

Cognitive underpinnings of Speech Sound Disorders: Implications for Reading ability

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Disclosures

- Financial: I am being compensated me for today's presentation. I am a faculty member at Emerson College and receive a salary for that job.
- Nonfinancial: I am the director of the Children's Literacy and Speech Sound (CLaSS) Lab, faculty at Emerson College, and the immediate Past President of the Massachusetts Speech, Language, and Hearing Association





As a result of this presentation, participants will be able to:

1. identify the role of phonological representations
2. discuss the risk factors and outcomes for children with persistent speech sound disorders as well as those with dyslexia
3. discuss the SLPs role in facilitating literacy skills for children with speech sound disorder and those with dyslexia




Children's Literacy and Speech Sound (CLaSS) lab


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Observation from a school-based SLP:
Subgroups of SSD????

		Remediates	
		YES	NO
Literacy Problems	NO		Motor Deficit?
	YES	Linguistic Deficit?	True phonological deficit

What is reading?




Who is reading?



The Simple View of Reading
(Catts, Hogan, & Fey, 2003; Catts, Hogan, & Adlof, 2005; Gough & Tunmer, 1986; Hoover & Gough, 1990)

Reading




The Simple View of Reading
(Catts, Hogan, & Fey, 2003; Catts, Hogan, & Adlof, 2005; Gough & Tunmer, 1986; Hoover & Gough, 1990)

Reading

↙

Word Recognition



The Simple View of Reading
 (Catts, Hogan, & Fey, 2003; Catts, Hogan, & Adlof, 2005; Gough & Tunmer, 1986; Hoover & Gough, 1990)

Reading Comprehension

Word
Recognition

Listening
Comprehension

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THE MANY STRANDS THAT ARE WOVEN INTO SKILLED READING

LANGUAGE COMPREHENSION
 SEMANTICS & GRAMMAR (vocabulary, syntax)
 TEXT PROCESSING (text structures, cohesion)
 BACKGROUND KNOWLEDGE (facts, concepts, etc.)
 VERBAL REASONING (problem solving, inference)
 METACOGNITION (comprehension strategies)

WORD RECOGNITION
 PHONOLOGICAL AWARENESS (syllables, phonemes, etc.)
 DECODING (alphabetic principle, spelling-sound correspondences)
 SIGHT RECOGNITION (of familiar words)

Labels in diagram: "increasingly strategic" and "increasingly automatic"

SKILLED READING: Fluent execution and coordination of word recognition and text comprehension.

See Scarborough, H. S. in Neuman, S.B. & Dickinson, D. K. (2001). *Handbook of Early Literacy Research*. New York: Guilford Press.

How does this apply to phonological impairments?

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Who are they?

- Speech sound disorders
 - Articulation
 - Phonology
- Dyslexia
 - Word reading
 - Phonemic decoding

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Speech Sound Disorders

“ SSD was formerly called *articulation disorder* (which emphasized putative problems in the motor programming of speech) and *phonological disorder* (which emphasized putative problems in the cognitive representations of speech). Since each of these terms made a premature commitment to the underlying processing deficit that causes the speech production problem, the neutral and descriptive term SSD is now preferred.”

- Pennington (2006)

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Speech sound disorders are characterized by a delay in the acquisition of appropriate speech sounds
(Lewis, Freebairn, Hansen, Shriberg, Stein, Taylor, & Iyengar, 2006).

Children with speech sound disorders are the primary population treated by school-based speech language pathologists
(ASHA, 2014, 2013, 2012; NIDCD, 1994).

Speech sound disorders can impact academic, linguistic, vocational, and socio-emotional skills in children and adolescents
(Hitchcock & McAllister-Byun, 2015; Lewis, Freebairn, Hansen, Iyengar & Taylor, 2004)

50-70% of children with speech sound disorders require some level of special education services through the 12th grade
(Felsenfeld, Broen, & McGue, 1994; Shriberg & Kwiatkowski, 1988).

Even once the speech sound disorder has been remediated through speech therapy services
(Anthony, et al, 2007; Farquharson, 2015; Overby, Trainin, Smit, Bernthal, & Nelson, 2012; Raitano et al., 2010).

