What It Means to Read: Tales from the Neurosciences

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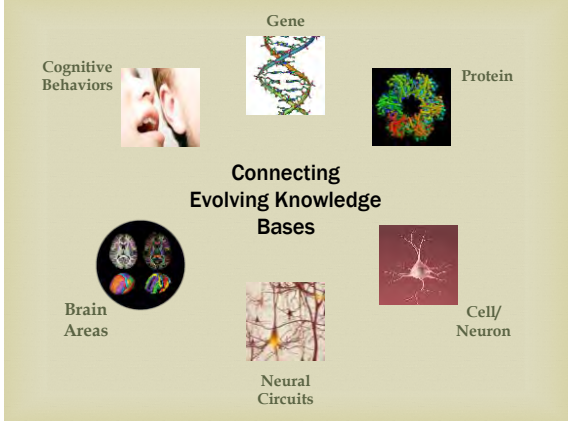
Tufts University
Pennsylvania Department of Education, March 8, 2017

The Center for Reading and Language Research

Committed to the pursuit of multi-disciplinary research about how the brain learns to read across all ages and stages of development

Tufts UNIVERSITY

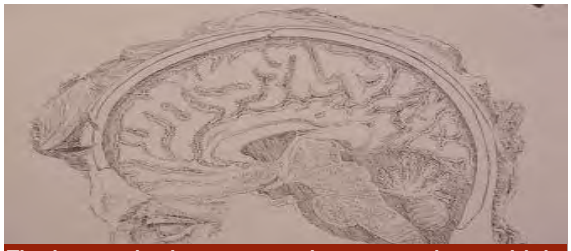
ase.tufts.edu/crlr



Tales from the Neurosciences: How the Reading Brain Informs

- Reading Development
- Deep Reading
- Dyslexia
- Intervention
- Digital Age
- Non-Literate Cultures

Preface: The Mystery



The human brain was never born to read or multiply numbers or program.

How then does the human brain learn new cognitive functions?

The Plastic Reading Brain Circuit

Principles of the Brain's Plasticity within Limits for Cultural Inventions

1.
Ability to form whole new connected circuits

2.
Ability to recycle and repurpose areas

3.
Depends on environment/ limits

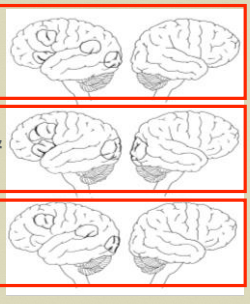
Dehaene, 2015

Multiple Circuits
Plasticity of Reading Brain

English

Chinese & Kanji

Japanese Kana



Brain can rearrange itself in multiple ways to read, depending on writing system and medium.

Bulger, Perfetti, & Schneider

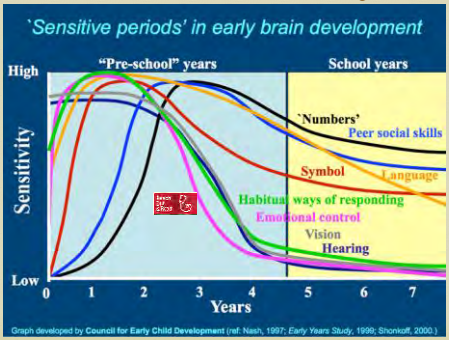
First Lesson:

