The Relation between *Phonetic Awareness* and Reading Ability

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Questions:

1. Do perceptual difficulties with speech sounds, i.e., *phonetic awareness*, underlie reading disabilities?
2. How do children with reading disabilities perform on phonetic awareness tasks compared to children without reading disabilities?
3. Among children with reading disabilities, are any performance patterns evident for consonants, vowels, and syllable-initial and syllable-final position for speech sounds?

Methods:

Subjects:

2 groups: **Reading Disabled (RD)**
- 6 girls and 3 boys
- Age range 8 to 10

Reading Controls (RC)
- 2 girls and 4 boys
- Age range 8 to 11

Experimental Design:

Syllables Confusion Oddball (SCO)

- 24 consonants (C) and 15 vowels (V)
- A random sequence of 3 nonsense CV or VC syllables
- 3 different talkers from a set of 18 talkers
e.g., [dɑ] (Voice 1) – [dɑ] (Voice 2) – [fɑ] (Voice 3)
- 2 of the 3 stimuli were the same; The 3rd stimulus differed in either its C or V.
- The child indicated the odd CV by:
pointing to a numbered wooden block (1, 2, or 3)
Number of trials varied per sound (with trial type randomly selected by the computer):
- *M* trials per sound = 41.0 trials (*SD* = 15.1)

Nonsense Syllable Confusion Matrix (NSCM)

- Used the 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.
- However this time only 1 syllable was presented at a time and the 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 = 69.0 trials

Plan for Analyses:

In the analyses, results are summarized from the data as the probability of error and entropy for both the SCO and NSCM tasks. Further, both probability of error and entropy are examined for all four conditions: consonants in initial (CI) position, consonants in final (CF) position, vowels in initial (VI) position and vowels in final (VF) position.

Visual Inspection of Figure 1 and Figure 2 reveals the probability of error on the SCO and NSCM tasks, respectively. Figure 3 shows the entropy for responses from all subjects under the CI, CF, VI and VF conditions. Based on the information from this plot of entropy, several subject's results have been selected and plotted in Figure 4.

Statistical testing is used to compare the differences in performance for both groups of subjects in all four conditions primarily in terms of probability of error. Significance of the tests for differences is evaluated.

Figure 1. Sorted Error Plots from the SCO Task

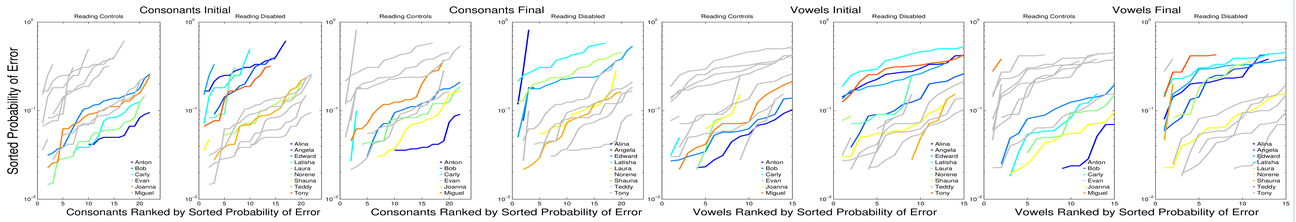


Figure 2. Sorted Error Plots from the NSCM Task

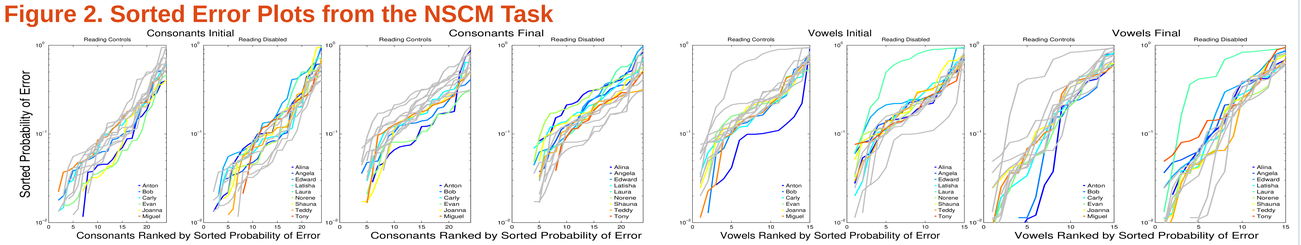


Figure 3. Entropy Plots from the NSCM Task

RD: {Al = 'Alina', Ag = 'Angela',Ed = 'Edward', Lt = 'Latisha', Lr = 'Laura', Nr = 'Norene', Sn = 'Shauna', Td = 'Teddy', Tn = 'Tony'};
RC: {At ='Anton', Bb= 'Bob', Cl = 'Carly', Ev = 'Evan', Jn = 'Joanna', Mg = 'Miguel'};