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Speech Sound Disorder

- More than half of children with SSD experience difficulties with reading (Bishop & Adams, 1990; Catts, Adlof, Hogan, & Weismer, 2004; Catts, 1986; Catts, 1991; Catts, Fey, Tomblin, & Zhang, 2002; McCardle, Scarborough, & Catts, 2001; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Tomblin, Zhang, Buckwalter, & Catts, 2000).
- Deficits in the phonological system often result in difficulty acquiring phonological awareness (PA) skills, a necessary pre-requisite for reading success (Larrivee & Catts, 1999).



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Prevalence of SSD

11-13% of children ages 5-7 years have a speech sound disorder

Approximately 10% of children ages 9-11 have a persistent speech sound disorder
Sound errors that persist past the typical age of acquisition (i.e., 8-years-old)

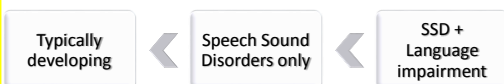
18% of 8-year-olds in the UK have unresolved speech sound errors

1.4% of college freshman have persisting speech sound errors



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Risk of Reading Difficulties




Carrol & Snowling (2004); Catts (1991)



Dyslexia is...

- A language-based problem
- A phonological processing disorder
- Neurobiological in origin
- Present from birth
- Usually experienced for life


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Dyslexia is...

- A spectrum disorder than can range from annoyance to severe limitation
- More common than any other kind of learning disability
- Responsive to expert, informed instruction (Moats, 2008)


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Dyslexia is...

- Characterized by weaknesses in word reading, phonemic decoding, and spelling
- Surprising, because this weakness exists in the presence of normal intelligence
- Present in adults who have compensated but are poor spellers, are slow readers, and have difficulty with novel and complex phonological forms


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Dyslexia is NOT...

- Characterized or diagnosed by seeing letters backwards
- Indicative of "gifted" status
- A disorder that cannot be diagnosed until 3rd grade
- A visual problem
- Responsive to colored lenses and/or eye tracking exercises


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Phonological processing deficit

- This phonological processing deficit seen across a variety of languages
 - French (Sprengr-Charolles et al., 2000)
 - Greek (Porpodas, 1999)
 - German (Wimmer et al., 1999)
- Manifestation is also different across languages
 - English: word reading
 - Dutch: word reading fluency
 - German: spelling


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Oral language deficits


- Phonological processing problems associated with dyslexia can impact other language skills
- Many studies show that subtle oral language deficits are present in children at risk for dyslexia before formal schooling (e.g., Lyytinen et al., 2001; Scarborough, 1990, 1991)

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Secondary Consequences
 (research committee of the IDA, Lyon et al., 2003)

- Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge


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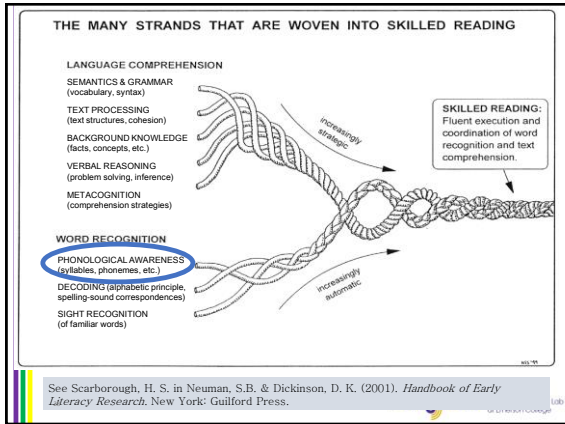
Dyslexia Summary

- Classic case is uncommon
- Impairment in phonological processing (not necessarily production)
 - Across the lifespan
- Compensated adults
 - Poor spellers
 - Poor at reading quickly
 - Still have subtle phonological processing deficits

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What is phonological awareness?

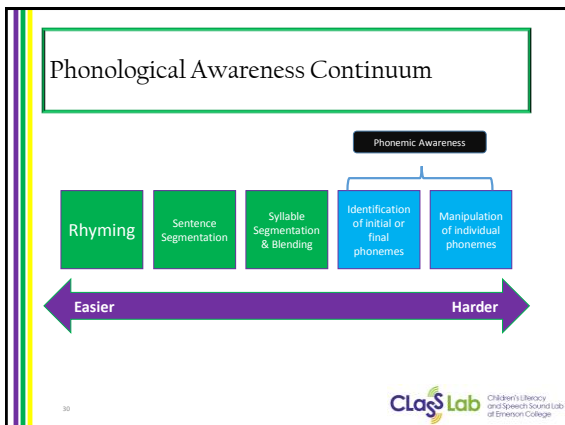
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Phonological awareness

