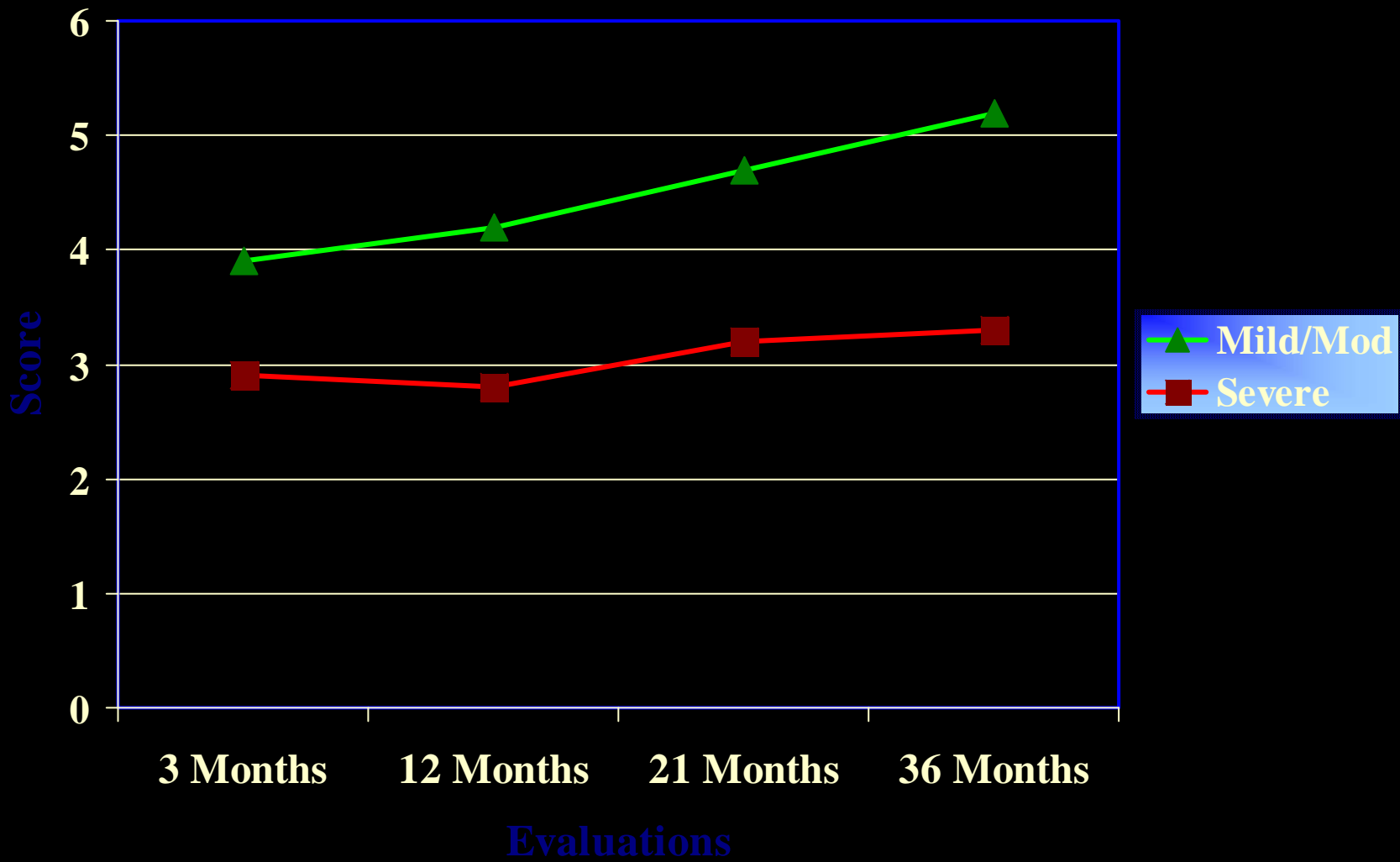


- Traumatic Brain Injury
- Attention Deficit/Hyperactivity Disorder
- Normal cognitive aging
- Mild cognitive impairment and early Alzheimers
- Typically developing teens

