Research- Informing Current Understanding of Reading and Writing Disabilities

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Federal Dyslexia Guidance

- OSERS issued a guidance letter in October of 2015.
- Reminded states to review policies and practices to ensure they do not prohibit the use of the terms dyslexia, dyscalculia, and dysgraphia in evaluations, eligibility, and IEP documents.
- OSERS encourages SEAs to remind their LEAs of the importance of addressing the **unique educational needs** of children with specific learning disabilities resulting from dyslexia, dyscalculia, and dysgraphia

DYSLEXIA SCREENING AND EARLY LITERACY INTERVENTION PILOT PROGRAM

- When Act 69 was enacted in June of 2014, Pennsylvania joined the majority of states that have either statewide dyslexia legislation.
- As of December of 2015, 28 states had enacted statewide dyslexia laws, 6 enacted some sort of program or resolution and and 14 others had developed handbooks and resource guides.
- Pennsylvania's Act 69 was the impetus for the establishment of pilot programs in eight school districts.
- The aim of this pilot is to provide early screening and intervention in order to attempt to mitigate risk factors and improve early literacy achievement.

Dyslexia Screening and Early Literacy Intervention Pilot.

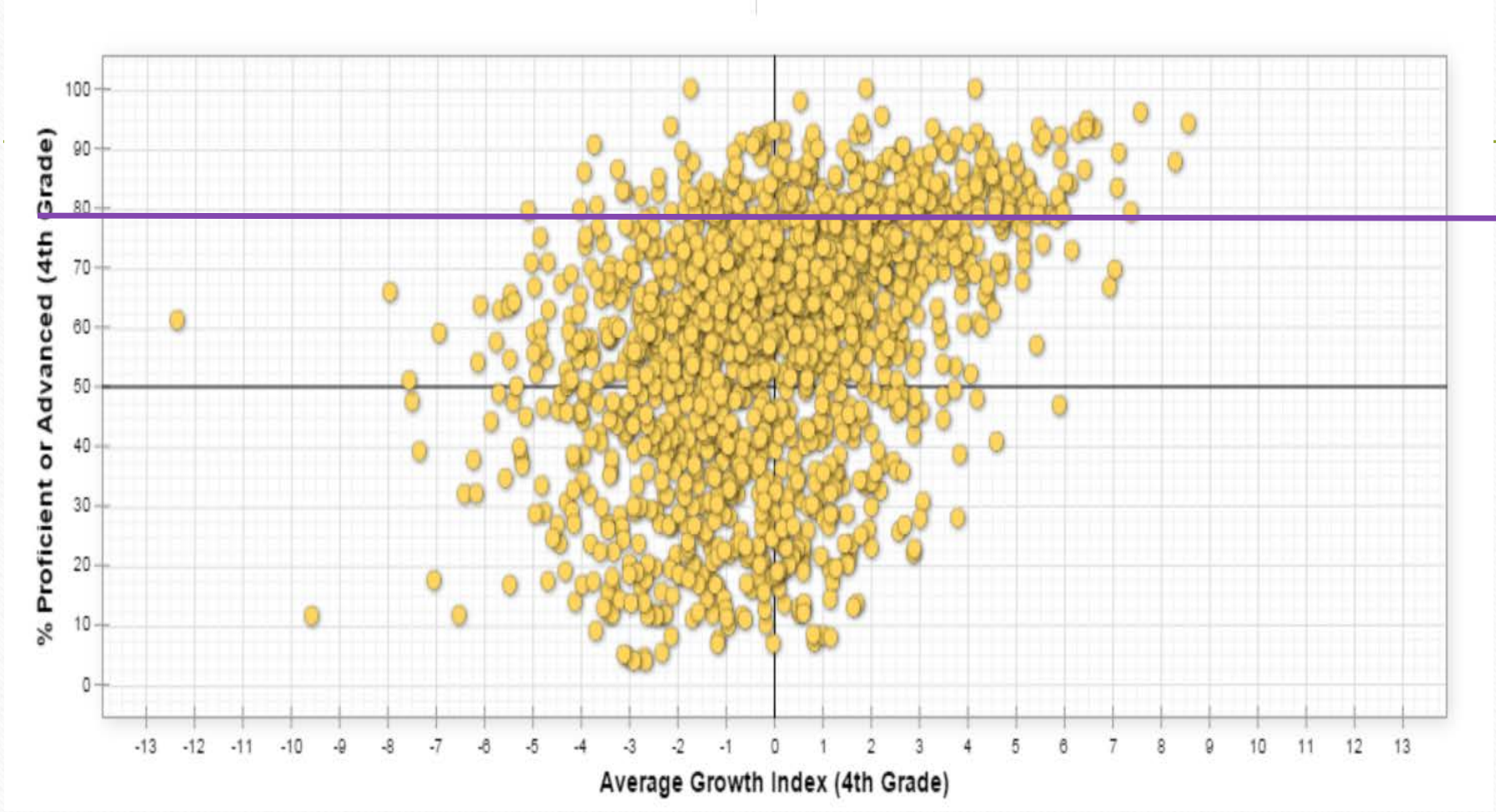
- Why this pilot?
  - Early identification and direct, multisensory structured language instruction is critical to prevent or mitigate word reading difficulties and dyslexia.
  - At least 15 and 20 percent of students experience academic failure due to reading problems.
  - Statistics indicate approximately 80% of children in special education experiencing reading difficulties.
  - The majority of students who struggle with reading, experience difficulties at the *word reading level*.
  - Neuroscience has clearly delineated how the brain organizes for reading and what type of instruction aids that organization.

