The Eye's Mind:
Visual Imaginations
Neuroscience and the Humanities

Visual Imagery:
The Nonverbal Code for Language and Cognition

Nanci Bell, President and Chief Executive Officer
Paul Worthington, Director of Research & Development

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- What is the significance of the "Eye's Mind"?
- Our view into the "Eye's Mind" has been from the aphantasia perspective otherwise referred to as agnosia, imagery generation deficits, defective revisualization, visual irreminiscence, or congenital prosopagnosia.
- But why?

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- Lindamood-Bell's research and practice is in the area of language and learning needs of individuals.
- A primary research question has been:
- What are the primary brain functions associated with learning, especially language comprehension?
- Our findings and conclusions? **Concept Imagery**

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"Concepts are mental representations of worldly entities—things, events, states, properties etc. They are exercised whenever we undergo cognitive mental states. One cannot notice something, recognize it, make a judgment about it without conceptualizing it in some way, without bringing it under a concepts.“

Michael Tye - *A Theory of Phenomenal Concepts, Philosophy 2003*

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Imagery for Cognition and Memory

This understanding is not new.

•References as far back as Aristotle, in his contemplations on the ability to reason, theorized that man cannot think without mental imagery.

"Thus, we have explained that memory or remembering is a state induced by mental images."

•Thomas Aquinas, in the 12th century, stated, *"Man's mind cannot understand thoughts without images of them."*

•William James (1890) suggested the static meaning of concrete words consists of "*sensory images awakened.*"

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- Jean Piaget (1936) wrote that *"over time schemata become internalized in the form of imaged thought."*

- The psychologist, Edward Titchener, wrote, *"My mind, in its ordinary operations, is a fairly complete picture gallery, not of finished paintings, but of impressionist notes."*

- Stephen Kosslyn, in *Image and Brain* (1994), stated, *"For present purposes, all that is important is that imagery relies on topographically organized regions of the cortex, which support depictive representations."*

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- Mozart said that a musical piece would grow in him until *"the whole, though it be long, stands almost complete and finished in my mind, so that I can survey it, like a fine picture or a beautiful statue, at a glance. Nor do I hear in my imagination the parts successively, but I hear them, as it were, all at once."*

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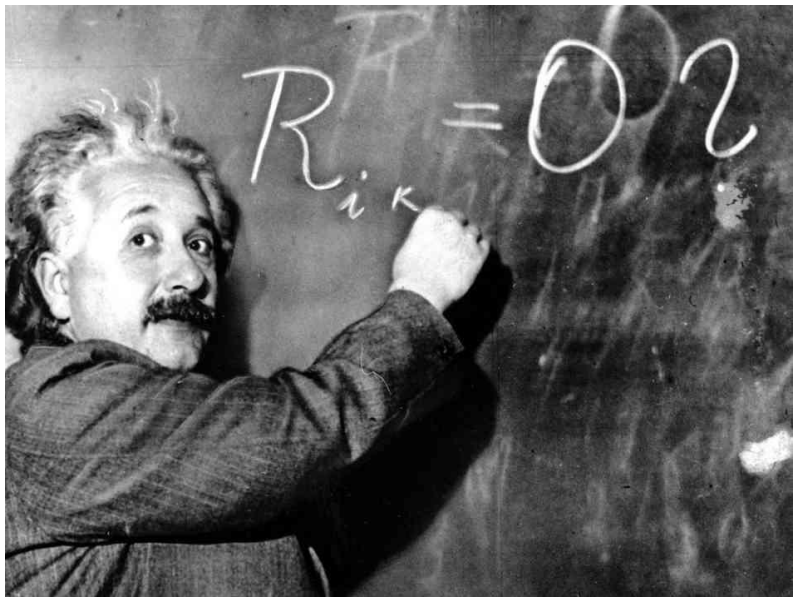
•Beyond the humanities, Albert Einstein's esteemed contributions were the result of his ability to think critically and creatively.

•He made his thinking **concrete** with the sensory-cognitive function of mental imagery. He formulated his theory of relativity though thought experiments using his imagination.

•He stated, *"If I can't picture it, I can't understand it."*



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Visual Imagery:
The Nonverbal Code for Language and Cognition

Imagery is the silent partner to language in human cognition. Behavioral neuroscience has validated the role of visual imagery in education as foundational to cognition, specifically for oral and written language comprehension. Recent neurological and behavioural research documents the role of visual imagery in remediating deficits in the area of visual imagination (such as aphantasia) as related to corresponding deficits in language comprehension. These studies are grounded in Dual Coding Theory (DCT), which posits that the dual coding of verbal and nonverbal information underlies human cognition. The application of DCT in a systematic instructional approach has successfully stimulated the nonverbal code of imagery for language in individuals of all ages.

