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



Texas Center *for* Learning Disabilities

Understanding Dyslexia: What We Know from Science

Jack M. Fletcher, Ph.D
Norman Geschwind Lecture
University of Houston
International Dyslexia Association,
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jackfletcher@uh.edu
www.texasldcenter.org





Disclosures (Dr. Fletcher)

- 1. Author of *The Primary Reading Inventory* (Amira Learning)-will not be discussed
- 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.

Norman Geschwind M.D. (Courtesy Elsa Hagen)

Professor of Neurology at Harvard Medical School



Continued the work of Dr. Orton regarding the neuroscience of dyslexia

“If we could somehow prevent these brain changes, and thus prevent the appearance of dyslexia, might we not find that we have deprived the society of an important and irreplaceable group of individuals endowed with remarkable talents?”





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 off children who struggle to learn to read. Tier 1 is the key.



President's Commission on Special Education (2004)

- 1. Focus on results, not process. Process does not lead to better outcomes.
- 2. Embrace a model of prevention, not a model of failure. Prevent, reduce the number who need remediation, and intensify remediation.
- 3. Children with disabilities are general education children first. SPED cannot be expected to deal with the range of reading difficulties experienced by students, esp. as an isolated service



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



Important Research Findings

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

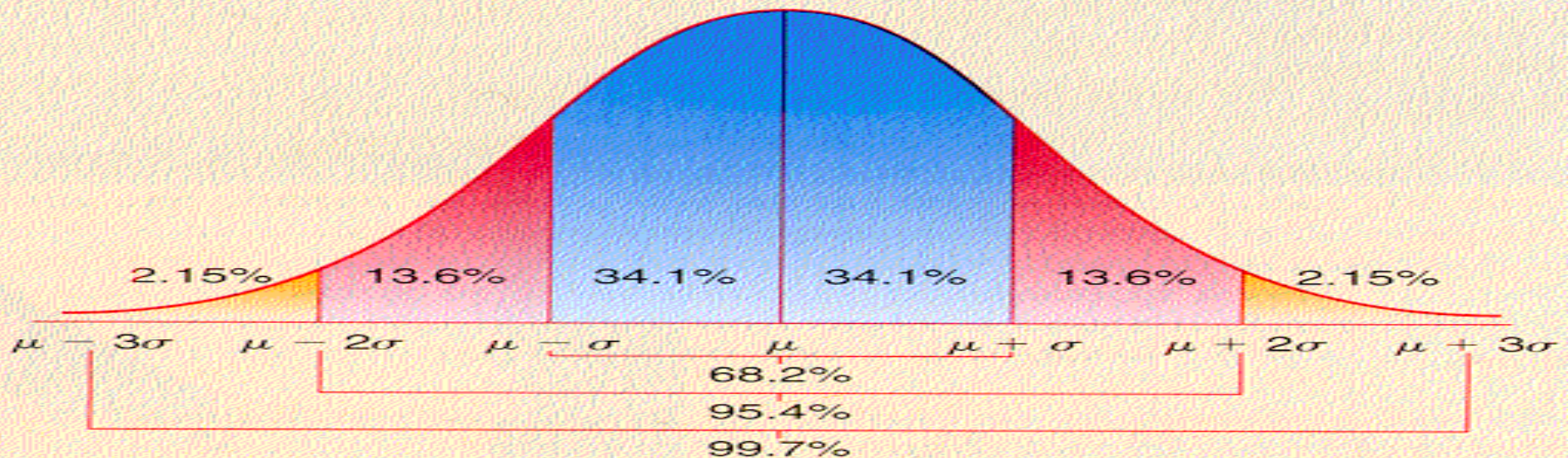


Alphabetic Principle

- 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 (high blood pressure or obesity, not the flu or mumps; Ellis, 1984)
- Caused and influenced by both genetic and environmental factors, including inadequate instruction



← Ease of Learning to Read →



Important Research Findings: Identification

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.

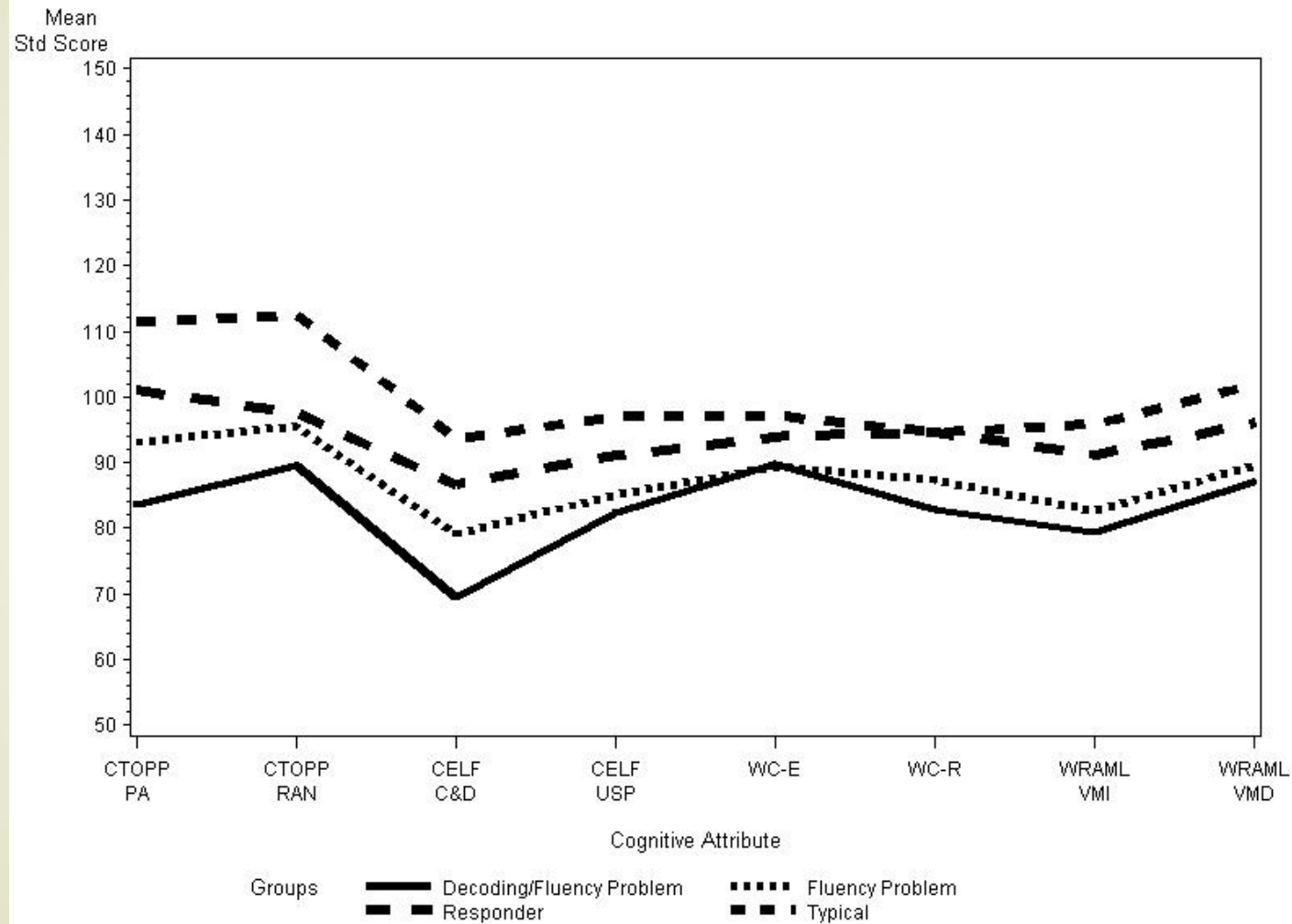


Oral and Academic Language- Important Research Agenda

- Some children have dyslexia as part of an oral language disorder-dyslexia/dyslexia+ (Denckla); phonological core-garden variety readers (Stanovich)-not IQ!
- May be value in separating children with dyslexia according to this attribute-best predictor is vocabulary (Wagner et al., 2022)
- Bayesian models, not discrepancy models
- Children with dyslexia and listening comprehension problems have much more severe reading comprehension problems (Wagner)

