Speech Perception and Reading Disabilities in Individual Children

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Abstract

Objectives: Reading disability (RD) is widely viewed as a key obstacle in the development of literacy. Studies show that between 15-20% of grade-school students have RDs, and as a result many drop out of school in their early age (i.e., by high-school). According to national statistics, fifty percent of the inmates in jail cannot read. One might reasonably conclude that RD can be a ticket to jail for a significant percentage of RD children.

Design: We shall show that the source of RD in young children (8-12 yrs) is related to inadequate phonetic non-categorical processing skills, rooted in pre-school language development. This conclusion is based on a Syllable Confusion Oddball task (SCO) on children with documented reading disabilities. The SCO task tested normal-hearing RD children, having normal language function, in their ability to identify different syllable (CV, VC) from a string of three such syllables, spoken by three different talkers, from a data base of 20 adult talkers.

Results:

The experimental results showed that the 10 RD children had 5 times the error compared to the reading control (RC) group.

Conclusion

1) RD children have a significant speech perception problem in identifying nonsense syllables, despite normal pure-tone hearing and language processing ability.

2) Our conclusions are at odds with previous publications which found no sign of phone impairment.

Methods

- 10 one-hour sessions weekly
- Approximately 10-min. blocks, with 5 min. of playtime between each block
- 24 consonants and 15 vowels
- Almost 15,000 trials per subject (average)
- Participants: Reading Control Group (RCs) and Reading Disabled Group (RDs)

Consonant Initial
RC vs RD
[ed][id][ed]

Consonant Final
RC vs RD
[ed][ed][et]

Vowels Initial
RC vs RD
[ig][ag][ag]

Vowels Final
RC vs RD
[da][da][di]

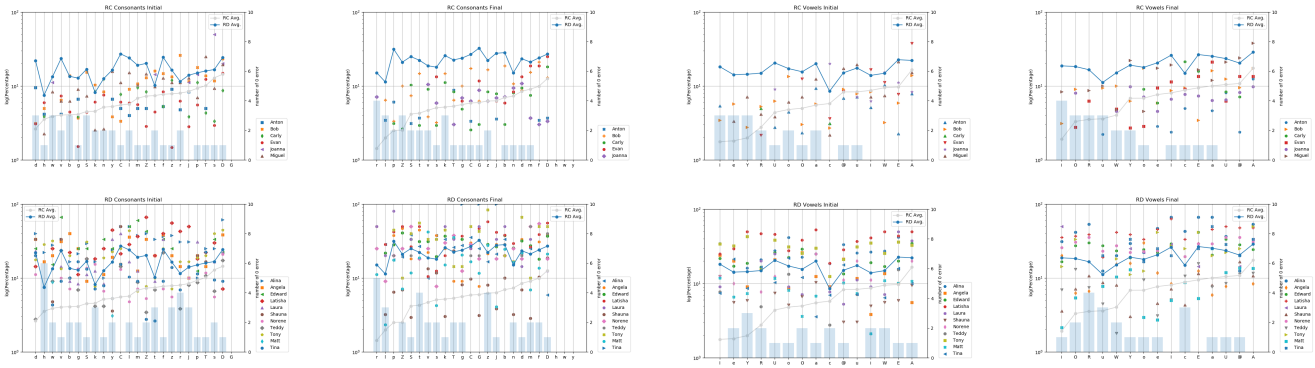

Figure 1: Sorted error plot for RC or RD group: The phones in the x-axis were sorted by RC average of error. The gray line represents the average error RC for Consonant Initial while the colored line is RD's. Scattered shows each child's data in RC group. And histogram means the number of individuals who had 0 error of each phone in Consonant Initial/ Consonant Final/ Vows Initial/ Vows Final experiment.

A Review of RD studies

- Brandt concluded that there was no significant impairment in phonetic perception in children with RD(1980).[1]
- Rosen pointed out some association, but no causal relation of auditory deficits (temporal processing or other) to specific RD (2003).[2]
- Rosen pointed out there is no correlation between auditory and speech perception deficits (2011).[3]
- Ziegler reported speech perception deficits in RD in noise but not in quiet(2009).[4]
- ***In summary***, there was a weak or no relation between speech perception and reading ability.

SCO Task

A random sequence of 3 nonsense CV(Consonant-Vowel) or VC （Vowel-Consonant） syllables

Spoken by 3 different talkers

From a set of 18 professionally recorded talkers e.g.:

[da] (Voice 1) – [da] (Voice 2) – [fa] (Voice 3)

[ga] (Voice 1) – [ba] (Voice 2) – [ga] (Voice 3)

[at] (Voice 1) – [it] (Voice 2) – [it] (Voice 3)

Figure 2: A child was doing our experiment

Fixed Effects from Regression Analysis. Generalized Linear Model: Error ~ SubGrp× PhonePos × PhoneType.

Fixed Effect	Estimate	Std. Error	z value	Pr(> |z|)	Sig. Level
(Intercept)	-2.18865	0.16294	-13.433	< 2e-16	***
PhonePos	-0.18853	0.09869	-1.910	0.056084	
SubGrp	1.21389	0.31710	3.828	0.000129	***
PhoneType	-0.02343	0.12473	-0.188	0.851011	
PhonePos:SubGrp	-0.14125	0.18889	-0.748	0.454600	
PhonePos:PhoneType	0.19163	0.17024	1.126	0.260321	
SubGrp:PhoneType	-0.07807	0.21251	-0.367	0.713346	
PhonePos:SubGrp:PhoneType	-0.31775	0.31830	-0.998	0.318151	
Signif. codes	$p < 10^{-3}$	'***';	10^{-2} '**';	0.05 '*'	

Conclusions

- RD children have a significantly larger phone error relative to the reading control (RC) children.
- Each RD subject has unique phone errors.
- RC subjects are similar in performance
- Our experiment result revealed a striking separation of the RC and RD children when discriminating both consonant and vowels in the syllable-initial or syllable final position.

References

- [1] Brandt, J. and Rosen, J.J. Auditory phonemic perception in dyslexia: Categorical identification and discrimination of stop consonants(1980)
- [2] Rosen, S. Auditory Processing in Dyslexia and specific language impairment: is there a deficit? What is its nature?(2003)
- [3] Messaoud-Galusi, Souhila and Hazan, Valerie and Rosen, Stuart. Investigating Speech Perception in Children with Dyslexia: Is There Evidence of a Consistent Deficit in Individuals?(2011)
- [4] Johannes C. Ziegler and Catherine Pech-Georgel and Florence George and Christian Lorenzi. Speech-perception-in-noise deficits in dyslexia(2009)