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What have we learned?

Based on 30 years of instructional experience with 35,000 individual in the United States, the United Kingdom, and Australia, five important aspects of the imagery-language connection have been revealed:

1) There are dramatic individual differences in the ability to generate visual imagery,
2) There is a significant correlation between visual imagination and language comprehension,
3) Individuals can be taught to consciously generate visual images, resulting in significant gains in reading and language comprehension,
4) Linking the sensory input of imagery to language results in significant neurological changes and reading improvements in children with dyslexia, and
5) Stimulating the imagery-language connection in children with autism spectrum disorder improves language comprehension that is accompanied by fundamental changes in the connectivity of the brain regions involved in reading comprehension.

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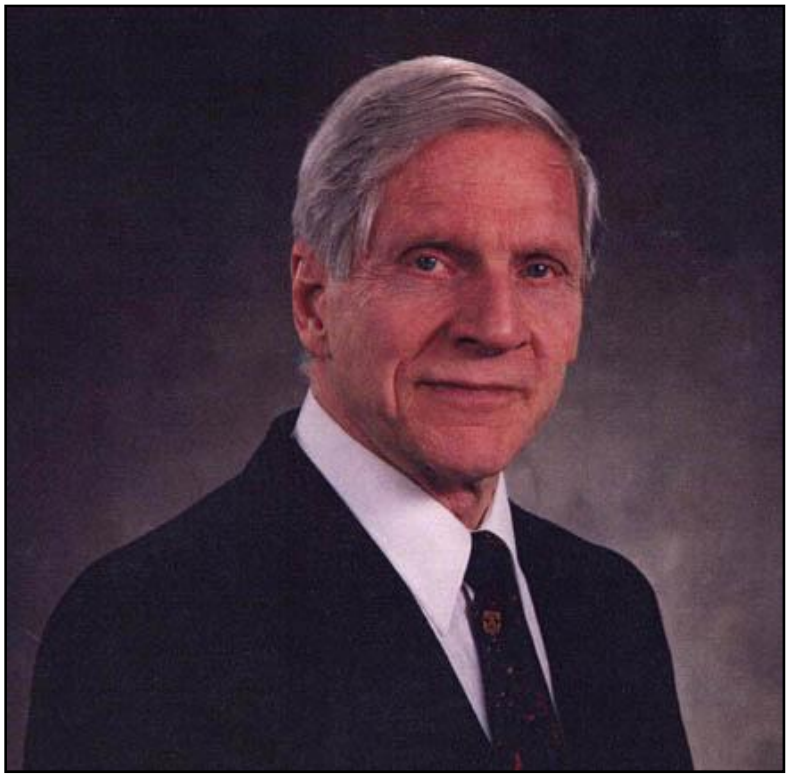
Dual Coding Theory (DCT)



"Cognition is proportional to the extent that the coding mechanisms of mental representations (imagery) and language are integrated."

"Performance is mediated by the joint activity of verbal and nonverbal systems…cognition is always an interplay between the verbal and nonverbal systems."

~ Allan Paivio

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•So how do we stimulate the brains Dual Coding mechanism?

•Starting in the early 1980s, we experimented by asking individuals to visualize and verbalize.

•Ultimately, the Visualizing and Verbalizing approach used for the last 20 years with individuals with "concept imagery deficits" (aphantasia) and has now been examined neuro-scientifically.

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Symptoms of Weak Concept Imagery

Weakness in:

- Written language comprehension
- Oral language comprehension
- Critical, logical, abstract thinking and problem solving
- Following directions
- Expressing language orally
- Expressing language in writing
- Grasping humor
- Interpreting social situations
- Cause and effect
- Mental mapping
- Responding to a communicating world

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Language to Develop Concept Imagery

