Sound beginnings: Variables affecting speech directed to infants and toddlers with auditory impairment in English- and Spanish-speaking families

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Introduction

This study investigates the use of LENA measures in describing the participants and outcomes of a parent-infant program for children with hearing loss, Sunshine Cottage School for Deaf Children. Sunshine Cottage supports families and children from San Antonio and South Texas. Infants enrolled in the Sunshine Cottage Parent-Infant program present with hearing losses or auditory dysynchrony/neuropathy that range from mild through profound. A substantial number of families in the program speak Spanish as their primary language or speak both Spanish and English in the home.

The LENA system offers several advantages for use with infants and toddlers with hearing loss. Not only do LENA measures describe the frequency of vocal input to infants and their own vocal behavior. Aspects of the acoustic environment that are crucial to access to spoken language can be discovered as well.

Four questions were posed:

1. Does degree of hearing loss impact LENA measures?
2. Does the language in the home impact LENA measures?
3. What is the acoustic environment in the lives of infants and toddlers with hearing loss?
4. How to LENA measures obtained from infants and toddlers with hearing loss compare to those obtained from typically developing infants?

Method

PARTICIPANTS

48 infants were recorded, 20 females and 28 males.

			Hearing Technology			Home Language		
Hearing Loss	***n***	**Mean Chron. Age (mos)**	**Hearing Aid(s)**	**BAHA**	**Cochlear Implant(s)**	**English**	**English + Spanish**	**Spanish**
Mild	7	17.9	7			5	2	
Moderate	10	20.1	7	3		6	4	
Mod-Severe	8	21.2	7	1		5	2	1
Severe	10	20.2	5	1	3	4	5	
Profound	14	23.6	2	1	11	10	3	1
Group	**48**	**21.0**	**28**	**6**	**14**	**30**	**16**	**2**

DATA COLLECTION

DLPs were provided to families who were instructed how to put the recorder on their infant and how to turn on the device. Recordings that were at least 10 hours in duration were used for data analysis. Parents completed the LENA Developmental Snapshot via interview with their Parent Advisor at the time of DLP recordings.

DATA ANALYSIS

The following variables were extracted via LENA analysis and analyzed:

Category	Measure	Measurement	Abbreviation
Acoustic Environment	Meaningful Speech	% of total duration	PCTMeaningful
	Distant Speech		PCTDistant
	Electronic Sources		PCTElectr
	Silence		PCTSilence
Vocal Counts	Adult Words	Counts projected for a 12-hour duration recording	AWCProj
	Conversational Turns		CTCProj
	Child Vocalizations		CVCProj
Vocal Percentiles	Adult Word Percentiles	Referenced to typically developing infants of equal age	AWCPctile
	Conversational Turn Percentiles		CTCPctile
	Child Vocalization Percentiles		CVCPctile
Developmental Status	Automatic Vocalization Analysis Estimated Developmental Age	Age equivalencies referenced to typically developing infants	AVADevtlAge
	LENA Snapshot Developmental Age		SnpshtDevAge

Results

EFFECTS OF DEGREE OF HEARING LOSS AND HOME LANGUAGE

A two-way MANOVA was performed to test the separate and combined effects of degree of hearing loss & home language on the acoustic environment, vocal counts, and developmental measures. Chronological age was included as a covariate. An alpha level of .05 was used as the criterion for statistical significance.

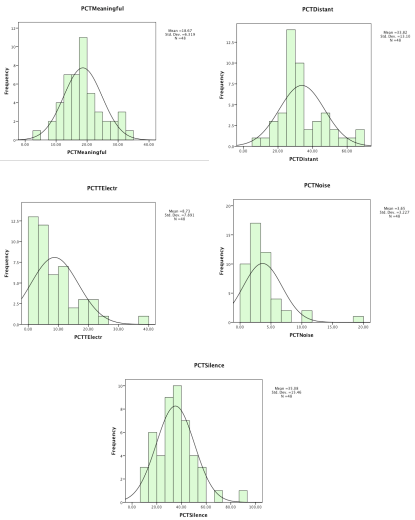
Only 2 out of 48 families reported that they used Spanish only in the home. The Spanish-only families were combined with families who reported that they spoke only English in the home to create 2 home language groups: monolinguals and bilinguals.

There was no statistically significant effect of degree of hearing loss or home language on measures of the acoustic environment or vocal counts.

Due to the absence of significant difference between groups by degree of hearing loss or home language, the full participant sample was combined for subsequent analysis.

