Unveiling the Source of Language Delay for Children with Hearing Aids

Susan Nittrouer, Department of Otolaryngology, The Ohio State University

The Ohio State University
Wexner Medical Center

The Speech Development Laboratory

BACKGROUND

Children need to master a variety of language skills to succeed academically and socially in the real world. These skills are viewed as being related to two kinds of structure: (1) *phonological*, referring to syllabic and phonemic structure; and (2) *morphosyntactic*, referring to morphological categories and how to combine them. As will be seen, a third category emerged in this study, termed *lexical*.

Problems acquiring language due to hearing loss (HL) arise from two kinds of deficits: (1) degradation of sensory input; and (2) diminished linguistic experience.

One goal of this study was to examine the extent to which each of these problems associated with HL accounts for acquisition of each kind of language structure. A second goal was to see how acquisition of skills associated with each kind of language structure affects functioning in the real world. This knowledge should inform where treatment efforts are placed.

METHOD

PARTICIPANTS

68 8-year-olds: 49 with NH and 19 with HL who wore hearing aids. Table 1 shows demographics. SES = socioeconomic status: scale is 1 (low) to 64 (high). BE PTA = better-ear pure tone average. Age of ID = age of identification of hearing loss and start of intervention. No children had any condition (other than HL) that would put them at risk of language delays. All children with HL received appropriate early intervention, with an emphasis on spoken language.

Table 1: Demographics.

	NH		HL	
	Mean	Range	Mean	Range
SES	35	12-64	31	12-64
BE PTA (dB)			63	52-78
Age of ID (mo)			9	0-29

PROCEDURES

All children visited the laboratory for a day and a half in the summer after they completed second grade, and were tested in 6 sessions. Measures included in these analyses are shown in Table 2. Methods and stimuli were standardized for consistent presentation. All testing was video-recorded for later scoring by two graduate students so that reliability could be monitored. Three measures of real-world functioning were also collected.

Language Measures

16 language measures thought to span the range from highly dependent on phonological structure to highly dependent on morphosyntactic structure were collected.

Table 2: 16 language measures included in analyses.

ICC	Initial Consonant Choice
FCC	Final Consonant Choice
PD	Phoneme Deletion
WM	Working Memory
NWRep	Nonword Repetition
WRead-I	Word Reading (Isolated Words)
WRead-C	Word Reading (Words in Context)
ReadComp	Reading Comprehension
ExpVoc	Expressive Vocabulary
AudComp	Auditory Comprehension of Language
NarrAb	Narrative Abilities (for Oral Stories)
BoundMor	Bound Morphemes (per 100 utterances)
NDW	Number Different Words (per 100 utterances)
Conj	Number Conjunctions, excluding *and* (100 utt)
Pron	Number Pronouns (per 100 utterances)
MLU	Mean Length of Utterance in morphemes

RESULTS

Principal Components Analysis (PCA) was done on these measures, originally permitting only 2 components. That did a reasonable job of fitting all measures, but 3 components revealed a third kind of structure. It was labeled *lexical* because expressive vocabulary loads most strongly on it. Table 3 shows how each measure loaded on each principal component.

Latent factor scores were derived to match each of these 3 principal components, using the NH group as the selection variable. Thus the mean for NH children was 0, and the SD was 1.0. The 3 measures that best represented each principal component was used to create each latent factor. Separate scores were computed for each child. Figure 1 shows means for children with HL. Only the phonological score showed a significant group effect, $t(66) = 3.16$, $p = .002$.

Table 3: Loading of each measure on each principal component.

	Phonological	Lexical	Morphosyntax
ICC	**.808**	.205	.123
FCC	**.786**	.329	.056
PD	**.613**	.482	.046
WM	**.676**	.001	.030
NWRep	.448	**.572**	-.009
WRead-I	.281	**.782**	-.227
WRead-C	**.562**	.484	.037
ReadComp	.239	**.680**	.349
ExpVoc	.111	**.865**	.031
AudComp	.183	**.735**	.366
NarrAb	.113	.447	**.554**
BoundMor	.046	.064	**.769**
NDW	.075	.222	**.875**
Conj	.057	-.152	**.831**
Pron	.002	.035	**.913**
MLU	.037	.080	**.940**

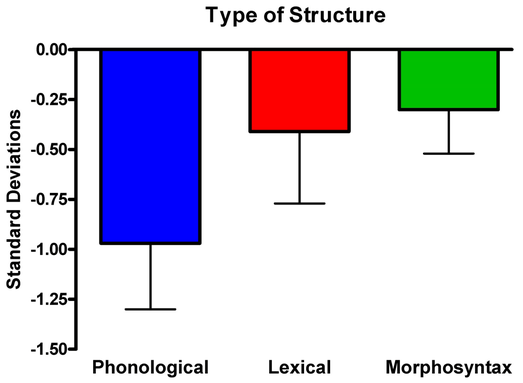

Figure 1: Mean scores and SEs on latent factors for children with HL.

Sources and Effects

Is sensory input or linguistic experience the *source* of variance in latent scores for children with HL?

Pearson correlation coefficients were computed for the 3 demographic factors for scores of children with HL. BE-PTA represented sensory input; Age of ID and SES represented linguistic experience. Age of ID explained no significant amount of variance for any latent score. Other correlation coefficients are shown in Table 4. Only r >.33 is shown (explaining more than 10% of variance).

Table 4. Correlation coefficients (r).

	Phonol	Lexical	Morsyn
BE-PTA	-.44		
SES	.41	.33	.62

Sensory input explained variance for phonological structure. Linguistic experience explained variance for all structure.

Do these skills have *effects* on real-life functioning for children with HL?

Pearson correlation coefficients were computed for the 3 latent scores and 3 metrics of real-life functioning: word recognition (CID); sentence recognition in noise (4-word syntactically correct, meaningless sentences at 0 dB SNR); and school grades. Table 5 shows results for r > .33.

Table 5. Correlation coefficients (r).

	Word Rec	Noise	Grades
Phonological	.54	.54	.33
Lexical		.52	.47
Morphosyntax	.47		.37

Skill with all 3 kinds of language structure are important to real life functions.

CONCLUSIONS

1. Children with HL who use hearing aids show significant deficits only with phonological processing skills, but mean performance remains slightly below that of peers with NH for lexical and morphosyntactic skills, as well.

2. HL explains a large portion of variance for phonological skills, but linguistic experience affects acquisition of all 3 kinds of skills.

3. Findings suggest that enhanced behavioral interventions could ameliorate these deficits.

ACKNOWLEDGEMENT

Work supported by NIDCD Grant No. DC-006237