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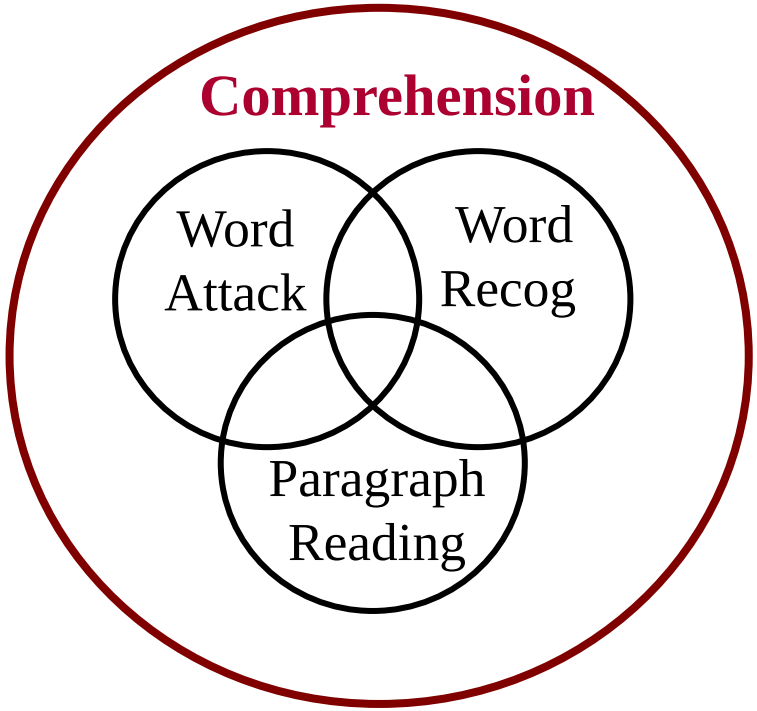
Steps of Visualizing and Verbalizing



1. The Climate
2. Picture to Picture
3. Word Imaging
4. Single Sentence Imaging
5. Sentence by Sentence Imaging
6. Sentence by Sentence Imaging with Higher Order Thinking
7. Multiple Sentence Imaging with Higher Order Thinking
8. Whole Paragraph Imaging with Higher Order Thinking
9. Paragraph by Paragraph Imaging with Higher Order Thinking
10. Page Imaging with Higher Order Thinking

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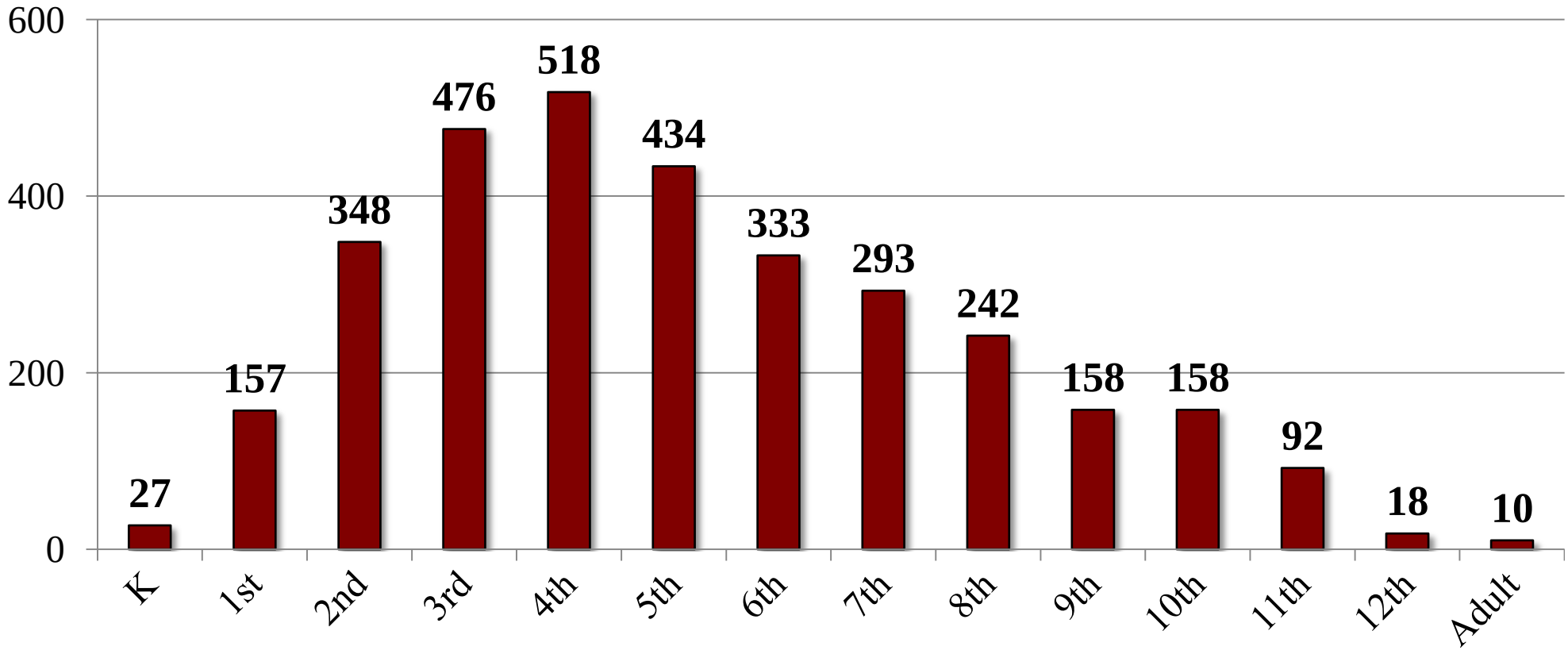
Students with Concept Imagery and Comprehension Deficits