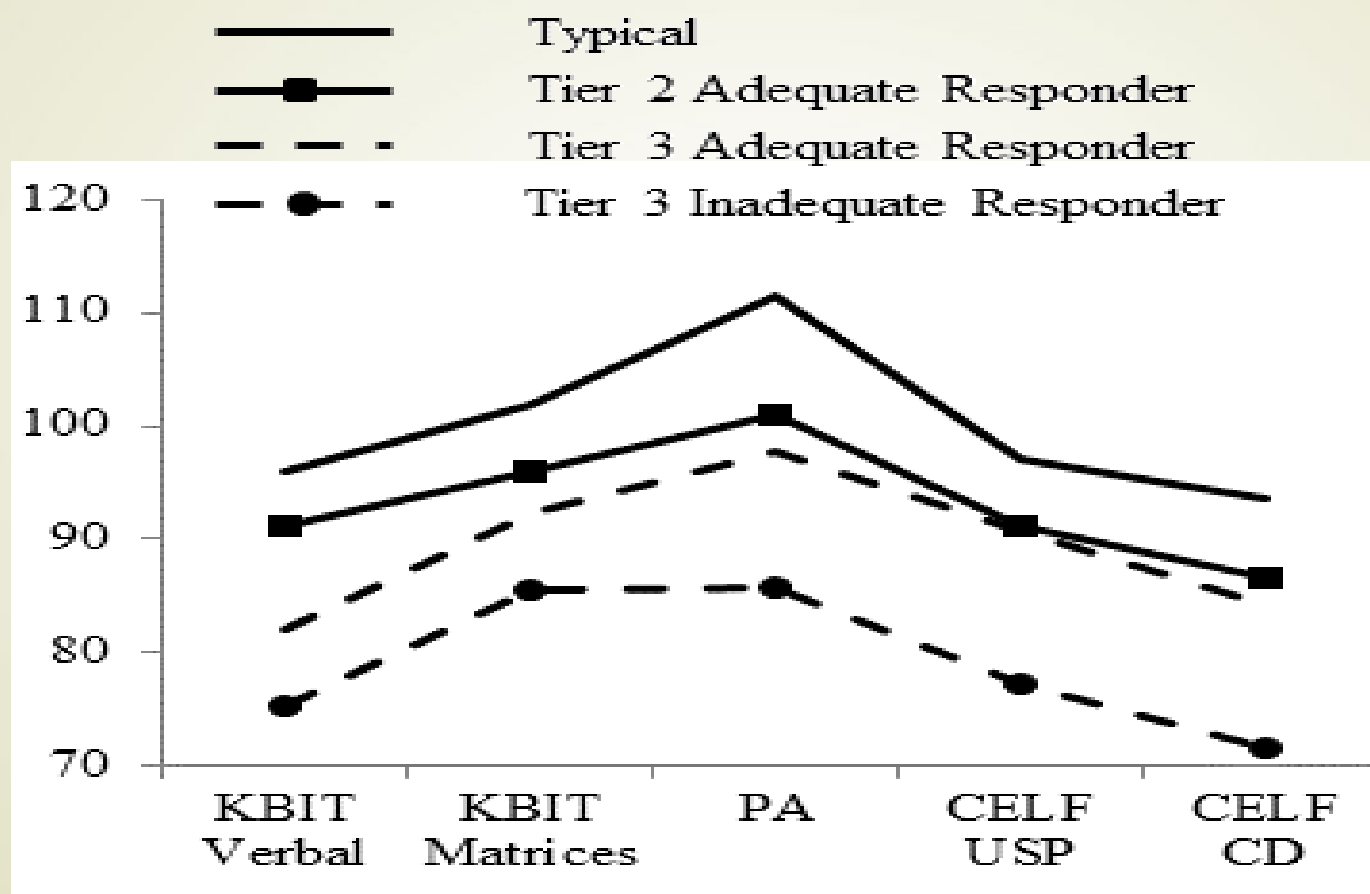


Inadequate Responders at Tier 2 (Fletcher et al., SPR, 2011)



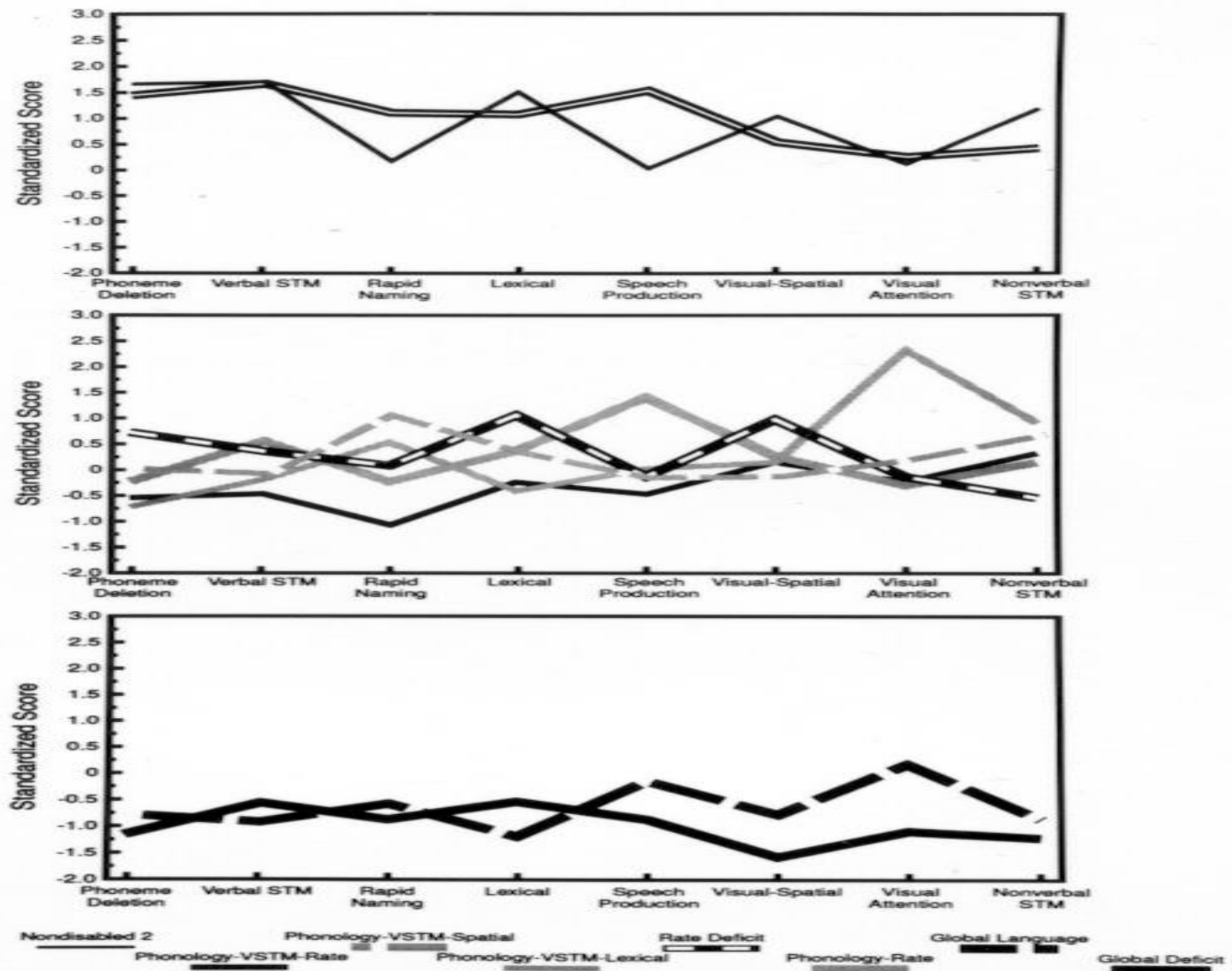


Inadequate Responders: Tier 3 Denton et al., 2012





Subtypes of Dyslexia (Morris et al., 1998)





