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2017 DYSLEXIA RESEARCH AND REMEDIATION

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Scientific Learning Corporation
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Different for a reason.

ONE HISTORICAL VIEW – DOUBLE DEFICIT HYPOTHESIS

- A well-regarded and research-supported hypothesis that:
 - Weaknesses in either rapid automatized naming (RAN) or phonological awareness (PA) can cause dyslexia, and that those with both deficits are the most severely impaired readers.
 - Research: brain structure, white matter tracts relating to phonological awareness have been identified
 - but no measures of tract organization have yet consistently been associated with RAN

Wolff M, Bowers, PG: [The double-deficit hypothesis for the developmental dyslexia](#). Journal of Educational Psychology, 1999, 91:415-438

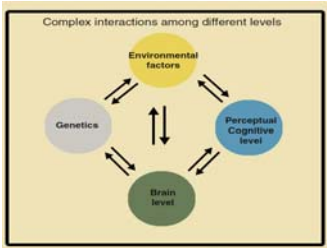
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MORE CURRENT VIEW:

MULTI-DEFICIT APPROACH TO DEVELOPMENTAL DYSLEXIA

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A MULTI-DEFICIT APPROACH TO DYSLEXIA

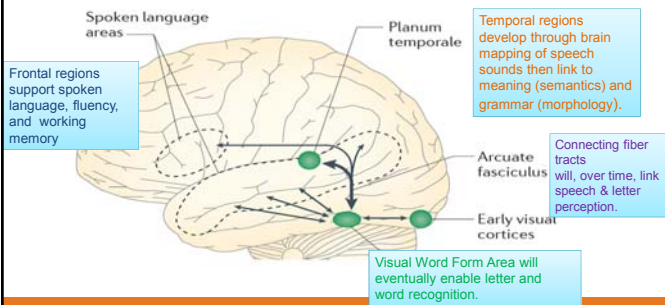


A Multi-Deficit approach to Dyslexia is now considered the most accurate way to understand causation.

Ozernov-Palchik, O., Wang XY., and Gaab, N., 2016

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Language and Reading in the Brain



DeHaene, et al. 2015

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RISK FACTORS

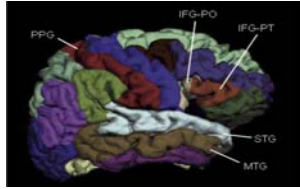
(OLA OZERNOV-PALCHIK, ET AL., 2016)

- **Genetic Factors**
- **Brain Level Differences**
- **Perceptual/Cognitive Level Differences**
 - Atypical sensorimotor and/or perceptual functions
 - Atypical language development and/or attention
 - Atypical PA, WM, RAN, Letter Knowledge, Vocabulary, Executive functions
- **Environmental Factors**
 - Low SES, low home literacy, stress and other adverse experiences
 - Ineffective schooling or interventions

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UNDERSTANDING GENETIC INFLUENCES

An association of rs5995177 with reading/language performance could potentially be mediated by reduced thickness in associated cortical regions.



Gialluisi, A. Et al (2015) Neuroimaging genetic analyses of novel candidate genes associated with reading and language. *Brain and Language*.

Fig. 1. Cortical brain regions tested for association in this study. MTG = middle temporal gyrus; IFG-PO = inferior frontal gyrus - pars opercularis; IFG-PT = inferior frontal gyrus - pars triangularis; PPG = postcentral parietal gyrus; STG = superior temporal gyrus