Demographics

***n* = 3,303**

62% male, 38% female

Number of Students by Grade Level



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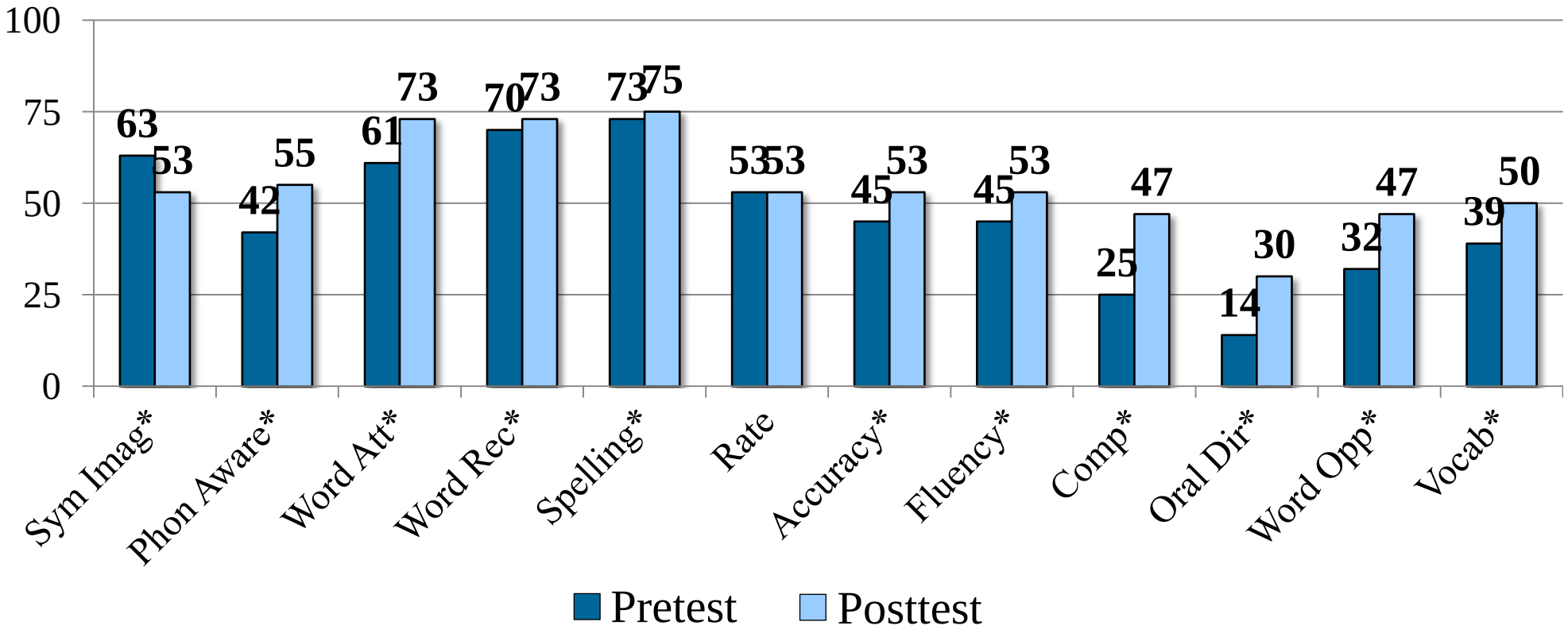
Students with Concept Imagery and Comprehension Deficits

Average Hours of Instruction: **97**

***n* = 3,303** • Average Grade Level: **6th**

Pre- and Posttest Percentiles



*Statistically significant ($p \leq .05$)

Based on students who received between 20 and 240 hours of V/V only instruction at Learning Centers, 2008 through 2015.

