MiMTSS Technical Assistance Center

Dyslexia Community of Practice Session 1:
Neurobiological Underpinnings of Dyslexia

Jack Fletcher, Professor Emeritus, University of Houston
Sharon Vaughn, & Elizabeth Stevens

MICHIGAN Department of Education

mimtsstac.org

A Note about Recording

- We are recording this session so the content may be available to:
  - Others in our Dyslexia Community of Practice who were unable to attend today
  - You! If you want to refer to this session later, it's available to you.
- Rest assured the recordings will not be made publicly available, so we hope you'll share your ideas freely within this safe space.

MiMTSS Technical Assistance Center

Creative Commons License Information

MiMTSS Technical Assistance Center

Training Effectiveness

- At the end of the session, you will be asked to provide feedback on today's training
- Results will be used to make improvements to professional learning and for reporting to TA Center stakeholders
- One of the feedback questions you will see is related to promoting and positively portraying diversity among educators and learners (e.g., focus on asset-based language, positive representation of multiple identities)

MiMTSS Technical Assistance Center

MiMTSS Dyslexia CoP Session Schedule

Date	Time	Topic
September 9, 2025	2:00-3:30pm ET	The Neurobiological Underpinnings of Dyslexia
October 7, 2025	10:00-11:30am ET	Misunderstandings of the Science of Reading
November 4, 2025	3:00-4:30pm ET	Structured Literacy
December 3, 2025	11:00am-12:30pm ET	Multisyllabic Word Instruction
January 23, 2026	2:00-3:30pm ET	Supporting Reading Comprehension for Students with Dyslexia
February 24, 2026	10:00-11:30am ET	Differentiating Tier 1 Instruction for Students with Dyslexia
March 26, 2026	3:00-4:30pm ET	Using Data to Inform Instruction
April 20, 2026	11:00am-12:30pm ET	Deliberate Practice and Feedback: The Secret Sauce

Objectives

1. **Define** the Science of Reading (i.e., what it *is*, what it is *not*).
2. **Identify** myths or misconceptions about the Science of Reading.
3. **Explain** why these are misconceptions using your knowledge of the research.
4. **Identify** implications for practice.
5. **Explain** how you will apply today's learning in your teaching and/or coaching role.

Neurobiological Correlates of Dyslexia: Effects of Reading Instruction on Brain Function

Jack M. Fletcher, Ph.D.
Department of Psychology, University of Houston

jackfletcher@uh.edu
www.texasldcenter.org

Dyslexia, Reading, and the Brain

- Reading is not a natural process and is not constructed as a result of simple exposure to language or words (Liberman)
- Good reading instruction is always brain-based and involved in the development of reading proficiency and in dyslexia, a word level reading problem
- The process of learning to read rewrites the organization of the brain (Eden), which varies depending on the structure and transparency of the language (Zigler)
- What is the relation of dyslexia and the brain?
- How does reading instruction affect brain function (and structure)?

Dyslexia is a Word Level Disorder

Most common and best understood form of LD (Dyslexia)

- Largest single group of students in special education: Almost **2/5** of all children identified for special education
- Many children not identified for special education have word level difficulties
- Addressed in IDEA as “basic reading” domain and often through 504
- Key to overcoming dyslexia is to **prevent** it through MTSS, with intensive remediation for inadequate responders

What is Dyslexia?

- Dyslexia occurs primarily at the **level of the single word**
- Involves the ability to **decode** and **spell** printed words in isolation (accurate)
- Leads to problems reading text, but is not a text level disability
- Word problems in reading and spelling are strongly associated with problems segmenting words and syllables into phonemes.

