Automated Analysis of the Language Abilities and Auditory-Linguistic Environments of Children with Hearing Loss

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Outcomes of Children with Hearing Loss
a study of children ages birth to six

Background

A new method of assessing children's linguistic development and variables in their auditory environments is available in the LENA (Language ENvironment Analysis) system. LENA collects and analyzes full-day recordings from children's natural environments via a small recording device worn by the child, providing raw data estimating, for example, number of words spoken by adults in the child's vicinity, number of conversational turns between the child and adults, and amount of television and noise exposure. Additionally, LENA's Automated Vocal Analysis (AVA) provides an age-normalized measure of the maturity of the child's speech production characteristics. Little is known about how the AVA relates to early measures of communication development for children with hearing loss (HL) or whether AVA scores are sensitive to differences between children with normal hearing (NH) and (HL).

Questions

1) Is the AVA sensitive to differences in the language skills of children with NH vs. mild to severe HL?
2) How does the AVA relate to clinician-elicited measures of language for children with HL as a group and individually?
3) Do the auditory-linguistic environments of children with NH and HL differ?
4) How do children's auditory-linguistic environments contribute to their language skills?

Subjects and Methods

	NH Group (n=12)			HL Group (n=35)			Between Groups	
	M	SD	Range	M	SD	Range	t	p
Age at 1st LENA Recording[a] (months)	26.8	6.1	13-35	22.6	7.1	11-36	1.77	.083
Age at MSEL Administration[b] (months)	25.9	5.1	13-32	23.3	5.3	11-33	1.65	.106
Age at hearing loss ID (months)				1.06	3.7	0-17		
Better Ear Pure Tone Average (dB HL)				50.2	12.6	28-83		

[a] Three LENA recordings per child were collected at consecutive one month intervals. LENA Variables were AVA standard score (SS), adult words spoken to or near the child, conversational turns between the child and adults, television time, and noise duration. These were averaged across the three recordings.
[b] The receptive and expressive language scales of the Mullen Scales of Early Learning (MSEL) were administered to children. The MSEL is a standardized, clinician-elicited language measure. T-scores were multiplied by two to calculate SSs.

Results: MSEL and AVA
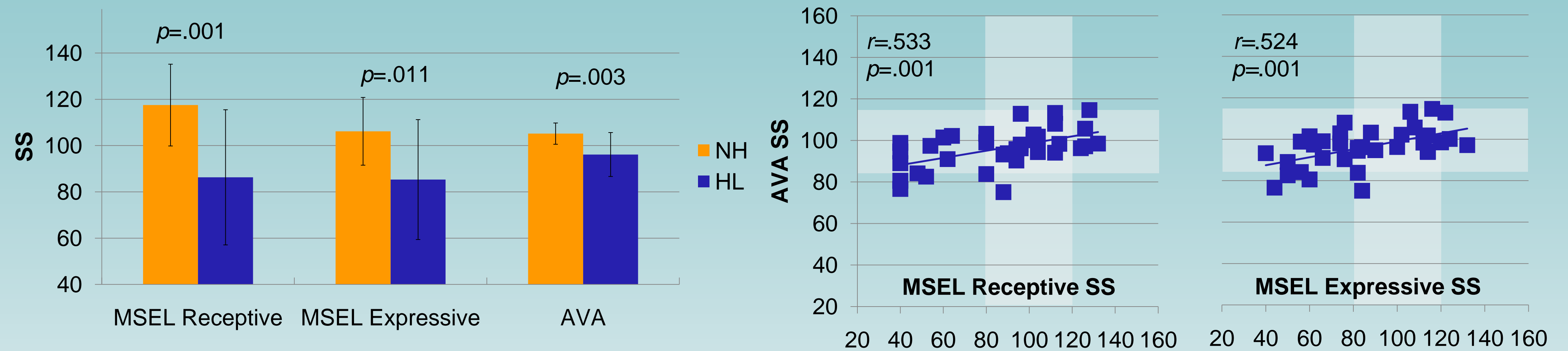
• The NH group outperformed the HL group on all three measures.
• The NH group scored *lower* on the AVA than on the receptive language scale (*p*=.030; expressive scale: *p*=.779). However, the HL group scored *higher* on the AVA than on either MSEL scale (receptive: *p*=.028; expressive: *p*=.007).

• 31% of the HH children scored in the below average range on the receptive scale and 43% scored in the below average range on the expressive scale as compared to only 17% on the AVA. The average range is shaded in the scatter plots (+/- 1SD of normative mean).

Results: Auditory-Linguistic Environments

• The auditory environments of children with HL and NH were similar; no significant differences were found between groups for LENA variables.
• For the HL group, conversational turn count was positively correlated with all three communication measures and television time was negatively correlated with receptive language, as seen in the table to the right. No other significant relationships were identified.

	MSEL Receptive	MSEL Expressive	AVA
Adult Word Count	.263	.295	.156
Conversational Turn Count	690**	.396*	.406*
Television Time	-.399*	-.026	-.117
Noise Duration	-.290	-.225	-.022

Discussion

• Children with mild to severe HL demonstrated weaker communication abilities than their NH peers in both clinical and real-world environments.
• Both the clinician-elicited measures of language and the AVA were sensitive to group differences in the communication abilities of children with NH and HL. However, the AVA may over estimate the communication abilities of children with HL, thus under-identifying language-delayed children in this group.
• For children with HL, engagement in conversational turns may be especially important for language development; even more important than the number of adult words spoken in a child's vicinity. Future investigations should further explore the relationships between children's communication outcomes and the quantity of adult words spoken to the child versus words spoken near the child but directed to other children or adults.
• TV time may negatively impact the receptive language abilities of children with HL. Further work should examine whether this relationship is mediated by a relationship between TV time and conversational turns, as early analyses indicate a relationship between these variables.