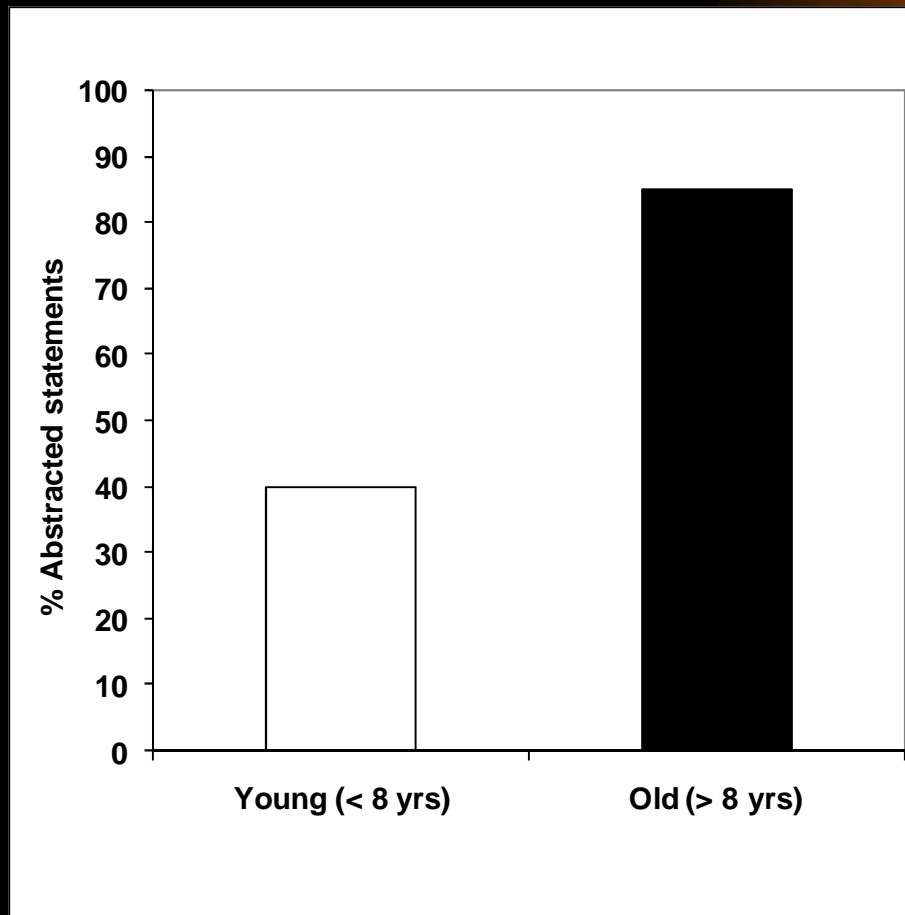
## Detail Component Meaning (DCM) Strong Recovery in Pediatric Brain Injury



# Abstracted Coherent Meaning (ACM) Stalled Recovery in Pediatric Brain Injury



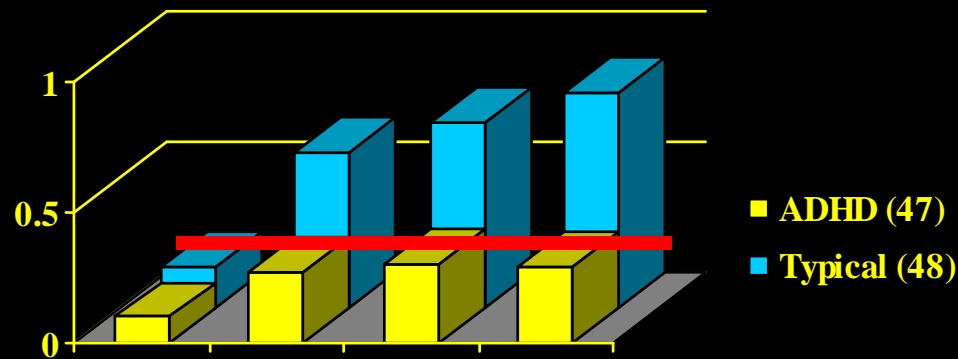
# Younger Age at brain injury: Lower Abstracted coherent meaning skills





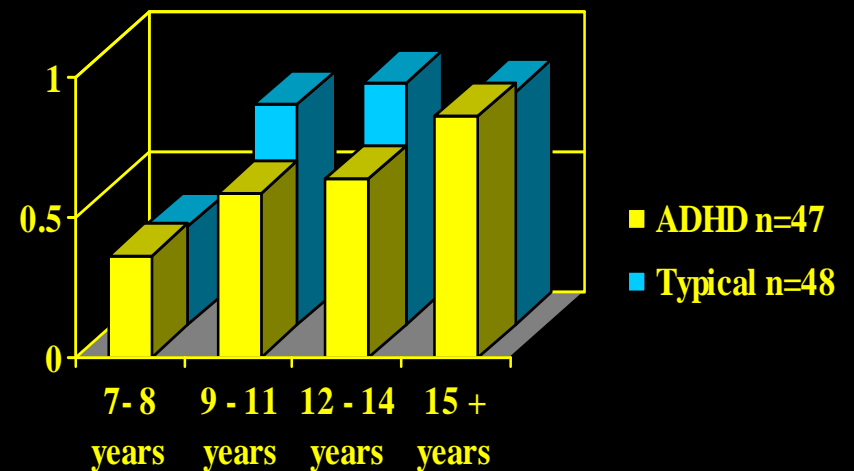
# Middle School Brain Crises In ADHD: Stall in Abstracted Coherent Meaning