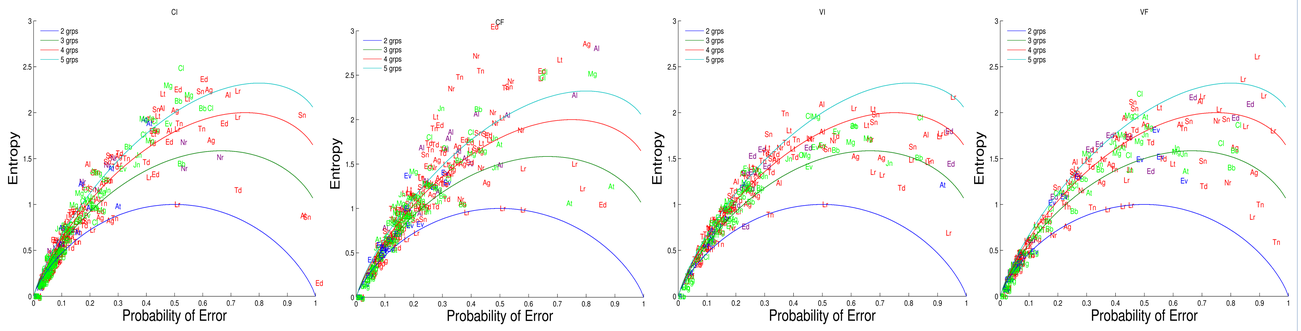
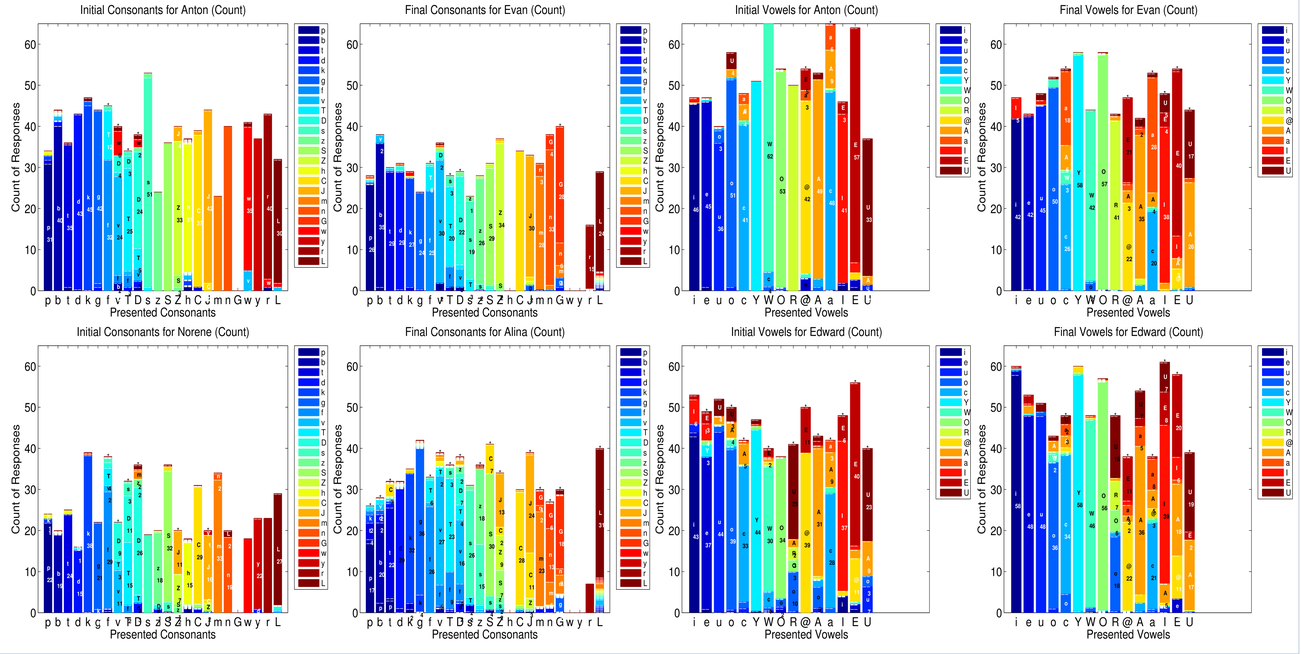


Figure 4. Consonants Confusions by Subject from the NSCM Task



RD-RC Paired T-test Results:

Table1. SCO (data type : Probability of Error)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CF	2.0839	0.04847	23	0.002 – 0.0437	0.0219
CI	3.1376	0.0046	23	0.0112 – 0.0546	0.0329
VF	9.092	2.996e-07	14	0.0731 – 0.1183	0.0957
VI	13.758	1.588e-09	14	0.1008 – 0.1381	0.1195

Paired *t*-test results for probability error data from the SCO task showed that in all situations, children with RDs have significantly higher error rates than children without RDs. Further, in general, vowel error rates are greater than consonant error rates.

