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Speech Perception and Reading Disabilities in Individual Children

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Phononological *Awareness (PA)*

- One of 5 pillars of children's success in in reading (National Reading Panel, 2000)
  - At least 3 decades of supporting research
  - For a recent review, see Kamhi and Catts (2012)

Speech Perception

- Speech Perception (SP) refers to the auditory (sensory) processing of speech sounds
  - Occurs earlier in the speech processing stream than PA
  - The *phonetic* rather than *phonemic* level of receiving the speech signal

- Does not require conscious awareness, judgment, or manipulation of individual phonemes within words

- We posit that SP is reflected in a child's ability to:
  - Discriminate whole nonsense syllables that differ by a consonant or vowel onset or offset
  - Identify whole nonsense syllables that contain particular consonants and vowels

- Some studies have shown that auditory temporal processing problems and/or difficulty perceiving speech sounds may be associated with problems in learning speech and language
  - Merzenich et al. (1996)
  - Rosen (2003)
  - Ziegler et al. (2005).

- Conceivably such problems could create even more difficulty in reading
  - Particularly when trying to learn printed symbols for sounds never quite discriminated or learned well.

- Consequently, we reasoned that RD might also be associated with speech perception difficulties
  - See Rosen, 2003, for a thoughtful discussion of the issues related to the link between auditory or speech perception and SLI or RD.

Recent Studies: Speech Perception in Children with Reading Disabilities (RD)

- Ziegler et al. (2009)
  - Children 8 to 12 years old
  - 19 dyslexic, 18 CA controls, 19 Reading Age (RA) Controls
  - French
  - 3 examples of each of 16 Cs in natural VCV syllables
  - In quiet and with speech-shaped noise
- Children with dyslexia had speech perception problems for “place” (even more than RAs)

- Messaoud-Galusi et al. (2011)
  - Children 6 to 13 years old
  - 62 children with dyslexia, 51 average readers
  - English
  - Categorical perception and 2-alternative forced choice tasks: “bee” – “pea” (highly natural, synthetic syllables)
  - In quiet and with 20-talker babble
- Most children with dyslexia showed no consistent deficit in speech perception

- White-Schwoch et al. (2015, July)
  - Children 8 to 14 years old
  - 26 with an LD diagnosis, 29 controls
  - American English (Chicago)
  - A synthesized [da] syllable with multitalker babble
  - A neurolinguistics study: electrodes were placed on the scalp
- Children with LD perform more poorly on this task: an early red flag, predictive of later reading problems

Significance of the Present Study

- Cf. Ziegler et al. (2009); Messaoud-Galusi et al. (2011); and White-Schwoch et al. (2015)
  - Comprehensive examination of all the Cs of English, as well as inclusion of all the Vs of English, spoken by multiple talkers (natural tokens)
  - In quiet rather than with speech-shaped or multi-talker noise (to preserve acoustic cues)

- We systematically examined speech perception for a large set of speech sounds (39 sounds) in 11 children with a history of reading problems and varying reading profiles.

Research Questions

1. Do children with RD confuse consonants and vowels more often than children without such reading difficulties?

2. Which measures of cognition, reading, speech, language, and phonological awareness are most closely related to speech perception in children with and without reading disabilities?

Method

Participants

Group with Reading Disabilities (RDs)

- 11 children (7 girls) with RDs
- In 3rd through 5th grades
- 8;4 to 10;8 years old

  M age = 9;6
- Attended weekly reading lessons at a private, nonprofit reading center.

Group with Reading Disabilities (RDs)

Child	Gender	Age	Grade	Race/Ethnicity
Alina	F	10;8	4th	Afric Am
Angela	F	9;0	3rd	Afric Am
Edward	M	8;5	Rep. 2nd, Home-Sch	Eur Am
Latisha	F	8;5	3rd	Afric Am
Laura	F	9;11	4th	Eur Am
Noreen	F	9;10	3rd	Afric Am
Shauna	F	10;1	4th	Afric Am
Tony	M	9;0	3rd	Eur Am
Teddy	M	8;4	3rd	Latino Am
Tina	F	10;4	4th	Afric Am
Matt	M	10;5	4th	Afric Am
Mean		9;6		

Reading Control Group (RCs)

- Served as comparison participants
  - No history of reading difficulties or any remedial services for reading.
- 6 children (2 girls)
- In 3rd through 5th grades
- 8;9 to 11;4 years old

  M age = 10;4

Reading Control Group (RCs)

Name	Gender	Age	Grade	Race/Ethnicity
Anton	M	11;4	5th	Asian Indian Am
Bob	M	9;10	3rd	Eur Am
Carly	F	8;9	2nd	Eur Am
Evan	M	11;6	5th	Eur Am –Pakistani Am
Joanna	F	10;3	4th	Eur Am
Mitchel	M	10;6	4th	Eur Am
Mean		10;4		

Assessment Battery

- Standardized tests, subtests, or other assessments

Assessment Battery for Reading

1. *Woodcock Reading Mastery Tests-Revised (WRMT-R)*
   a. *Word Identification* subtest (WI)
   b. *Word Attack* subtest (WA)
2. *Gray Oral Reading Test, 4th Edition (GORT-4)*
   a. *Fluency* score (R-FLU)
   b. *Comprehension* score (R-COMP)

Reading Scores for 2 Reading Ability Groups

	WI	WA	R-FLU	R-COMP
Reading Control Group				
Mean	112.33	112.83	14.50	14.33
SD	(10.46)	(7.94)	(4.32)	(2.58)
Reading Disability Group				
Mean	90.00	90.89	6.67	8.22
SD	(8.59)	(8.18)	(2.45)	(3.31)

Note. WI, WA = Standard Scores (or Quotients; Mean = 100, SD = 15). R-FLU, R-COMP = Scaled Scores (Mean = 10, SD = 3).

- As expected, the two groups differed significantly on reading abilities
  - R-COMP ($p < .01$)
  - WI, WA, R-FLU ($p \leqq .001$)

Assessment Battery for Hearing, Cognition

1. Hearing screening
2. Nonverbal cognition: *Kaufman Brief Intelligence Test (KBIT-M)*
   a. *Matrices* subtest

Assessment Battery for Speech-Language

1. *Peabody Picture Vocabulary Test, 3rd Edition (PPVT-III)*

2. *Clinical Evaluation of Language Fundamentals-4 (CELF-4)*
   a. *Concepts and Following Directions* subtest (CFD)
   b. *Recalling Sentences* subtest (RS)

3. *Goldman-Fristoe Test of Articulation-2 (GFTA-2)*

4. *Dollaghan and Campbell's (JSLHR, 1998) Nonword Repetition Task (NRT)*

5. *Comprehensive Test of Phonological Processing (CTOPP)*

6. Language sample

Cognitive, Speech, and Language Assessment Battery for Two Reading Ability Groups

	KBIT-M	PPVT-III	CFD	RS	GFTA-2	NRT
Reading Control Group						
Mean	119.50	119.67	12.00	12.67	104.00	0.92
SD	(8.89)	(15.85)	(1.55)	(1.86)	(1.67)	(0.04)
Reading Disability Group						
Mean	102.00	94.44	7.44	8.00	98.67	0.80
SD	(13.91)	(16.57)	(2.88)	(2.00)	(8.99)	(0.12)

Note. SD = Standard Deviation. KBIT-M, PPVT-III, GFTA-2 = Standard Scores (or Quotients; Mean = 100, SD = 15). CFD, RS = Scaled Scores (Mean = 10, SD = 3). NRT = proportion of items correct.