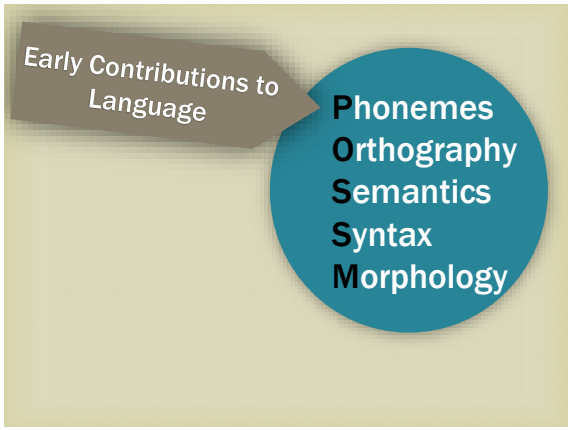
The Developing Brain

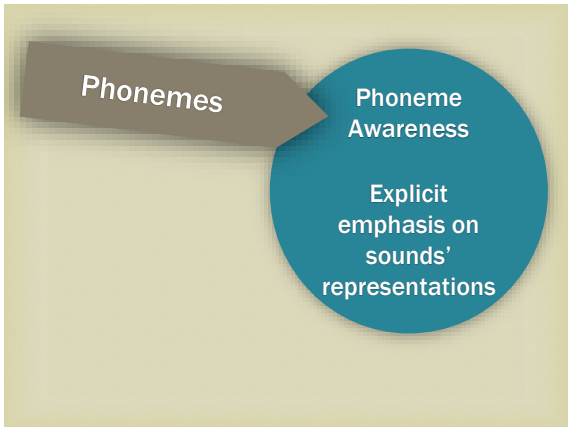
How Does the Young Brain Learn to Read?

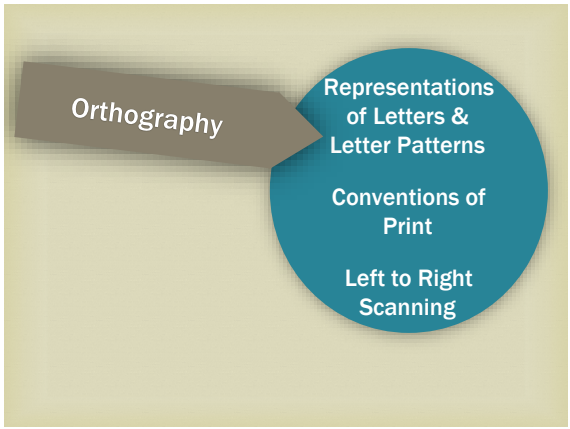
Each new reader must create a ***new reading circuit*** from older cognitive and linguistic structures and their connections

Best To Start Early…




Early Contributions to Language
Phonemes
Orthography
Semantics
Syntax
Morphology

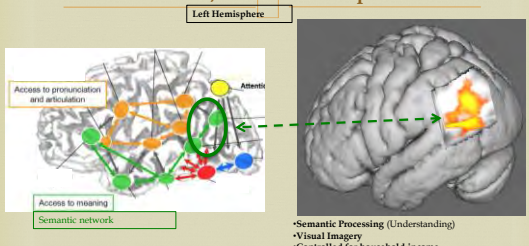

Phonemes
Phoneme Awareness
Explicit emphasis on sounds' representations


Orthography
Representations of Letters & Letter Patterns
Conventions of Print
Left to Right Scanning

Semantic Development

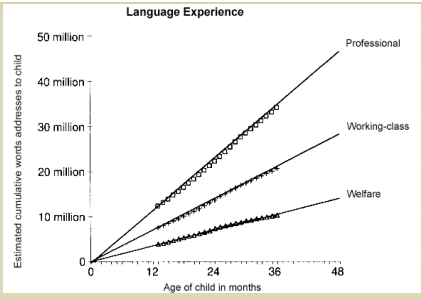
Semantic Development in Every Book and Story

Study 1: Quantitative Home Reading Environment and Neural Activation During Story Listening in Preschoolers 3-5 y/o: John Hutton, Cincinnati Hospital

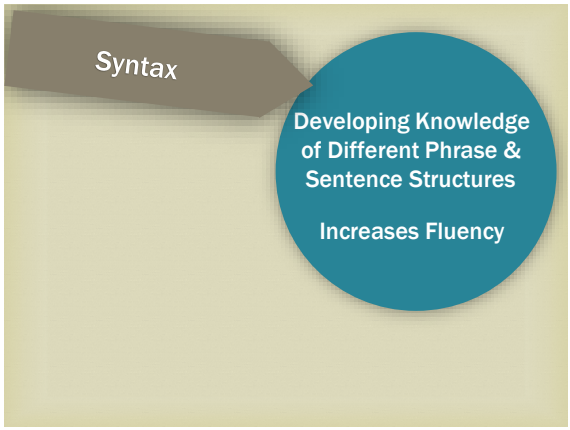


- **Semantic Processing** (Understanding)
- **Visual Imagery**
- **Controlled for household income**