**Stall in Reasoning**



## BrainHealth Team Discovery

**Recall of Details**

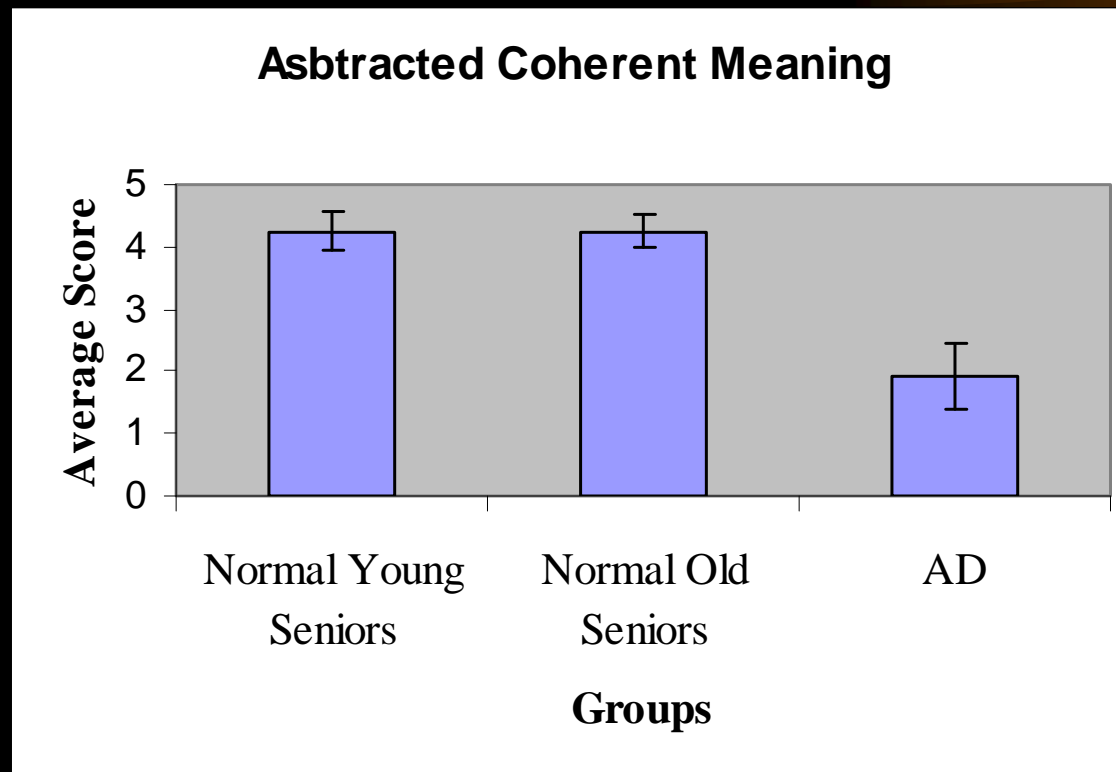


## Children with ADHD

Gamino, Chapman, Hart, et al. (2008)