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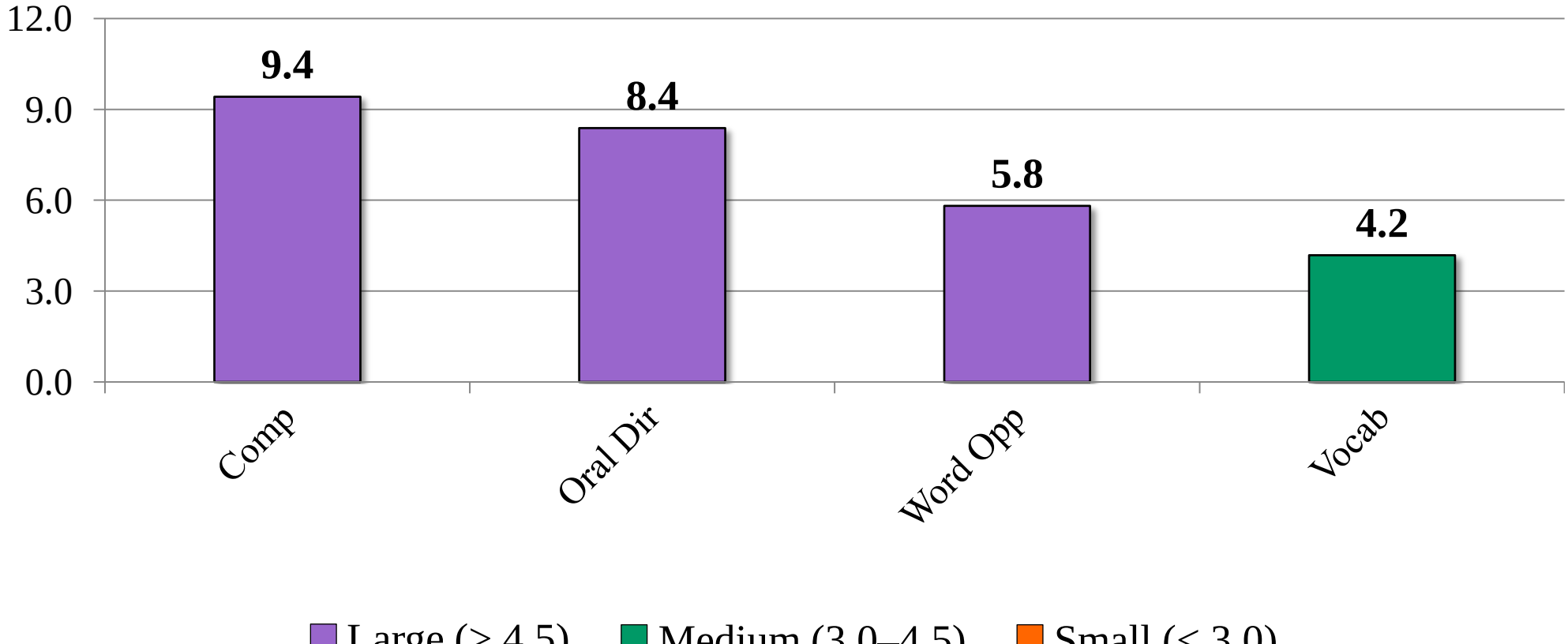
Students with Concept Imagery and Comprehension Deficits

Average Hours of Instruction: **97**

***n* = 3,303** • Average Grade Level: **6th**

Average Standard Score Changes



Based on students who received between 20 and 240 hours of V/V only instruction at Learning Centers, 2008 through 2015.

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Neuroimaging Research

Validates the Imagery-Language Connection

University of Alabama at Birmingham

Donna Murdaugh, Rajesh Kana, et al

UAB DEPARTMENT OF PSYCHOLOGY
College of Arts and Sciences

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Neuroimaging Research (UAB)†

- Researchers studied the impact of Visualizing and Verbalizing (V/V) on brain circuitry and connectivity in children with autism spectrum disorders (ASD).

- Two papers have been published:

  - Murdaugh, D. L., J. O. Maximo, and R. K. Kana. 2015. "Changes in intrinsic connectivity of the brain's reading network following intervention in children with autism." *Human Brain Mapping*.

  - Murdaugh, D. L., H. D. Deshpande, and R. K. Kana. 2015. "The Impact of Reading Intervention on Brain Responses Underlying Language in Children With Autism." *Autism Research*.

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Neuroimaging Research (UAB)†

- A neuro-scientific discovery was made: individuals identified with ASD have an impaired ability to communicate from one cortical area of the brain to another.

- The biological basis: an impaired conductivity in the white matter of the brain, the communication pathways, the axons/dendrites, the lipids or fatty tissue necessary to pass on signals from one area of the brain to another.

†Murdaugh, D. L., J. O. Maximo, and R. K. Kana. 2015. "Changes in intrinsic connectivity of the brain's reading network following intervention in children with autism." *Human Brain Mapping*. doi: 10.1002/hbm.22821.