- As expected, the two groups differed significantly on all scores except the articulation (GFTA-2) score.
- KBIT-M, PPVT-III, NRT ($p < .05$)
  - All children had nonverbal IQ scores ≥ 85 on the KBIT-M, however, indicating nonverbal intelligence in the normal range
- CFD ($p < .01$)
- RS ($p \leqq .001$)

2 Experimental Tasks

Syllable Confusion Oddball Task (SCO)

- A nonsense syllable discrimination task
- 10 hourly sessions (once or twice a week)
- In approximately 10-min. blocks, with 5 min. of playtime between each block
- To determine which of 24 consonants and 15 vowels caused confusion errors for a child

- The child listened over headphones to a random sequence of 3 nonsense CV or VC syllables
  - Spoken by 3 different talkers from a set of 18 professionally recorded talkers (Fousek et al., 2004); e.g.:
    - [dɑ] (Voice 1) – [dɑ] (Voice 2) – [fɑ] (Voice 3)

- 2 of the 3 stimuli were the same;
- 3rd stimulus differed in either its C or V.
- The contrast and speaker was randomly chosen by the computer program, from the pre-recorded nonsense syllable database.

- Stimuli were presented over headphones
  - Via a laptop computer
  - At a comfortable listening level for the child

- The child indicated the odd syllable, by pointing to a building block with a 1, 2 , or 3 printed on top of the block.
- Child could indicate that he or she wanted to hear the trial again (as many times as requested
  - By pointing to a white “Repeat” button.

SCO

- The number of trials varied per sound:

  Mean = 41.0 (SD = 15.1) trials per sound.
- A purely perceptual task (no syllable segmentation or speech production required)

Nonsense Syllable Confusion Matrix Task (NSCM)

- A speech identification task
- Same CV and VC stimuli as the SCO Task
- To determine each participant's accuracy and particular confusions for the same target Cs and Vs.
    - Only 1 syllable presented at a time; child simply imitated it.

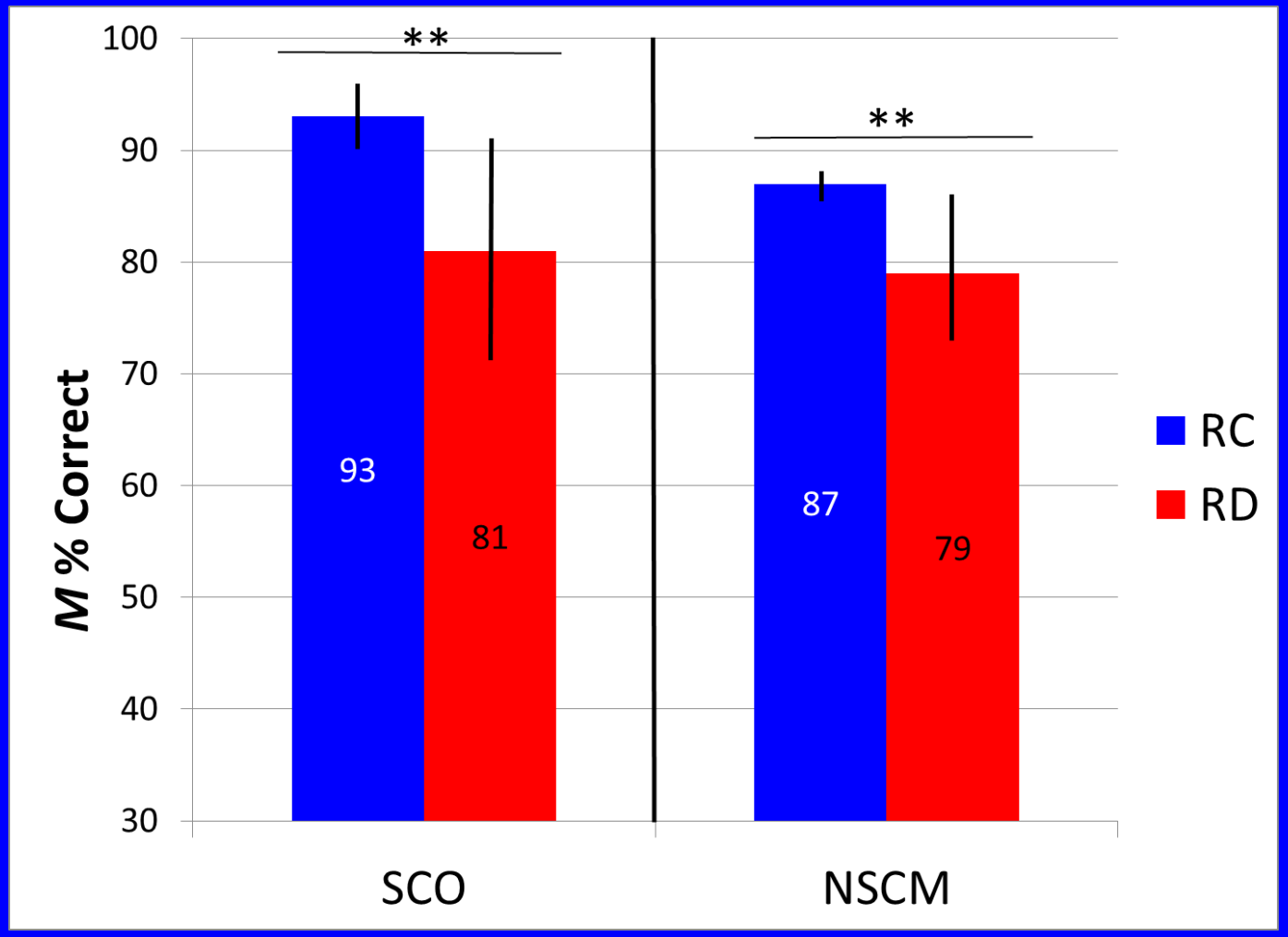
- Responses were entered into the laptop computer by one examiner.
- Transcribed phonetically (in the International Phonetic Alphabet) by a second examiner.
- Because of random presentation, the number of trials varied per sound.
    - *M* = 68.2 trials (*SD* = 10.5)