- One's sensitivity to the sound structure of a word
- Measured by rhyming, blending, and deletion tasks
- Research supports causal link between phonological awareness and early reading
 - Good phonological awareness = good readers
 - Poor phonological awareness = poor readers
- The component of reading in which SLPs are most likely to be involved

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PA & SSD – Relations over time

Preschool:

- Preschoolers with SSDs are at increased risk for deficits with **phonological awareness** (Anthony et al., 2011; Bird, Bishop, & Freeman, 1995; Foy & Mann, 2011; Lewis et al., 2011; Lewis & Firebairn, 1992; Peterson, Pennington, Shriberg, & Boada, 2008; Raitano, Pennington, Tunick, Boada, & Shriberg, 2004; Roachew, Ollberg, Grawburg, & Heyding, 2003)
- Atypical speech sound errors and distortions in preschool are predictive of weak PA skills (Preston & Edwards, 2010)
- This is true even when language is normal (Bird et al., 1998; Overby, Trainin, Smit, Bernthal, & Nelson, 2012; Raitano et al., 2004; Roachew et al., 2003)
- The proportion of speech sounds in error at age 5 is related to the likelihood of persistent errors at age 8 (Roulstone et al., 2009)

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PA & SSD – Relations over time

School-aged:

- Children with persistent speech sound disorders (2-5th grade) have markedly weaker PA skills compared to same-age peers (Farquharson, 2012)
- Children with “residual” SSD, ages 8.5-10, exhibit cortical and subcortical differences during phonological processing tasks (Preston, Feherfeld, Frost, Mend, Fulbright, Grigorenko, Lindi, Seki, & Pugh, 2012)
- Atypical speech sound errors in preschool are predictive of school-age PA abilities; if more than 10% of the child’s speech has atypical errors, the child is likely to have deficits in PA, reading, and spelling (Preston & Hall, 2012)

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PA & SSD – Relations over time

Adolescents:

- 10-14 year old children with “residual” speech sound errors (no comorbid diagnoses) have weaker phonological processing skills compared to same-aged peers (Preston & Edwards, 2007)
- Phonological processing (word reading and phonological working memory) skills have been shown to be weak even once the speech sound disorder is remediated (Farquharson, 2015; Raitano, Tunick, Pennington, Boada, & Shriberg, 2004)

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How do we use this information?


Early identification

↓

Early intervention


↓

Reduced Risk of Reading disorders



Early Intervention

- Critical because children who start out as poor readers generally continue to be poor readers
- Poor reading achievement quickly leads to a host of negative consequences




Downward Spiral of RD

Low Motivation

Negative Expectations

Limited Practice

Academic Failure



Early Indicators

- Problems in **oral language and speech sound** development are primary signs of risk for reading disorders

• Nathan, Stackhouse, Goulandris, & Snowling (2004); Pennington (2005); Raitano, Pennington, Tunick, Bouda, and Shriberg (2004)

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Early signs of risk for Dyslexia

- Family history of reading or language impairment
- Difficulty learning the letter names and sounds
- Consistent use of unusual or nondevelopmental errors
- Multisyllabic words especially difficult

(Catts, 1986, 1989; Dodd, et al., 1995; Magusson & Naucler, 1990; Larrivee & Catts, 1999; Leitao & Fletcher, 2004)

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Not early signs of dyslexia

- Reversing letters when writing
 - This is typical until ~2nd grade
- Common errors on long words
 - animal/ animal
 - paskeri/ spogeri

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New frontiers in early identification of dyslexia

- Speech discrimination at 3-5 days old
 - Guttorm et al., 2005
- Babbling complexity in infants
 - Farquharson, Hogan, Hoffman, Green, Wang, & Green, (under review); Lambrecht-Smith et al., 2008



Resources

- International Dyslexia Association (IDA)
 - <http://ida.org/>
- Decoding Dyslexia
 - <http://www.decodingdyslexia.net/>
 - #saydyslexia

See last few slides for additional resources



PA & phonological representations

- Testing phonological awareness is a robust measure of underlying phonological representations



Phonological Representations

spoken language
written &
blocks for
Building

The diagram consists of four overlapping horizontal bars. From top to bottom: a purple bar with 'spoken language', a yellow bar with 'written &', a green bar with 'blocks for', and a blue bar with 'Building'. The bars overlap such that 'spoken language' is above 'written &', 'written &' is above 'blocks for', and 'blocks for' is above 'Building'. The word 'Building' is larger and more prominent than the other text.

