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The Brain Basis of Fluency Development: Implications for Assessment & Instruction

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Why does Fluency Matter?


We want kids to love reading

- Love = easy + fun + relaxed

Stamina, ease, and everyday time constraints






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Reading Fluency

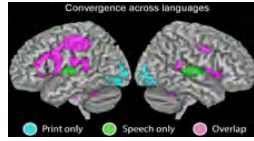
Relatively effortless reading of unfamiliar text with levels of accuracy, rate, phrasing, and prosody that reflect the *automaticity* and coordination of reading sub-processes.

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Fluent Reading Sounds like Speech

Speech networks are active during silent reading.



Rüeckl et al. (2016)



Guiding Questions

What does the eye movement and brain research tell us about how reading fluency develops?

What tests should we choose to zero-in on the source(s) of dysfluent reading?

How does this research align with the clinical observations of Orton, Gillingham, Rawson, & Rome?




Reading Development: Brain Networks and Eye Movements



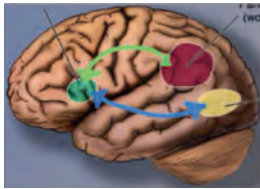
Fluency Results from Change at Several Levels


- Brain: Phonological processing becomes faster and the orthographic network comes online
- Cognition: Cooperative processing leads to automatic word recognition and fewer fixations
- Behavior: Reading shifts from being labored and effortful to sounding like speech

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Brain Networks for Fluent Reading




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Perceptual Span: Novice Readers

* * * * *
New readers have smaller perceptual spans

* * * * *
and do not process much text parafoveally.

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Perceptual Span: Efficient Word Recognition

* * * * *
Better readers process more than one word

* *
during each fixation.

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Reading Changes as Fluency Develops

Grade 1

- Vocal
- Slow
- Decoding
- Monotone

Grade 5

- Silent
- Rapid
- "Sight" words
- Prosodic


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A Closer Look at Changes
in Brain Networks

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Reading Fluency Development

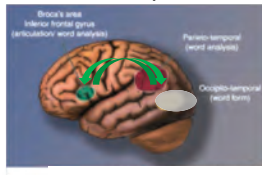
- Reading fluency is a product of accurate decoding and text exposure.
 - Decoding leads to high-quality memories of words.
 - Repeated, accurate recognition of common words helps wire the orthographic network and supports the recognition of HF words.
- The result is automatic word recognition.

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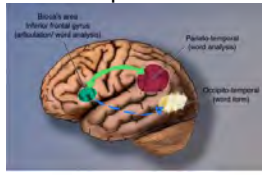



Learning to Read (with Good Phonemic Awareness)

Partial Alphabetic



Full Alphabetic

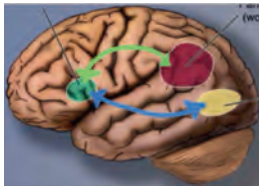


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Cooperative Activation in Fluent Reading

Consolidated



Networks fire simultaneously, then word recognition is accurate and instantaneous.

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How Fast is Automatic Word Recognition?

Adults read about 250 words per minute on average, about twice as fast as we can comprehend speech.

Words get recognized within 200 milliseconds.

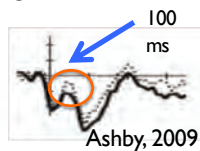
How is this speed possible?

- Fast phonological processing
- Efficient word recognition

A Fast Phonological Network (Halderman, Ashby, & Perfetti, 2012)

Process phonological information within 1/10th of second during silent reading

Incongruent *****
Congruent —————




Efficient Word Recognition is Parafoveal

* * * * *

Better readers process more than one word


* *

during each fixation.



Reading Fluency: Brain and Eyes


- The phonological network and the orthographic network cooperate in the first 100 ms of word reading.
- Word recognition begins without awareness and completes effortlessly.





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When Reading is not Automatic
t says /th/

Magnetic resonance imaging (MRI) and other techniques illustrate quite concretely that poor readers are struggling with the basics, sounding out and recognizing words bit by bit. Good readers, however, have developed word identification habits that are supported by the posterior or back areas of the brain. The “poor reader” patterns change when remediation is successful.



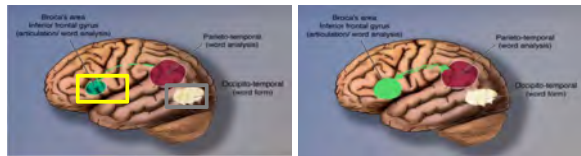
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How do Brain Networks for Reading Differ in Children who Struggle?