The Goal of the Pilot

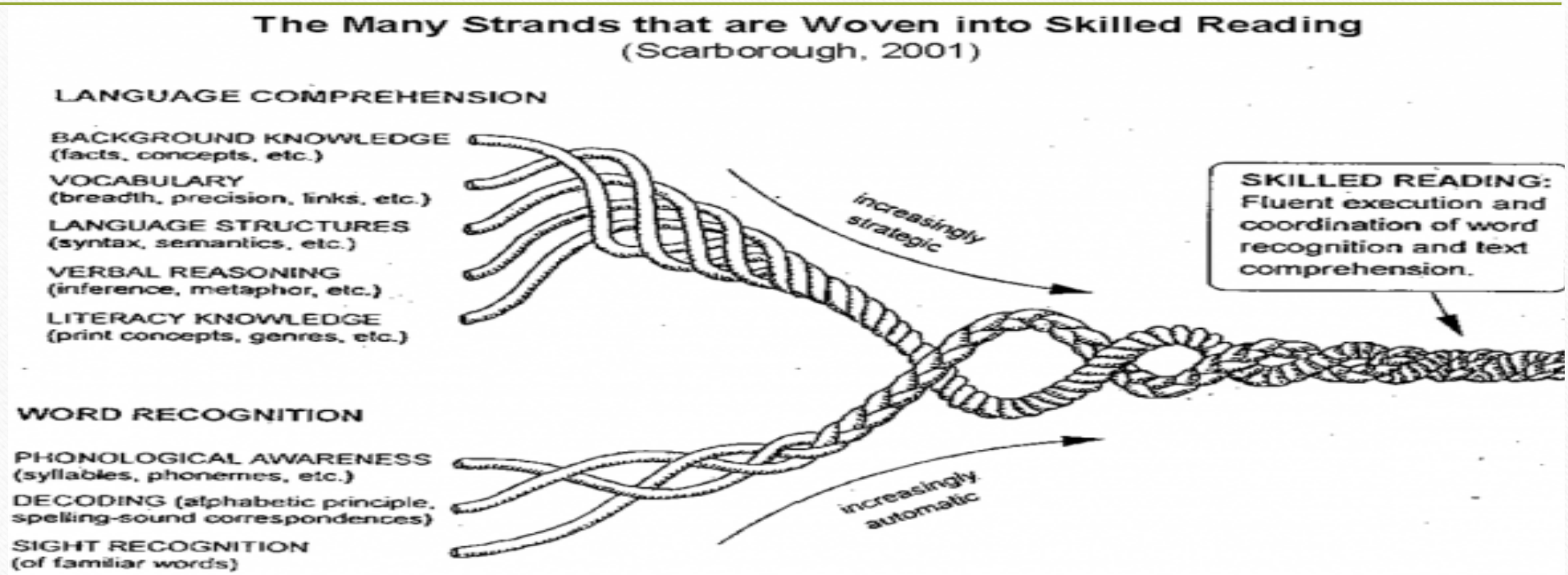
- To increase the number of children reading proficiently or better by the end of third grade…because third grade proficiency predicts to life success.
- Better outcomes are associated with earlier intervention, primarily because children fall far behind their peers when they are not able to access print. (Torgensen, et. al, 2001).
- Many children are at risk for dyslexia because of neurobiological and environmental factors, and even those with genetic risk may not manifest the disorder depending on their home environments and *quality of instruction* (Fletcher, 2011).

How are we doing with early literacy in Pennsylvania?

14-15 ELA PSSA, 4th Grade



Reading is a Complex Process



Much of what we have learned about the 'Reading Brain' comes from research on Dyslexia.

IDA and NICHD Definition

- Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other classroom abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension….

British Dyslexia Association

- Dyslexia is a specific learning disability which mainly affects the development of literacy and language related skills. It is likely to be present at birth and to be lifelong in its effects. It is characterized by difficulties with phonological processing, rapid naming, working memory, processing speed and the automatic development of skills that may not match up to an individuals other cognitive abilities.

Some of What We Know About Dyslexia and Other Reading Disorders

- From the time the term was coined in the 1800's, through the 1950's, thought to be a visual processing problem.
- Sally Shaywitz published in Scientific America in 1994 about a 'new theory' related to core phonological processing deficits.
- Convergence of neuroimaging data around the notions that dyslexics process reading differently from normal readers and intervention can begin to 'normalize' the 'reading circuit' in many cases. This seems to be more true when children are younger.
- More recently, Maryanne Wolf and others demonstrated the significance of rapid automatic naming facility as a factor.
- Laurie Cutting has recently started to unravel the neurobiology of reading comprehension disorders. Their findings suggest such disorder are related to weaknesses in accessing lexical-semantic representations.

The brain matters in all learning and academic tasks but many misunderstandings exist amongst educators.

Myths About The Brain and Learning

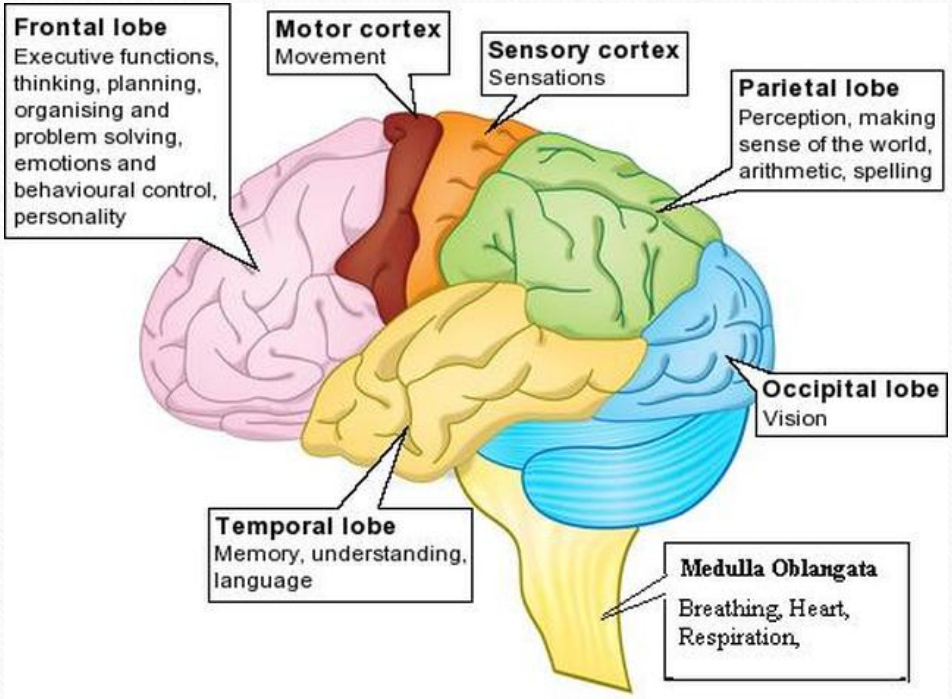
James B. Hale, MEd, PhD, ABPdN, ABSNP

- The left side of the brain is for language, the right brain is for visual-motor abilities.
- All children use the same brain areas to do an academic task like word reading or math computation.
- Since all children learn the same way, it is important they get the same instruction, and if they don't succeed, provide increasingly "intense" instruction.
- We are born with a brain that is "hard-wired" and you can do little to change the brain to overcome disability.
- We only use 10 percent of our brains.