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Phonological Representations

- How phonological information – like speech sounds – is stored in long term memory

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Phonological Reps + SSD


- Underdeveloped in children with SSD (Catts & Larivee, 1999)
- May be difficult to access for children with SSD because working memory resources are limited
- May be the reason why some children with speech sound disorders experience difficulties with literacy and some do not.

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How could this affect reading?


- Learning decoding skills
 - Letter sound correspondence
- Learning sight words

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What is a sight word?


- The sight of the word immediately activates its pronunciation and meaning in memory
- To build sight words in memory, **orthographic mapping**, is required
- What is needed for orthographic mapping?

(Ehri, 2014)

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Orthographic Representations

- The storage of orthographic information in long term memory (Apel, 2011)
- Provides information regarding how to represent spoken language in written form.

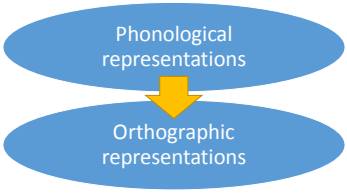
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Orthographic Mappings

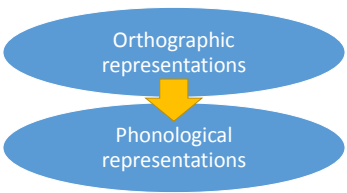
- Mappings from phonology to orthography occur early on in reading development.
- Parallel connections between orthography and phonology
 - Phonological awareness appears to provide extra support. (Nilsen & Bourassa, 2008)



PONY = BOLOGNA




COUGH=THROUGH= ROUGH = THOUGH



SSD and mapping

- Children with SSD often struggle to make the translation between phonology and orthography (Sutherland & Gillon, 2005).
- Long-term difficulties even after the sound is remediated (Farquharson, 2015; Felsenfeld et al.)
 - How will we know if there are strong phonological representations?

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SSD and Literacy

- Children with SSD were found to have poorer performance on the following tasks:
 - Phonological processing
 - Phonological learning
 - Phonological awareness
 - Word recognition
 - Letter knowledge**


• (Carroll & Snowling, 2004)

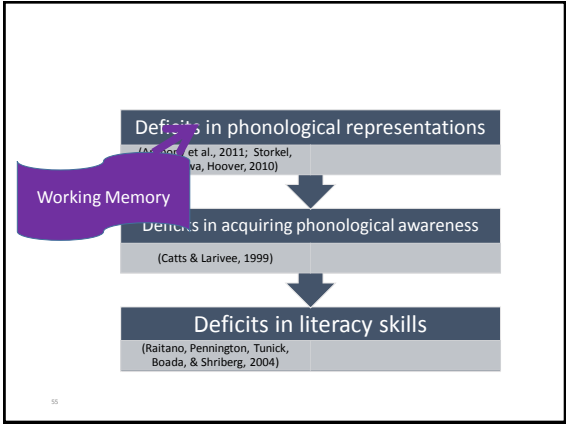
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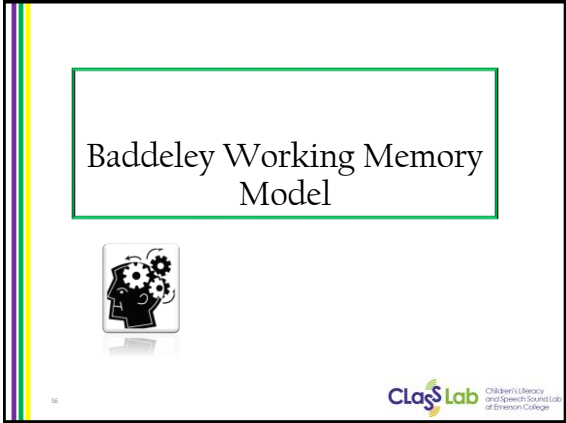