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



Important Research Findings

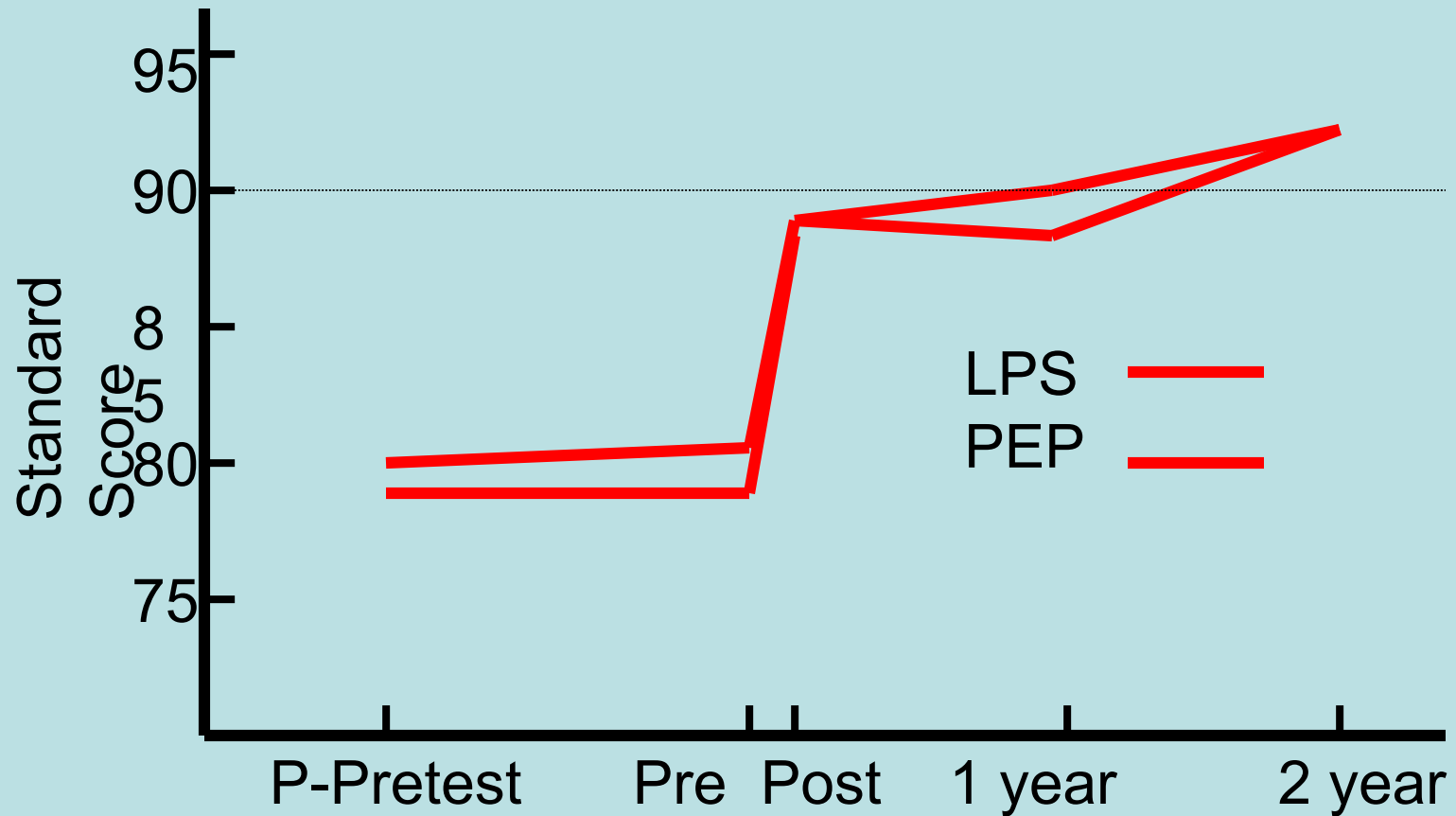
Dyslexia can (often) be prevented.

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

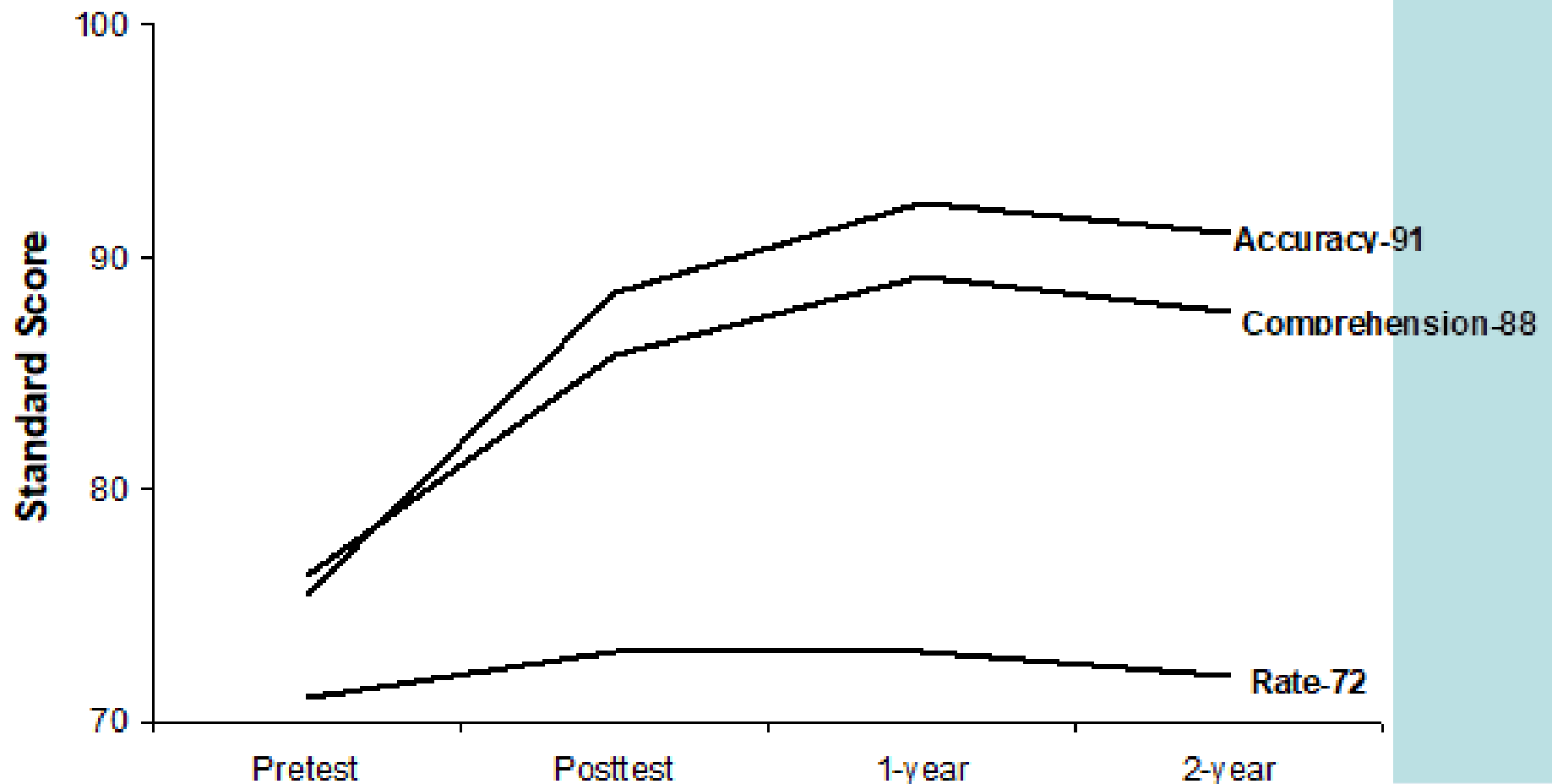


Torgesen et al., 2001

Time x Activity Analyses for the Two Intervention Approaches

	LIPS	EP
Phonemic Awareness and Phonemic Decoding	85%	20%
Sight Word Instruction	10%	30%
Reading or writing connected text	5%	50%

Automaticity!





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.