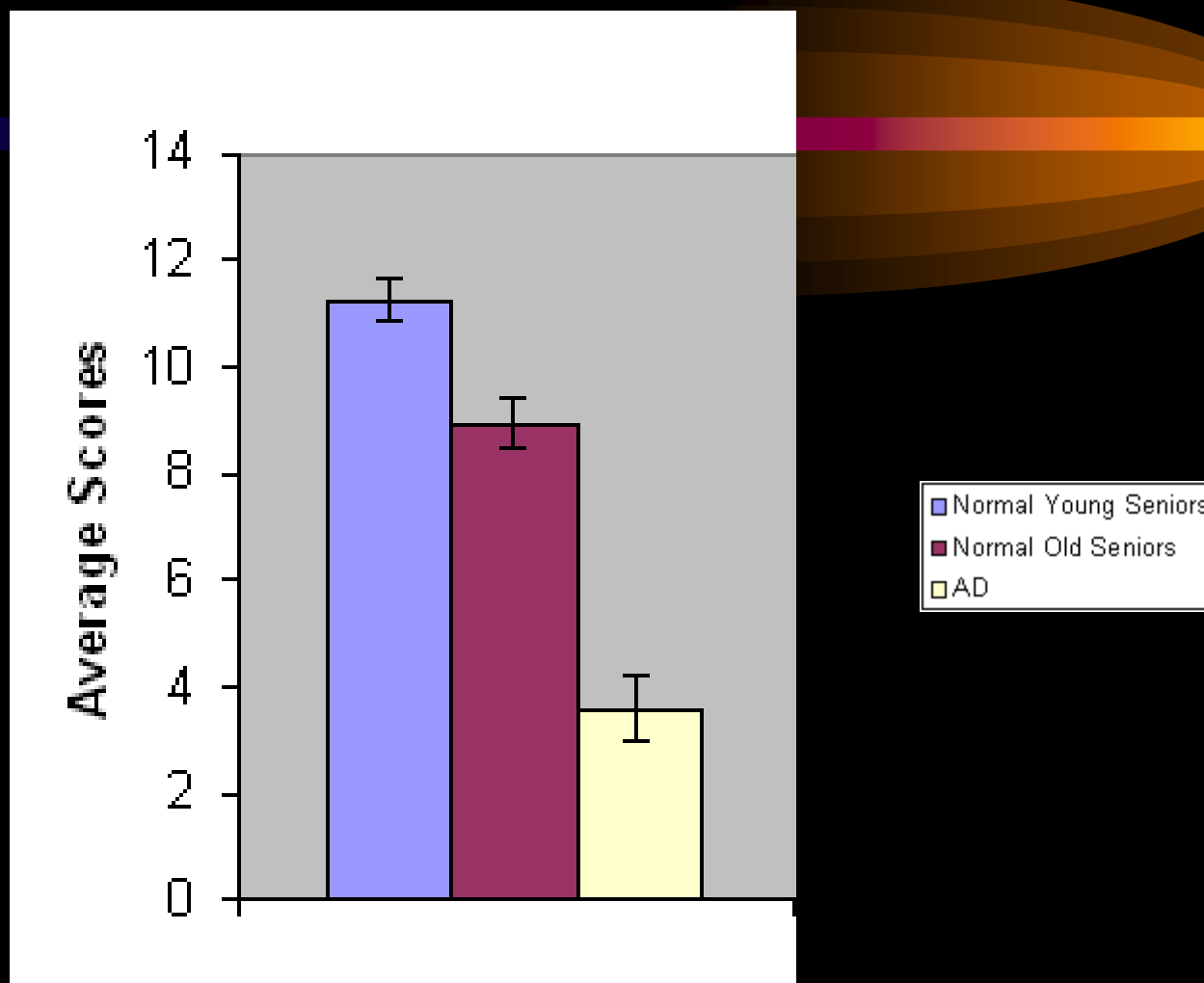
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# Cognitive marker of Normal Aging vs. Pathology