Table 2. NSCM (data type : Probability of Error)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CF	4.2535	0.00030	23	0.0317 – 0.0917	0.0617
CI	3.351	0.00277	23	0.0173 – 0.0732	0.0452
VF	3.314	0.00512	14	0.0242 – 0.1132	0.0687
VI	5.0667	0.00017	14	0.0495 – 0.1221	0.0858

Paired *t*-test results for probability error data from the NSCM task showed that in all situations, children with RDs have significantly higher error rates than children without RDs. The error rate for VI position was notable for children with RDs compared to their peers in the control group.

Table 3. NSCM (data type: Entropy)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CF	6.0786	3.362e-06	23	0.1663 – 0.3378	0.2520
CI	2.2917	0.03141	23	0.0618 – 0.1208	0.0635
VF	3.6595	0.002576	14	0.0626 – 0.2399	0.1512
VI	4.1713	9.416e-04	14	0.1026 – 0.3198	0.2112

Paired *t*-test results for entropy data from the NSCM task showed that children with RDs had greater diversity in error responses than children without RDs in all conditions: CF position, CI position, VF position, and VI position.
For all four conditions, the CF position had significantly higher entropy for RD children than for the RC children. This was also true for VI position.

RD Consonant-Vowel T-test Results:

Table 4. SCO (data type: Probability of Error)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CI - VI	-4.4586	0.0004	14	-0.1093 – -0.0394	-0.0744
CF - VF	-5.0039	0.0002	14	-0.0973 – -0.0389	-0.0681

For children with RDs on the SCO task, in both initial and final position, error rates were significantly higher for perceiving vowels than consonants.

Table 5. NSCM (data type: Probability of Error)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CI - VI	-1.1717	0.2609	14	-0.2336 – 0.0686	-0.0826
CF - VF	-0.8193	0.4263	14	-0.2042 – 0.0913	-0.0565

In contrast, on the NSCM task, error rates for vowels and consonants were similar for children with RDs, regardless of syllable position.

RD Consonant Final-Initial T-test Results:

Table 6. SCO (data type: Probability of Error)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CF-CI	-1.4802	0.1524	23	-0.0278 – 0.0046	-0.0116

For children with RDs on the SCO task, error rates did not differ significantly by syllable position.

Table 7. NSCM (data type: Entropy)

Position	t-value	p-value	df	95% Conf. Int.	Δmean
CF-CI	2.4359	0.0230	23	0.0428 – 0.5244	0.2836

For children with RDs on the NSCM task, errors for CF position were significantly more diverse than errors for CI position.

Conclusions:

1. Results from both the SCO and NSCM tasks indicate that children with RDs have significantly higher error rates in phonetic awareness (both consonant and vowel awareness) than their peers in without RDs.
2. Children with RDs have more difficulty perceiving speech sounds than children without RDs for all four conditions: consonants in syllable-initial and syllable-final position, and vowels in syllable-initial and syllable-final position. Only the NSCM task provides enough data to generate insight about the diversity of error responses in the perception of speech sounds. Here consonants in syllable-final position are notable for their high error rate.
3. Regardless of syllable position, vowels are harder than consonants for children with RDs to perceive.
4. In the SCO task, children with RDs have similar error rates for perceiving consonants in syllable-initial and syllable-final position.
5. In contrast, in the NSCM task, children with RDs confuse consonants more often in syllable-final than syllable-initial position.
6. Because reading disabilities present lifelong challenges, mapping the perceptual confusions of individual children with RDs may contribute to our understanding of which speech sounds are susceptible to confusion in other populations, such as aging adults. It will now be important to consider how particular confusions might negatively impact reading and, therefore, how to specifically target them in remediation.

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Abstract:

Reading disabilities (RDs) are thought to affect at least 15% of children (IRA, 1998; NICHD/NRP, 2000). We propose that RDs start prior to formal reading instruction, present challenges into adulthood (Pratt & Brady, 1988), and are fundamentally related to the auditory perception of speech sounds. This study aims to determine if children with RDs demonstrate greater perceptual confusion of 24 consonants (Cs) and 15 vowels (Vs) than typical readers, and to describe the nature and degree of any confusions. Eleven children with RDs and six reading controls (RCs), 8 to 11 years old, participated in two tasks. The Syllable Confusion Oddball Task presented a sequence of three natural CV or VC syllables (prerecorded by 18 different talkers), with one syllable differing in its C or V. The child then identified the odd syllable. The Nonsense Syllable Confusion Matrix Task randomly presented the same syllables one at a time, and the child imitated each. The RD group made significantly more perceptual confusions than the RC group on both tasks. Confusions were primarily for fricatives, affricates, and lax vowels. Children with RDs demonstrated many idiosyncratic confusions and more errors in syllable-final position. Findings suggest that children with RDs experience moderate difficulty perceiving a substantial number of Cs and Vs. We theorize that this level of confusion presents challenges when learning to read. Mapping the perceptual confusions of children with RDs may contribute to our understanding of perceptual vulnerabilities in dyslexic or aging adults, and to the development of training to improve perception.

References:

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