The Brain

Four Lobes of the Cortex Frontal, Temporal, Parietal, Occipital

Subcortical Structures- Medulla, Pons, Cerebellum



Cerebrum and Neocortex
Where All Higher Brain Function Takes Place

- **Neocortex is the outer layer of the Cerebrum, which is divided into hemispheres, each with the following Lobes.**

- **<u>Neocortical Structures and Function, Associated Activities</u>**

- **Temporal Lobe-** Auditory; hearing/ understanding/ memory/visual object recognition- INPUT
- **Parietal Lobe** – Somatosensory; feeling/texture/pressure- INPUT
- **Occipital Lobe-** Vision; seeing- objects/ words/faces/color INPUT

(Hale and Fiorello, 2004)

Cerebrum and Neocortex: Where all higher brain function takes place

Neocortical Structures and Function, Associated Activities Hale and Fiorello, 2004

Frontal Lobe- Motor; drawing/writing –OUTPUT

* Dorsal Lateral Prefrontal Cortex is implicated in ADHD- Inattentive Type
* Orbital Frontal Cortex is implicated in ADHD- Hyperactive Type. Rich connections with limbic system

Forebrain Structures-

*** Basal Ganglia**- Motor ; posture, executive functions

*** Limbic –** Emotion, includes **Hippocampus**- Memory; **Amygdala**- Emotion valence; **Cingulate**- Executive- inhibition, monitoring

More Brain Terms

Gray Matter – Neuron soma, dendrites and axon terminals

White Matter- Myelinated Axons that connect neurons

Multiple Myelinated Axons –known as **Tracts**

Corpus Callosum - white matter tract connects left and right hemispheres

Cingulate – white matter tract- Anterior cingulate and posterior cingulate

Sulcus and Gyrus- fissures and bumps in the brain.

Functional Organization of Brain
Three Axes of Assessment

1. **Posterior(Temporal, Occipital , Parietal) to Anterior Axis (Frontal)**

   Input, Comprehension, Sensory vs Output Executive and Motor
   Learning and Production

2. **Left Hemisphere to Right Hemisphere Axis** (next slides)

3. **Anterior (Cortical) to Inferior (Subcortical) Axis** (associated with psychopathology-Regulating Brain Function)

   Executive Regulation and Supervision vs Executive Efficiency, Precision in Motor and Language

(Hale and Dixon, 2012)

Hemisphere Functions Language

Neuroimaging has provided us with a better understanding

(Hale and Fiorello, 2004)

Hemisphere Functions

Left hemisphere Concerned with rote, detailed, local and concordant information, previously learned information, memory.

Right Hemisphere- Concerned with big picture, processes novel, holistic, global and discordant information., and new learning

Language processes are represented bilaterally Different neuropsychological processes are what determine the participation of each hemisphere.

Left hemisphere appears to be specialized for closely related words, single interpretations, and semantic integration- **Explicit Language**

Right hemisphere is important for exploring multiple word meanings and distant semantic relationships-**Implicit Language**

Hemisphere Functions and Language

- Why does this matter? How does it inform our practice?

- A child struggling with Implicit Language is struggling with making inferences. She will require explicit instruction to find clues and evidence, understand multiple word meanings, understand referential language and support conclusions.

Hemisphere Functions

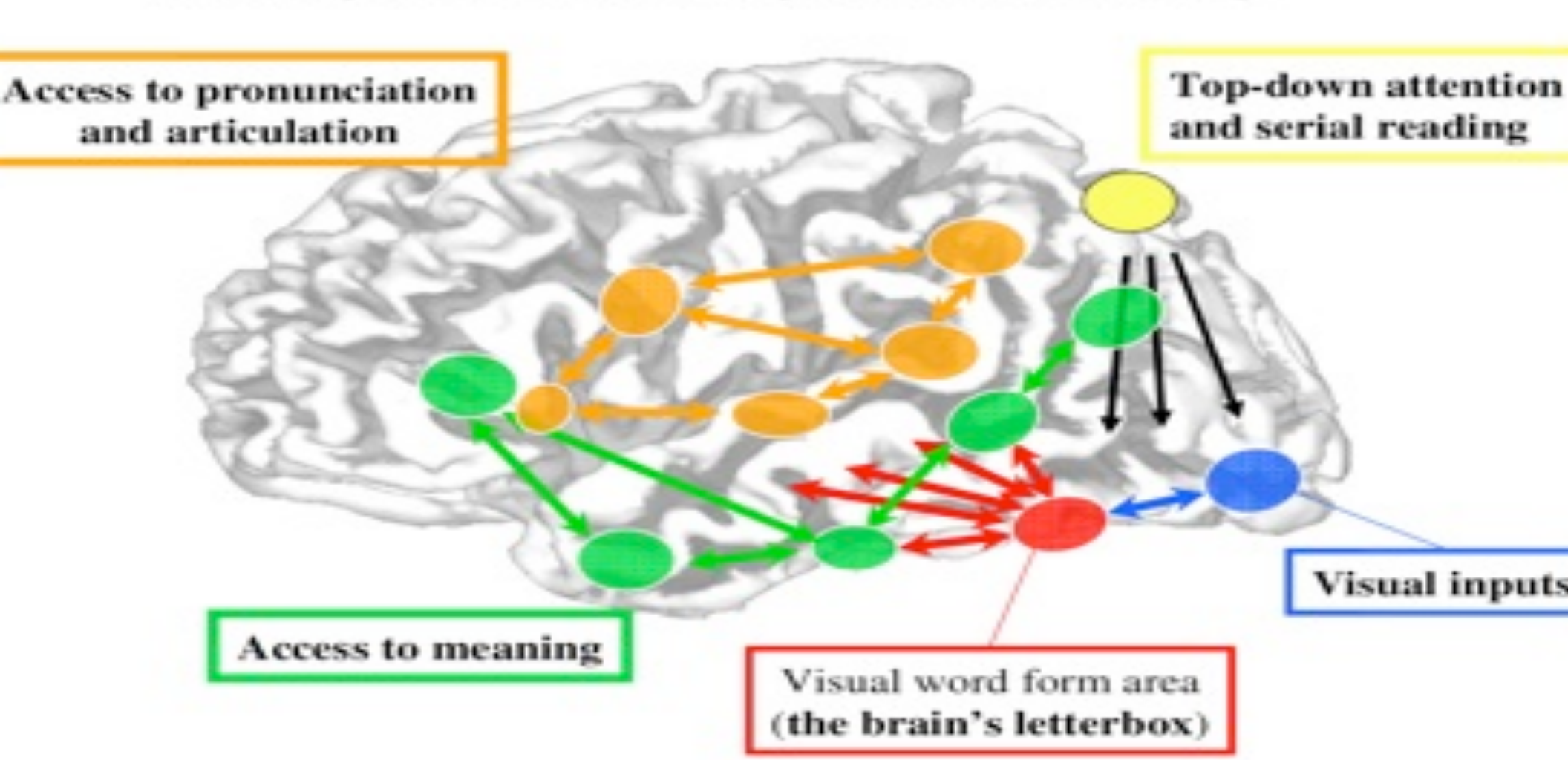
- **Left hemisphere**- detailed, local concordant **;Right Hemisphere-** global, novel, discordant
- **Example**- In visual field studies, left hemisphere can identify known persons, while the right hemisphere appears to be specialized for global perceptions such as gender.
- **Example** Left Parietal- sensitive to local stimulus characteristics such as direction, orientation, pattern. Right Parietal – sensitive to global, holistic, and spatial configurations. **Applying this to a task like Block Design-** our left parietal focuses on details and predictable stimuli, our right parietal looks for multiple pieces of information to get the big picture. Both hemispheres may be involved.