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Network Development when Phonemic Awareness is Poor



Inaccurate & Slow
Decoding

More Accurate &
Still Slow Decoding

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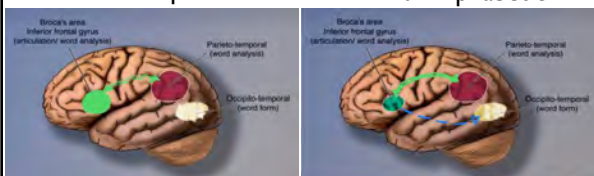


Some Good News for Readers with Poor Phonemic Awareness

An OG approach can build those brain networks.

Partial Alphabetic

Full Alphabetic



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The O-G Approach to Teaching Reading

- Accurate decoding supports precise word memories.
(phonological route/ decoding)
- Crisp word memories support easier recognition of those words in the future.
(both routes instant recognition)
- Fast word recognition is necessary for text reading fluency and comprehension.

Sources of Fluency Problems


- Poor word recognition
- Poor understanding of syntax
- Combined poor word rec & poor understanding of syntax

The majority of fluency problems involve slow/inaccurate word recognition.



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Finding the Source of Fluency Problems


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Finding the Source


How can we use the research to select tests that will help us to zero-in on the sources of dysfluent reading?
Are some measures of fluency more helpful than others?
Do we want word lists or passages? Or both?



Three Sources of Dysfluency:



- Slow/inaccurate phonological processing
- Lack of reading practice; little consolidation
- Difficulty with higher level language skills


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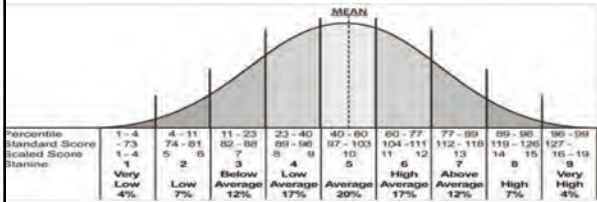
A Small Sample of Standardized, Norm-Referenced Tests

Disclaimer: This is not a complete review. It is just what we thought was a good idea at the time that we wrote this talk. Just because a test is included in this discussion does not mean it is appropriate for your child or examinee.

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The Minute Lesson - Test Scores



Farrall, M. (2012). *Reading Assessment: Linking Language, Literacy, and Cognition*. Hoboken, NJ: John Wiley and Sons.

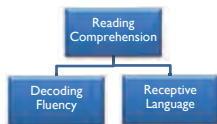
Case Study

Student	TOWRE2: Word Lists	GORT-5: Passages
Sasha	Stanine 3	Stanine 3
Masha	Stanine 5	Stanine 2

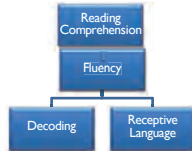
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What Passages Tell Us

View 1



View 2



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Word Lists

- Test of Word Reading Efficiency, Second Edition (Torgesen, J.K., Wagner, R.K., Rashotte, C.A., 2012)
 - Sight Word Efficiency & Phonemic Decoding Efficiency
 - “General outcome measure” to be administered 3-4 times yearly.
- Kaufman Test of Educational Achievement, Third Edition (Kaufman, A.S., & Kaufman, N.L., 2014)
 - Word Reading Fluency & Decoding Fluency
 - Two Forms, twice yearly



Contrast Between Word ID & Decoding

- In younger children, word lists help us to discern between those who read by sight and those who can apply their phonics skills to unfamiliar words.
- In older individuals, word lists help to identify
 - Whether students have acquired basic decoding skills as a foundation for developing a rich sight vocabulary.



What is an Error?



What is an error?

The crowd cheered the chimpanzee as he stared at his keeper.	ERRORS THAT PRESERVE MEANING			ERRORS THAT ALTER MEANING	ERROR COUNT	
	Synonyms	Repetitions	Self-Corrections	Just Plain Wrong	Miscue	Absolute
Alice: The crowd cheers the ... champion as he starts to kick.	0	0	0	4	4	4
Ralph: The crowd cheers/cheered the chump/chimp/chimpan-zee as he starts/started to go/stared at his ... keeper.	0	0	4	0	0	4
Ethel: The crowd...the crowd cheers ...cheered the chimpanzee as he stared ... stared at his...his keeper.	0	3	1	0	0	4

Errors

- Automaticity presumes accuracy and a level of skill in which it must be easier to read the word than not.
- All miscue errors (repetition, self correction, synonyms) are the result of inaccuracies in decoding.
- We want to use tests that are sensitive to all errors and not just those that affect meaning.