ACOUSTIC ENVIRONMENT

The following histograms display the frequencies of duration of each acoustic environment as



Durations of acoustic environment type as measured by percentage of the recording time could be fit fairly well to a normal distribution curve with these exceptions:

(1) a clustering in the distribution of electronic background in shorter durations and

(2) outliers appearing at longer durations of electronic source, noise and silent episodes.

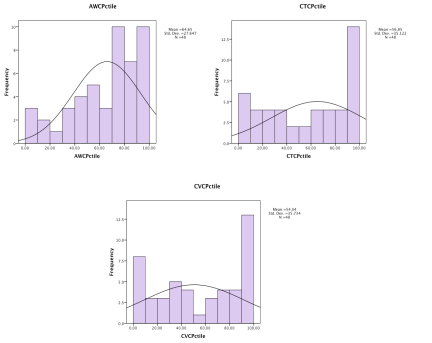
COMPARISON TO TYPICALLY DEVELOPING INFANTS: VOCAL COUNTS

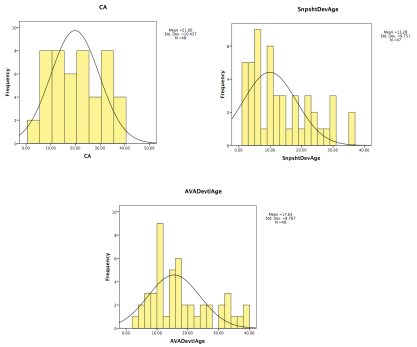
The histograms to the right display frequencies of occurrence for percentile rankings of adult words, conversational turns, and child vocalizations.

The mean percentile rankings of Adult Word Counts, Conversational Turns, and Child Vocalizations were slightly above the *50*th percentile for typically developing infants.

Just over one-third of the sample produced Adult Words (35.42%) and Conversational Turns (37.50) at a rate that was at or above the *80*th percentile for families of typically developing children.

The distribution of Child Vocalizations was bi-modal, with 62.5% of the distribution clustering at the highest and lowest *20*th percentiles. 37.5% of the infants produced vocalizations at rate that placed them at or above the *80*th percentile. 25.0% of the infants produced vocalizations that placed them in the *20*th percentile.

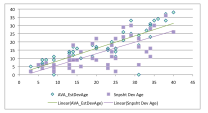




DEVELOPMENTAL MEASURES

The figures to the left display frequencies of occurrence of chronological ages, LENA Developmental Snapshot ages, and Automatic Vocalization Analysis Estmated Developmental ages (AVA), plotted in months. The mean Snapshot and AVA age equivalencies lag behind the mean chronological age. The mea AVA age lags behind the mean Snapshot developmental age by 4.35 months.

The scatterplot below displays the relationship between Snapshot and AVA age equivalencies across infant chronological age. AVA age remains higher than the Snapshot Developmental across ages. The slopes of the trend lines are almost identical, 0.70 for the Developmental Snapshot and 0.76 for AVA. This suggests that although each measure predicts different developmental levels, rate of change over time is equivalent.



CONCLUSIONS: Variations in degree of hearing loss did not create differences in vocal interactions as measured by LENA. Nor did the condition of bilingual input in the ambient language have an impact.

Individual variations were noted in the extent to which families managed the acoustic environment, with a few families living with more extensive periods of background electronic sources, noise or even silence than others in the sample.

When LENA measures were compared to values obtained from typically developing children and their families, 2 findings were obtained.
•Parents and caregivers tended to supply high rates of input to result in a mean AWC that was greater than the 50th percentile and a substantial proportion of families whose rate of input fell within the upper 20th percentile. This trend was also reflected in the rate of conversational turns that parents engaged.
•Infants, however, demonstrated variability in vocalization rates. Some vocalized at rates higher than or equivalent to their hearing peers, commensurate with other reports of equal volubility among infants with hearing loss and their typically developing peers.
•Still other infants vocalized at a much lower rate, possibly indicating a risk for slow development of spoken language.

Developmental measures indicated that infants with hearing loss lagged behind hearing peers in vocal behavior. Discrepancy was observed in the extent of delay as measured by the AVA Estimated Age and LENA Snapshot.

FUTURE DIRECTIONS: The individual variations observed will be analyzed further in order to identify factors that predict high *vs* low performance. Several variables were not used in this analysis that should be examined, specifically the duration of hearing technology use (*aka* hearing age) and the existence of other disabling conditions or health impairment. Finally, the vocalizations recorded by the DLP should be transcribed and analyzed to identify the source of discrepancy between parent reports of developmental level and developmental age estimated from LENA speech recognition algorithms. A working hypothesis is that infants with hearing loss produce a variety of vocal types that are coded by the LENA algorithm as being typical when they are not.