(Hale and Fiorello, 2004)

The Reading Brain

Spoken language is instinctive—built into our genes and hardwired into our brains. Learning to read requires us to take advantage of what nature has provided: a biological module for language.

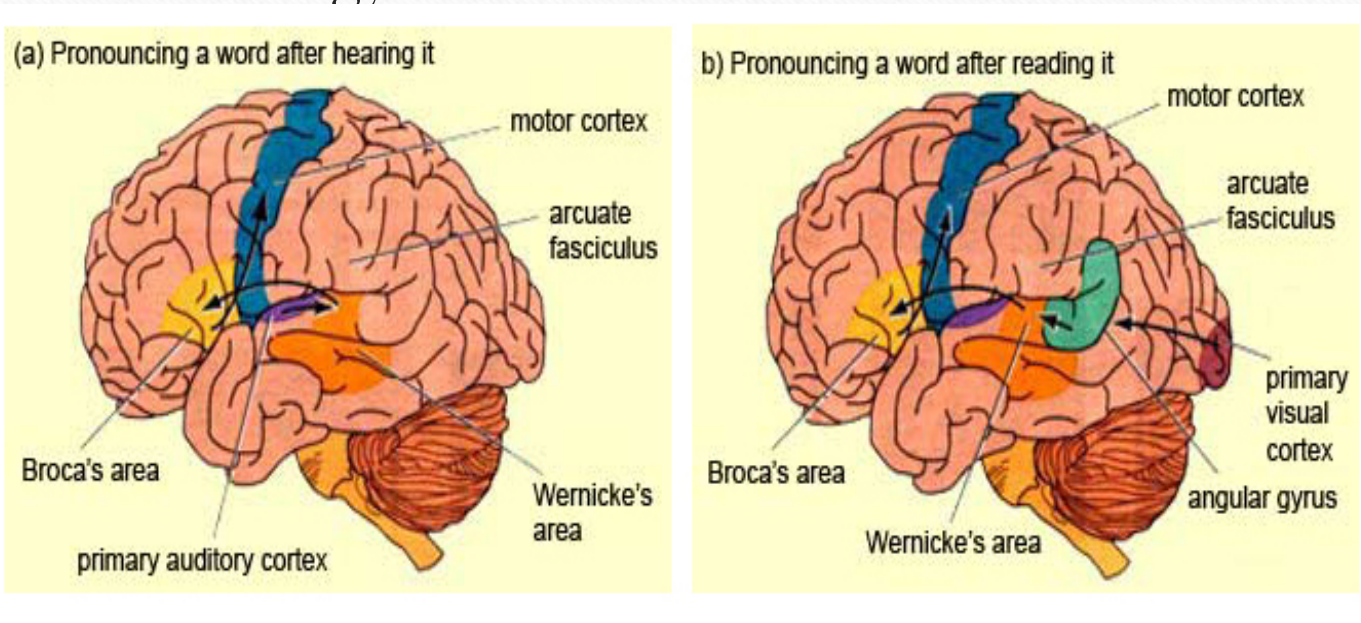
~*Sally Shaywitz*


Access to pronunciation and articulation
Top-down attention and serial reading
Visual inputs
Access to meaning
Visual word form area
(the brain's letterbox)

Learning to read literally **rewrites** the organization of the brain. Since we are not born to read, in contrast to speaking, instruction of some sort is necessary to engage these regions of the brain (Liberman, 1997).

Pronouncing after Hearing vs after Reading. Brain regions activated.