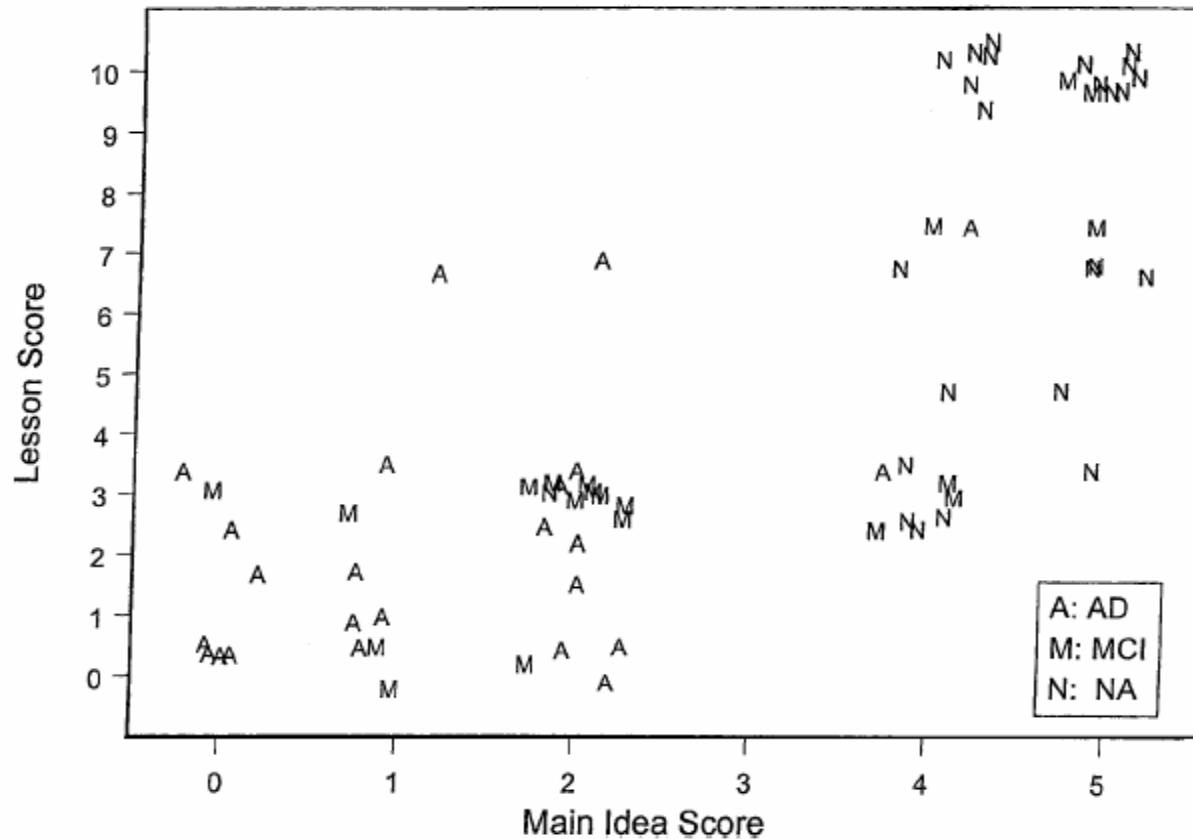
Source: Chapman, S. B., Anand, R., Sparks, G., & Cullum, C. M. (2006). Gist distinctions in healthy cognitive aging versus mild Alzheimer's disease. *Brain Impairment*, 7, 223-233.

# Detail Component Meaning



Source: Chapman, S. B., Anand, R., Sparks, G., & Cullum, C. M. (2006). Gist distinctions in healthy cognitive aging versus mild Alzheimer's disease. *Brain Impairment*, 7, 223-233.

# Cognitive marker of Normal Aging vs. Pathology



**FIG. 1.** (Chapman, Zientz, Weiner, Rosenberg, Frawley, and Burns). Scatter plot of individual gist-level responses for the three groups (A = mild AD, M = mild cognitive impairment, N = normal controls) on main idea (x-axis) and lesson (y-axis).

Source: Chapman, S. B., Zientz, J., Weiner, M., Rosenberg, R., Frawley, W., & Burns, M. H. (2002). Discourse Changes in early Alzheimer's disease, mild cognitive impairment, and normal aging. *Alzheimer's Disease and Associated Disorders*, 16, 177-186.