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Fluency Tests: Recognition of Deviations from Text

	WIAT-III Errors	GORT-5 Errors	DIBELS-N Errors
Repetitions	NO	YES	NO
Self-Corrections	NO	YES	NO (within 3 seconds)
Skipped Lines	NO	YES	YES
Contractions	NO	YES	YES
Insertions	YES	YES	NO
Omissions	YES	YES	YES
Substitutions	YES	YES	YES

WIAT III: Oral Reading Fluency (Pearson, 2010)

- Grades 1 through 12: 2 passages per grade level (grades 7/8, 9-12)
- Provides scores for Accuracy, Rate and Fluency
- Comprehension questions are designed to ensure focus on reading for meaning.
- Prosody Scale
- Does not count repetitions, self corrections, skipped lines and contractions as errors.

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Gray Oral Reading Tests, Fifth Edition (Wiederholt & Bryant, 2012)

- Ages 6 through 23
- The GORT brand has been redeemed.
 - New ceiling and basal rules
 - Text dependent questions
- Scores for Rate, Accuracy, Fluency, and Comprehension.
- Students read increasingly difficult passages and respond to open-ended questions based on what they remember.

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What about Measures of Silent Reading Fluency?

- WJ-IV: Marking sentences as true/false
 - Grass is orange. True False
 - Milk is dry. True False
- KTEA-3: Answering yes/no questions
 - Do people walk on water? YES NO
- Guessable, concrete, and low readability
- Good as a screening


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Slasher Tests

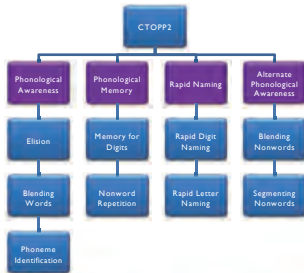
~~It's time for all good children to go to bed.~~

- Highly Efficient
- Can be administered in groups
- *Test of Silent Word Reading Fluency, Second Edition* (Mather, Hammill, Allen, & Roberts, 2014)
- *Test of Silent Contextual Reading Fluency, Second Edition* (Hammill, Wiederholt, & Allen, 2014).

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Comprehensive Test of Phonological Processing, Second Edition

(Wagner, R.K., Torgesen, J.K., Rashotte, C.A., 2013)



Rapid Letter Naming

B	C	D	S	K	P	S
P	S	K	C	B	D	K
B	P	S	D	P	C	B
S	C	P	K	S	D	S

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RAN: What is it?

- Not associated with cognitive ability (Bowers, Steffy, & Tate, 1998)
- Not associated with articulation (Stanovich et al., 1998)
- Not the same as processing speed (Kail & Hall, 1994)
- Often subsumed under phonological processing (Torgesen & Wagner, 1998)

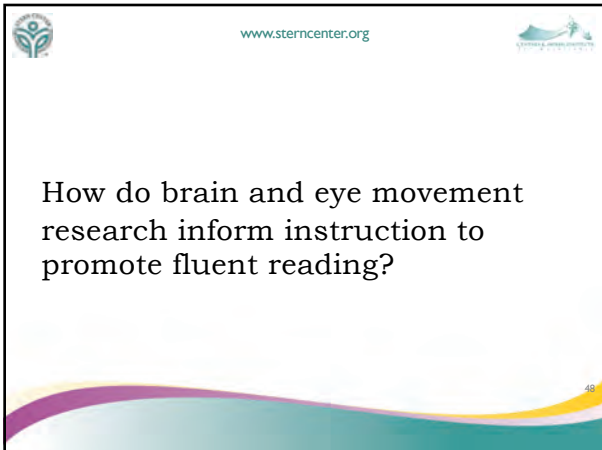


Dyslexia Subtypes?

