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Concurrent Predictors of Reading Performance in Children with Hearing Loss

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INTRODUCTION

Today, many children with hearing loss (CHL) perform within normal limits on standardized measures of reading performance (Moeller et al., 2007), a change from previous decades that should be celebrated. However, CHL as a group continue to test below classroom peers in both pre-literacy skills (Cupples et al., 2014) and overall reading performance (Antia, Jones, et al., 2009). Moreover, a subset of CHL appear to be driving these results, with as much as 30% of CHL at risk of reading failure (Antia, Jones, et al., 2009). The current study examines reading performance and possible contributing factors (a) across all children with hearing loss in the sample, and, (b) by grouping children with hearing loss by reading performance.

PARTICIPANTS

Children with mild-to-moderate hearing loss (CHL; n=51) were recruited from pediatric audiology clinics and school systems throughout the middle Tennessee area to participate in a larger, ongoing study examining listening effort and fatigue in school-age children with hearing loss. “Mild” hearing loss was defined as a pure tone average (PTA; thresholds at 0.5, 1.0 and 2.0 kHz) between 20 and 40 dB HL or thresholds greater than 25 dB HL at two or more frequencies above 2.0 kHz. “Moderate” hearing loss was defined as a PTA of 45-70 dB HL in the better ear.

Children in this data set included 26 females and 25 males who were between 6 years, 3 months and 12 years, 11 months. Children qualified for the study if they had no diagnosis of autism spectrum disorder or cognitive impairment as reported by the parents. All children spent at least two hours per day in a general education classroom.

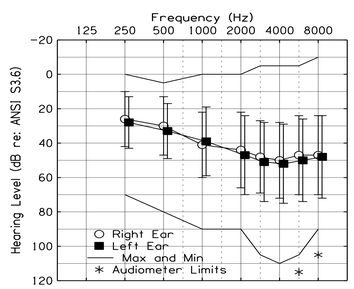

Figure 1. Composite audiogram. Average (1SD) thresholds for left (filled squares) and right (open circles) ears of children included in this data set. Solid lines represent minimum and maximum thresholds recorded from individual children. Asterisks indicate “no response” obtained at the limits of the audiometer at those frequencies for at least one participant.

METHODS

Demographic information was collected through parent report. Audiological information was obtained through booth testing by a licensed audiologist or by graduate students supervised by a licensed audiologist. CHL received a comprehensive audiologic examination including air and bone conduction threshold testing and tympanometry to rule out any obvious ear pathology. Language and literacy information was derived from a battery of tests given by a licensed speech language pathologist or by graduate students supervised by a licensed speech language pathologist. Children received the following measures: Test of Nonverbal Intelligence, 4th edition, an untimed test of spatial reasoning; Arizona Articulation Proficiency Scale, 3rd edition, a word-level articulation measure; Clinical Elements of Language Fundamentals, 4th edition, an omnibus test of receptive and expressive language; Peabody Picture Vocabulary Test, 4th edition, a receptive vocabulary test; the Comprehensive Test of Phonological Processing, a test of phonological awareness and memory; and the Woodcock Johnson Reading Mastery Test, 3rd edition, a measure of reading skills including comprehension and decoding.

RESULTS

	CHL-Full Sample (n=51)	CHL-Good Readers (n=39)	CHL-Poor Readers (n=12)	Difference Good vs. Poor Readers
Demographic Factors				
Age	10;0	9;9	10;10	n.s.
Maternal Education (median)	“College degree”	“Graduate degree”	“Some college”	n.s.
Audiologic Factors				
Degree HL Descriptive	71% “moderate”	67% “moderate”	83% “moderate”	n.s.
Better Ear PTA	40.58dB HL (15.56)	38.38dB HL (15.59)	47.36dB HL (13.97)	n.s.
Reported Age ID	5;0	5;1	5;0	n.s.
Reported Age Fit	5;8	5;8	5;9	n.s.
HA Use Descriptive	70.27% “consistent users”	67.85% “consistent users”	70.00% “consistent users”	n.s.
Speech Recognition – Words Correct	46.11%	47.22%	41.67%	n.s.
Speech Recognition – Phonemes Correct	77.07%	77.18%	76.67%	n.s.
Language And Academic Factors				
Nonverbal Intelligence	101.82 (12.07)	104.56 (11.89)	92.92 (11.52)	t(49)=2.99, p<.01
Articulation	93.94 (5.51)	94.62 (5.89)	92.08 (3.90)	n.s.
Language	90.59 (21.78)	97.86 (18.72)	68.17 (14.03)	t(47)=5.04, p<.01
Vocabulary	92.74 (16.02)	97.58 (13.88)	76.67 (5.53)	t(49)=4.48, p<.01
Phonological Awareness	89.44 (16.74)	94.52 (15.88)	75.50 (9.90)	t(43)=3.86, p<.01
Decoding	95.80 (18.17)	103.55 (13.64)	74.50 (10.11)	t(43)=6.71, p<.01
Comprehension	97.89 (16.86)	105.27 (12.64)	77.58 (7.62)	t(43)=7.10, p<.01
Reading Achievement	**96.71 (18.77)**	**104.97 (13.69)**	**74.00 (9.87)**	**t(43)=7.17, p<.01**