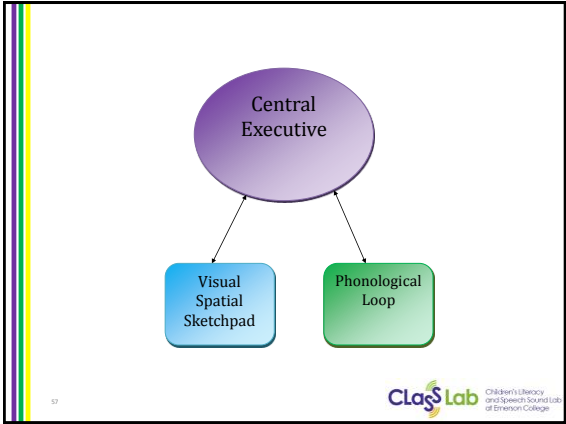
Does Working Memory play a role?

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Central Executive

- Allocates attentional resources to the appropriate subsystems (i.e., phonological loop or visual-spatial sketchpad)

• (Baddeley, 1992; Reisberg, 2010)


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Visual Spatial Sketchpad

- Stores visually presented information, such as pictures or words

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Phonological Loop

- Stores auditorily presented information, such as speech sounds

"...most involved in language processing and development"
(Hartmann, 2008, p. 1216)

Has a positive relationship with speech and language acquisition
(Adams & Gathercole, 2000)

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Phonological Loop and SSD

- 12-year old with remediated SSD had poor WM
 - Speidel (1993)
- Preschoolers with low WM had more speech errors than preschoolers with high WM
 - Nonword repetition
 - Adams and Gathercole (1995)
- Preschoolers with SSD had poor WM
 - Nonword repetition
 - Munson, Edwards, & Beckman (2005)



Research Question

Are there differences in the working memory skills of school-aged children with persistent SSD and typically developing children?



Method



Participants

<p>Persistent Speech Sound Disorder</p> <ul style="list-style-type: none"> • n = 20 (13 males) • M age = 112.3 months • M grade = 3.3 • GFTA M Standard Score = 80.5 • CTOPP M Standard Score = 91.6 	<p>Typically Developing</p> <ul style="list-style-type: none"> • n = 20 (10 males) • M age = 113.3 months • M grade = 3.3 • GFTA M Standard Score = 104.45 • CTOPP M Standard Score = 105.25
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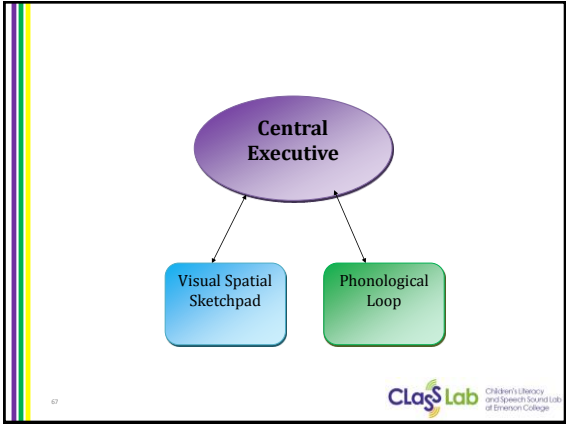
All Participants: Inclusionary Criteria

- Monolingual
- Normal hearing
- Normal vision (corrected)
- Normal non-verbal intelligence
 - Reynolds Intellectual Assessment Scales (RIAS)

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Experimental Tasks

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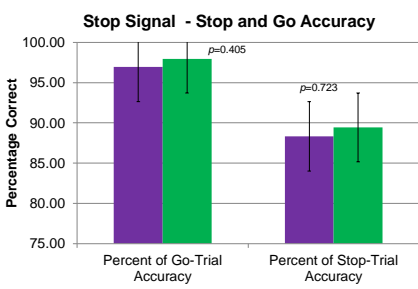
- Phonological Loop Tasks
- Sentence span task
 - Nonword repetition task
 - Henry Task