Alphabetic Principle

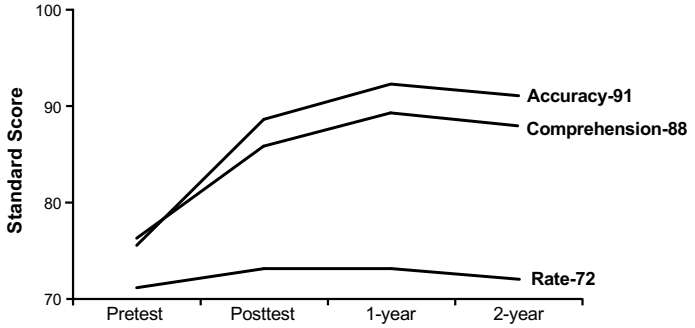
- Print represents speech through the alphabet or other visual symbol
- Regardless of surface appearance (orthography), words represent internal units based on sound (phonemes)
- In learning to read, the child makes explicit an implicit understanding that words have internal structures linked to sounds (phonological awareness)
- Reading is parasitic on language

Identification (Science, not Policy)

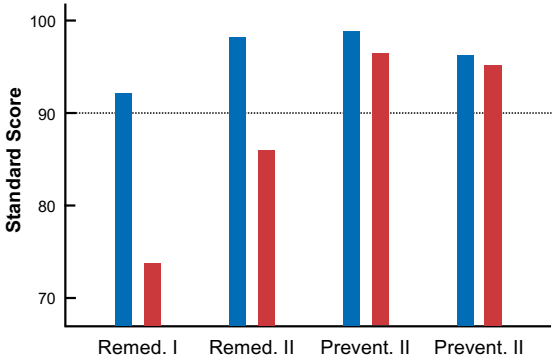
- Dyslexia is best identified through **assessments of reading and spelling skills, and instructional response**. Cannot be identified independently of instruction
- IQ tests are not necessary (Dyslexia is uncoupled from IQ): Methods for identification of LD based on IQ-discrepancy or patterns of cognitive strengths and weaknesses lack validity.
- Documentation of processing deficits not required.

- ✓ Dyslexia can (often) be **prevented**.
- ✓ Remediation requires much more **intensity**
- ✓ Skills that prevent dyslexia must be taught **early** in school
- ✓ Remediation **after Grade 2** demonstrably less effective (Connor; Lovett): diminishing returns

Torgesen et al. (2001)



Differences in outcomes for Basic Reading Skills and Rate in Prevention vs. Remediation Studies



Remediation is Not a Solution to Overcoming Dyslexia!

- Decoding usually teachable at any age with sufficient intensity
- Reading rate is limited because the proportion of words in grade level passages that children can read “by sight” is less than for average readers.
- How do you close the gap when the student is already 3–5 years behind (exposure and experience, not age)?

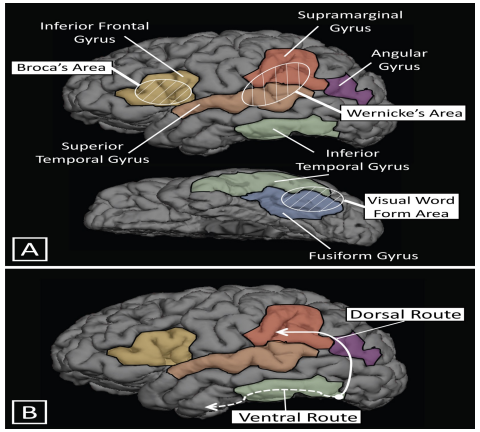
Neuroscience Explains Why

- Two metaphors
  1. Reading is parasitic on speech (Liberman; sublexical, dorsal system)
  2. Reading is unlocking language from vison (Dehaene) or language at the speed of sight (Seidenberg)
- Malleability in development and in instructional response, but access and experience is key for automaticity

Dual Route Theory

- **Dorsal (assembled) route**: Sublexical, must access phonological representation and identify substituent parts (indirect)- (reading is parasitic on language; sound and print)
- **Ventral (stipulated or addressed) route**: Lexical, directly from word form to pronunciation (reading is unlocking language from vision; language at the speed of sight; print and meaning; requires experience)
- Operate in parallel depending on the properties of the word