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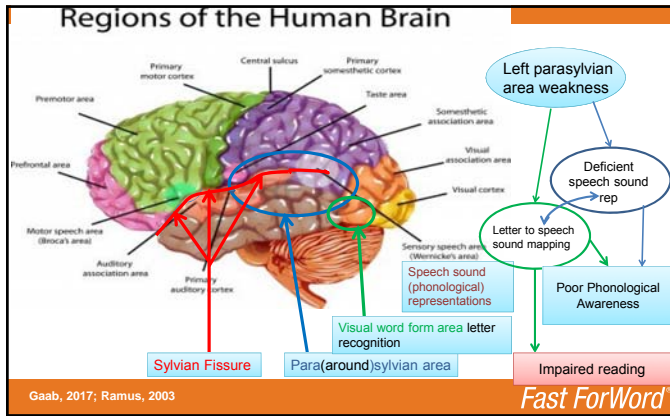
GENETIC FACTORS (GAAB, 2017)

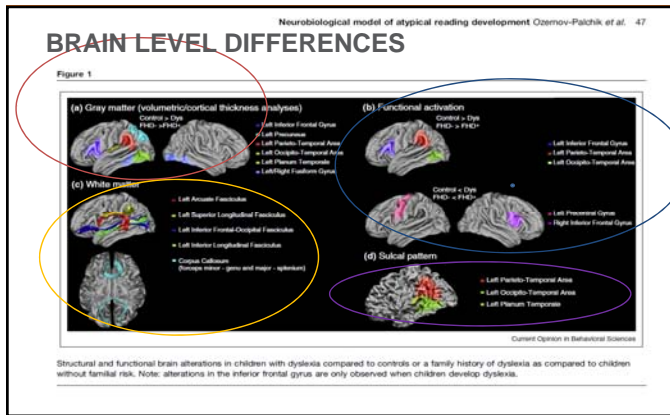
- Developmental Dyslexia is strongly heritable:
 - 50% of children with a sister, brother, mother or father with dyslexia will receive the diagnosis themselves
 - 68% in identical twins
- Specific genes known to be associated with developmental dyslexia are important drivers of brain development (ROBO1, DYX1C1, KIAA0319, DCDC2)

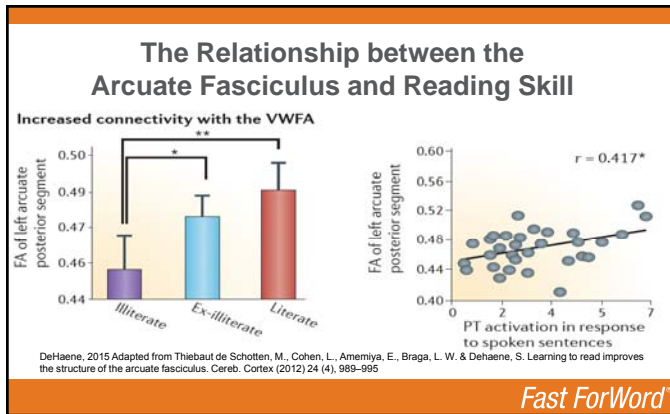
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BRAIN LEVEL DIFFERENCES

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White Matter Tract Differences – most notably to date the left arcuate fasciculus (AF)

(Langer, et al., 2017)

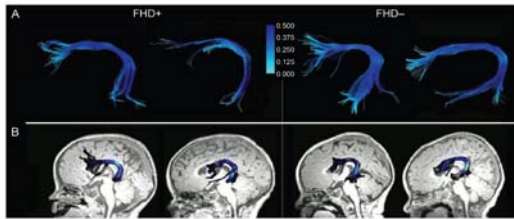


Figure 2. Exemplary left arcuate fasciculi. AF tractography in infants with (FHD+) and without (FHD-) a familial risk for DD using (A) manual and (B) automated methods. The intensity of the color represents the magnitude of the FA.

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PHONOLOGICAL & ORTHOGRAPHIC DEFICIT THEORIES

VANDERMOSTEN, 2016

- Phonological deficit theory:
 - Especially in phonological awareness (i.e., the ability to process and manipulate the sound structure of words)
 - Although the Temporal Parietal region is implicated in children with phonological deficits, the research has not consistently shown causation
- Orthographic deficit theory:
 - The ability to identify written letter patterns and words as whole units (rather than letter by letter).
 - The left ventral OT area, including the fusiform gyrus, plays a key role in orthographic processing in skilled readers.