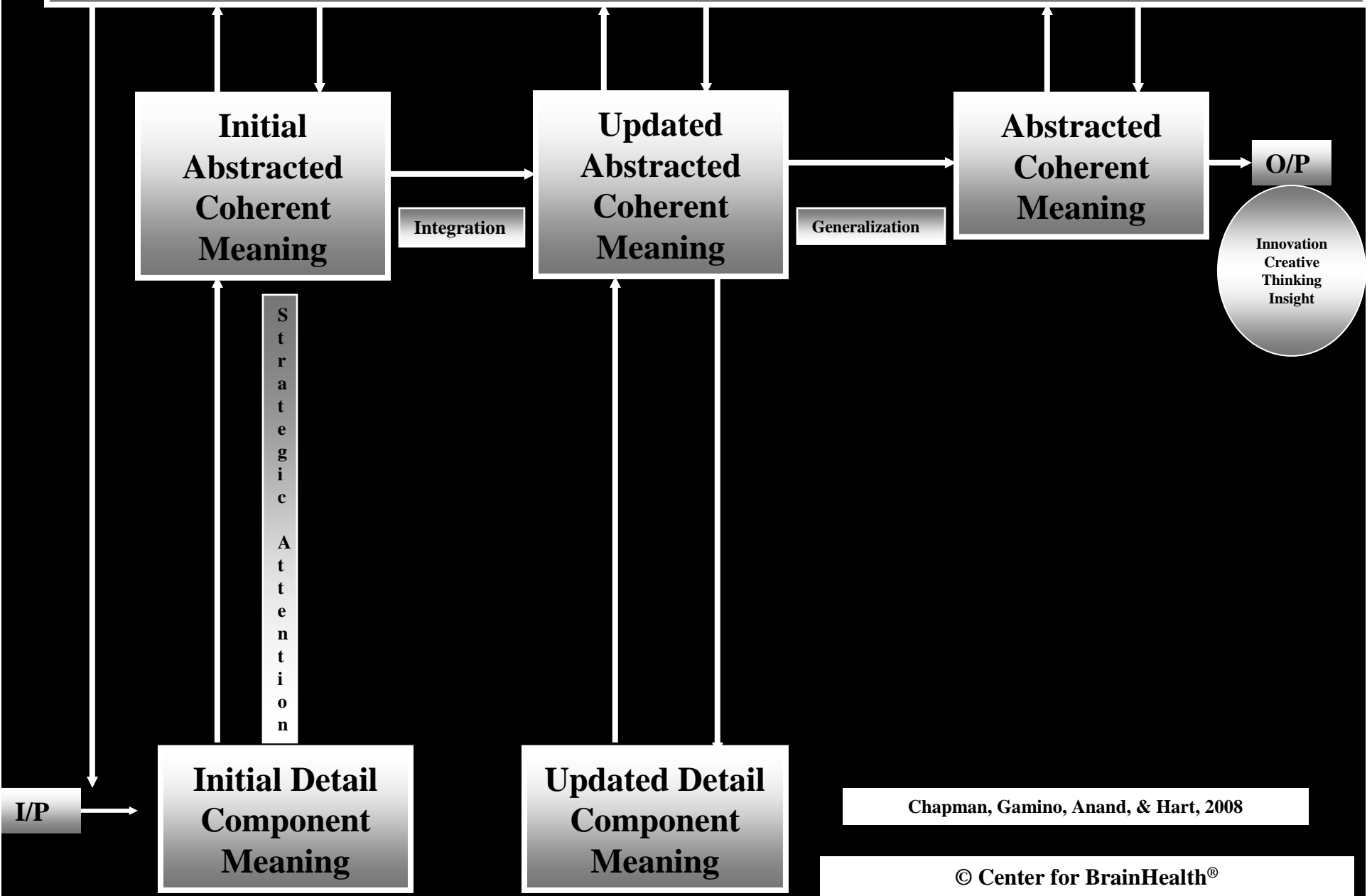


# Potential Moderator Variables in Strategic Reasoning



- Intelligence – fluid/crystallized
- Attention
- Inhibition
- Episodic Memory
- Working Memory
- Language comprehension & expression
- Binding to form abstract or novel ideas
- Education experience