Results

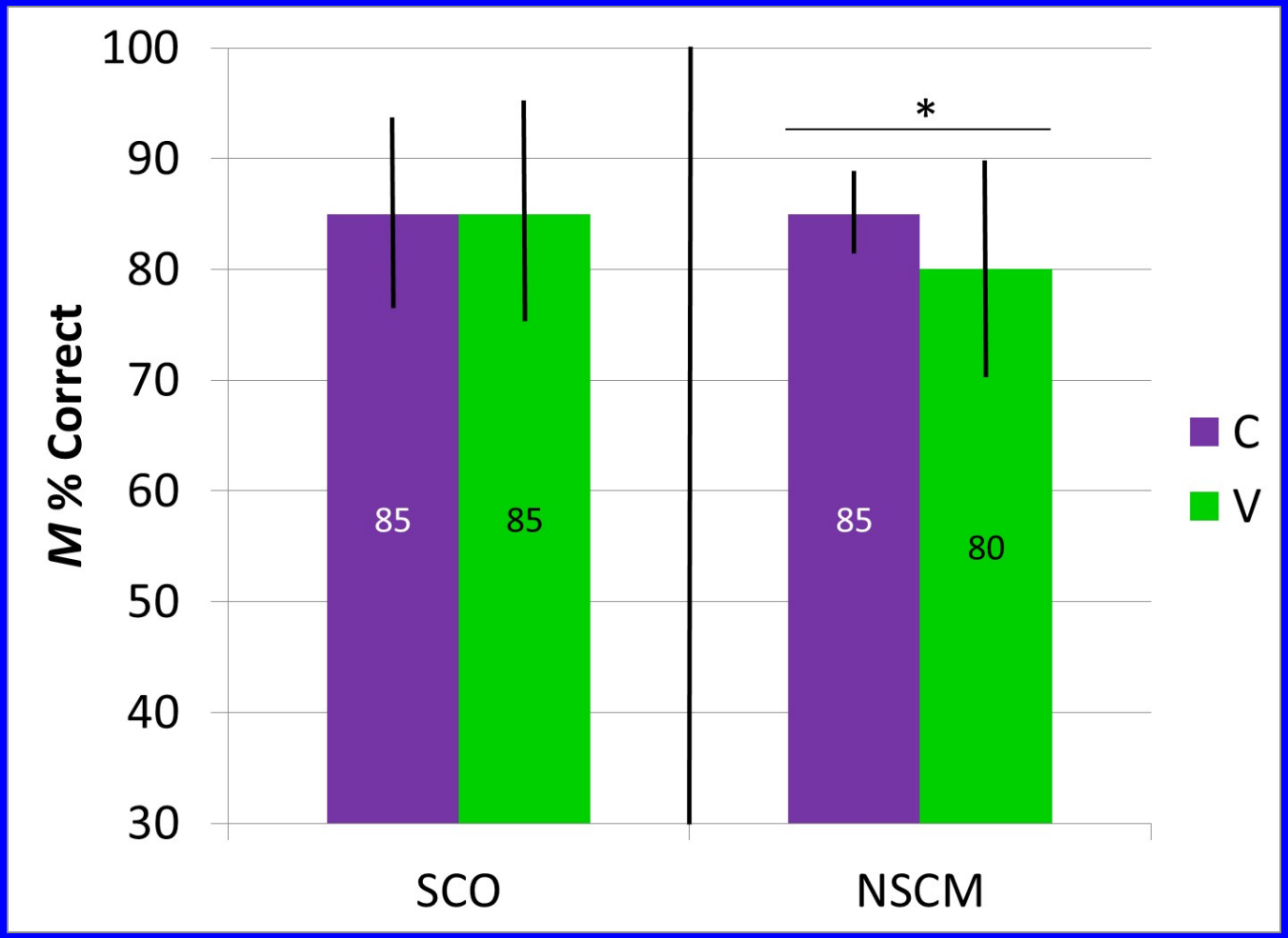
Repeated Measures ANOVA

- % correct scores on the two speech perception measures were arcsin transformed
- Repeated Measures ANOVA:
  - 1 Between
    1. Group: RD and RC
  - 2 Within
    1. Sound Type: Consonant vs. Vowels
    2. Syllable Position: Initial vs. Final