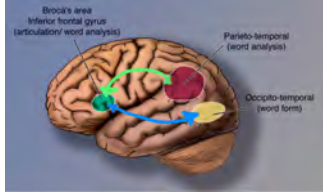
Phonological		RAN		So-Called Double-Deficit	
PA	Weak	PA	Good	PA	Weak
RAN	Good	RAN	Weak	RAN	Weak
Classic Dyslexic/RD: Needs to learn that words have sounds as a foundation for phonics and spelling instruction		Less commonly encountered RD. May or may not have accurate decoding skills. Needs to learn that words have sounds as a foundation for phonics and spelling instruction		Dual (triple) deficit. Needs to know that words have sounds. Requires highly individualized intensive instruction.	



How do brain and eye movement research inform instruction to promote fluent reading?



Building Connections for Fluency

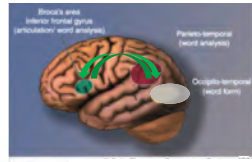


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Brain Research & Reading Instruction

The phonological network develops from speech,
and is necessary for the orthographic network.

- Phonemic awareness
- Decoding
- Spelling

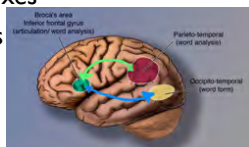


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Brain Research & Reading Instruction

The orthographic network has its foundation in the
phonological route. To encourage orthographic
processing

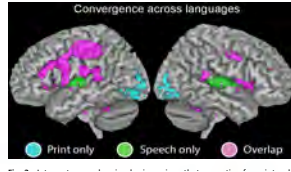
- Teach base words & affixes
- Greek combining forms
- Latin roots



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For Effective Instruction that Builds Fluency

Reach for Speech



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Reach for Speech

- Accuracy, then fluency in every part of the lesson.
- Build automaticity by overlearning phonograms, syllable types, syllable division, & morphology
- Word list
 - Encourage blending words into a spoken form
 - Revisit words until recognition is instant (?)
- Passage reading should occur at an individual pace, which is the inner-voice.

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Reach for Speech

- Build phonological networks by increasing the accuracy and automaticity of phonemic awareness skills (Kilpatrick, 2016)
- Bind orthography & phonology with integrated reading and spelling instruction

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Thoughts about Progress Monitoring

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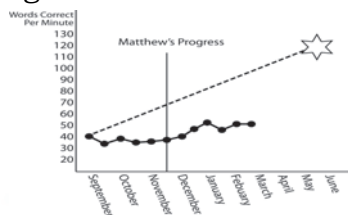
Progress Monitoring

- A set of standardized, individually administered measures of early literacy development. They are designed to be short (one minute) fluency measures used to regularly monitor the development of pre-reading and early reading skills.
- Designed to identify students early

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Individual scores are not reliable for high-stakes decision making.



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Progress Monitoring Caveats

- Good potential for screenings
- Must monitor what is being taught
- Undo focus on reading speed in beginning readers



Summary



Choose Your Tests Carefully

- Be sure to measure what you are teaching.
- Select tests that are sensitive to all errors and not just those that affect meaning.
- Do not emphasize fluency over accuracy in beginning readers.



Fluency & the Brain

Reading fluency involves a dynamic process of cognitive reorganization that occurs over time.

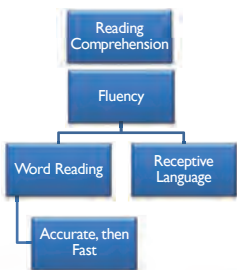
Changing behaviors result from changes in cognition and those result from changes in brain wiring.



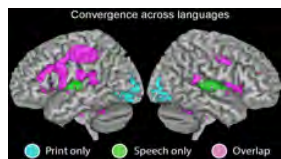
Fluency & the Brain

- Fluency rests on a foundation of accurate decoding and automatic word recognition.
- If that is not in place, then don't expect expressive reading. Expression is third.
- What fires together wires together, slowly.
- Strive for accuracy, then speed in the word list.
- During oral reading, keep your watch in your pocket.





Reach for Speech



What would the Greats think?

J.L.Orton, Gillingham, Rawson, & Rome



Thank You!



Average (50th percentile) Reading Fluency

	2006
End of first grade:	53 wpm
End of second grade:	89 wpm
End of third grade:	107 wpm
End of fourth grade:	123 wpm
End of fifth grade:	139 wpm
End of sixth grade:	150 wpm
End of seventh grade:	150 wpm
End of eighth grade:	151 wpm

Hasbrouck, J., & Tindal, G. (2017). *An update to compiled ORF norms*. (Technical Report No. 1702). Eugene, OR: Behavioral Research and Teaching, University of Oregon.