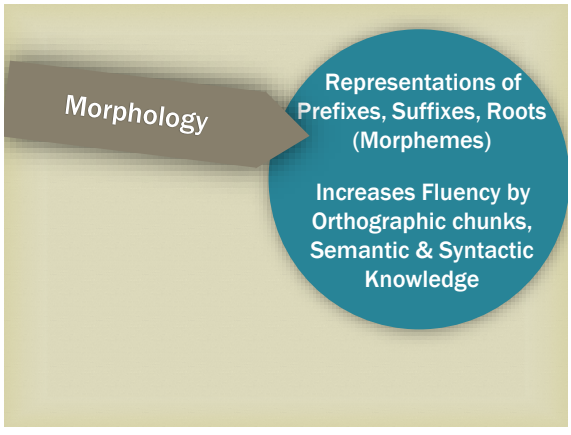
1. Adapted from S. Dehaene, "Reading the Brain," 2010.
2. Hutton, et al. *Pediatrics*, 2015.



32 Million Word Gap

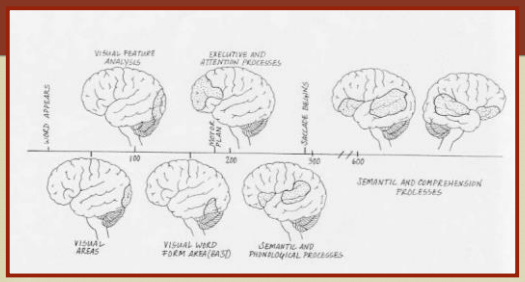


Semantic and Syntactic Processes (with George Eliot)



Decoding plus "Deep Reading"

Connected in Milliseconds



Dehaene, 2015

Second Lesson:

Deep Reading

The Heart of Expert Deep Reading

At the heart of reading, 100 to 200 milliseconds allow us

"time to think our own new thoughts".

"We feel quite truly that our wisdom begins with that of the author…By a law which perhaps signifies that we can receive the truth from nobody, that which is the end of their wisdom appears to us as but the beginning of ours."
Marcel Proust

"Nous sentons tres bien que notre sagesse commence ou celle de l'auteur finit… "

Deep Reading

Background Knowledge	Inference, Deduction/Induction, Analogical Thinking
Perspective Taking	
Critical Analysis	Imagery
Novel Thought	Insight & Reflection

Going beyond the wisdom of the author

Background Knowledge: We are the sum of what we read and how we read….

"Reading is cumulative and proceeds with geometric progression: each new reading builds upon what the reader has read before."

Albert Manguel, A History of Reading. "

Empathy and Perspective Taking:

Passing over to the Perspectives of Other…..Other Time, Other Place, Other Consciousness ....John S Dunne

Perspective taking

Theory of Mind- passing over into the thoughts and feelings of others

Strategic Thinking

Expansion of Understanding and Empathy

Communicative Function

Antidote to Aloneness

Hemingway's Shortest Story

For Sale: Baby shoes. Never worn.

Insight and Novel Thought

"An insight is a fleeting glimpse of the brain's huge store of knowledge. The cortex is sharing one of its secrets".
Jonah Lehrer.