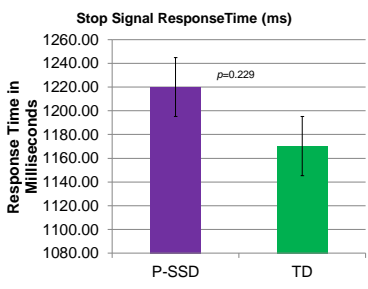


Research Question

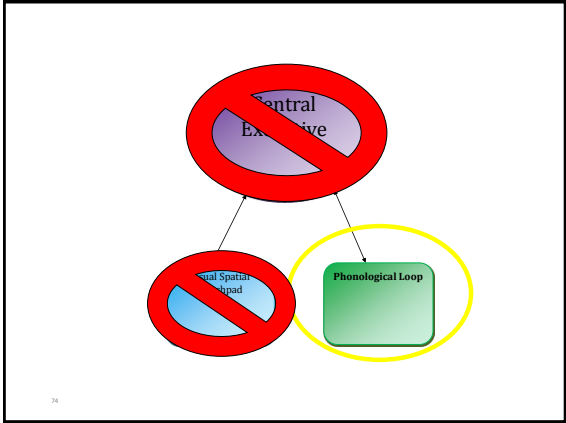
Are there differences in the working memory skills of school-aged children with persistent SSD and typically developing children?







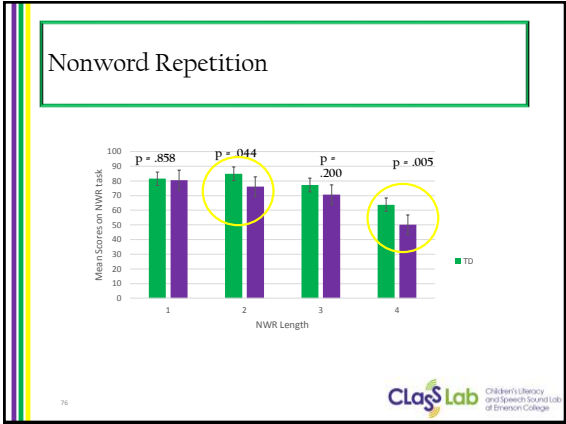


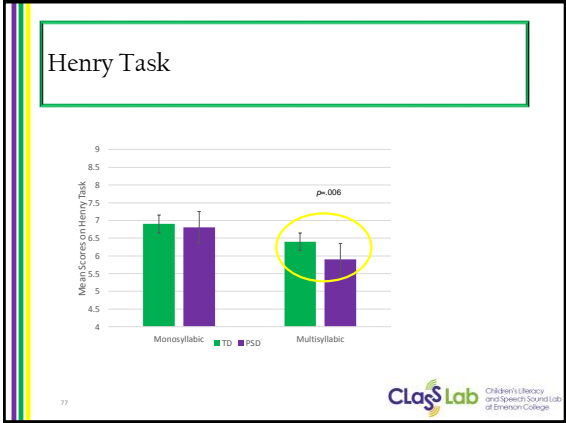


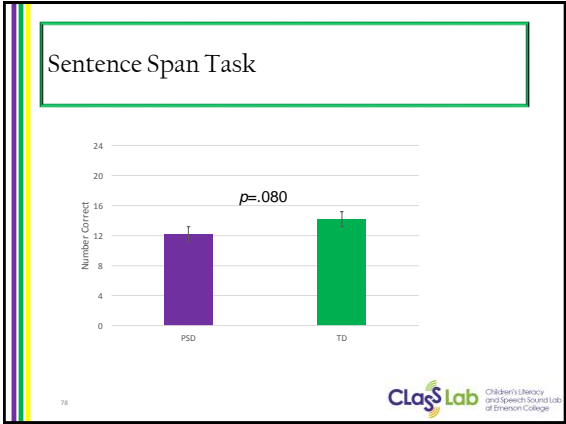
Tasks used for Analysis

- Phonological Loop:
 - NWR ✓
 - Henry Task ✓
 - Sentence Span ✗

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Conclusions

- Children with P-SSD appear to have deficits specific to the phonological loop of working memory
- Specifically, children with P-SSD struggle with complex word structures (e.g., multisyllabic words; longer lists of words)
- Indicates limited phonological representations as well as limited working memory

Results Summary

- Children with persistent SSD performed poorer than peers on phonological working memory tasks... BUT
- This relation was mediated by their nonverbal IQ scores (not vocabulary)
- It is not common place to test nonverbal IQ in children with SSD, but it may have predictive value for working memory and literacy skills

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What about after dismissal?