Table 1. “Good Readers” were defined as being within 1 SD of the mean or above (standard score >85 on the WRMT). “Poor Readers” were defined as being at least 1 SD below the mean. CHL who were good readers and CHL who were poor readers *did not differ* on any audiologic measure, including better ear PTA, reported age of ID and fit, or speech recognition. CHL who were good readers and CHL who were poor readers differed on *all speech/language and academic measures* except articulation.

Relationship Between Receptive Language and Reading Scores in CHL (r=.81)

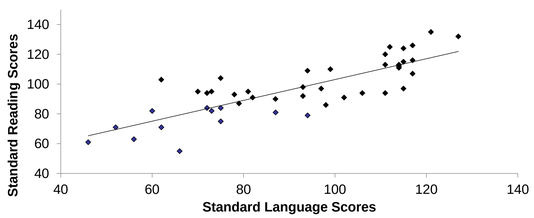

Figure 3. CHL-Good Readers (black diamonds) and CHL-Poor Readers (blue diamonds) appear to belong to the same general distribution, where CHL-Poor Readers represent the bottom 24% of all CHL in the sample.

Proportion of Children Who Repeated A Grade

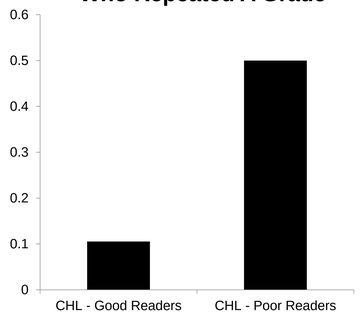

Figure 2. CHL-Poor Readers are at immense risk of academic failure. 50% of CHL-Poor Readers had already repeated at least one grade.

Predictor Variable	Correlation with Reading	Predictor Variable	Correlation with Reading
Age	-.31*	Articulation	.30*
Maternal Education	.42*	Nonverbal Intelligence	.61**
Better Ear PTA	-.25	Language - Receptive	.81**
Reported Age ID	-.03	Language - Expressive	.78**
Speech Rec – Words	.12	Receptive Vocabulary	.74**
Speech Rec – Phonemes	.12	Phonological Awareness	.70**
Hearing Aid Use	-.03	Phonological Memory	.61**

*Correlation is significant p<.05
**Correlation is significant p<.01

Table 2. No audiologic factors were significantly correlated with reading outcome, while all language factors were correlated with reading outcome (and intercorrelated among themselves).

A regression analysis used the base unstandardized regression model of *reading achievement = 19.84 + -.36(age) + 2.46(maternal ed) +-.36(better ear PTA) +1.32(articulation) + E*, F(4,39) = 8.77, p<.01, which accounted for 42% of variance. Receptive language, receptive vocabulary, and phonological awareness were each tested against the base model. The final unstandardized regression model of *reading achievement = 22.15 + -.17(age) + 1.85(maternal ed) +-.09(better ear PTA) +.36(articulation) + .612(receptive language)+ E*, F(5,38) = 21.13, p<.01 accounted for 70% of variance. **Neither receptive vocabulary nor phonological awareness were unique predictors of reading performance beyond receptive language.**

DISCUSSION

Receptive language is the most significant concurrent predictor of reading outcome in CHL. In the current sample, neither vocabulary nor phonological awareness were unique predictors beyond receptive language, at odds with previous findings (e.g., Cupples et al., 2014). The Pearson correlations (Table 2) are consistent with previous findings. Educational audiologists and speech-language pathologists may be able to harness this information to provide better services for CHL.

CHL-Good Readers and CHL-Poor Readers both performed higher (>.5 SD) on reading measures than they did on verbal language measures. **Reading** (written language) appears to be a **relative strength** for CHL, which may be able to be harnessed in environments when listening (auditory comprehension) is difficult, i.e., noisy classroom settings.

50% of CHL-Poor Readers had already repeated at least one grade by age 10. These children are not at risk for academic failure – they are already failing. The relative success of CHL in general classroom settings should not overshadow these individual children.

A key limitation of the data is that it represents a concurrent sample. We therefore cannot test the causal effects of language on reading. A longitudinal assessment of audiologic factors, language factors, and reading factors would allow for a better representation of the effect each variable at an earlier time point has on other variables at a later timepoint.

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