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CONCLUSIONS

(VANDERMOSTEN, 2016)

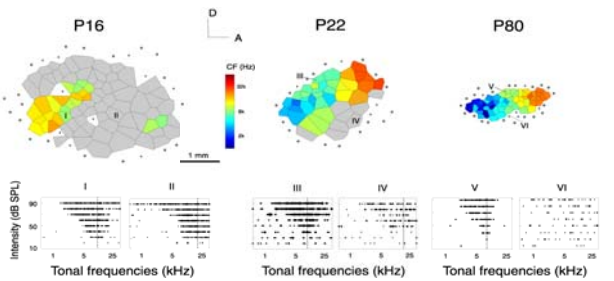
- The most consistent findings across studies are differences in left TP brain regions between at-risk pre-readers and controls.
- Because left TP is associated with phonological processing, this provides substantial support for the phonological deficit theory.
- Differences in left ventral OT regions are also observed prior to reading onset, though less consistently.
- **Finally, some evidence is also provided for an early deficit in perceptual regions, especially in the auditory domain [15,17].** It is important to highlight that several studies indicate early connectivity differences in at-risk pre-readers [3,16,18].

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PERCEPTUAL AND COGNITIVE LEVEL DIFFERENCES

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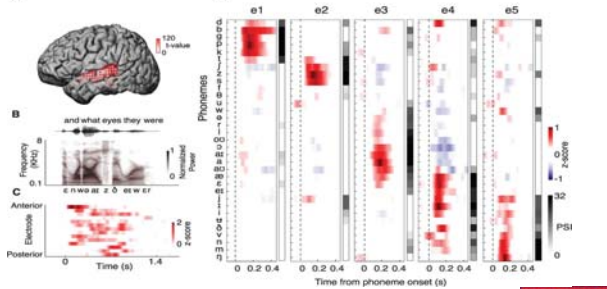
Normal Development of the Brain Maps for Hearing



Zhang, Bao & Merzenich, Nature Neuroscience, 2001

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Fig. 1 Human STG cortical selectivity to speech sounds. (A) Magnetic resonance image surface reconstruction of one participant's cerebrum.



N Mesgarani et al. Science 2014;343:1006-1010

Science

Published by AAAS

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SUMMARY CHRISTMANN, C A., LACHMANN, T. & STEINBRINK, C. (2015)

- Auditory Processing Deficits were found **prior to school entry**
- Results **support the existence of a general auditory processing impairment** in developmental dyslexia **that might be the cause of the phonological problems** at least in a large subset of persons with dyslexia.

- [Evidence for a General Auditory Processing Deficit in Developmental Dyslexia From a Discrimination Paradigm Using Speech Versus Nonspeech Sounds Matched in Complexity](#), *Journal of Speech, Language and Hearing Research*, Feb. 2015, VOL 58, 107-121

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OTHER RESEARCH: EARLY CLUES TO WHY SOME CHILDREN MAY HAVE READING WOES



- By Lauran Neergaard | AP July 14, WASHINGTON
- Research suggested it may be possible to predict Preschoolers who will struggle to read in later years.
- It has to do with **how the brain perceives speech** when it's noisy.

The Auditory Neuroscience Lab, Northwestern University, shows scalp electrodes to pick up how children's brains react to sounds such as speech in a noisy background. Researchers analyzed brain waves of children as young as 3.

• [White-Schwach T, Woodruff Carr K, Thompson EC, Anderson S, Nicol T, et al. \(2015\) auditory Processing in Noise: A Preschool Biomarker for Literacy. PLOS Biol 13\(7\): e1002196. doi:10.1371/journal.pbio.1002196](#)

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DYSLEXIA-RELATED DIFFERENCES IN PRE-READERS

(VANDERMOSTEN, 2016)

- "Provide the first evidence that neurobiological differences observed in adults and children with dyslexia are not purely reading experience-driven,
- But are more likely related to etiological differences."