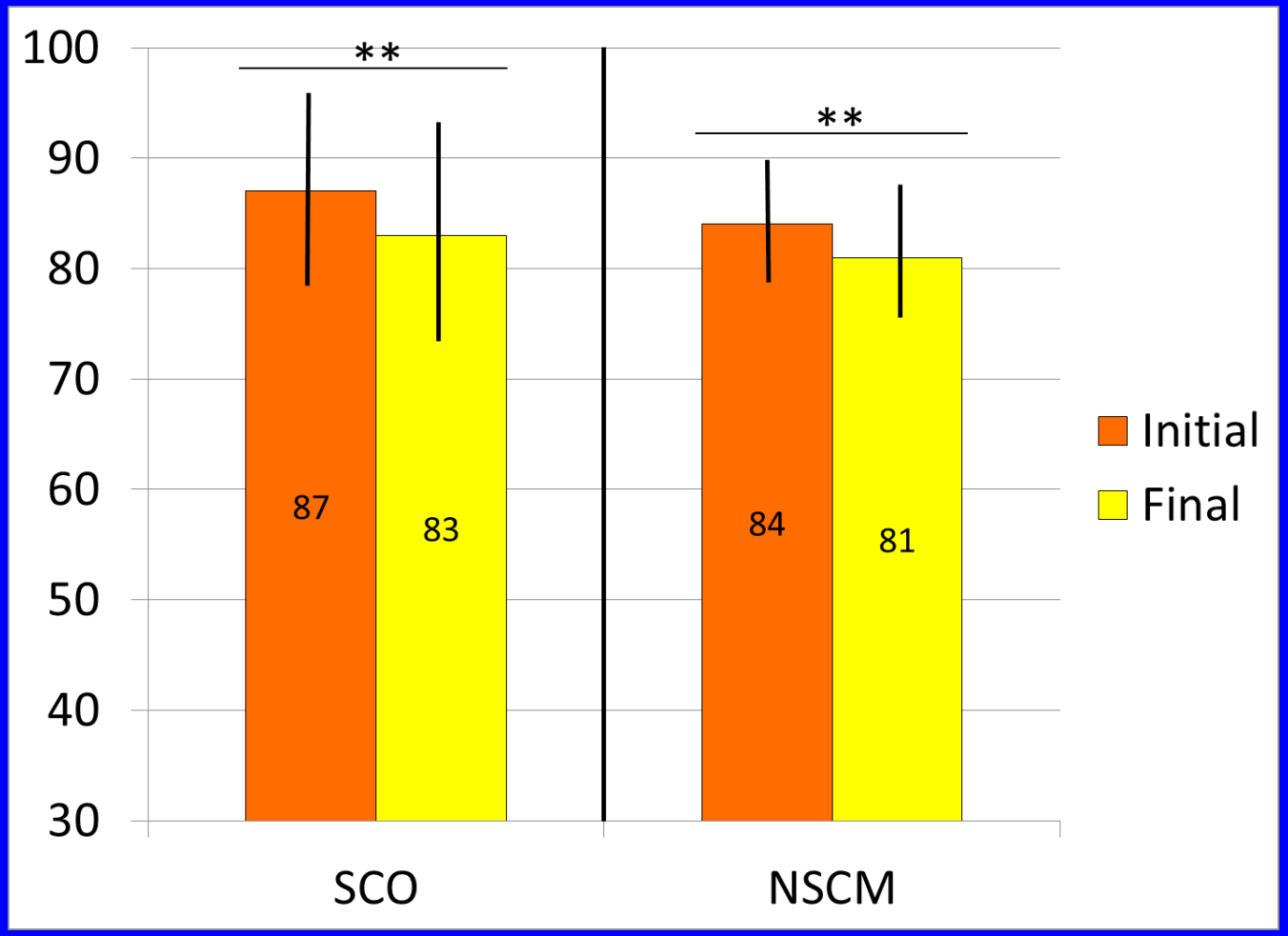
Group Main Effects



Sound Type Main Effects



Syllable Position Main Effects



SCO Task Results

- RC > RD**
  - F (1, 15) = 9.48, p < .01
- Consonants vs. Vowels (NS)
  - not significant
- Initial > Final syllable position**
  - F (1, 15) = 10.41, p <.01
- All interactions of factors (NS)

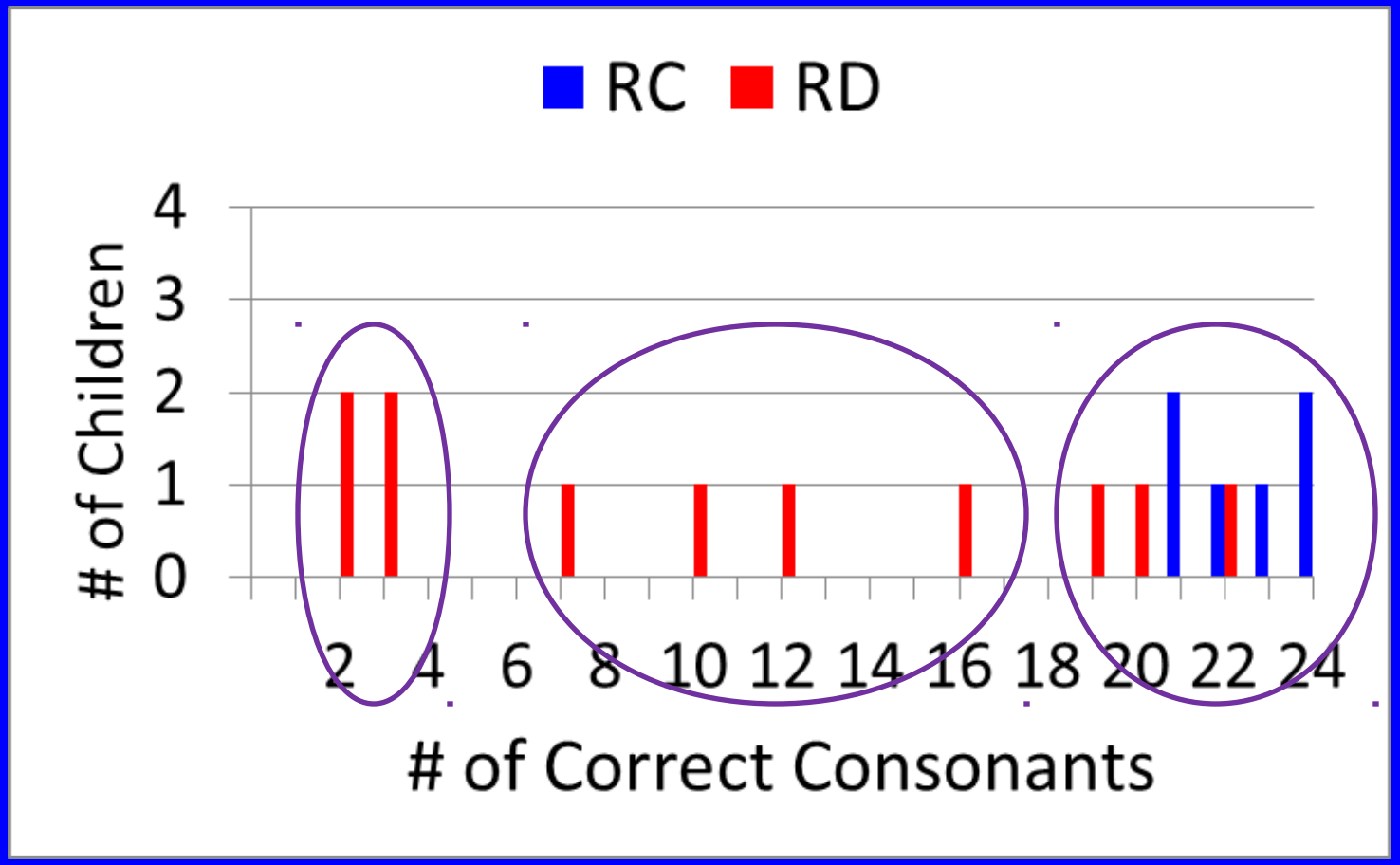
NSCM Task Results

- RC > RD**
  - F (1, 13) = 9.34, p <.01
- Consonants > Vowels*
  - F (1, 13) = 5.86, p <.05
- Initial > Final syllable position
  - F (1, 13) = 9.68, p <.01**
- All interactions of factors (NS)

SCO: Sounds Perceived Well

- All individuals had some sounds for which the perceptual accuracy was 85% or higher, demonstrating that all the RDs could do the task:
- The RCs had good perception of nearly all sounds.
  - In contrast, the RDs ranged from good perception of nearly all sounds to difficulties with many sounds.