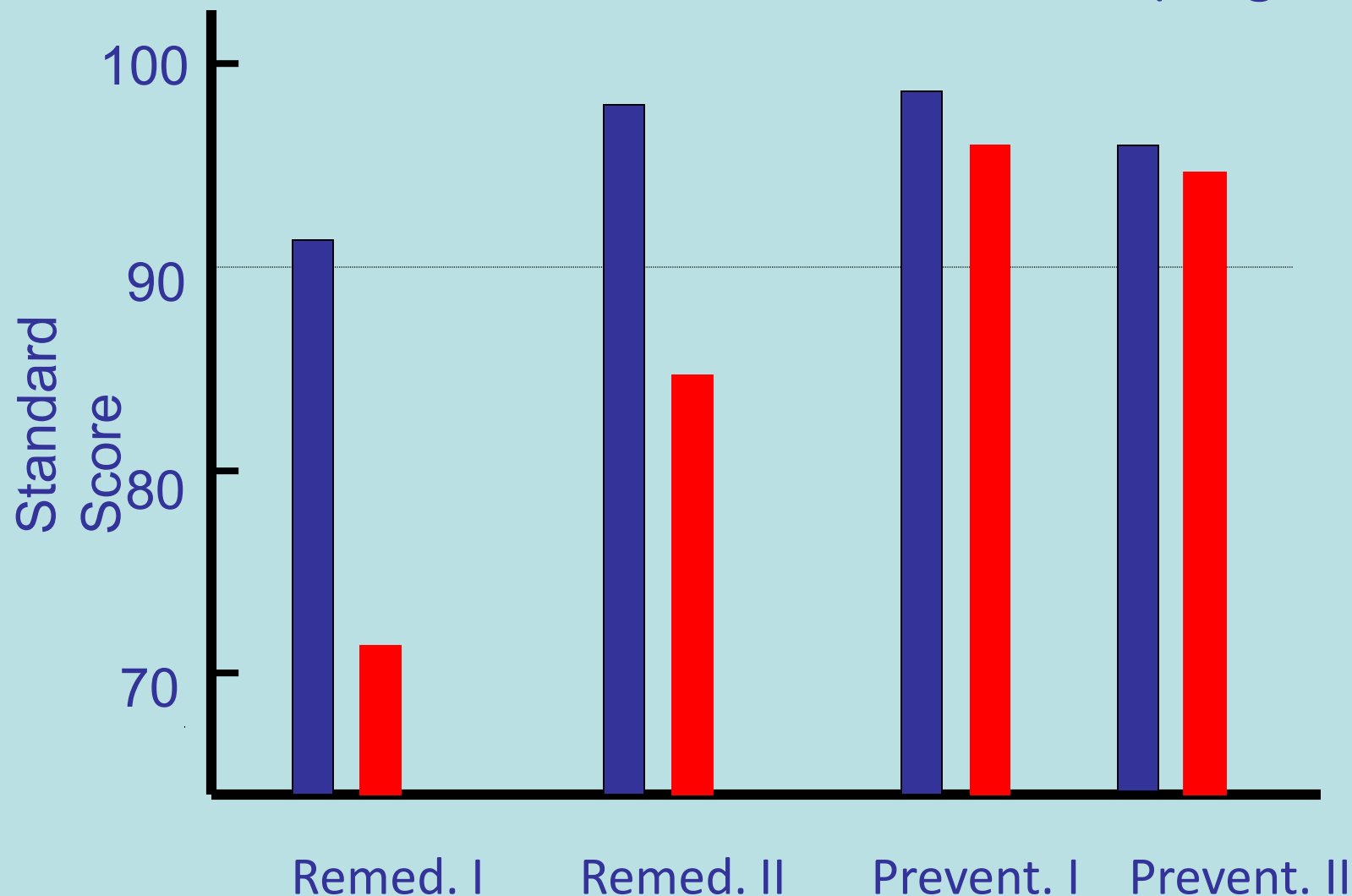
How do you close the gap when the student is already 3- 5 years behind (exposure and experience, not age)?

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)



Fletcher et al., 2021 (From Morris et al., 2012)

Table 2

Effect Sizes and Confidence Intervals for Comparisons of Interventions for Poor Readers that Taught Multiple Reading Strategies and Systematic Phonics (PHAST+PHAB) Versus Systematic Phonics and Classroom Survival Skills (PHAB+ CSS)

Measure	PHAST (n = 73)		PHAB+CSS (n = 69)		g	Variance of g	SE	95% (low)
	Mean	SD	Mean	SD				
WRMT-R Word Attack	11.68	6.67	7.49	5.36	0.69	0.03	0.17	0.5
WRMT-Word Identification	38.51	12.41	32.21	13.24	0.49	0.03	0.17	0.1
TOWRE Word Reading Fluency	25.80	12.31	20.72	12.44	0.41	0.03	0.17	0.0
WRMT-R Passage Comprehension	19.68	8.12	15.87	8.44	0.46	0.03	0.17	0.1
WRMT-R Spelling	20.33	2.64	19.1	2.85	0.45	0.03	0.17	0.1
GORT-3 Accuracy	3.88	4.68	2.54	3.94	0.31	0.03	0.17	-0.1
GORT-3 Fluency	2.37	3.03	1.33	2.01	0.40	0.03	0.17	0.1
GORT-3 Comprehension	9.77	6.58	9.66	6.38	0.02	0.03	0.17	-0.1

Note. WRMT-R = Woodcock Reading Mastery test- Revised; TOWRE = Test of Word Reading Efficiency; GORT-3 = Gray Oral Reading Test (3rd Ed.)



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

Grade 1 Multi-Tiered Intervention Funded by NSF
through the IERI

Patricia Mathes and Carolyn Denton:
Early Reading Intervention (Mathes et al., RRQ, 2005; Denton et al., 2006, JLD). Recipient, Albert J. Harris award, 2007, IRA

A. Papanicolaou, P. Simos: **Brain Activation Patterns** (Simos et al., Neuropsychology, 2005; 2007; JLD, 2007)



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***

Proactive Intervention (Mathes, Torgesen)