"An insight is so capricious, such a slippery thing to catch *in flagrante,* that it appears almost deliberately designed to defy empirical inquiry….. (one could say) it's everywhere!"
Arne Dietrich and Riam Kanso

Deep Reading Brain Circuit and St. Thomas Aquinas

When asked what he was most grateful for,
Thomas Aquinas answered simply,
"I have understood every page I ever read".
G.K. Chesterton

Third Lesson:

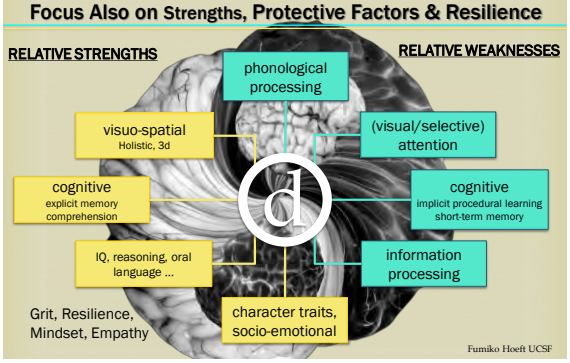
How the Reading Brain helps us
to reconceptualize readers with dyslexia

Cerebrodiversity and What can go Right and Wrong in Dyslexia

The Diversity of Dyslexia

Arts & Science	Entrepreneurs
Alexander Graham Bell	Richard Branson
Lewis Carroll	John Chambers
Leonardo Da Vinci	Stephen Cloobeck
Antoni Gaudi	Walt Disney
Pablo Picasso	William Hewlett
Robert Rauschenberg	Steve Jobs
Auguste Rodin	Craig McCaw
Steven Spielberg	Anita Roddick
Nikola Tesla	Charles Schwab

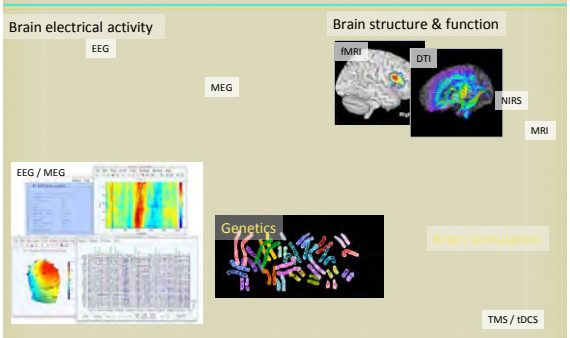
The Neuroscience of Dyslexia – Emerging View
Focus Also on Strengths, Protective Factors & Resilience



Integrative Approach | New Neuroscience | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

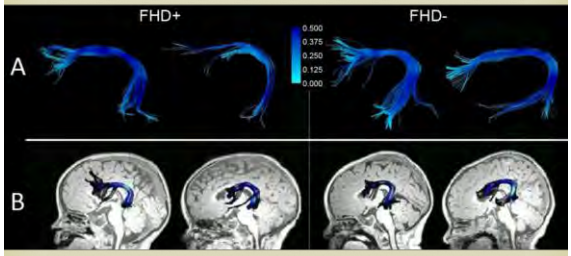
Integrative Approach to Dyslexia Research

Fumiko Hoeft UCSF



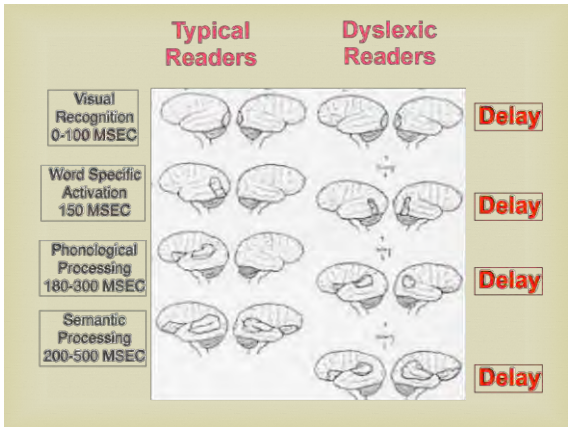
Integrative Approach | New Neuroscience | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

Dyslexia Risk Evident in Infancy



Less robust arcuate fasciculas correlated to familial risk.