- Journal of Cosmology



Brain Regions Activated

- **Hearing/pronouncing Brain-** Importance of Primary Auditory Cortex; Arcuate Fasciculus, Motor Cortex, Wernicke and Broca areas.
- **Reading /pronouncing Brain-** Importance of Primary Visual Cortex, Arcuate Fasciculus, Motor Cortex, Wernicke and Broca areas. Involvement of **Angular Gyrus-** which is a cross-modal area where converging multisensory information is combined and integrated for comprehension, semantic processing, etc. (Seghier, 2012)
- **Reading is a complex activity involving cross modal association areas of the brain**. (Gabriel, 2011)

Cognitive Processes Necessary for Reading

- **Age-appropriate speech and language development:** necessary for Phonological Awareness and for reading comprehension.
- **Auditory processing:** essential for processing and learning language, words, and concepts presented orally, and for following instructions.
- **Oral comprehension:** essential foundation for reading comprehension.
- **Phonological Awareness**: the awareness of sounds in *spoken* language. (a language skill, necessary for learning the sound-symbol associations)

Cognitive Processes Necessary for Reading

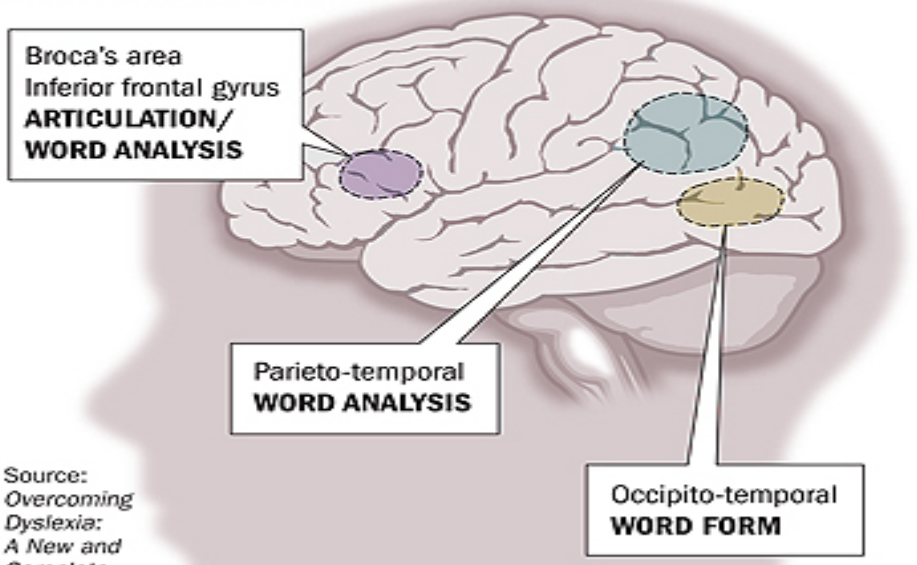
- **Processing speed/rapid naming:** necessary for fluency in decoding, in word recognition, and in meaning/semantic retrieval.
- **Orthographic processing**: visual processing is essential for processing letters, letter digraphs, and words, for reading charts and graphs, for understanding spatial concepts.
- **Retrieval fluency:** necessary for retrieval of word meaning, of past uses of word, of contextual information to aid comprehension.

Cognitive Processes Necessary for Reading

- **Verbal memory (short-term and long-term):** necessary for learning to automaticity the phonemic sounds associated with letters and letter blends, for blending sounds, for remembering what you have read so you can comprehend, for developing lexical and background knowledge.
- **Visual memory (short-term and long-term**): necessary for learning to automaticity the visual symbols (letters, letter dighraphs) and for fluent word recognition.
- **Working Memory, both verbal and visual:** necessary for decoding multisyllabic words, for sentence and passage comprehension, and for oral retelling.

Brain systems for reading

Brain imaging has shown three areas are involved in reading. Broca's area is active when you vocalize words in your mind. The middle "temporal-parietal" area decodes the sounds of letters and words, and is much less active in people with dyslexia; the rearmost area contains the memories of whole words. The better someone reads, the more active it becomes.



Source: *Overcoming Dyslexia: A New and Complete Science-Based Program for Reading Problems at Any Level* by Sally Shaywitz

James Hilston/Post-Gazette

Cognitive Processes and Corresponding Brain Regions Involv for Language and Reading

- Sounds come from the ear to the **Auditory Cortex- Temporal Lobe**
- Primary Auditory Cortex Temporal Lobe- auditory processing takes place in **Heschl's gyrus-** slightly larger on left side of brain than right.
- Language comprehension occurs in **Wernicke's area**,
- **Superior Temporal Gyrus and Superior Temporal Sulcus** involved on phonological processing and social language.
- **Broca's area** in Frontal Lobe –expressive language.

(Feifer, DeFina & Goldberg 2000, Feifer 2013)

Cognitive Processes and Corresponding Brain Regions Involved for Language and Reading

- Wernicke's and Broca's are connected by a neural pathway –**the Arcuate Fasciculus.** (Feifer, DeFina & Goldberg 2000, Feifer 2013)
- **Research** indicates that the arcuate fasciculus plays an important role in the development of reading skills **(Yeatman, et al, 2011).**
- Learning to read improves the structure of the arcuate fasciculus **(de Schotten et al. 2012).**
- Gabrielli (2016) **Arcuate Fasciculus** size is correlated to difficulty in acquiring word reading skills. **Implication for Early Intervention**

Cognitive Processes and Corresponding Brain Regions Involved for Language and Reading

- Important tertiary zones -**Supramarginal gyrus** and the **Angular Gyrus** - reading and writing.
- The **supramarginal gyrus** is adjacent to the inferior portion of the somatosensory cortex and appears to be more involved in phonological and articulatory processing of words and the spatial appreciation of sounds.
- The **angular gyrus** is located in the inferior parietal lobe, and is bounded by the visual occipital areas and appears to be more involved with mapping sounds onto symbols and semantic processing.
- **Inferior Frontal Gyrus** –Reading comprehension