- 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

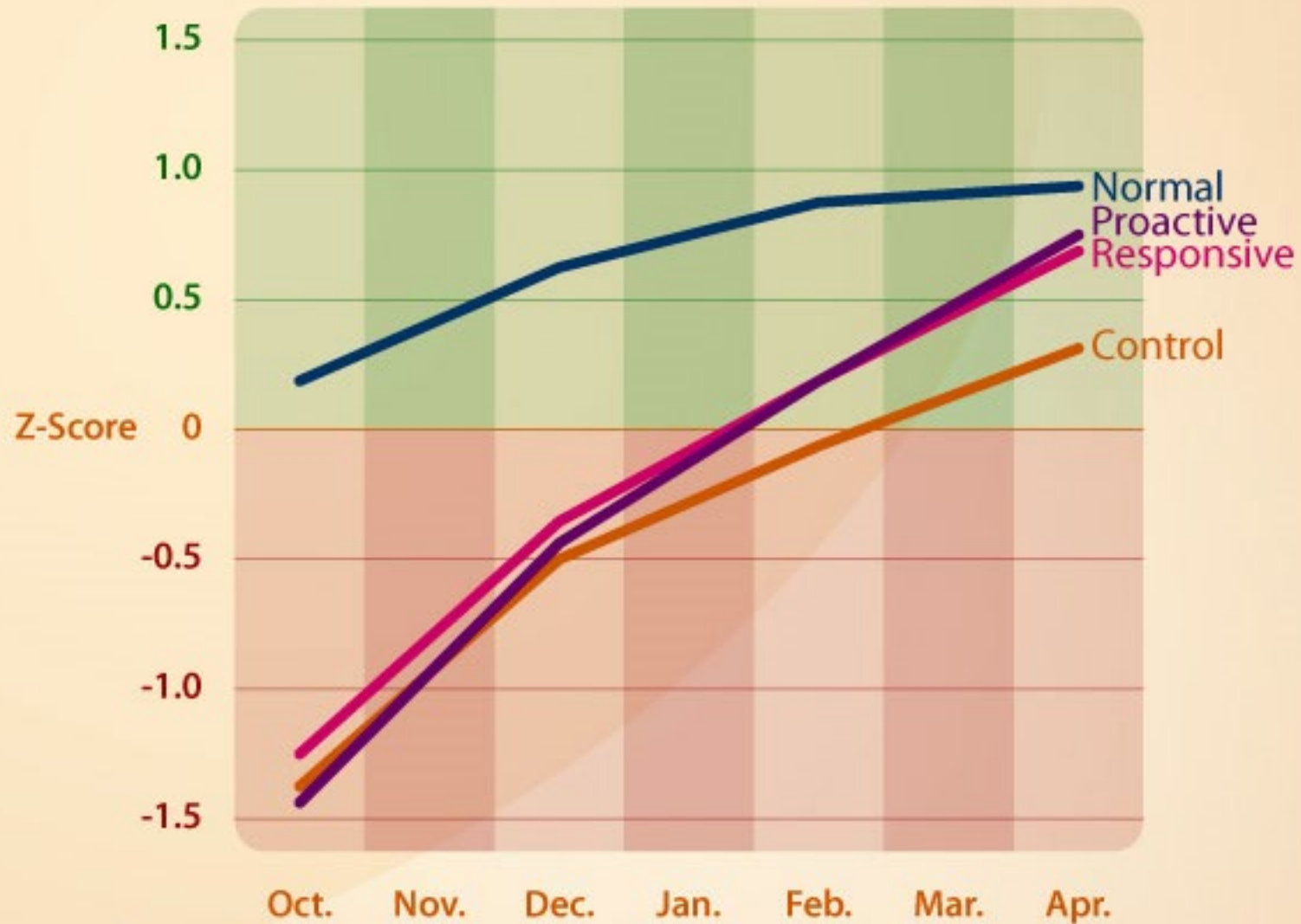


The Responsive Intervention

- 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





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

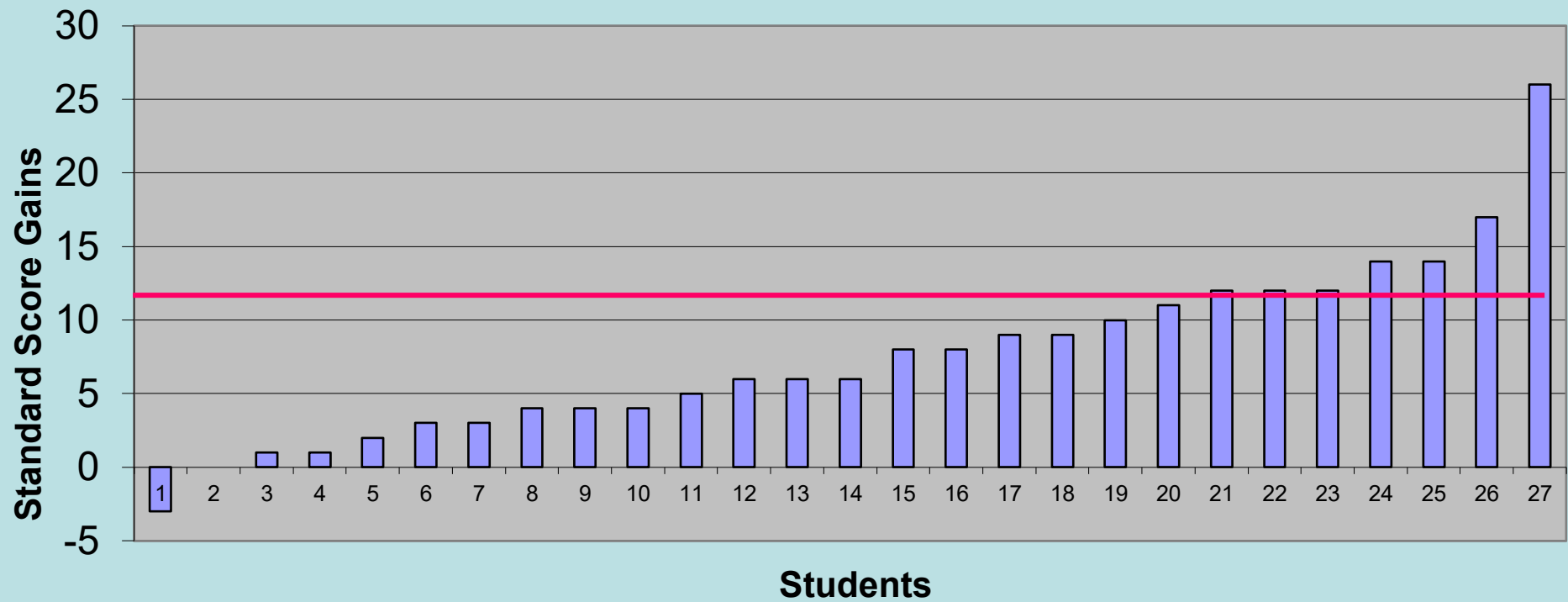
ECI only: $15/92 = 16\%$ (3.2% of school population)

ECI + Tier 2 Tutoring:

- $7/163 = 4\%$ (<1% of school population)

(Basic Reading < 30th percentile) (5 others did not meet fluency benchmarks)

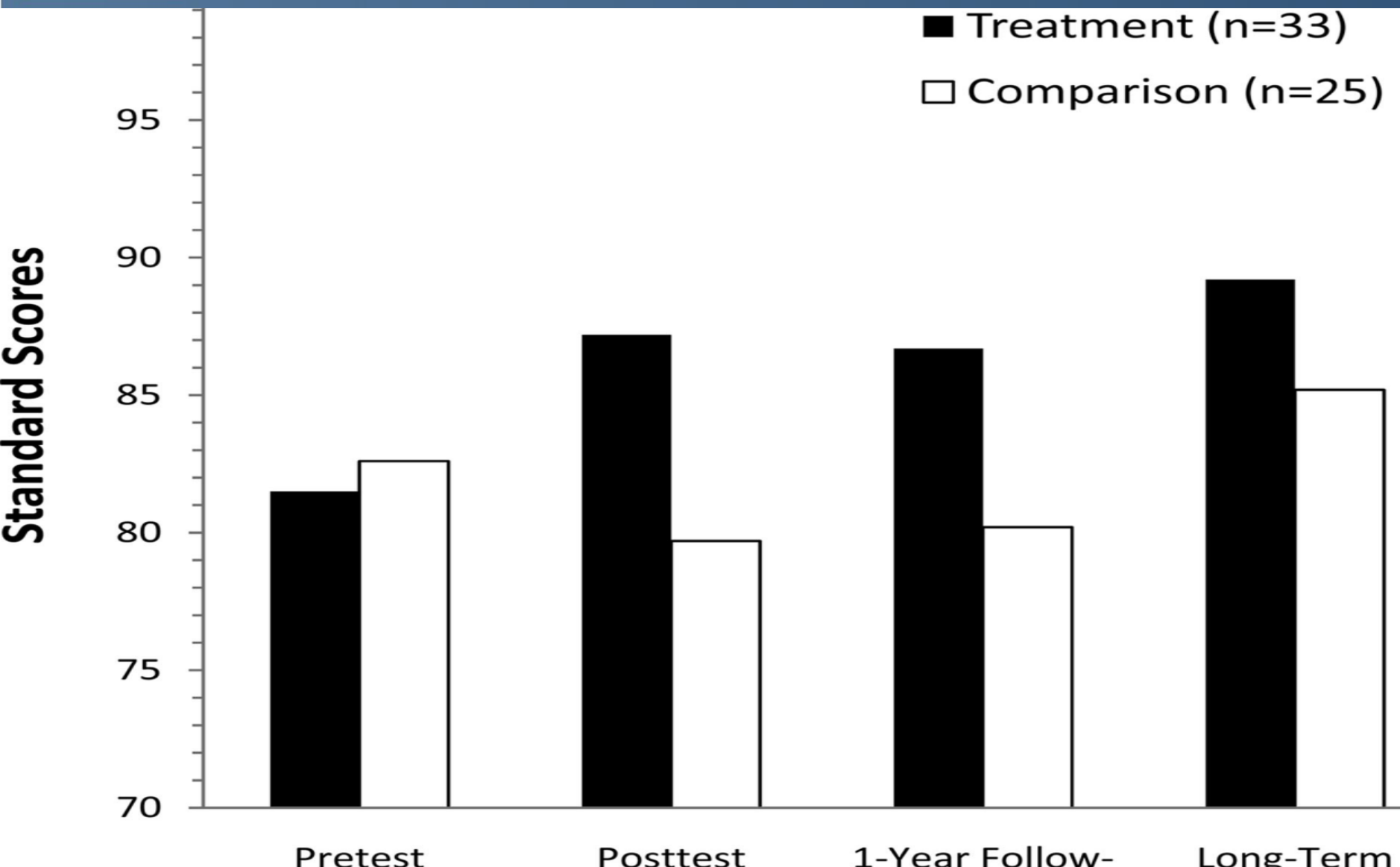
Gains in Basic Skills Standard Score Points During 16-Week Intervention



(Denton et al., JLD, 2006)