SCO: Number of Consonants Perceived Well (≥ 85% correct)



SCO
Consonants Perceived Well

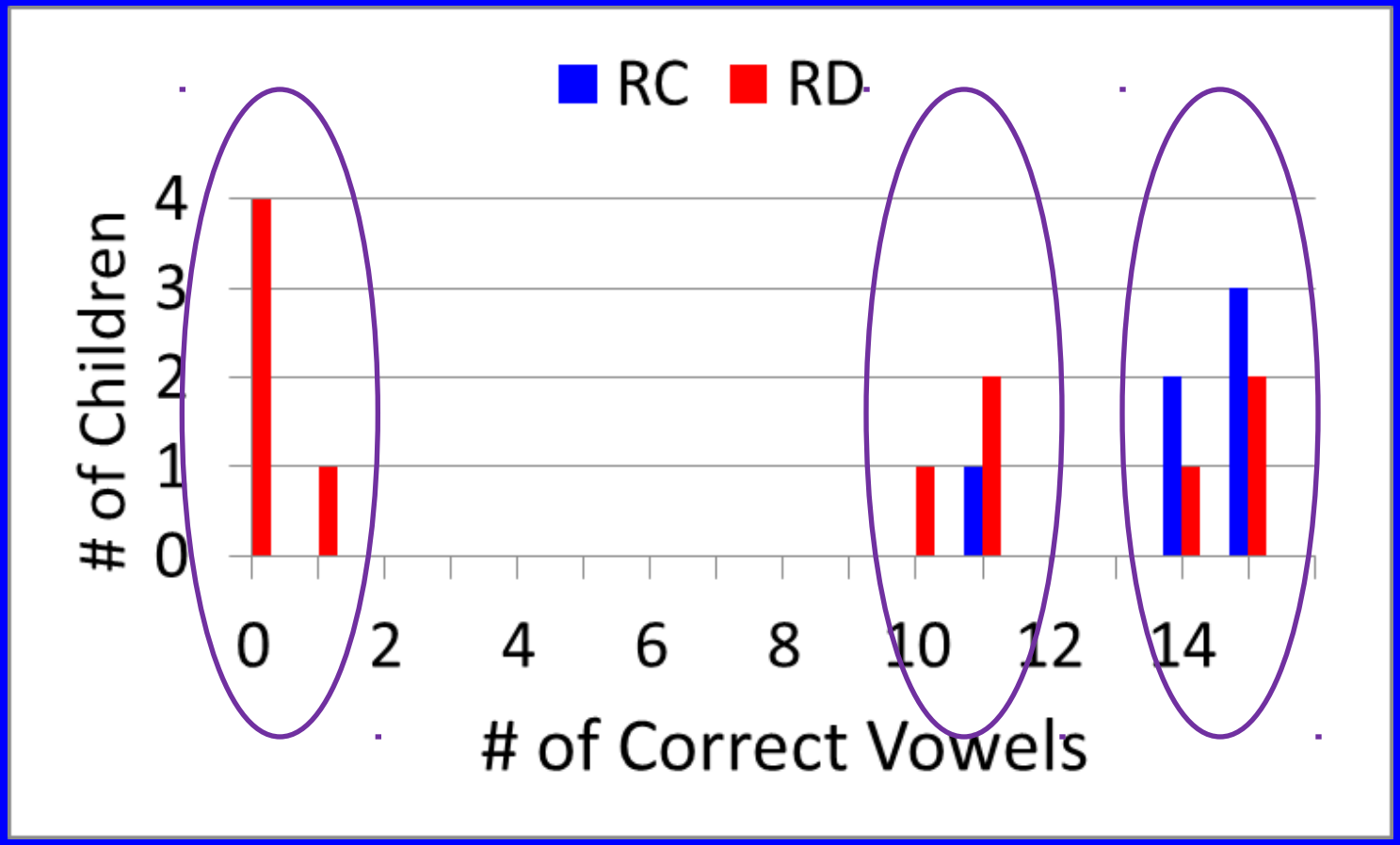
- 7 or 8 of the 11 RD children perceived 5 consonants well (≥ 85% correct):

  /ʒ, h, n, w, r/

  - Only the 4 lowest performing children in the RD group had difficulty with these 5 consonants.
  - Alina, Angela, Latisha, Tony (perhaps Edward)

- Suggests that difficulty with these 5 consonants might be a red flag and possible quick screening for perceptual difficulties in RD.
- All the RC children perceived these well.
  - RCs perceived nearly all other consonants well.

SCO: Number of Vowels Perceived Well (≥ 85% correct)



SCO
Vowels Perceived Well

- 6 of the 11 RD children perceived 7 vowels well (≥ 85% correct):

  / i, u, ɔ, ɝ, aʊ, aɪ, ʌ /

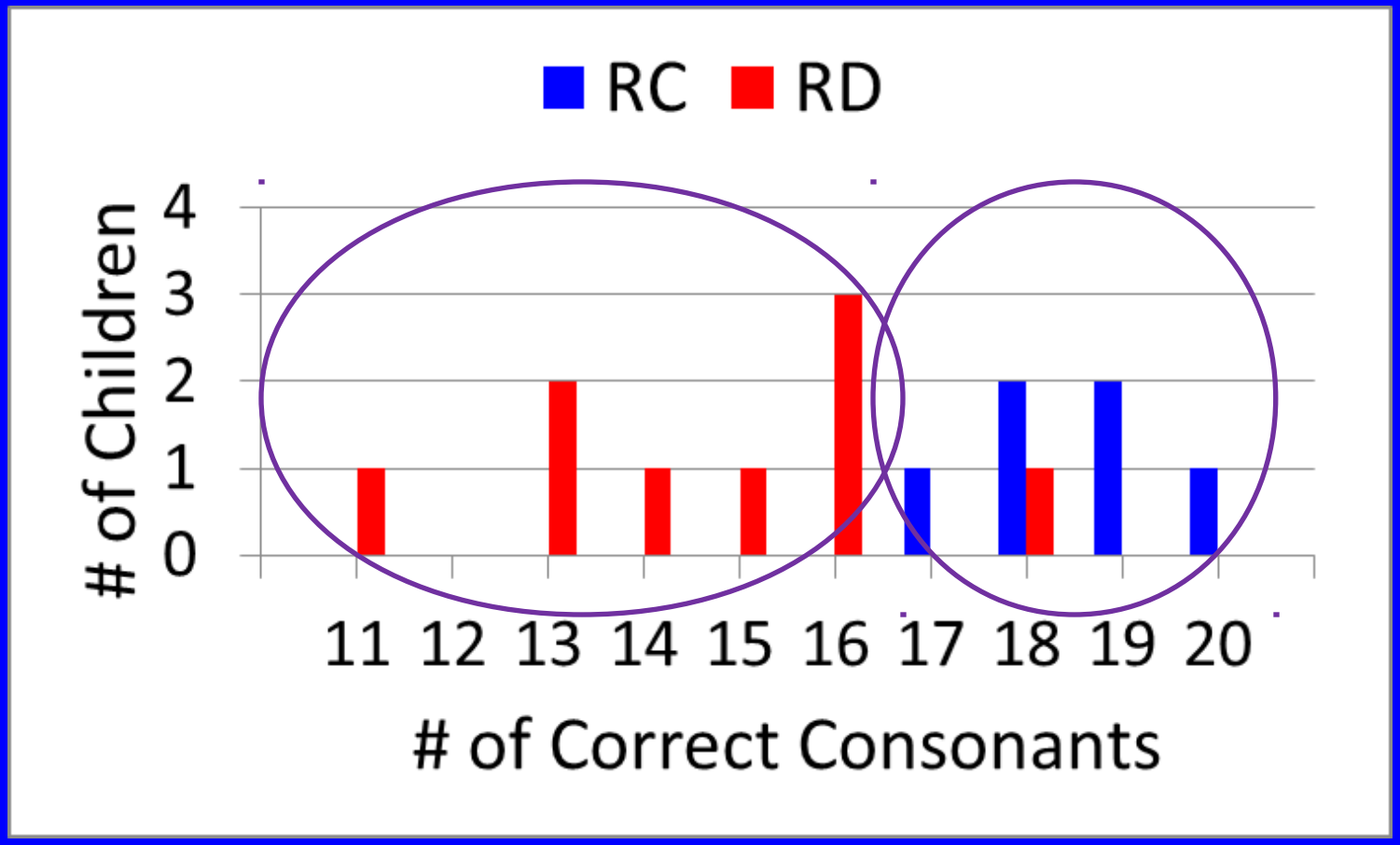
- 5 RD children had no vowels (or only 1) ≥ 85% correct:
  - Alina, Edward, Latisha, Norene, Tony