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COGNITIVE LEVEL DIFFERENCES

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CORE COGNITIVE FACTORS IN CHILDREN WITH READING AND LANGUAGE PROBLEMS

The skills below are also core factors in children with reading and language problems:

- **Memory skills**
- **Attention skills**



Syntactic Versus Memory Accounts of the Sentence Comprehension Deficits of Specific Language Impairment: Looking Back, Looking Ahead

James W. Montgomery, Ronald B. Gillam and Julia L. Evans
Journal of Speech, Language, and Hearing Research, December 2016, Vol. 59, 1491-1504.

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MONTGOMERY, GILLAM AND EVANS (2016) REVIEW ARTICLE IN JSHR

- Looking Back: Two Accounts Language and Reading Comprehension Deficits
- Looking Ahead: Future Directions in Language Research
- A syntax-specific deficit view and
- Understanding the full range of memory skills including attention and long term retention
- A working memory (WM)-based account

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EXPLAINING THE SEX DIFFERENCE IN DYSLEXIA

ARNETT ET AL (2017)
J CHILD PSYCHOL PSYCHIATRY ONLINE FEB. 9, 2017

- The sex difference in dyslexia is also real
- The cognitive differences identified to account for a portion of the sex difference in dyslexia in this research were
 - **processing speed (PS)** and
 - **inhibition (INH)** –
- males showed better verbal reasoning
- No difference in female vs. male verbal skills (interesting)

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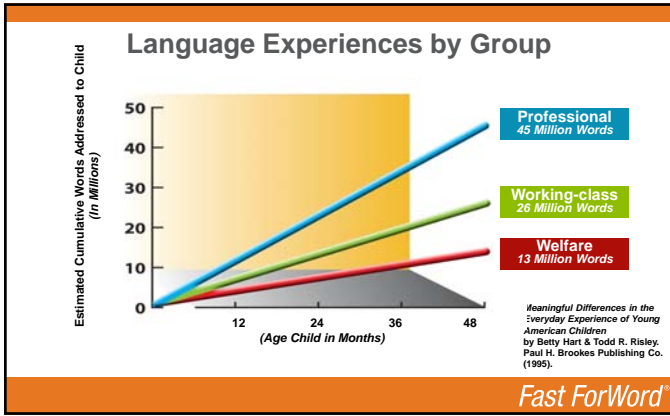
ARNETT ET AL (2017) CONCLUSIONS

- **Processing speed**, which is **slower and more variable in males**, mediates the sex difference in both dyslexia and attention deficit/hyperactivity disorder.
- This research clearly supports the content and science that underlies of the Fast ForWord exercises – with emphasis on building
 - **Working Memory**
 - **Rapid Auditory Processing** and in some cases **Processing Speed** more closely akin to that term used by neuropsychologists, and
 - **Inhibition** in the form of vigilance tasks like in the Fast ForWord exercises: Moon Ranch and Flying Fish.

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ENVIRONMENTAL DIFFERENCES

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UNDERSTANDING GENETIC INFLUENCES

- Gialluisi, A. Et al (2015) Neuroimaging genetic analyses of novel candidate genes associated with reading and language. *Brain and Language*.
- An association of rs5995177 with reading/language performance could potentially be mediated by reduced thickness in associated cortical regions

Fig. 1. Cortical brain regions tested for association in this study. MTG = middle temporal gyrus; IFG-PO = inferior frontal gyrus - pars opercularis; IFG-PT = inferior frontal gyrus - pars triangularis; PPG = postcentral parietal gyrus; STG = superior temporal gyrus

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WHAT DOES POVERTY AFFECT BESIDES LANGUAGE? (JUST OUT IN JANUARY)

[Behavior & Society](#)

Does Poverty Shape the Brain?