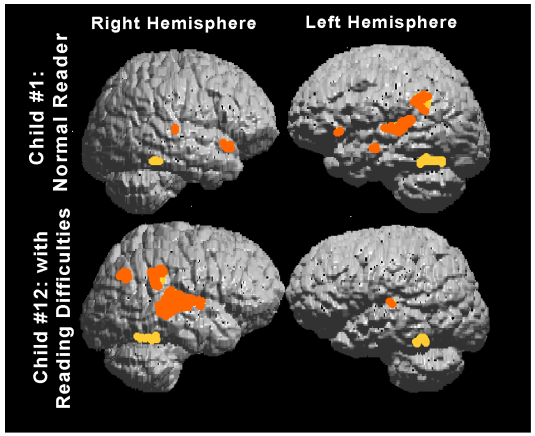
The Reading Brain



Functional and Structural Neuroimaging

Center for Clinical Neuroscience, Children's Learning Institute;
A.C. Papanicolaou, U of Texas Health Science Center- Houston
(P.G. Simos, Jenifer Juranek, Roozbeh Rezaie)

Brain Function in Dyslexia (Simos et al., 2001; Pseudowords)



Neural Response to Intensive Intervention

Does the pattern of brain activation change in response to intervention?

- 8 children with severe dyslexia
- 8 week intense phonologically-based intervention (2 hours a day = up to 80 hours of instruction)

Simos et al., *Neurology*, 2002

Neural Response to Intensive Intervention

- Demographic Information

Child	Gender	Age (years/mo)	WJ-III Pre (%)	WJ-III Post (%)	IQ	Medication
1	M	15	13	55	103	Adderall
2	M	10	2	59	95	Ritalin
3	M	10	2	38	110	Ritalin
4	F	8	3	55	105	Ritalin
5	F	7	2	50	110	Ritalin
6	M	7	18	60	101	—
7	M	11	1	38	98	Ritalin
8	M	17	1	45	102	—

Simos et al., *Neurology*, 2002

Early Development of Reading Skills: A Cognitive Neuroscience Approach (Jack M. Fletcher – PI)

Grade 1 Multi-tiered Intervention

- Patricia Mathes and Carolyn Denton: **Early Reading Intervention** (Mathes et al., *RRQ*, 2005; Denton et al., *JLD*, 2006)
- A. Papanicolaou and P. Simos: **Brain Activation Patterns** (Simos et al., *Neuropsychology*, 2005; 2007; *JLD*, 2007)

The Core Sample

Children: two Grade 1 cohorts sampled across 2 years (2001–2002)

- 300 At-Risk Readers - assigned randomly to intervention in Grade 1 (two small group tutorial, one Enhanced Classroom Intervention); all programs in each school
- 100 Low Risk Readers

Teachers

- 6 Intervention teachers; 30 General education 1st-grade Teachers

Schools

- 6 elementary schools in a large urban school district

The Interventions

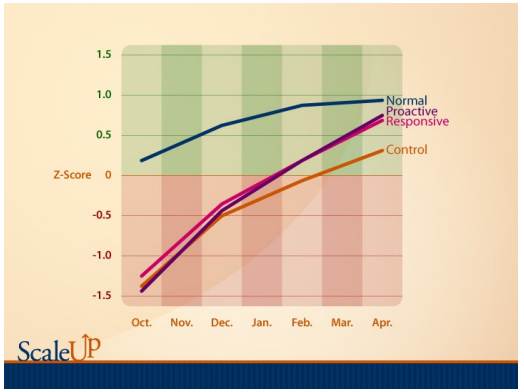
Enhanced Classroom Instruction (Comparison; typical practice)

- District provided extensive professional development and new materials
- All children identified as at-risk for principal, teachers, and parents
- Progress monitored with feedback to principal, teachers, and parents
- Some children tutored

Comparison of Pullout Interventions

- 40 minutes, 5 days per week, for 30 weeks
- 1:3 teacher-student ratio
- Taught by certified teachers: School employees supervised and trained by our group
- Supplemented enhanced classroom instruction

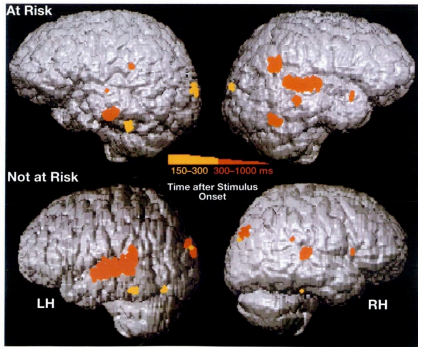
Growth in Fluency by Intervention



What Percentage of Children Don't Respond Adequately to Quality Intervention?