# Pre-existing Knowledge



# Investigating brain bases for Strategic Learning

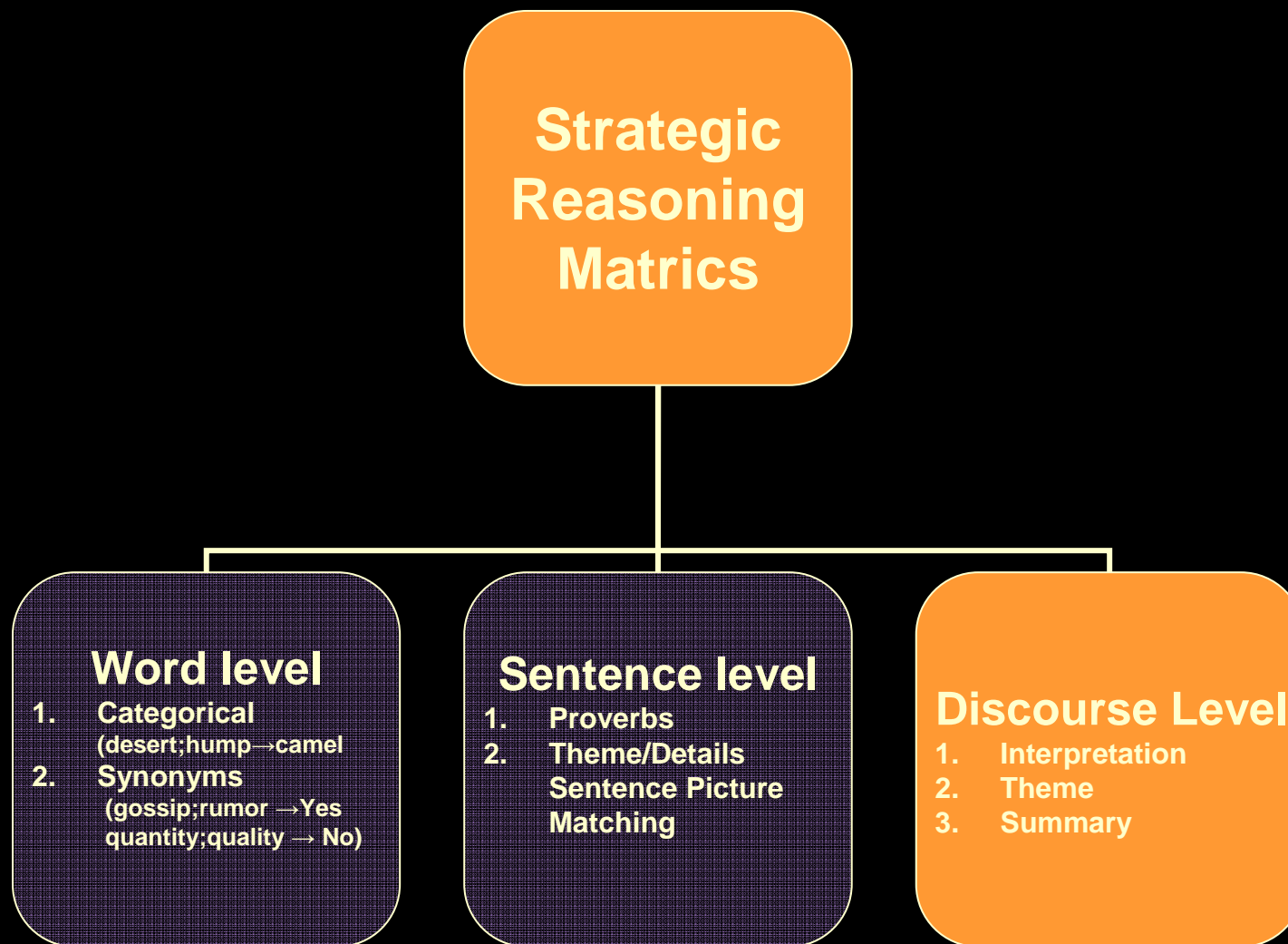


Key:

1. Identify brain mechanisms associated with strategic reasoning success/failure
2. Develop and test training to enhance strategic learning and teen brain development with pre and post measurements

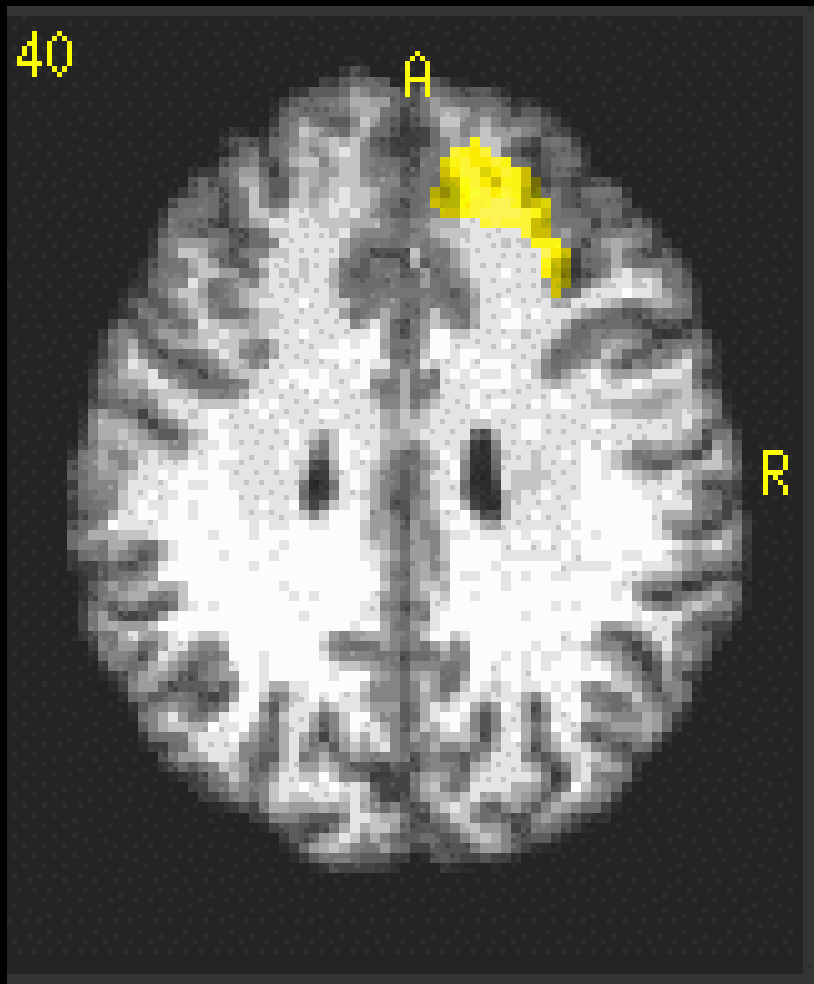
# Multi-Level Metrics of Strategic Reasoning