- 4 of the 6 RC children perceived these 7 vowels well.
  - 2 RCs perceived 6 of the 7 vowels well.
  - RCs perceived nearly all other vowels well.

NSCM
Sounds Perceived Well

- All participants had many sounds for which accuracy was ≥ 85%, demonstrating that they could do the task.

NSCM: Number of Consonants Perceived Well (≥ 85% correct)



NSCM
Consonants Perceived Well

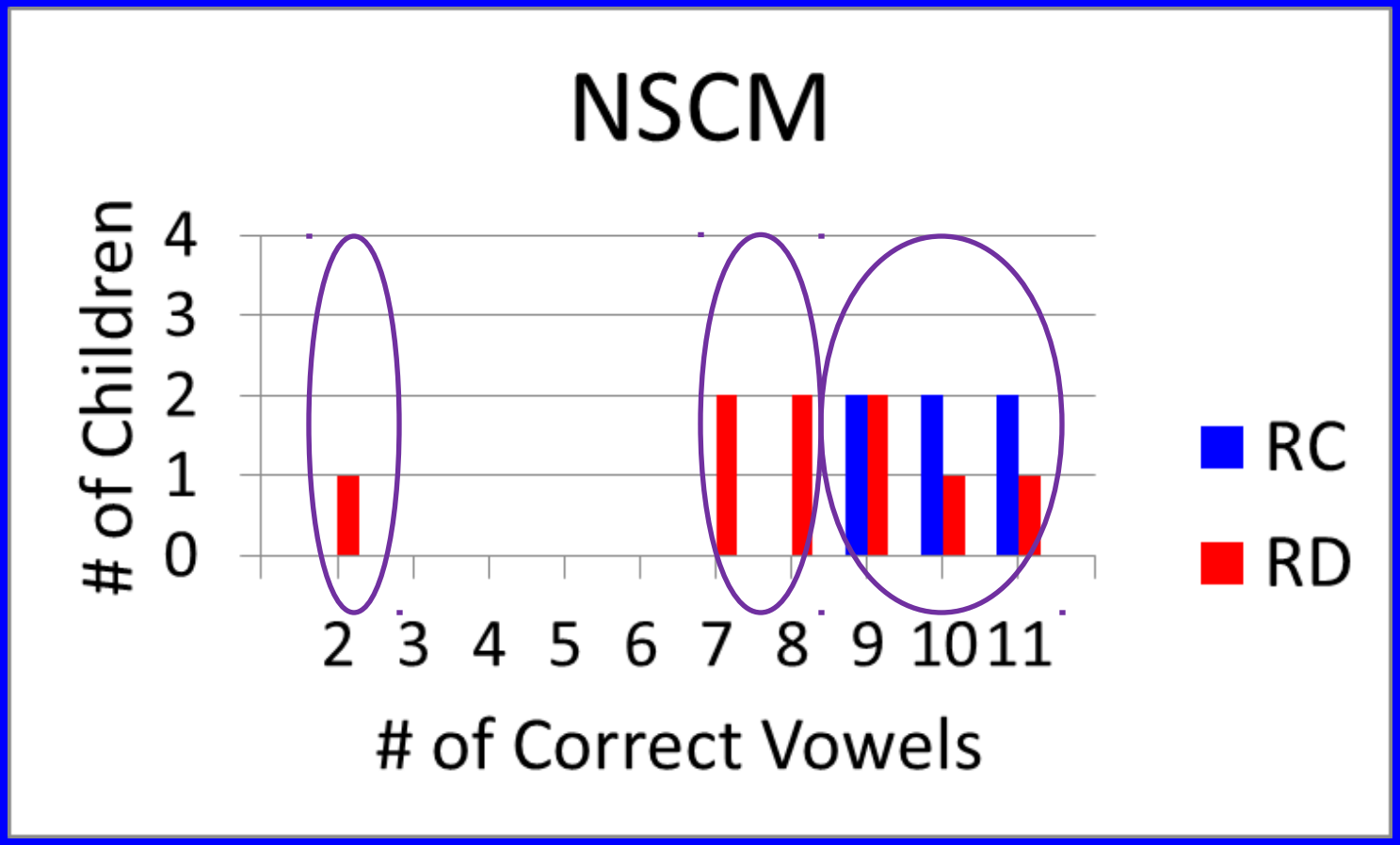
- All the RD children perceived 4 consonants well (≥ 85% correct):

  /k, d, ʧ, w/

- All the RC children perceived these well.
  - RCs additionally perceived 10 other consonants well:

    / p, t, g, s, ʃ, ʤ, h, m, n, j/

NSCM: Number of Vowels Perceived Well (≥ 85% correct)



NSCM
Vowels Perceived Well

- 8 or 9 of the RD children perceived 6 vowels well (≥ 85% correct):

  / i, e, u, o, ɔɪ, aɪ/

  - All RDs perceived /u/) well
  - 8 RDs perceived the other 5 vowels well
  - One child with RD (Laura) only perceived / i, u / well.