- **ECI only**: 15/92 = 16% (3.2% of school population)
- **ECI + Tutoring**: 7/163 = 4% (< 1% of school population)
- Basic Reading < 30th percentile (5 others did not meet fluency benchmarks)

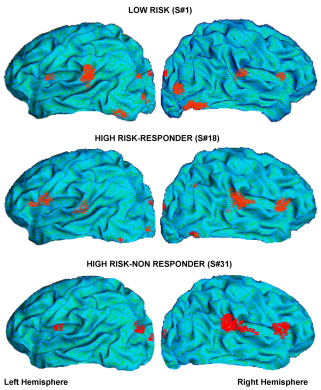
Brain Activation Profiles Before Intervention
(End K; Letter sound task)



N = 45 children (6 yrs old)

Simos et al., *J Child Neurology*, 2002

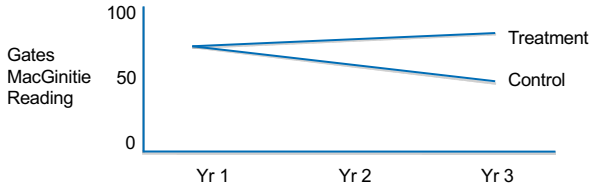
After Grade 1 Intervention (pseudoword task)



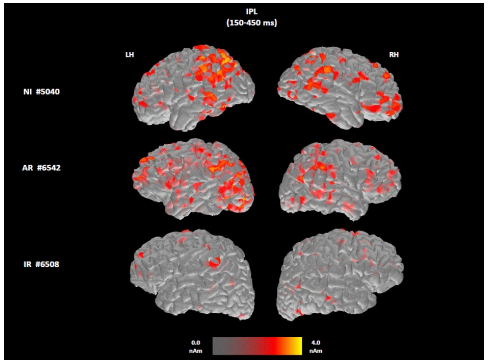
- Simos et al., *Neuropsychology,* 2005 – After Grade 1 intervention in Mathes et al. (*RRQ*, 2005)

NICHD Middle School Studies – Intensive interventions for adolescents with severe reading difficulties

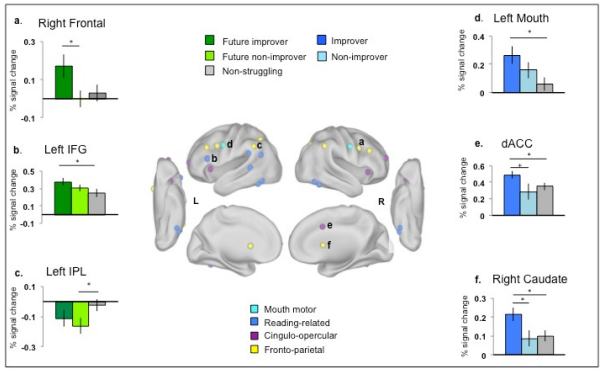
- Cohort of minimal responders followed for three years indicated a decline in performance for the participants in the control condition, with significant improvement in the treatment group



Baseline MEG Patterns for Adolescent Adequate and Inadequate Responders



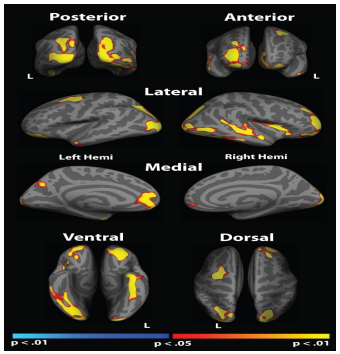
What About Reading Comprehension?
(Nugiel, Church et al., 2019)



Are People Born with Dyslexia?