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Neuroimaging Research (UAB)†

- 31 children with autism were randomly assigned to experimental (V/V) and control (no V/V) conditions.

Characteristic	*Experimental (n = 16)*	*Control (n = 15)*
Age	10.3	11.0
Gender	12 M, 4 F	12 M, 3 F
WASI FSIQ	94.7	97.2
GORT-Comprehension	76.7	84.2
SORT	107.5	105.5

- Groups were similar on all variables.

†Murdaugh, D. L., J. O. Maximo, and R. K. Kana. 2015. "Changes in intrinsic connectivity of the brain's reading network following intervention in children with autism." *Human Brain Mapping*. doi: 10.1002/hbm.22821.

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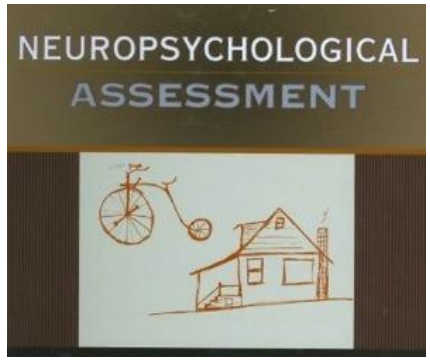
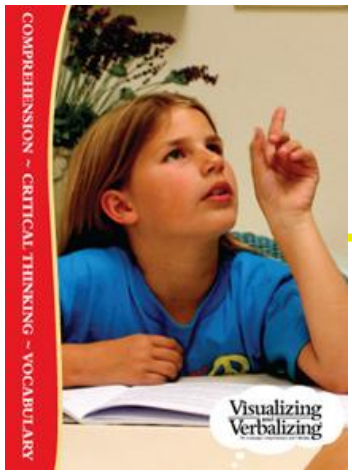
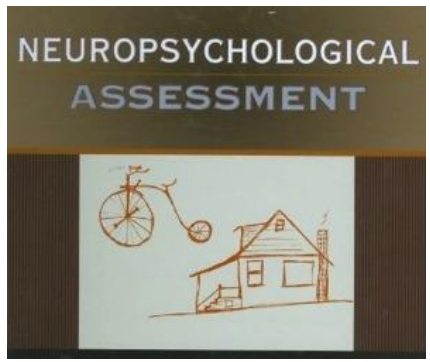
Neuroimaging Research (UAB)†







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Neuroimaging Research (UAB)†

- Children received brain scans (fMRI) and were administered the GORT-comprehension 10 weeks apart.
- Experimental children received 4 hours of V/V a day, 5 days a week for 10 weeks.
- Pre- to posttest brain and GORT-comprehension changes favored the experimental group.

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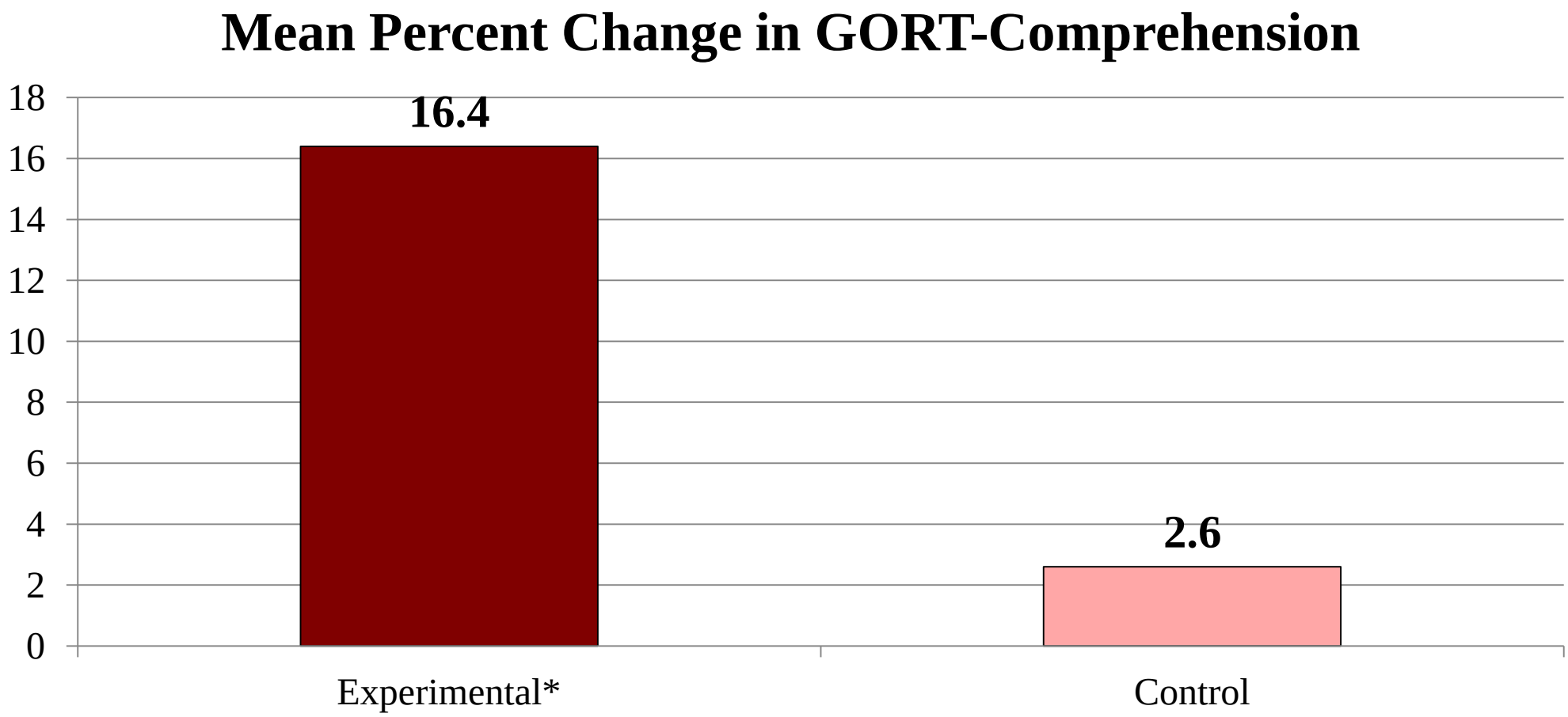
Neuroimaging Research (UAB)†