- All the RC children perceived these 6 vowels well.
  - RCs additionally perceived 2 other vowels well: /ɝ, aʊ/

NSCM
Speech Sound Confusions

- Errors ≥ 10%
- by individual child in the RD group

Consonants

Laura
C

- 23 confusion patterns
  - For 12 Cs

Laura (RD)	Stop	Fricative	Affricate	Nasal	Liquid
Targets Confused	/g/	/f, v, θ, ð, s, z, ʒ/	/dʒ/	/n, ŋ/	/r/
Syll. Initial		f → v, θ, ð		n → m	
		v → b, f, θ			
		θ → ð			
		s → θ			
Syll. Final		v → s		n → ŋ	r → l
		ð → v		ŋ → n, m	
		z → s			
		ʒ → dʒ			
Both	g → k	v → ð	dʒ → ʧ		
		θ → f			
		ð → θ			
		ʒ → ʃ			
Conf. Types	1	16	1	4	1

Angela C

- 20 confusion patterns
  - For 10 Cs

Angela (RD)	Stop	Fricative	Affric.	Nasal	Liquid
Targets Confused	/b/	/v, Θ, ð, z, ʒ/	/dʒ/	/n, ŋ/	/l/
Syll. Initial		v → b			
		Θ → ð, s			
		ð → l			
		ʒ → ʃ, dʒ			
Syll. Final	b → p	ð → z		n → ŋ	l → d
		ʒ → z		ŋ → n, m	
Both		v → f, ð	dʒ → ʧ		
		Θ → f			
		ð → Θ, v			
		z → s			
Conf. Types	1	14	1	3	1

Edward C

- 17 confusion patterns
  - For 9 Cs

Edward (RD)	Stop	Fricative	Affric.	Nasal	Liquid
Targets Confused		/f, v, θ, ð, s, z, ʒ/	/ʧ/	/m/	/r/ misartic.
Syll. Initial		f → v			
		v → ð, l			
		θ → ð			
		ð → θ, d			
Syll. Final		f → θ	ʧ → ʤ	m → n	
		θ → s			
		z → s, ʤ			
Both		θ → f			
		ð → v			
		s → ʃ			
		z → ʒ			
		ʒ → ʤ			
Conf. Types	0	15	1	1	N.A.

Alina
C

- 21 confusion patterns
  - For 15 Cs

Alina (RD)	Stop	Fricative	Affric.	Nasal	Liquid
Targets Confused	/p, t, g/	/f, v, Θ, ð, z, ʃ, ʒ/	/ʧ, ʤ/	/m, n, ŋ/	
Syll. Initial		f → v	ʧ → ʤ		
		Θ → ð			
Syll. Final	p → t	f → Θ	ʤ → ʧ	m → ŋ	
	t → p, ʧ	ð → f		n → m, ŋ	
	g → k	z → s		ŋ → m	
		ʒ → ʃ			
Both		v → f			
		Θ → f			
		ð → v			
		ʃ → ʧ			
		ʒ → ʤ			
Conf. Types	4	11	2	4	0

Consonant Features Confused

RD Group	Voice	Place	Manner
Laura	11	13	2
Angela	8	11	4
Edward	5	12	4
Alina	9	11	3

Vowels

Laura
V

- 28 confusion patterns
  - For 12 Vs

Laura (RD)	Tense	Lax	Low Back	Diphthong	Rhotic
Targets Confused	/o/	/ɪ, ɛ, æ, ʌ, ʊ/	/ɔ, ɑ/	/aɪ, aʊ, ɔɪ/	/ɝ/
Syll. Initial	o → u	ʊ → ɔɪ, ɝ	ɑ → aɪ	aʊ → ʌ, aɪ	
			ɔ → o	aɪ → ɔ, e	
Syll. Final		æ → aʊ			
		ʌ → aʊ			
		ʊ → æ, aʊ			
Both		æ → ɛ, ɑ	ɑ → aʊ	ɔɪ → ʌ	ɝ → ɛ
		ʌ → æ	ɔ → ɑ, aʊ, aɪ	aʊ → ɝ	
		ɛ → ɪ		aɪ → ʊ	
		ɪ → e			
		ʊ → u, ʌ			
Conf. Types	1	13	6	7	1

Angela V

- 18 confusion patterns
  - For 9 Vs

Angela (RD)	Tense	Lax	Low Back	Diphthong	Rhotic
Targets Confused	/i, o/	/ɪ, ɛ, æ, ʊ/	/ɔ, ɑ/	/aʊ/	
Syll. Initial	o → u	ʊ → u	ɑ → ɔ	aʊ → æ, ɛ	
Syll. Final		æ → ʌ		aʊ → o	
		ɛ → æ, ʌ			
		ʊ → æ, aʊ			
Both	i → ɪ	æ → ɛ	ɑ → ʌ		
		ɪ → ɛ	ɔ → ʌ, ɑ		
		ʊ → ʌ			
Conf. Types	2	9	4	3	0

Edward V

- 15 confusion patterns
  - For 9 Vs

Edward (RD)	Tense	Lax	Low Back	Diphthong	Rhotic
Targets Confused	/i, e/	/ɪ, ɛ, æ, ʌ, ʊ/	/ɔ, ɑ/		/ɝ/ misartic.
Syll. Initial	e → ɪ	ʌ → o	ɔ → ʌ		
	i → ɪ	ʊ → u			
Syll. Final		ʌ → ʊ	ɔ → o		
		ɛ → ʌ			
		ɪ → ʊ			
Both		æ → ɛ	ɑ → ʌ, ɔ		
		ɛ → æ			
		ɪ → ɛ			
		ʊ → ʌ			
Conf. Types	2	9	4	0	N.A.

Alina
V

- 9 confusion patterns
  - For 6 Vs

Alina (RD)	Tense	Lax	Low Back	Diphthong	Rhotic
Targets Confused		/ɪ, ɛ, æ, ʊ/	/ɔ, ɑ/		
Syll. Initial					
Syll. Final		æ → ɛ	ɑ → ʌ, ɔ		
		ɛ → æ, ɪ	ɔ → ʌ, ɑ		
		ɪ → ɛ			
		ʊ → ʌ			
Both					
Conf. Types	0	5	4	0	0

Vowel Features Confused

RD Group	Height or Front-Back	Tense -Lax	Schwa	Rhotic	Diphthong	Round
Laura	8	5	5	2	15	14
Angela	7	2	5	0	3	4
Edward	7	3	6	N.A.	0	6
Alina	6	0	3	0	0	4

Discussion and Conclusions

Groups, Sounds Types, and Syllable Position

1. Children with reading disabilities perform worse than children with typical reading on 2 speech perception tasks for nonsense syllables:
   a. On both an oddball discrimination task (SCO) and a single-syllable identification task (NSCM).
   b. Despite the fact that that the identification task simply required immediate imitation.