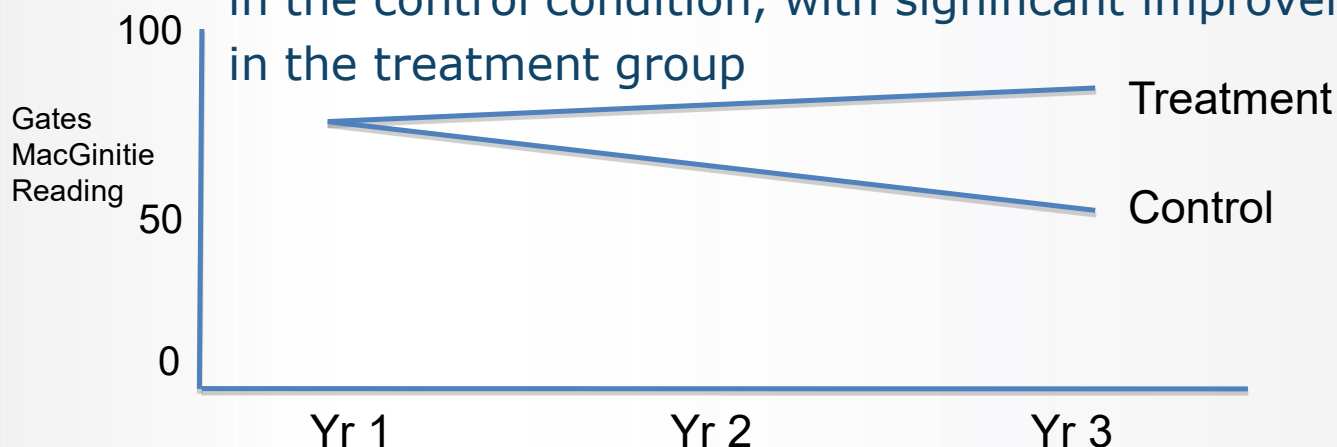


Persistence: Blachman et al., 2014: 10 Year Follow-up



- 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





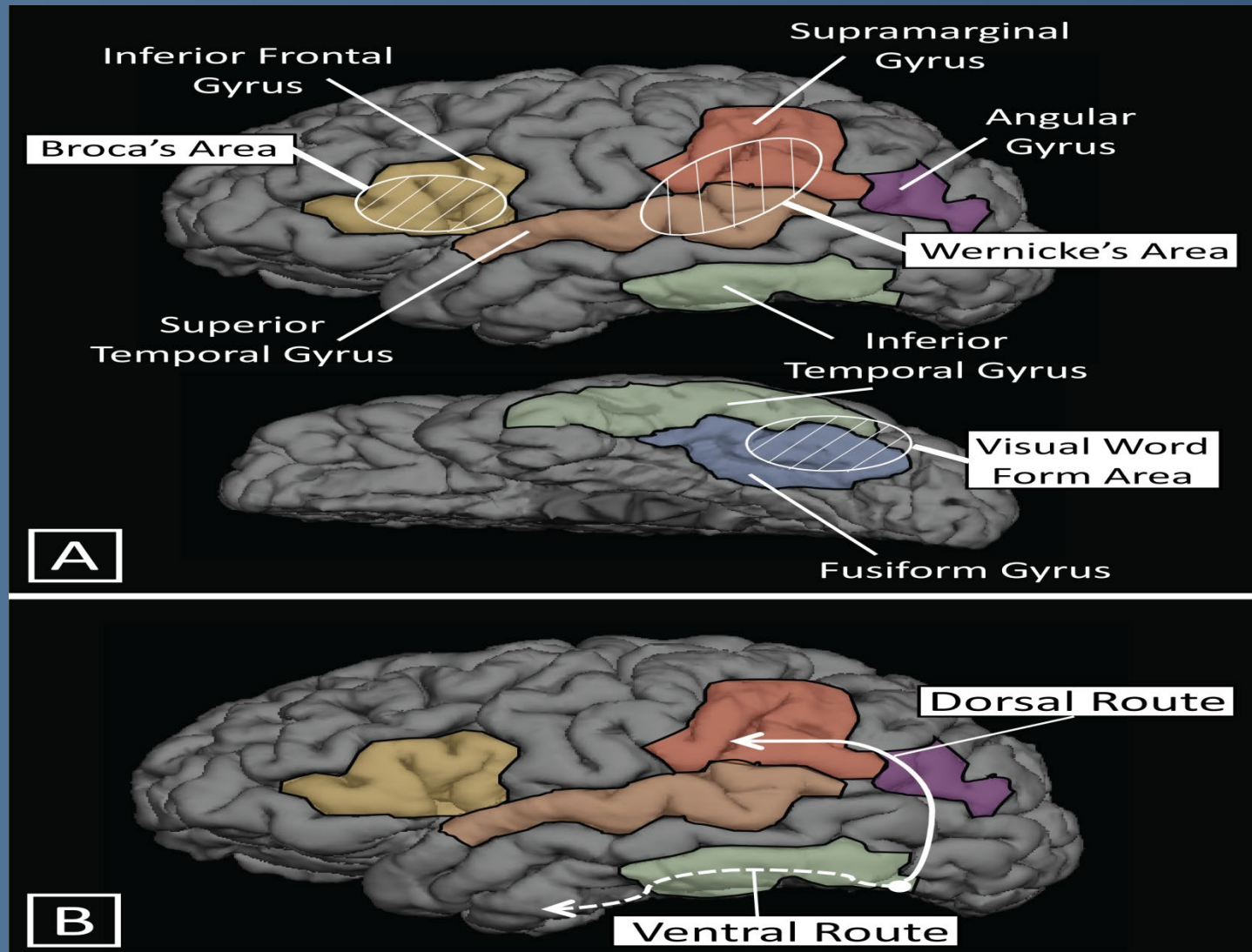
Neuroscience explains why

- 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



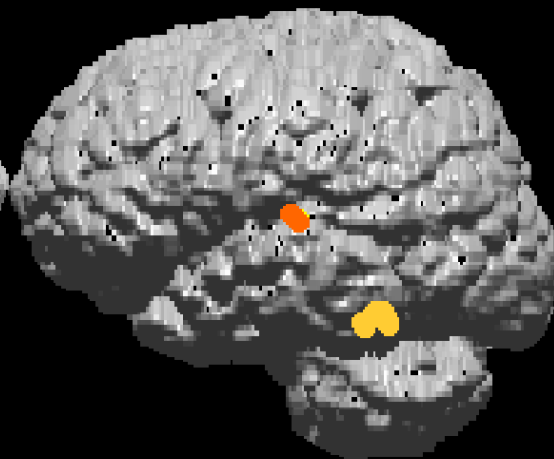
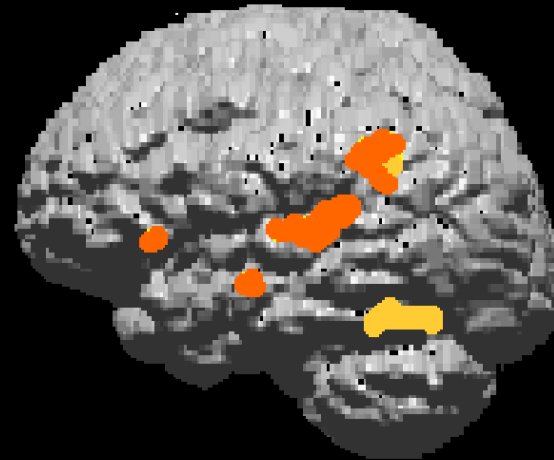
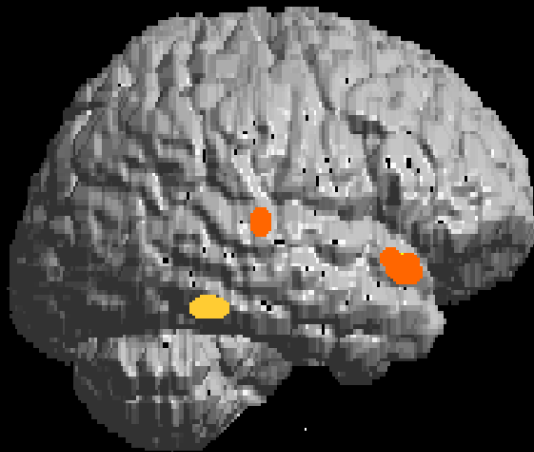
Brain Function in Dyslexia (Simos et al., 2001; Pseudowords)