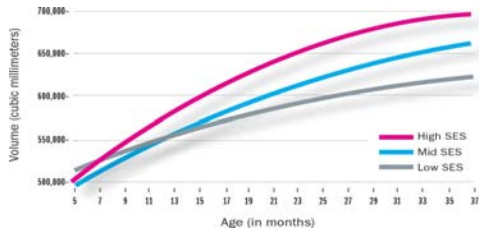
Growing up in a poor family can leave a mark on the developing brain. Understanding how and why has important implications for educators and society.

By [John D. E. Gabrieli](#), [Silvia A. Bunge](#)

January 2017 Issue

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"FAMILY POVERTY AFFECTS THE RATE OF HUMAN INFANT BRAIN GROWTH"
JAMIE L. HANSON ET AL., IN PLOS ONE, VOL. 8, NO. 12, ARTICLE NO. E80954;
DECEMBER 11, 2013



Total Gray Matter: Using MRI to track brain development in 77 infants, psychologists at the University of Wisconsin–Madison found that differences associated with socioeconomic status (SES) became increasingly pronounced over time. By age three, toddlers from low-income households showed significantly less gray matter than those raised in wealthier homes.

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IMPLICATIONS FOR EDUCATIONAL PRACTICE AND POLICY

- Can neuroscience inform a definition of dyslexia?
 - Research “supports the multi-deficit approach to dyslexia by suggesting that distinct brain mechanisms are associated with the various dyslexia profiles.” page 51
- How do environmental factors influence a brain’s ability to read?
 - “Policies and interventions that encourage parents to optimize their home literacy environment, by increasing shared reading time and using rich child-directed speech, have been shown to have important positive impacts on language and reading outcomes.” page 51

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IS NEUROSCIENTIFIC RESEARCH USEFUL FOR EDUCATORS?

([YLINEN](#) AND [KUJALA](#), 2015)

Neuroscientific research has demonstrated that improved behavioral performance is coupled with changes in **both brain function and brain anatomy.**



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Normal readers Dyslexics before training

Temple et al., 2003; Gabrieli, 2008

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And so, what is the intervention for the left temporal and frontal deficits?

Difference before and after training

(Temple, et al., 2003; DeHaene, pg. 260)

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THE SOONER CHILDREN CAN LEARN TO READ, THE BETTER

PERSPECTIVES **How Reading Changes the Brain**

■ Increased response to spoken words

Words read per minute	PT activation	Category
0	0	Illiterate
~25	~1.5	Ex-illiterate (learned to read in adulthood)
~50	~2.5	Literate (learned to read in childhood)
~75	~3.0	Literate (learned to read in childhood)
~100	~3.5	Literate (learned to read in childhood)
~125	~4.0	Literate (learned to read in childhood)

DeHaene, et al. (2015) Illiterate to literate: behavioural and cerebral changes induced by reading acquisition. *Nature Reviews Neuroscience* APRIL 2015: VOLUME 16 234-244

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SO AN EXCELLENT APPROACH TO READING INTERVENTION....

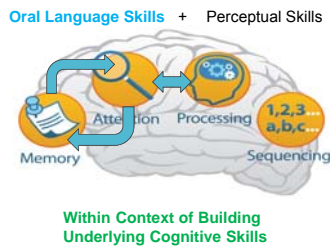
- Builds speech sound perception skills
- Focuses intensively on oral language skills
- Provides instruction on morphology and grammar
- Improves vocabulary
- Works on verbal reasoning skills

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THE FAST FORWARD PRODUCTS

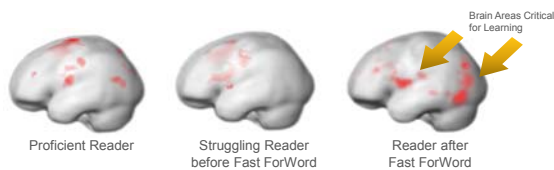
Well-designed neuroscience technologies build in exercises that:

- address cognitive skills essential to academic success
- promote life skills (executive functions).