*Statistically significant (p = .0006)

†Murdaugh, D. L., J. O. Maximo, and R. K. Kana. 2015. "Changes in intrinsic connectivity of the brain's reading network following intervention in children with autism." *Human Brain Mapping*. doi: 10.1002/hbm.22821.

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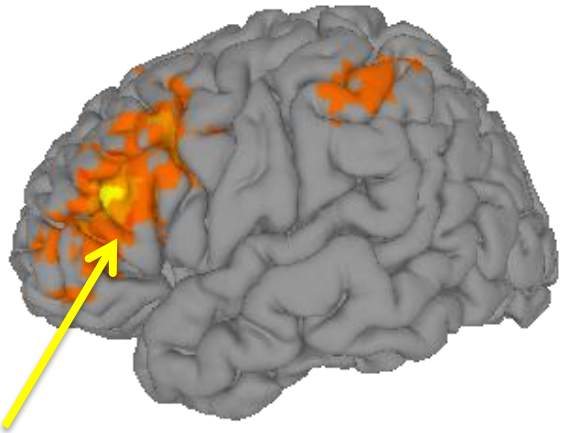
Change in Brain Connectivity*
Experimental Group

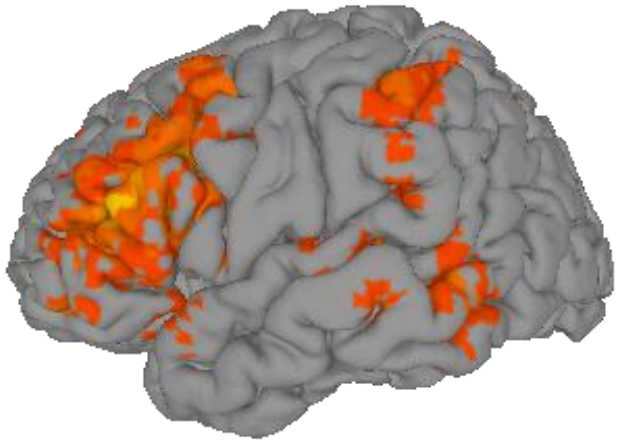
Before intervention



Broca's area

10 weeks

After intervention



*Statistically significant ($p < .05$).

- Greater connectivity in the experimental group compared to the control group at posttest.

†Murdaugh, D. L., J. O. Maximo, and R. K. Kana. 2015. "Changes in intrinsic connectivity of the brain's reading network following intervention in children with autism." *Human Brain Mapping*. doi: 10.1002/hbm.22821. Figure used with authors' permission.

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Neuroimaging Research (UAB)†

- "Overall, this study [Changes in intrinsic…] revealed widespread changes in functional connectivity of the brain's reading network as a result of intervention [V/V] in children with ASD."