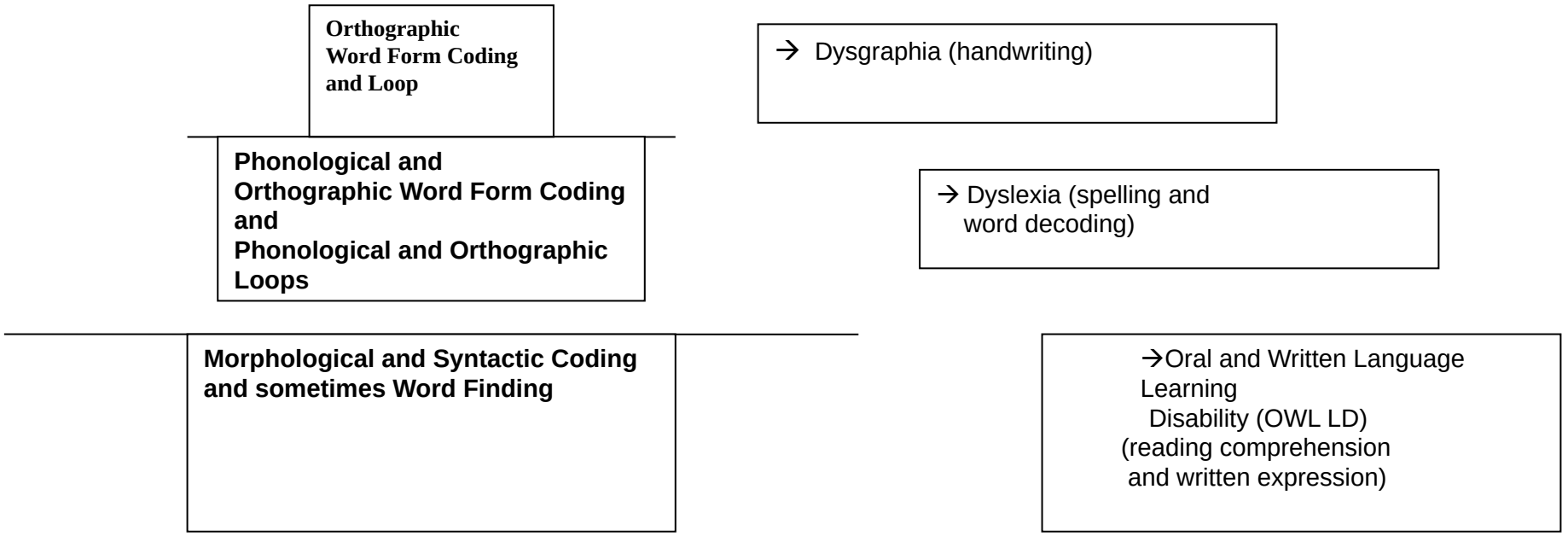
(Feifer, DeFina & Goldberg 2000, Feifer 2013)

Cognitive Processes and Corresponding Brain Regions Involved for Language and Reading

- **Left Fusiform Gyrus-** visual word form processing, learning, memory (Feifer, DeFina & Goldberg 2000, Feifer 2013)
- **Visual Word Form Area (VWFA)** is located in the left occipito-temporal sulcus bordering left fusiform gyrus. VWFA plays a prominent role in reading by serving as an interface between the ventral visual recognition system and perisylvian language areas (Bouhali et al, 2014) (McCandliss, Cohen & Dehaene, 2003).

Dysgraphia, Dyslexia, OWL, LD

Virginia Berninger



Does Research Show How to Define Dyslexia? Are all Reading Problems Dyslexia?

- **YES**, dyslexia, a Greek word that means impaired **word reading and spelling**, exists and can be defined.

- **NO**, not all reading and spelling problems are dyslexia.

Virginia W. Berninger, International Dyslexia Association Dallas, TX October 29, 2015

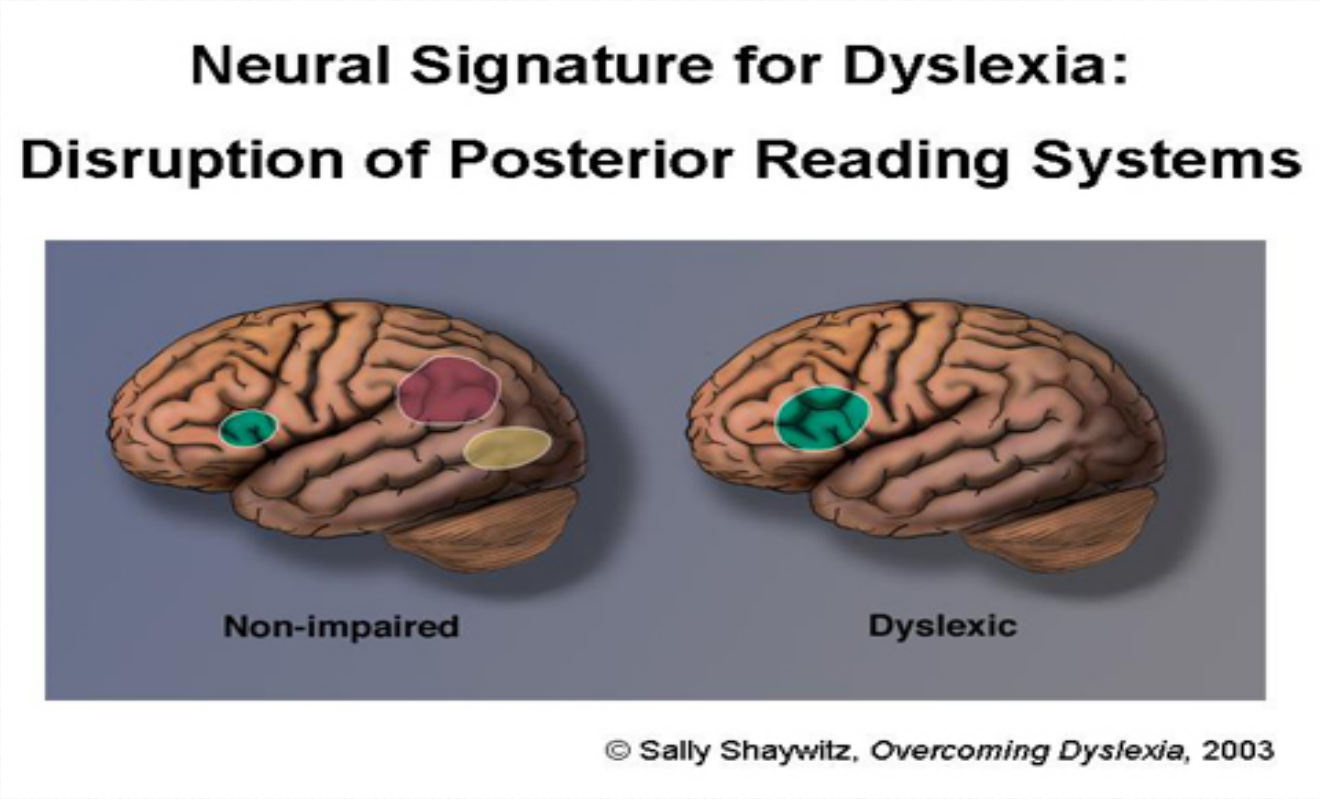
<u>Learning Profile for Dyslexia</u>: Impaired word reading (decoding, wo
identification—accuracy and/or rate; oral and/or silent) and spelling.

