Understanding Dyslexia: What We Know from Science

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The Texas Center for Learning Disabilities (TCLD) investigates the classification, early intervention, and remediation of learning disabilities.
Disclosures (Dr. Fletcher)

1. Author of *The Primary Reading Inventory* (Amira Learning)
2. Author of *Learning Disabilities: From Identification to Intervention* (2nd ed.) Guilford Press, 2019
3. Research supported by NICHD grant, P50 HD052117, Texas Center for Learning Disabilities (www.texasldcenter.org)- R. Lyon, P. McCardle, B. Miller, D. Alexander
4. Presentation not intentionally aligned with any standards. I am a neuropsychologist and scientist. Professional tester.
Some initial observations

- We know more about the science of reading than the science of reading instruction (Vaughn).

- Focus on assessing response to instruction and on building educators’ capacity to deliver more intense, customized interventions.

- Assessments and interventions need to be delivered through a seamless system of well-coordinated general and special education.

- Remediation/SPED are not solutions to the number of children who struggle to learn to read. Tier 1 is the key.
Things we know

- Dyslexia is real. People with dyslexia often have other problems (ADHD, math, written expression). Not the only type of RD

- Many children at-risk for dyslexia can be taught to read with early identification and explicit, comprehensive, and differentiated multi-component reading instruction

- Remediation of dyslexia after Grade 2 requires high intensity and explicit, comprehensive reading instruction

- We know lots about brain function, malleability (plasticity in development and in relation to intervention) and the heritability of dyslexia
Things we don’t know

- Exactly how many people have dyslexia
- The level of intensity required to remediate dyslexia
- How “dyslexia” differs from “other” word level disorders
- How to scale effective identification and intervention and translate what’s known from science into instruction
- How to use the research on brain function and genomics to identify and intervene with dyslexia- not a roadmap or a sledge hammer
- Accommodations and adjuncts for people with intractable reading problems
Word Level Reading Difficulties

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
**Dyslexia** is a specific learning disability that is neurological 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 cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge.

*Adopted by the Board of Directors: November 12, 2002*
Dyslexia occurs primarily at the level of the single word and involves the ability to decode and spell printed words in isolation (accurately and automatically). It leads to problems reading text, but is not a text level disability. Many students not identified with dyslexia have word level problems.
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, but it is not a natural, evolutionary process.
Dyslexia- Prevalence Depends on the Threshold (Dimensional)

- Variation on normal development (i.e., high blood pressure or obesity, not the flu or mumps; Ellis, 1984)

- Caused and influenced by both genetic and environmental factors, including inadequate instruction.
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; Shaywitz): Methods for identification of LD based on IQ-discrepancy or patterns of cognitive strengths and weaknesses lack validity. Documentation of processing deficits not required.
Screening for Dyslexia

- Screening is rapid prioritization of at-risk students that does not burden the teacher
- Goal is to determine who needs more assessment
- Should be <5 minutes
- Accuracy is best geared to minimizing false negative errors; false positive errors are inevitable and a tradeoff
- Cannot separate students with dyslexia from others with foundational reading problems (Elliott & Grigorenko, 2014); instructional response is key!
Screening for Dyslexia

- KG: timed and untimed letter names and sounds, phonological awareness
- Beginning G1: timed and untimed word reading, phonological awareness
- End Grade 1, Grade 2: Timed and untimed word reading
- Positives need progress monitoring and/or reading inventory
- Embrace the concept of risk and reserve identification for comprehensive evaluations. Dyslexia should not be diagnosed independently of efforts to treat it.
Rapid Naming

- Alphanumeric symbols most predictive—unique predictor, but does inclusion lead to better decisions?
- In KG, determined by letter name/sound knowledge
- Not specific to dyslexia—RAN does not discriminate kids with different LDs or ADHD (automaticity a more general problem; Waber; Breier)
- Once students should be able to read, word reading is the best screen
Progress Monitoring is Critical

- KG: timed knowledge of letter sounds
- G1-3: Timed word reading (lists or passages)
- G4-8: Timed Passages (Maze)
- How many interventionists in SPED or elsewhere formally monitor progress and adjust instruction frequently according to progress?
Specificity

- Dyslexia is often part of a complex presentation; generalist genes affect multiple LDs and ADHD (continuity hypothesis)
- Comorbidity: ADHD and oral language problems common; if language and working memory problems significant, math impaired; anxiety is common. Written expression and reading comprehension almost always impaired
- Phonological processing/decoding presentation shines through the glare of complexity, but must deal with the complexity, especially in inadequate responders
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
Growth in Total Reading Skill Before, During, and Following Intensive Intervention

Torgesen et al., 2001
### Time x Activity Analyses for the Two Intervention Approaches

<table>
<thead>
<tr>
<th>Activity</th>
<th>LIPS</th>
<th>EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonemic Awareness and Phonemic Decoding</td>
<td>85%</td>
<td>20%</td>
</tr>
<tr>
<td>Sight Word Instruction</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td>Reading or writing connected text</td>
<td>5%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Automaticity!