Lange, Peysakhovich, Zuk, Drottar, Sliva, Smith,Becker, Grant, & Gaab, 2015



Rapid Automatized Naming (R.A.N.): Predictor of Fluency

o a s d p a o s p d

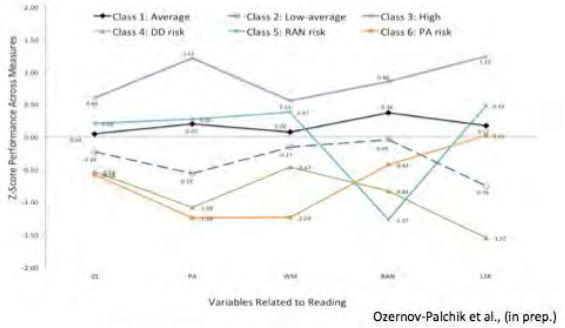
s d a p d o a p s o

a o s p s d p o d a

d a p o d s a s o p

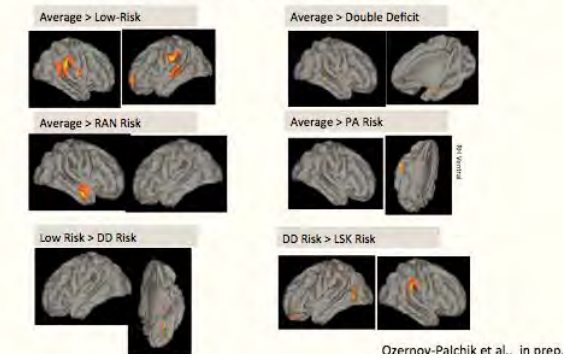
o a d s d p o a p s

Six distinct cognitive profiles of early reading have emerged in a diverse sample of 1,200 children



Ozernov-Palchik et al., (in prep.)

Distinct patterns of grey matter volume reductions in the risk groups as compared to the average kindergartners



Ozernov-Palchik et al., in prep.

Fourth Lesson:

Using the Reading Brain Circuit to Inform Instruction and Intervention

The Dyslexia Paradox

Early Intervention is Best.

Identification at 9 is the Norm.

Components of the Reading Brain Circuit (POSSuM)

Millisecond Connections

Deep Reading Processes

Reverse Engineering of Reading Brain Components for Differences in Dyslexic Brain and Dysfluent Readers

1. Explicit emphases on circuit parts and how words work
2. "Deep reading" comprehension processes
3. Their millisecond connections

RAVE-O Characters

Metacognitive Strategies Embodying Circuit

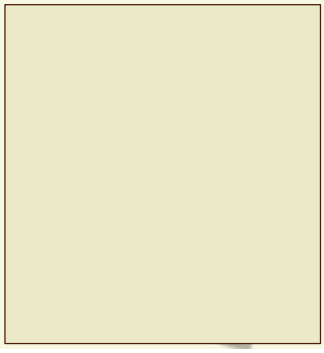
RAVE-O Characters: Metacognitive Strategies Addressing Each Component

Morphological Analysis Skills

j am s

j am m ing

j am m ed



Strategies that Promote Memory

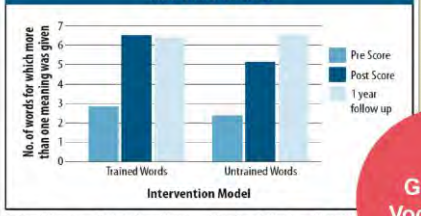
- Interesting Characters
- Strategies to Support Memory

"Think Thrice" is one way students learn to interact with text in a meaningful way.

Cambium Learning Sopris

WORD-R Test (elementary): Expressive Vocabulary and Semantics

Gains both short- and long-term in vocabulary knowledge and semantic flexibility after 70 one-hour instruction sessions.

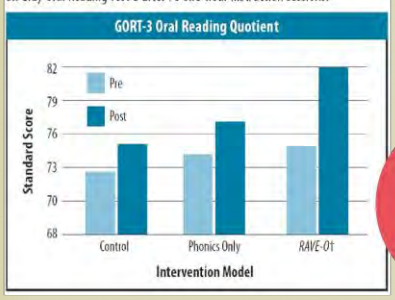


Trained Words = *RAVE-O* Core Words Untrained Words = Word-R
(All results significant at $p \leq .001$ level.)