Phenotype Profile: Impaired phonological coding, orthographic codin
phonological loop, and/or orthographic loop.

Has research shown there a brain basis for dyslexia? **Yes**

Virginia W. Berninger, International Dyslexia Association Dallas, TX , October 29,

The Dyslexic Brain compared to the Reading Brain



Qualitative Differences between Dyslexic brain and Reading brain

Dyslexic Brain

* Over reliance on Frontal Lobes

Posterior areas disrupted in dyslexic Brain

*Parietal /Temporal – associated with word analysis

*Occipital Temporal –associated with word form

Subtypes of Reading Disabilities
Dyslexia
Reading Comprehension

DYSLEXIA Subtypes

- **Dysphonetic Dyslexia-** difficulty with phonological skills and sounding out words.
- **Surface Dyslexia-** difficulty with automatic recognition of words in print.
- **Mixed Dyslexia-** Multiple reading deficits involving phonological and orthographic processing skills. (Feifer, DeFina & Goldberg 2000, Feifer 2013)

READING Comprehension Disability

- **Reading Comprehension Deficits** –phonological and orthographic skills intact. Difficulty deriving meaning from text. (Feifer, 2013)

Does Research Show How to Define OWL LD?

YES, research has shown that some children struggle in learning oral language during the preschool years and then during the school years they struggle in understanding teacher's instructional talk, reading written language in instructional materials, using written language to express themselves, and using language to learn

Learning Profile: Nonverbal cognition may be higher than verbal cognition. Impaired listening comprehension, oral expression, reading comprehension, and written expression/composition.

Phenotype Profile: Impaired syntactic coding and often morphological coding. Impaired syntactic levels of four language systems (by ear, mouth, eye, and hand) with without word finding problems.

Has research shown a brain basis for OWL LD? yes

Does Research Show How to Define Dysgraphia?

- **YES,** dysgraphia, which is a Greek word meaning impaired **letter** writing by hand, exists and can be defined. **Learning Profile for Dysgraphia**: Impaired legible and automatic alphabet letter writing (handwriting) (which may interfere with learning to spell and compose, and legible and accurate numeral writing, which may interfere with written math.
- **Phenotype Profile for Dysgraphia**: Impaired orthographic coding (mind's eye), sequential finger planning, orthographic loop from letter coding in mind's eye to sequential finger movements to produce letters, and executive functions for supervisory attention.
- **Has research shown there a brain basis for dysgraphia?** yes

Working Memory Phenotype Profiles of 3 SLDs

mmon Lower Level Executive Function Problems across all 3 SLDs (**Supervisory ttenti**on).

hographic Loop= Orthographic Coding of Letters/ Words and Sequential Finger lovements

onological Loop=Phonological Coding of Letters /Words and Sequential Mouth lovements

ding=Storing and Processing Word Forms **Syntax Buffe**r Stores and Processes ccumulating Words.

Does Intervention Change the Brain?

Cortical reorganization in dyslexic children after phonological training: evidence from early evoked potentials

Chiara Spironelli, Barbara Penolazzi, Claudio Vio, Alessandro Angrilli

First published online: 5 August 2010

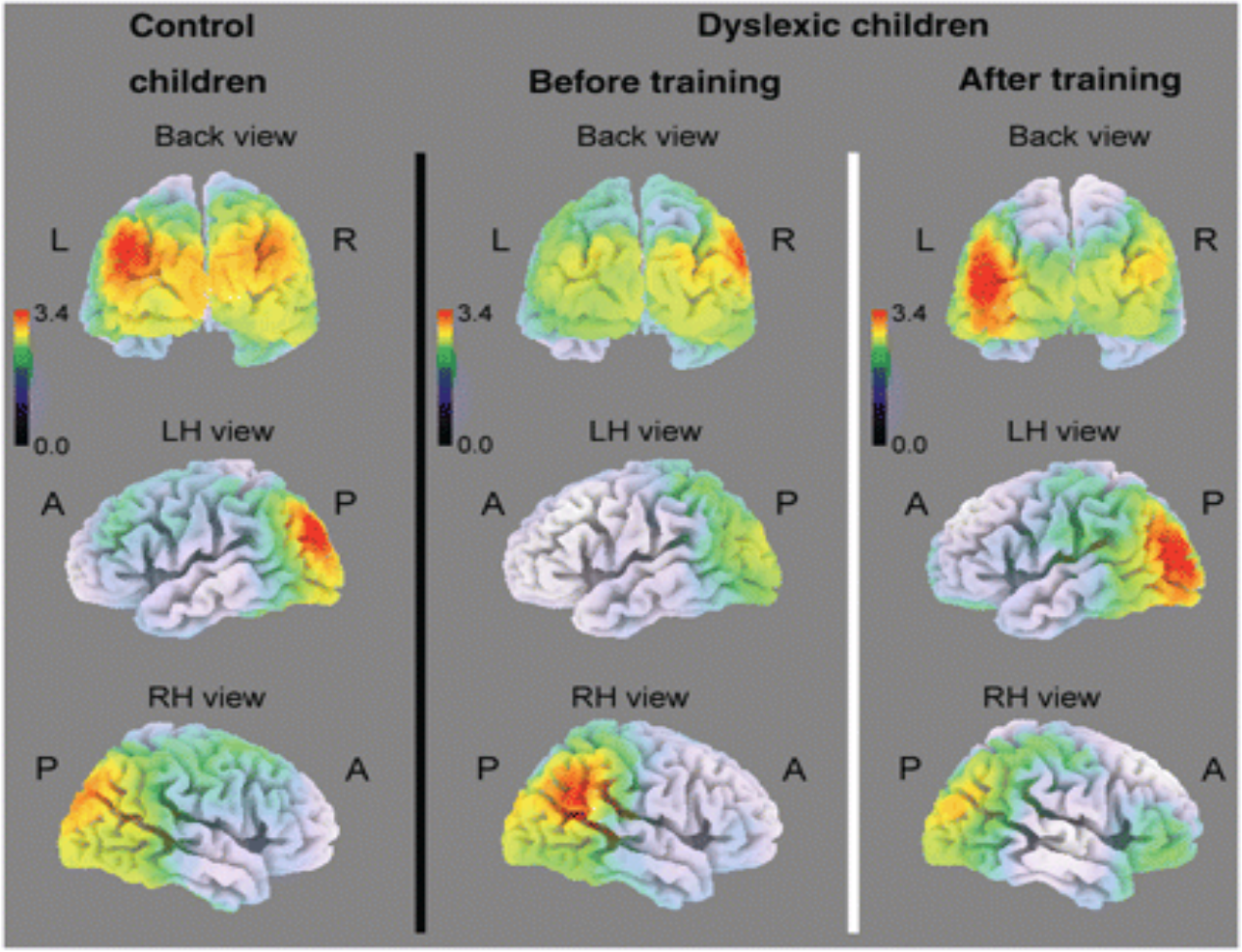
- Brain plasticity was investigated in 14 Italian children affected by developmental dyslexia after 6 months of phonological training. The means used to measure language reorganization was the recognition potential, an early wave, also called N150, elicited by automatic word recognition. This component peaks over the left temporo-occipital cortex and its amplitude depends on linguistic expertise. N150 elicited by written words was measured both in dyslexic children before and after training and in a sample of matched normal readers during phonological, semantic and orthographic tasks.