- "Thus, the findings of this study [The Impact of Reading Intervention…], which supports the principles of dual coding theory [Paivio 2007], suggest the potential of a strength-based reading intervention [V/V] in changing brain responses and facilitating better reading comprehension in ASD children."

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Murdaugh, D. L., H. D. Deshpande, and R. K. Kana. 2015. "The Impact of Reading Intervention on Brain Responses Underlying Language in Children With Autism." *Autism Research*. doi: 10.1002/aur.1503.

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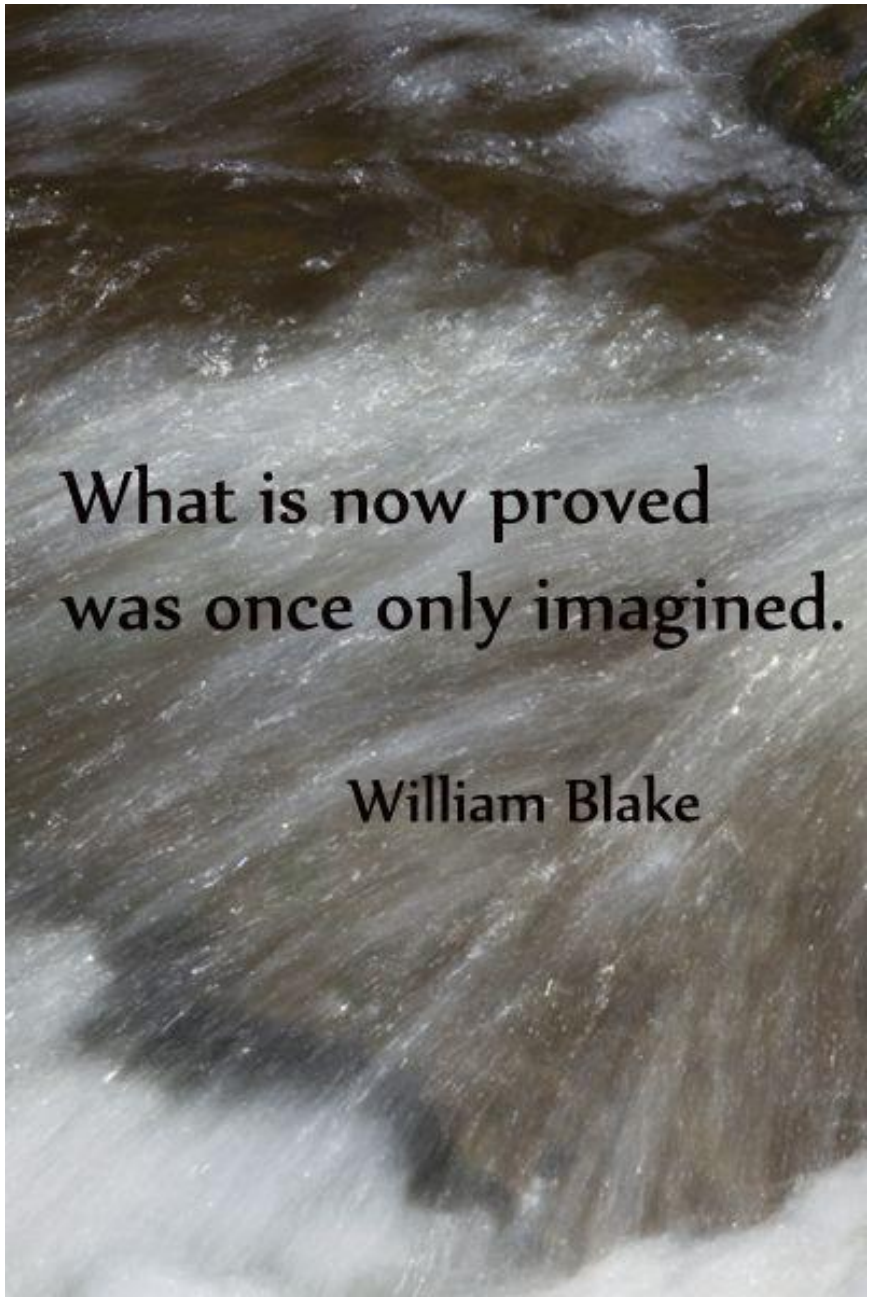

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Thank you!

Question/comments?

Nanci Bell, nanci.bell@lindamoodbell.com

Paul Worthington, paul.worthington@lindamoodbell.com

Valentina Nikolic, Lindamood-Bell Learning Processes, England - valentina.nikolic@lindamoodbell.com