2. Some children with RD appear to have substantial short-term, auditory memory challenges, as demonstrated by poor perception on an oddball task (SCO).
    2. 4 of the 11 children with RD (Alina, Latisha, Edward, and Tony) performed more than 10 percentage points below the other RD and RC children.

3. Vowels are more difficult than consonants for all children to perceive (whether RCs or RDs), but only on the single-syllable identification task (NSCM).
   - This appears to be due to the identification of lax vowels, rather than tense ones.

4. All children (whether RCs or RDs) have more difficulty with the perception of speech sounds in syllable-final position, compared to syllable-initial position.
    a. Regardless of the nature of the task: oddball discrimination (SCO) or identification (NSCM).

Speech Sound Targets and Confusion Patterns

5. Nearly all children perform well above chance for most speech sounds on the oddball discrimination task (SCO).

- Although there was wide variability among children with RD for the number of Cs and Vs they discriminated well.

- There was less variability among children with RD for the number of Cs (but not Vs) they identified well on the single-syllable NSCM task.

Robust Speech Sounds

5. In an oddball discrimination task (SCO), children with RD are most likely to perceive 12 of 39 speech sounds well:

   /ʒ, h, n, w, r/ and /i, u, ɔ, ʌ, ɝ, aʊ, aɪ/.

   In a single-syllable identification task (NSCM), children with RD are most likely to perceive 10 of 39 speech sounds well:

   /k, d, ʧ, w/ and /i, e, u, o, ɔɪ, aɪ/

   –It appears that speech perception difficulties are selective.

Difficult Speech Sounds

6. In general, children with RD had confusions for:
   - Fricative, affricate, and nasal Cs
   - Lax Vs (but 1 or 2 tense vowels)

   - Place and voicing of Cs > manner
   - Height and front-back features of Vs > tense-lax, schwa, and rounding

- In 2 previous studies (Allen & Phatak; Phatak & Allen, 2007), typical young adults showed some of the same confusions (in noise) as our children with RD.
  - for fricatives /f, v, θ, ð, z, ʒ/
  - lax vowels /ɪ,ɛ,æ,ʌ/
- often to a lesser degree
- in an NSCM task (1 stimulus at a time)

- We hypothesize that children with RD are less able than peers and adults to sustain auditory traces of syllables
- in order to discriminate and identify speech sound differences
- in the presence of differing speaker voices.

Child-Specific Profiles

7. Individual children with RD varied in how many and which Cs, Vs, and features were confused.

Distinctive Confusions

- Laura: /g, r, ɝ/ and all 3 diphthongs, and voicing of Cs
- Angela: fewer fricative confusions, but /b, l, aʊ/
- Edward: no stop confusions, only 1 nasal, but > place than voicing of Cs
- Alina: /p, t, g/, both affricates, and all 3 nasals confused (> targets confused); V confusions only in final position, no tense V confusions

Child-Specific Profiles

- It appears that children with RD have idiosyncratic patterns of confusion.
- Therefore, in the future, mapping patterns of confusion for individual children would seem to be important.

Overall Conclusion

- Reading difficulties appear to be related to speech perception problems in a number of children who demonstrate RD, despite apparently normal hearing and generally normal articulation.

- Perceptual confusion was not general or usually great in degree, but did affect a substantial number of consonants and vowels.
- If perceptual confusions occur on a simple oddball task, it is not hard to imagine the disruption to more complex tasks such as reading.

- Good perception of syllable sequences (the SCO task) appears to be related to reading success.

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Extra Slides

- PA is a *metalinguistic* skill
  - Requires *conscious awareness* of the sub-units that comprise words
  - Typically targets real words (syllables that carry meaning, i.e., *language*)
    - Phonological Awareness: conscious awareness of syllables (or onset/rime or phonemes) within words
    - *Phonemic Awareness (PA):* conscious awareness of onset/rime or phonemes within words

- PA tasks
  - Catts (1991); Carson et al. (2013); Schuele, M., & Boudreau, D. (2008)
  - Judging whether words rhyme
  - Identifying the first or last phoneme in a word
  - Blending syllables or phonemes into recognizable words
  - Segmenting words into syllables or phonemes
  - Manipulating the sequence of syllables or phonemes

- In children with LI
  - Tallal et al. (1996)
  - Wright et al. (1997)
- In children with otitis media
  - Mody et al. (1999)
  - Paden et al. (1987)

- Other studies have established that children with LI are at risk for reading disabilities (RD)
  - Catts et al. (2002)
  - Flax et al. (2003).

Correlations with Cognition, Speech-Language, and Reading

- Correlations were computed for the assessment measures and performance on the experimental tasks.
  - For ALL participants

Correlations of Assessment Battery with 2 Experimental Speech Perception Tasks

Assessment	SCO	NSCM
KBIT-M	.55*	.00
PPVT-III	.41	.16
CFD	.46	.33
RS	.55*	.74**
GFTA-2	.37	.43
NRT	.30	.79*
NSCM	.33	

Note. * = p < .05 (light yellow)
** = p < .01 (orange, *r* = .70-.79)

- Correlations were computed for the assessment measures and the performance on the reading measures.
  - For ALL participants.

Correlations of Assessment Battery with the Four Standardized Reading Measures

Assess-ment	Word Identification	Word Attack	Reading Fluency	Reading Compre-hension
KBIT-M	.68**	.63*	.62*	.66**
PPVT-III	.53*	.49	.61*	.53*
CFD	.58*	.70**	.67**	.56*
RS	.67**	.70**	.79**	.68*
GFTA-2	.19	.53*	.27	.05
NRT	.41	.53*	.51	.52*
SCO	.79**	.73**	.77**	.62*
NSCM	.31	.44	.39	.38

Note. * = p < .05 (light yellow)

** = p < .01 (dark yellow, *r* = .60-.69; orange, *r* = .70-.79)

Correlations of Assessments and the 2 Speech Perception Tasks

8. Although many of the assessment measures correlate with speech perception and reading measures, among the strongest correlations with reading are those with spoken sentences (CFD, RS) and speech perception (SCO, but ***not*** NSCM).

Significance

- Much of the study of phonological aspects of RD has focused on:
  - letter-sound correspondence in decoding
  - or phonological or phonemic awareness (i.e., conscious manipulation of speech sounds in words)
  - rather than purely speech-perception abilities.