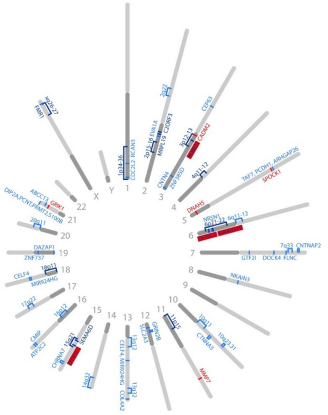
- Brain function is malleable–but some children do not respond to intervention
- Differences in brain structure and function apparent before instruction in children with familial risk (Gaab)
- Tend to correspond with areas identified in functional studies
- If a child is not adequately taught, their brain will appear “dyslexic”
- Must embrace the concept of RISK

Differences in Cortical Thickness
(Typical > Dyslexic; Williams et al., 2014)



Heritability of SLD: Individual Differences in Ability Traits

- Reading, math, and writing are heritable traits, but individual gene effects small
- In reading and math, heredity accounts for 50–80% of variance in outcomes
- No genes specific to poor development (e.g., no dyslexia genes)
- Genetic correlation increases with grade (Olson et al., 2014)-effect of schooling
- Move away from “bad- gene, bad brain” theory to the idea of genomic organizations that make brains at risk and risk modified by environment: Biology is not destiny-risk/resilience models



Is Brain Plasticity an Issue?

- The neural systems underlying reading seem malleable, show plasticity across the age range, and are not disorder-specific; continuum of severity (Vellutino).
- Mostly normalizing, not compensatory
- Don’t know enough about inadequate responders
- Need to tie functional results to structural correlates (gray matter increases with intervention (Eden) and parallels differences in literate and illiterate adults (Castro-Caldes); coregister across imaging modalities
- Are neuroimaging measures effective predictors of growth and intervention response?

Who is Dyslexic?

- ✓ The student who does not respond to quality instruction: *hard to teach, not unable to learn*
- ✓ Low achievement and inadequate instructional response
- ✓ Often preventable with early intervention
- ✓ Heritable, but neural systems are malleable in development and instructional response

Reading Sculpts the Brain (Eden), but Must Be Taught (Moats, Foorman, Vaughn)!!

We are all born with dyslexia… good at speech, but disabled as readers and writers; the difference among us in reading/writing is simply that some are fairly easy to cure and some are not. - Liberman, 1996

jackfletcher@uh.edu
Support: NICHD grant P50 HD052117

In your breakout rooms…

- In your break out room discuss the following and be prepared to bring your thoughts back to the group.

"Ms. Michaelson, a fourth grade teacher, indicated that she had several students in her class who were reading more than 2 grade levels below grade level. She asked you how she could determine if the students had dyslexia? How would you explain dyslexia to Ms. Michaelson?"

More Resources to Explore

Fletcher, J. M., & Miciak, J. (2019). The identification of specific learning disabilities: A summary of research on best practices. Austin, TX: Texas Center for Learning Disabilities.

Vaughn, S., & Fletcher, J. M. (2021). Identifying and Teaching Students with Significant Reading Problems. American Educator, 44(4), 4.

Fletcher, J. M., Francis, D. J., Foorman, B. R., & Schatschneider, C. (2021). Early detection of dyslexia risk: Development of brief, teacher-administered screens. Learning Disability Quarterly, 44(3), 145-157.

Fletcher, J. M. Identifying Students at Risk for Reading Difficulty - *This is not an article but Dr. Fletcher's webinar companion document.*

What's coming up?

Date	Time	Topic
September 9, 2025	2:00-3:30pm ET	The Neurobiological Underpinnings of Dyslexia
October 7, 2025	10:00-11:30am ET	Misunderstandings of the Science of Reading
November 4, 2025	3:00-4:30pm ET	Structured Literacy
December 3, 2025	11:00am-12:30pm ET	Multisyllabic Word Instruction
January 23, 2026	2:00-3:30pm ET	Supporting Reading Comprehension for Students with Dyslexia
February 24, 2026	10:00-11:30am ET	Differentiating Tier 1 Instruction for Students with Dyslexia
March 26, 2026	3:00-4:30pm ET	Using Data to Inform Instruction
April 20, 2026	11:00am-12:30pm ET	Deliberate Practice and Feedback: The Secret Sauce

Stay Connected to the MiMTSS TA Center

Facebook

@MiMTSSTACenter

facebook.com/MiMTSSTACenter

#MiMTSS

Listserv

tinyurl.com/MiMTSSListserv

TA Offering, updates

YouTube

@MiMTSSTACenter

youtube.com/@MiMTSSTACenter

Videos & Playlists

Instagram

@MiMTSSTACenter

instagram.com/MiMTSSTACenter

#MiMTSS

MiMTSS
Technical Assistance Center