Gains in Vocabulary

Gray Oral Reading Test-3: Fluency and Comprehension

Changes in Oral Reading Quotient (fluency + comprehension) Standard Scores on Gray Oral Reading Test-3 after 70 one-hour instruction sessions.



Gains in Text Reading & Comprehension

Fifth Lesson

Knowledge about the plasticity of the "reading brain" informs the *transition as a species to a digital culture*

"The real question is whether the affordances of reading on screen lead us to a new normal, one in which *length* and *complexity* … and *memory* and especially *concentration* are proving more challenging."
(Baron, 2015--CASBS 2013-14)

"Skimming is the new normal": So is Distraction, Attention Switching, and Voluminous Information

1.
In scanning, browsing, bouncing, keyword spotting
(Liu, 2005, 2009,2014)

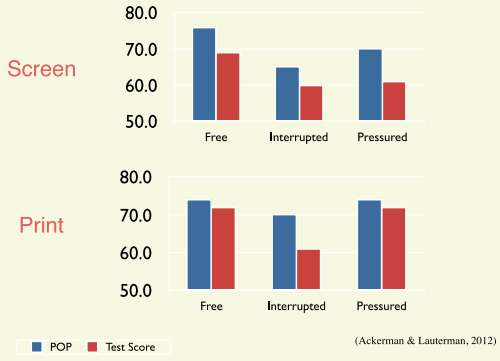
2.
Less time on in-depth, concentrated reading; 27 distractions an hour.

3.
Decreased sustained attention and memory.
(Baron,2014)

Dehaene, 2015

Will changes in attention and the expectation for constant, immediate information from external platforms of knowledge threaten the formation of deep reading in young digital readers?

Comprehension for On-Screen vs. Print



(Ackerman & Lauterman, 2012)

We cannot go back to a pre-digital time; but, we should not lurch without understanding **what we will lose, what we will gain,** for our species' cognitive repertoire.

"A culture can be judged by how it pursues three lives: the life of activity and productivity, the life of enjoyment, and the *life of contemplation.*"

-*Aristotle*

SO ALSO…..
THE GOOD READER

Sixth Lesson

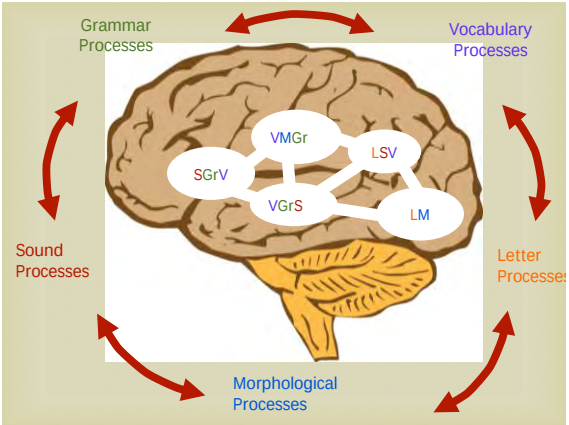
Knowledge about the "reading brain" informs our ability to bring literacy to non-literate cultures

Can all children become literate?

Can we create an experience on a tablet that can help children learn to read who have inadequate or no schools in remote parts of the world or our backyards?

CURIOUS LEARNING: A Global Literacy Project

Collaboration: Tufts University, MIT MEDIA LAB, GSU



Ethiopia

Rural Alabama/Georgia

Seventh Lesson:

What can each of us do?

"Children are a sign. They are a sign of hope, a sign of life, but also a "diagnostic" sign, a marker indicating the health of families, society, and the entire world. Wherever children are accepted, loved, cared for and protected, the family is healthy, society is more healthy, and the world is more human".

Our Hope with YOU for the Next, Literate Generation