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IMPROVEMENTS IN LEARNING IN 8 WEEKS



Stanford (2003) and Harvard (2007) researchers validate impact. After eight weeks, brain activation patterns change and reading performance improves.

Adapted from Temple et al., Proceedings of the National Academy of Sciences, 2003 and Gaab, N., Gabrieli, J.D.E., Deutsch, G.K., Tallal, P., & Temple, E. (2007). Neural correlates of rapid auditory processing are disrupted in children with developmental dyslexia and ameliorated with training: An fMRI study. Restorative Neurology and Neuroscience, 25, 295-310.

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LANGUAGE V2 - HOOP NUT



Builds Speech Sounds and Perception Skills

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LANGUAGE V2 - POLAR MATCH



Builds Speech Sounds, Perception Skills and Auditory Attention

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LITERACY - LUNAR TUNES



Builds Speech Sounds, Perception Skills and Auditory Working Memory

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LANGUAGE TO READING - COSMIC READER

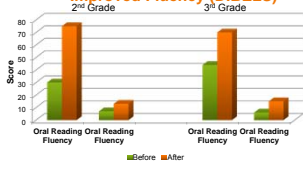


Builds Oral Language Skills: Grammar and Morphology

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MECHANICVILLE, NY

Improved Fluency (DIBELS)



Grade	Measure	Before	After
2nd Grade	Oral Reading Fluency	~35	~75
	Retell Fluency	~10	~15
3rd Grade	Oral Reading Fluency	~45	~75
	Retell Fluency	~10	~15

Improved Language (CELF)




Time	Score
Before	~75
After	~85

Before and after using Fast ForWord products, students had their oral reading fluency and retell fluency measured with the DIBELS and/or their language skills measured with the CELF-4. On average, students made statistically significant improvements on oral reading fluency and retell fluency, shown in the left graph (2nd graders: $t(13)=10.7$, $p<0.01$, $t(13)=7.8$, $p<0.01$, 3rd graders: $t(22)=10.3$, $p<0.01$, $t(22)=6.5$, $p<0.01$). As shown in the right graph, on average, students also made statistically significant gains in language skills ($t(19)=8.0$, $p<0.01$), raising the group's language skills into the average range.

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READING LEVEL 3 - BOOK MONKEYS

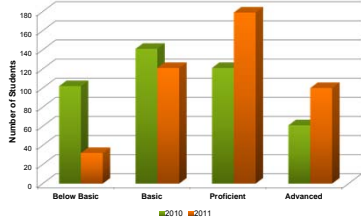


Reading: Decoding, Vocabulary and Comprehension

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PALMYRA, PA SPECIAL EDUCATION

Improved Reading Achievement

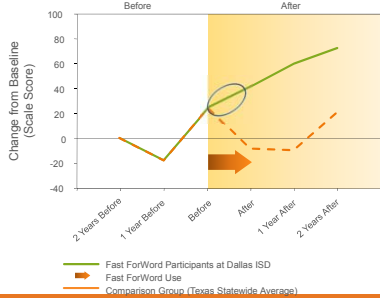


Students in 4th – 5th grades who were targeted for Fast ForWord use included students with Individual Education Plans (IEP's) and English language learners. In all, 433 students in 4th – 8th grades used the Fast ForWord products during the 2010 – 2011 school year and were evaluated in the Spring of 2010 and 2011 with the PSSA. On average, 34% of the students improved their reading achievement by one or more levels, with the number of proficient students increasing from 43% in 2010 to 64% in 2011.

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...AND ENDURING OVER TIME

Dallas ISD: TAKS (Texas Assessment of Knowledge and Skills) Reading



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BEFORE WE TAKE QUESTIONS

1. Check your inbox tomorrow for:

- Link to the recording
- Certificate of Attendance
- Link to sign up for free samples



2. Sign up to view free samples of Fast ForWord at www.scilearn.com

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QUESTIONS?

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