Child #1:
Normal Reader

Child #12: with
Reading Difficulties

Right Hemisphere

Left Hemisphere





Neural Response to Intensive Intervention

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

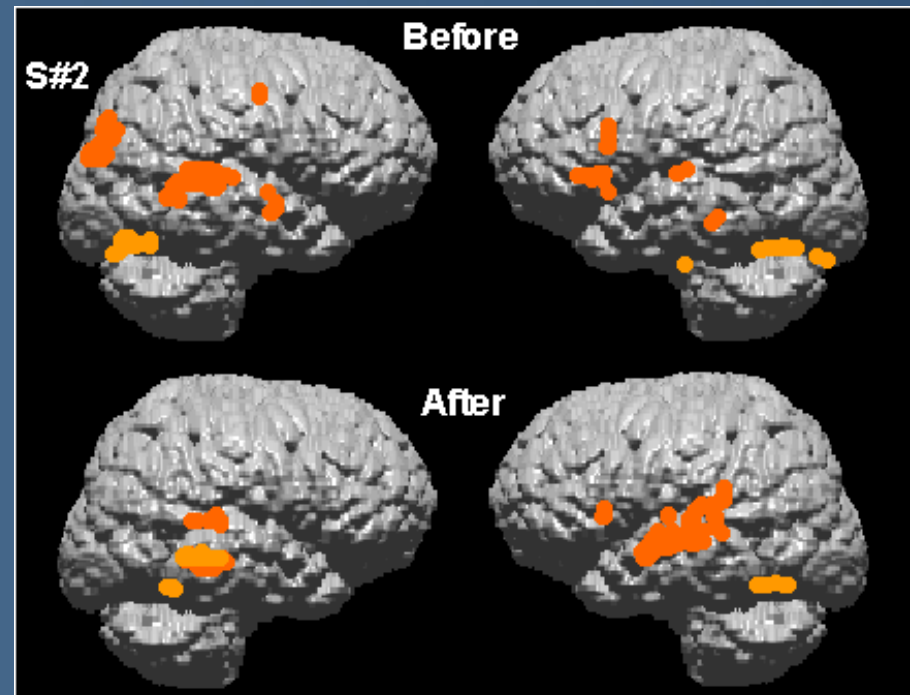
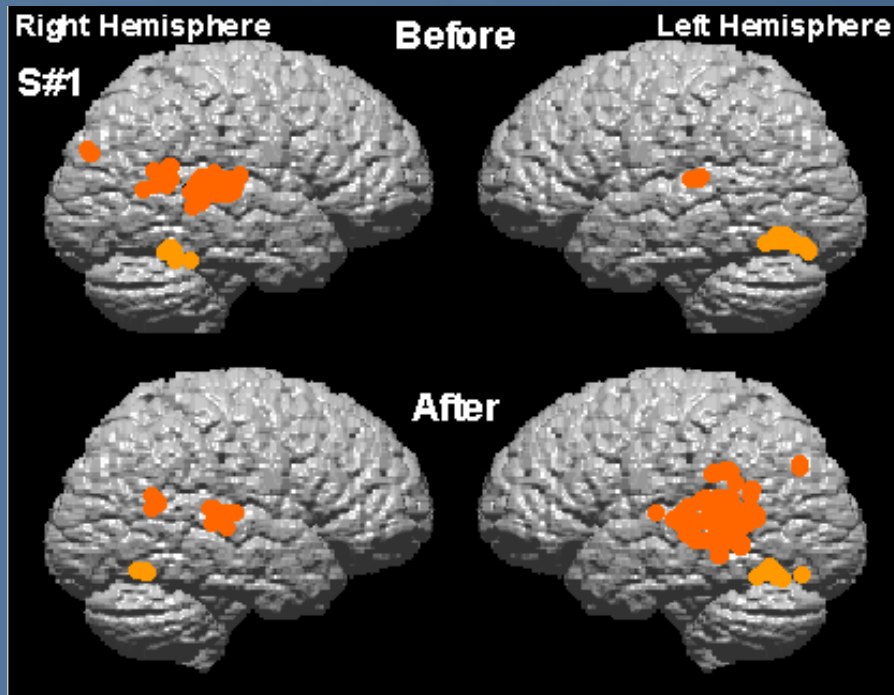
8 children with severe dyslexia