Preparation or Educational Issues
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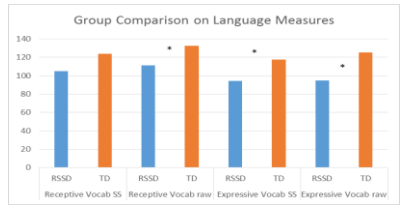
After Dismissal: Examining the Language, Literacy, and Cognitive Skills of Children With Remediated Speech Sound Disorders

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Disclosure: Financial: Kelly Farquharson has no financial interests to disclose.
Nonfinancial: Kelly Farquharson has no nonfinancial interests to disclose.

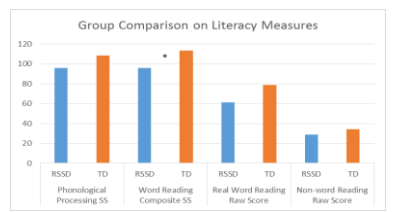
- <http://sig16perspectives.pubs.asha.org/Article.aspx?articleid=2240012>

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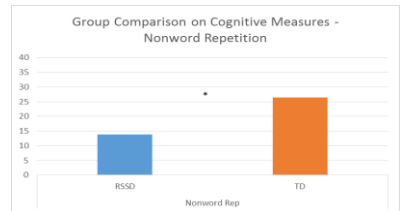
Language Measures



Literacy Measures



Nonword Repetition



Assessment Implications

- Test phonological awareness in all SSD evaluations
- Test PA using both expressive and receptive measures
 - (see the Comprehensive Test of Phonological Processing- 2nd Edition [CTOPP-2] for a possibility)
- Obtain material from preschool/ classroom teachers regarding decoding, phonological awareness, or spelling skills
- Screen early and often; and don't screen "just" for speech sound production



Treatment Implications

- Include phonological awareness
- Try minimal pairs
- Include reference to orthography
- Partner with reading specialists and special educators
- Push in to the classroom
- Use curriculum based vocabulary



Clinical Implications

- Children with SSD will likely have poor phonological representations
- SLPs are on the front lines of defense for these children
 - Early SSD and language impairments put children at risk for later literacy deficits... EVEN IF the issue has remediated
- Be mindful of the warning signs and open to collaboration or consultation



Thank you!

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Suggested Assessments

- **Comprehensive Test of Phonological Processing – 2nd Edition (CTOPP-2;** Wagner, Torgesen, Rashotte, & Pearson, 2009)
 - Measures phonological processing – skills needed for word reading/ decoding
 - Ages 4:0 – 24:11
 - **Subtests:** Elision, Blending, Sound Matching, Phoneme Isolation, Blending Nonwords, Segmenting Nonwords, Memory for Digits, Nonword Repetition, Rapid Digit Naming, Rapid Letter Naming, Rapid Color Naming, and Rapid Object Naming
- **Woodcock Reading Mastery Test – 3rd Edition (WRMT-3;** Woodcock, 2011)
 - Measures most aspects of reading – decoding and its related skills & comprehension and its related skills
 - Ages 4:6 – 79:11
 - **Subtests:** Phonological Awareness, Listening Comprehension, Letter Identification, Word Identification, Rapid Automatic Naming, Oral Reading Fluency, Word Attack, Word Comprehension, Passage Comprehension



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Suggested Assessments (continued)

- **Reynolds Intellectual Assessment Scales – 2nd Edition (RIAS-2;** Reynolds & Kamphaus, forthcoming)
 - Measures nonverbal and verbal intelligence (provides IQ score)
 - Ages 3-94
 - **Subtests:** Guess What, Odd-Item Out, Verbal Reasoning, What's Missing, Verbal Memory, Nonverbal Memory, two new speeded processing subtests
- **Kaufman Brief Intelligence Test – 2nd Edition (KBIT-2;** Kaufman & Kaufman, 2004)
 - Measures nonverbal and verbal intelligence (provides IQ score)
 - Ages 4:0 – 90:0
 - **Subtests:** Verbal Knowledge, Riddles, and Matrices




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Helpful websites

- Classlab.emerson.edu
- www.facebook.com/classlabemerson
- [Florida Center for Reading Research](#)
- [International Dyslexia Association](#)
- [ASHA Practice Portal for SSD](#)
- [What Dyslexia Is and Is Not](#)
- [Classroom accommodations for dyslexia](#)
- [Speech Bite](#)
- [Decoding Dyslexia](#)
- [International Literacy Association](#)
- [Use IPA on any website/ email/ document](#)

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