[Graph showing the improvement in standard scores from pretest to 2-year posttest for Accuracy, Comprehension-88, and Rate-72.]
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)?
Early Intervention is Effective

- Prevention studies show that 70-90% of at risk children (bottom 20%) in K-2 can learn to read in average range. Prevents automaticity problems.
Differences in outcomes for Basic Reading Skills and Rate in Prevention vs. Remediation Studies (Torgesen)
To prevent (and remediate), dyslexia must be treated in the context of MTSS

- Facilitates early identification through universal screening and progress monitoring
- Must focus on instruction and amplify the role of general education instruction
- Data on instructional response
- Isolating students with dyslexia as a disorder that must be remediated is a recipe for persistence
- Restricting eligible interventions to “multisensory” is not empirically supported unless multisensory means “multimodality:” see it, say it, write it, etc.
Effective Intervention

- Strong core reading program that explicitly teaches decoding, fluency practices, and comprehension in a multi-component framework (NRP).

- Add Tier 2 that builds on Tier 1 for struggling readers. Tier 3 may isolate an area that is not developing.

- Developmentally appropriate and personalized instruction practices (e.g., teach phonological awareness in K and 1 and to severely impaired readers, but move to letter-based component as PA skills are mastered to promote generalization.

- Spelling, writing, and vocabulary essential
Effective Intervention

- No specificity of appropriate intervention programs for dyslexia. Research supports explicit, comprehensive, and differentiated (personalized) approaches at classroom and supplemental level.

- Research does not support multisensory (in traditional sense), balanced, manualized, multiple cuing systems, discovery or constructionist or rule-based verbalizing approaches to phonics.

- Structured literacy- family of approaches that include components to help children access internal structures of words “in relation to research-supported features of instruction, rather than narrowly focused on particular programs or methods (Spear-Swerling, 2022)"
Early Development of Reading Skills: A Cognitive Neuroscience Approach
(Jack M. Fletcher – PI)
Grade 1 Multi-Tiered Intervention Funded by NSF through the IERI


Double Dose of Instruction for Struggling Readers

90 Minutes of Quality Classroom Reading/LA Instruction

Tier 2 Intervention:
40 minutes per day in groups of 3-4
Explicit instruction in synthetic phonics (blending), with emphasis on fluency.

Integrated decoding, fluency, and comprehension strategies (authentic stories by hired authors with phonics principles).

100% decodable text, isolated practice

Prescriptive: Carefully constructed scope and sequence designed to prevent possible confusions taught to mastery taught to mastery.
Responsive Intervention (Denton)

- Explicit instruction in synthetic phonics (blending) and analogy phonics (word families)
- Taught decoding, using the alphabetic principle, fluency, and comprehension strategies in the context of reading and writing
- No scope and sequence
- Teachers responded to student needs as they are observed.
- Leveled text, not phonetically decodable
The Responsive Intervention

- **Fluency Work** (Repeated Reading) and Assessment: 8-10 minutes
- **Word Work**: 10-12 Minutes (only sounding out)
- **Supported Reading**: 10-12 Minutes
- **Supported Writing**: 8-10 Minutes
Growth in Fluency by Intervention

Z-Score


Normal  Proactive  Responsive

Control

ScaleUP
What percentage of children don’t respond adequately to quality intervention?

**ECI only:** $\frac{15}{92} = 16\%$ (3.2% of school population)

**ECI + Tier 2 Tutoring:**

- $\frac{7}{163} = 4\%$ (<1% of school population)

(Basic Reading $< 30^{th}$ percentile) (5 others did not meet fluency benchmarks)
Gains in Basic Skills Standard Score Points During 16-Week Intervention

(Denton et al., JLD, 2006)
Persistence: Blachman et al., 2014: 10 Year Follow-up

- **Treatment (n=33)**
- **Comparison (n=25)**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Treatment</th>
<th>Comparison</th>
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<tbody>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
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<tr>
<td>Posttest</td>
<td></td>
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<tr>
<td>1-Year Follow-up</td>
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<tr>
<td>Long-Term</td>
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The graph shows standard scores over time for the treatment and comparison groups. The treatment group consistently scores higher than the comparison group across all time periods.
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.

![Graph showing performance over years]
Neuroscience explains why

- Two metaphors

1. Reading is parasitic on speech (Liberman; sublexical, dorsal system)

2. Reading is unlocking language from vision (Dehaene) or language at the speed of sight (Seidenberg)

- Malleability in development and in instructional response, but access and experience is a 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

Diagram showing brain regions involved in reading:
- Inferior Frontal Gyrus
- Supramarginal Gyrus
- Angular Gyrus
- Wernicke’s Area
- Broca’s Area
- Superior Temporal Gyrus
- Inferior Temporal Gyrus
- Visual Word Form Area
- Fusiform Gyrus

(A) Diagram showing the brain regions labeled above.
(B) Diagram showing the dorsal and ventral routes.
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)

All developed average decoding skills

Simos et al., *Neurology*, 2002
Neural response to intervention; (Pseudoword Task; Simos et al., 2002)
Growth in Fluency by Intervention

- Normal
- Proactive
- Responsive
- Control

Z-Score: 0, -0.5, -1.0, -1.5

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 Scans (Rezaie et al., 2011)
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
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

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