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

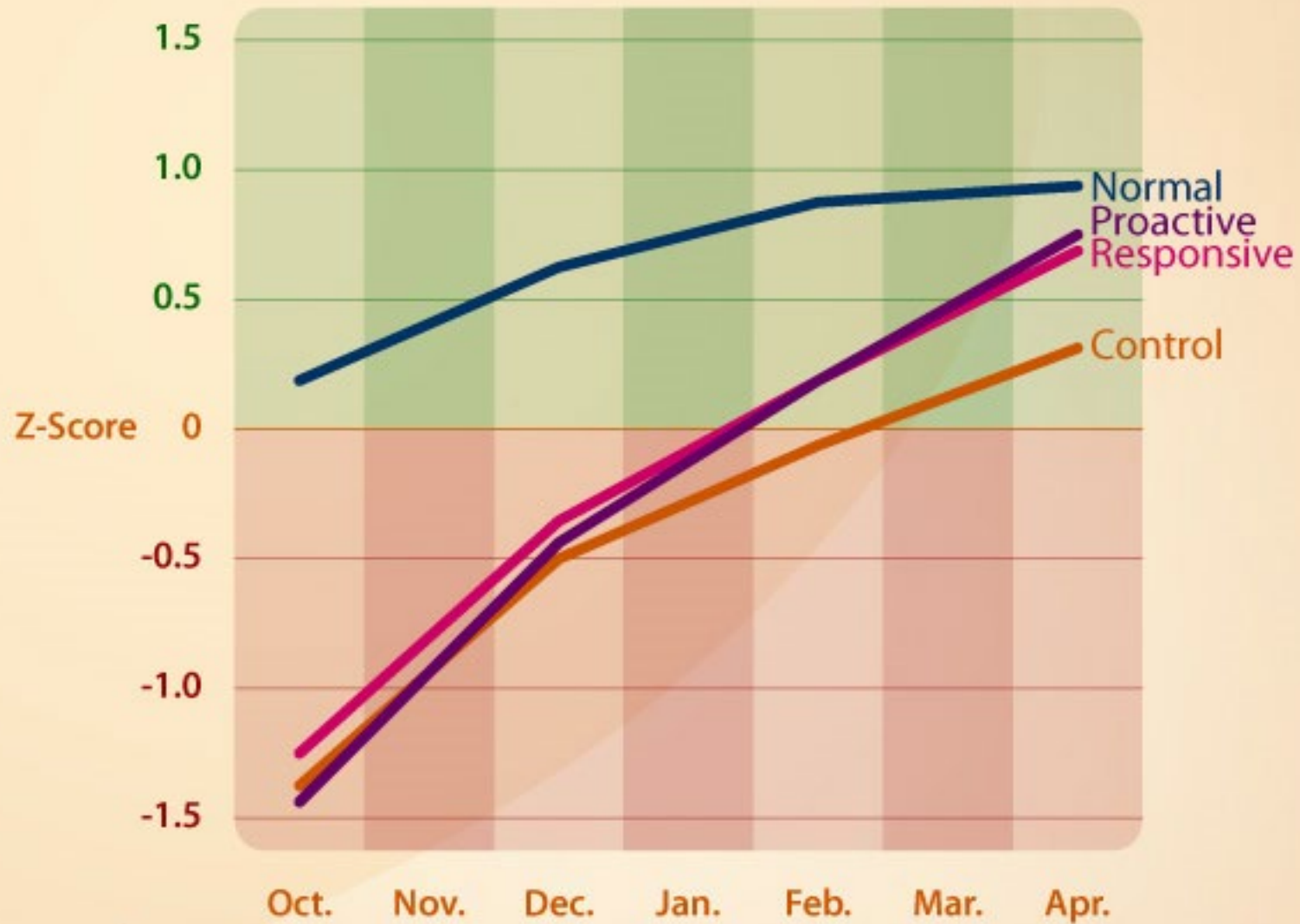
All developed average decoding skills

Simos et al., *Neurology*, 2002

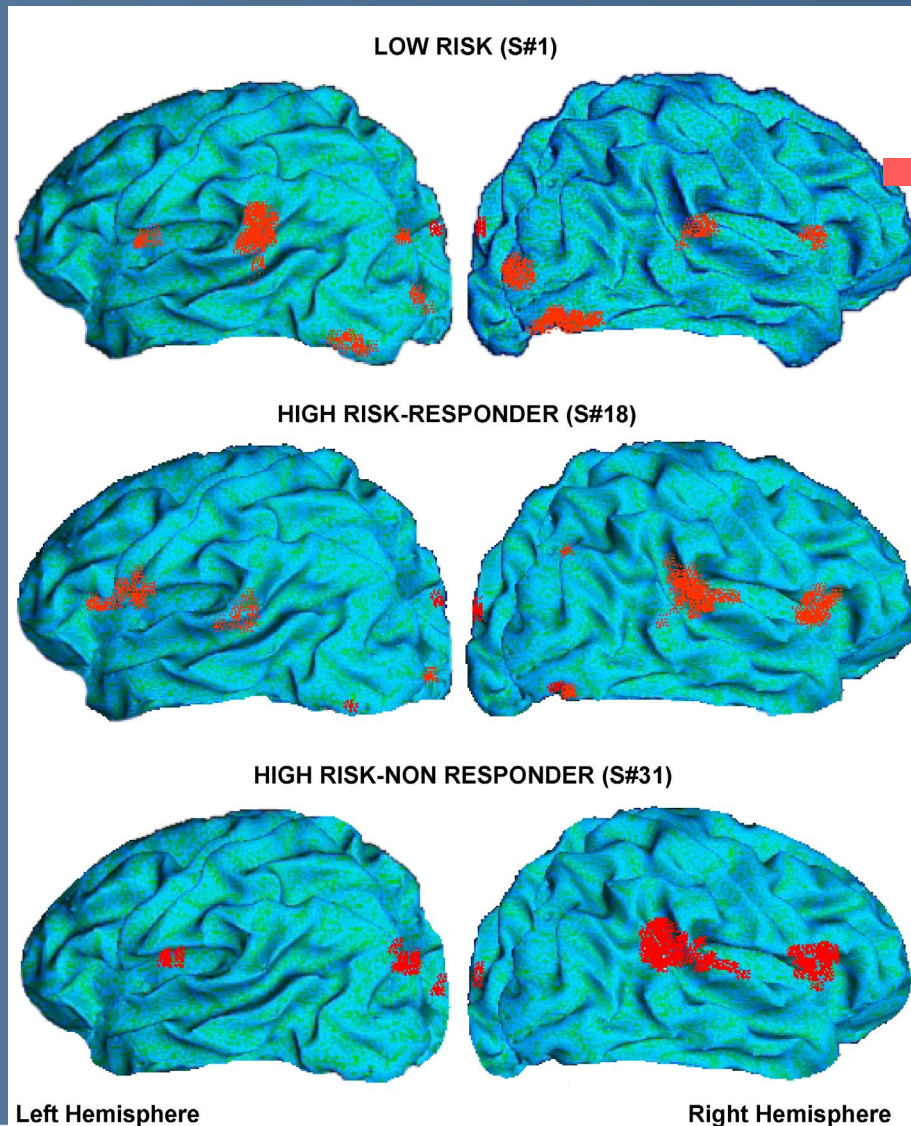
Neural response to intervention; (Pseudoword Task; Simos et al., 2002)



Growth in Fluency by Intervention



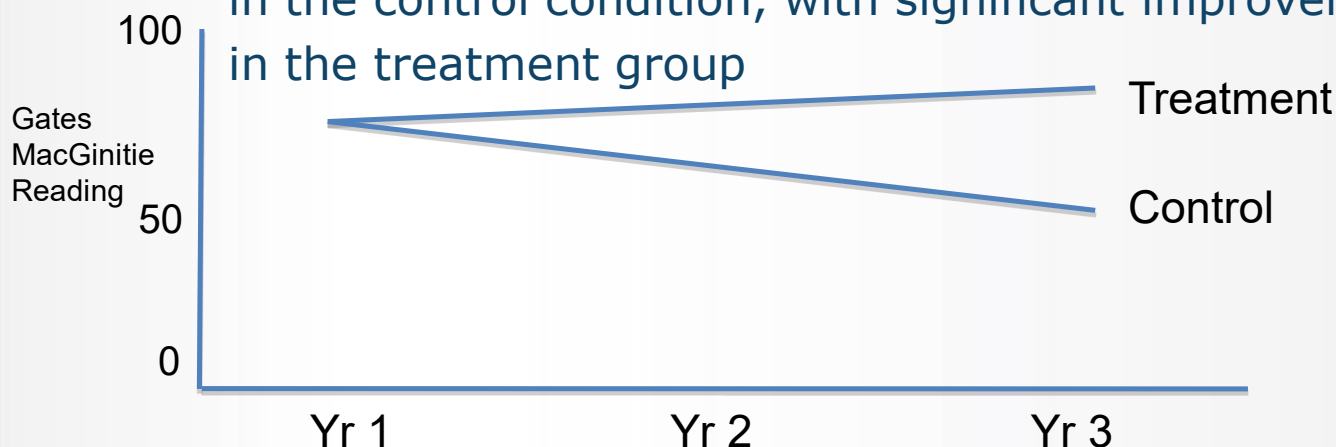
Grade 1 Intervention (pseudoword task)



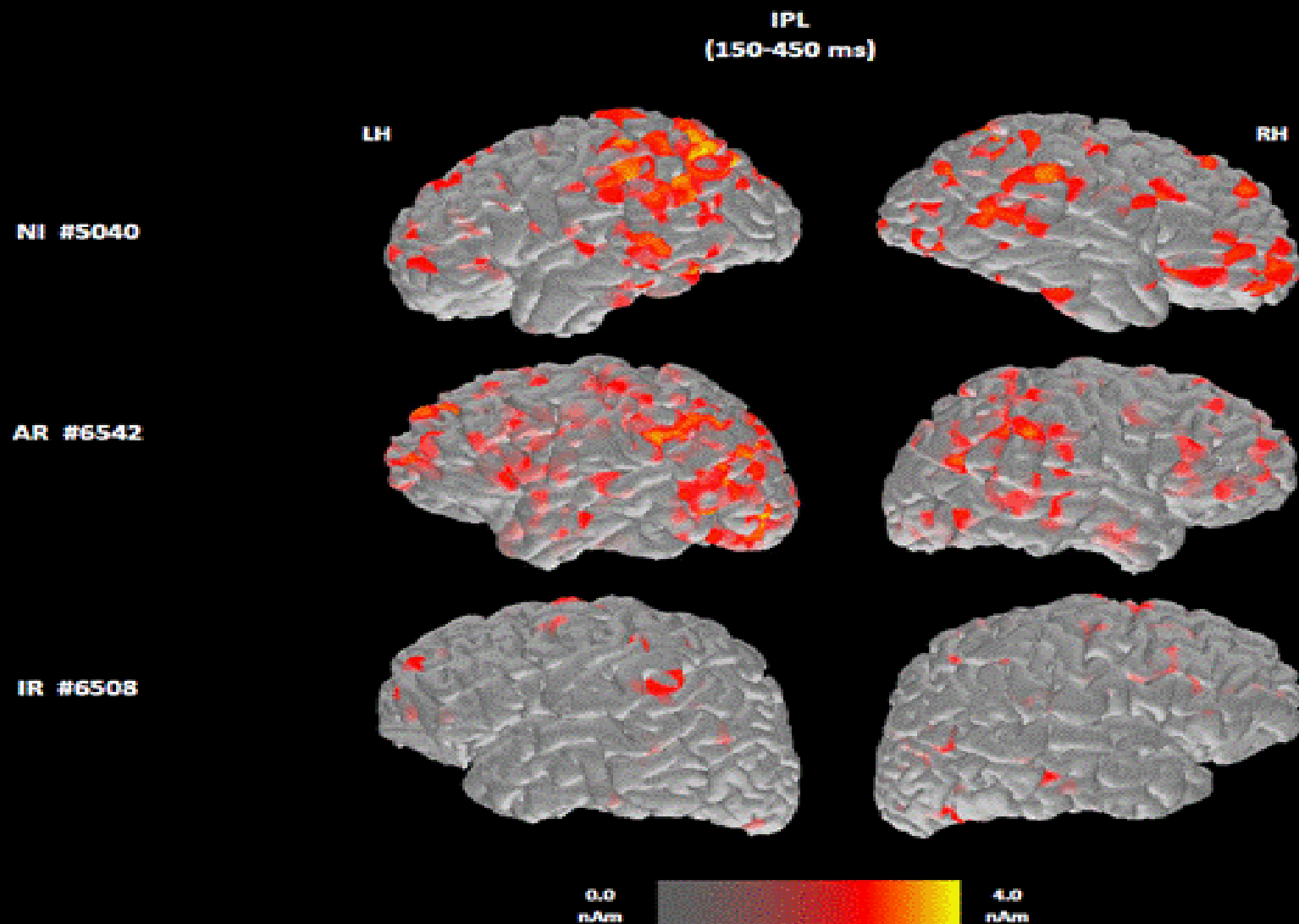
Simos et al
(Neuropsychology, 2005)-
after Grade 1
intervention
in Mathes et
al. (RRQ,
2005)

- 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



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

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