Cortical reorganization in dyslexic children after phonological training: evidence from early evoked potentials

Chiara Spironelli, Barbara Penolazzi, Claudio Vio, Alessandro Angrilli

First published online: 5 August 2010

- After training, dyslexic children increased their reading speed. Normal readers showed a typical left posterior N150, whereas in dyslexic children it was equally distributed across hemispheres before and shifted to left posterior sites after training. In addition, dyslexics' left posterior N150 asymmetry on the phonological task after training was significantly correlated with reading speed improvement, that is, those children who showed the greatest left shift in phonological N150 also had the greatest reading speed improvement.


Control children
Dyslexic children
Before training
After training
Back view
Back view
Back view
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R
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3.4
0.0
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Why Understand Processing Deficits?

"We want to do a better job of assigning children to interventions by predicting which intervention is most likely to work for a given child". *J. Gabrielli*

An Example

- Decoding. Student is scoring in 5th% for decoding but all other scores are high, so total score is average. School says classroom teacher will work on reading, per principal (against school psych's rec's in RR). Should further testing be done? (students scores match the scores of the example on testers websites)

Works Cited

- Berninger, Virginia W. *Not All Specific Learning Disabilities Are the Same: Lessons from Translation Science for Diagnosis and Treatment and FAPE 4 All.* Proc. of International Dyslexia Association, Texas, Dallas. Print.
- Bouhali, F., M. Thiebaut De Schotten, P. Pinel, C. Poupon, J.-F. Mangin, S. Dehaene, and L. Cohen. "Anatomical Connections of the Visual Word Form Area." *Journal of Neuroscience* 34.46 (2014): 15402-5414. Web.
- Feifer, Steven G., De Fina Philip A., and Elkhonon Goldberg. *The Neuropsychology of Reading Disorders: Diagnosis and Intervention Workbook*. Middletown, MD: School Neuropsych, LLC, 2000. Print.
- Feifer, Steven G., D.Ed. "The Neuropsychology of Reading, Writing and Mathematics: A Framework for Effective Intervention." School Neuropsychology Certificate Program. 3 Dec. 2013. Web.
- Fletcher, J. M. "Dyslexia: The evolution of a scientific concept. *Journal of the International Neuropsychological Society* 15.4 (2009) 501-508.

- Gabrielli, J. "From Brain Imaging to Personalized Medicine. *Brain Scan*, McGovern Institute for Brain Research at MIT. 2013, no. 27.
- Hale, James B., and Catherine A. Fiorello. *School Neuropsychology: A Practitioner's Handbook*. New York: Guilford, 2004. Print.
- Hale, James B., Ph.D, and Shauna Dixon, M.S. *Brain Gain: Conducting School Neuropsychology Evaluations That Enhance Academic and Behavioral Outcomes*. Philadelphia: NASP Workshop, 2012. Print.
- Joseph, R. Gabriel, Ph.D. "Origins of Thought Consciousness Language, Egocentric Speech and the Multiplicty of Mind." *Journal of Cosmology* 14 (2011). Web.
- Liberman AL. How theories of speech affect research in reading and writing. In: Blachman BA, editor. Foundations of reading acquisition and dyslexia: Implications for early intervention. Lawrence Erlbaum; Mahwah, NJ: 1997. pp. 3–19.
- Mccandliss, Bruce D., Laurent Cohen, and Stanislas Dehaene. "The Visual Word Form Area: Expertise for Reading in the Fusiform Gyrus." *Trends in Cognitive Sciences* 7.7 (2003): 293-99. Web.
- Norton, E. & Wolf, M. "Rapid Automatized Naming and Reading Fluency: Implications for Understanding and Treatment of Reading Disabilities". Annu. Rev. Psychol. 2012.63:427-452. Downloaded from www.annualreviews.org by Tufts University on 03/05/12.

- Schotten, M. Thiebaut De, L. Cohen, E. Amemiya, L. W. Braga, and S. Dehaene. "Learning to Read Improves the Structure of the Arcuate Fasciculus." *Cerebral Cortex* 24.4 (2012): 989-95. Web.
- Seghier, M. L. "The Angular Gyrus: Multiple Functions and Multiple Subdivisions." *The Neuroscientist* 19.1 (2012): 43-61. Web.
- Shaywitz, Sally E. *Overcoming Dyslexia: A New and Complete Science-based Program for Reading Problems at Any Level*. New York: A.A. Knopf, 2003. Print.
- Spironelli, C., B. Penolazzi, C. Vio, and A. Angrilli. "Cortical Reorganization in Dyslexic Children after Phonological Training: Evidence from Early Evoked Potentials." *Brain* 133.11 (2010): 3385-395. 5 Aug. 2010. Web. 1 Mar. 2016.
- Yeatman, Jason D., Robert F. Dougherty, Elena Rykhlevskaia, Anthony J. Sherbondy, Gayle K. Deutsch, Brian A. Wandell, and Michal Ben-Shachar. "Anatomical Properties of the Arcuate Fasciculus Predict Phonological and Reading Skills in Children." *Journal of Cognitive Neuroscience* 23.11 (2011): 3304-317. Web.

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