## Binding details to form abstract meaning





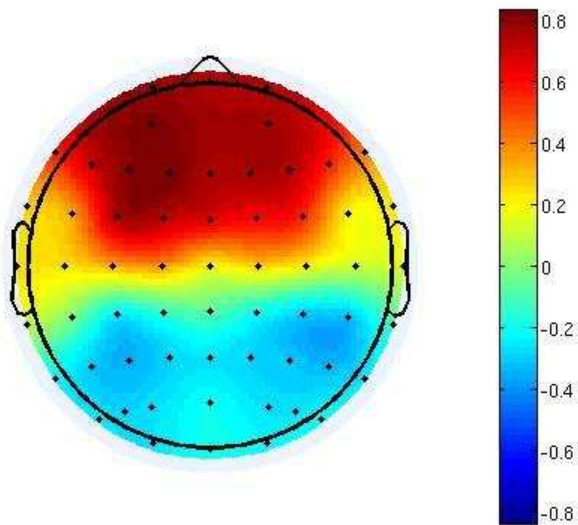
# Difference in brain function (SPECT): Good vs Poor Recovery in Abstract Coherent meaning



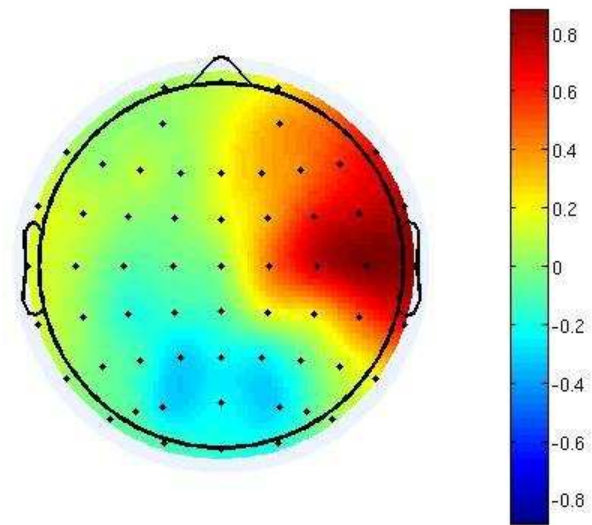
## Positive Covariance

Less recovery associated  
with decreased brain  
blood flow in Rt.  
Superior Frontal

## Topographical maps of factor loadings (spatial factors) that showed differences between gist and details (Anand, 2008)



Significant Differences between Gist and Details ( $p = .005$ );  
Time Range: 690-850ms; 1000-1070ms



Significant Differences between Gist and Details ( $p = .002$ )  
Time Range: 750-950ms

# Advance of Basic Science to Guide Education Practices



- Educators/scientists often adopt instructional principles based on superficial understanding of complexity of brain and cognitive functions
- Studies are needed to examine strategic reasoning with rigorous control over moderator variables.

# Investigating Brain Bases for Strategic Learning



- Which brain networks are involved when processing abstracted and detail information?
  - Correctly
  - Incorrectly
  - Inefficiently
- How does training of each (abstract – detail) modify brain activation patterns, behavior, and learning?



# Investigating Brain Bases for Strategic Learning



- Does training of one (detail $\leftrightarrow$ abstract) transfer to the other and to novel learning contexts and academic performance?
- Which direction of training is most efficient?  
Top – down versus Bottom-up
- Appropriate age to train strategic reasoning?

# Theoretical Issues



- Is memory for detail component meaning prerequisite for constructing abstract meaning?
- Are detail and abstract meaning compromised in a parallel, but not causative relationship?
- Can poor memory for detail meaning co-occur with good abstract coherent meaning?

# Strategic Reasoning



- Underlies ability to acquire new meaning
- Draws upon and expands pre-existing knowledge
- Relates to innovative thinking and insight
- Provides the basic building blocks for generalization to solving new problems

# Strategic Reasoning Applicable to Multiple Domains



- Educational training
- Industry (e.g., Systems engineers)
- Business productivity
- Retirement Planning
- Healthy Brain Aging
- Brain Rewiring after injury



# Strategic Memory and Reasoning in Teens

- To understand behavioral and brain basis of strategic reasoning
- To identify factors that influence strategic reasoning
- To evaluate the significance of strategic reasoning in determining academic and vocational success
- To determine the effects of strategic reasoning training in various clinical populations using behavioral and brain imaging measures
- To identify factors (e.g. dose) that determine maximal change with strategic intervention training



