Identifying Reliable and Efficient Measures of Speech Processing Abilities: A First Step for Future Use with Deaf and Hard-Of-Hearing Infants

Karson Kennedy, Giovanna Morini, Ph.D.

University of Delaware

Abstract

Hearing loss affects approximately 3 in 1,000 newborns, making it one of the most common birth defects in the United States (Ross, Holstrum, Gaffney, Green, Oyler, & Gravel, 2008). Of those infants affected by hearing loss, 41% fall within the moderate to severe category of hearing loss. Within this category it is unknown whether a hearing aid (HA) or cochlear implant (CI) is the best form of amplification. Currently, candidacy for amplification is determined by anatomical and audiometric findings. Infants within this moderate to severe group typically go through a "hearing aid trial" that lasts up to six months prior to receiving CI's. The success of the HA trial is primarily based on parental reports and typically no detailed measures of speech perception are completed. Therefore, treatment recommendations are typically made without clear knowledge of what speech input, if any, the child is processing. The purpose of this paper is to present an analysis of individual and group data from typically developing hearing children who were assessed at three different times with a series of tasks that measured their speech processing abilities. The results will allow us to establish a task baseline and ultimately inform the field of infant speech perception by conducting test-retest reliability of these commonly used measures. If the tasks are found to be a reliable measure of speech processing ability in individual children, then this study will serve as a first step in determining a more efficient method of assessing deaf or hard-of-hearing (DHH) infants' speech processing abilities.

Background

- The intervention, language development, and academic achievement of DHH children is highly variable.
- The Early Hearing Detection and Intervention Guidelines recommend a hearing screening by 1-month of age, diagnosis by 3-months, and intervention by 6-months.
- For most DHH children, lengthy trials are necessary to determine if a HA or a CI is necessary.
  - Evaluation during the trial is based on auditory measures and parental reports and no measures of the infants' speech processing abilities
    - An infant "trialing" amplification that is inadequate further delays them in receiving auditory language input.
      - Delays in auditory language input early in life is correlated with decreased neural and language development and future academic achievement.

Purpose

- The study aimed to examine the test-retest reliability of two speech processing measures with typically-developing hearing children in order to establish a task baseline and depending on the findings from this first group, potentially extend these measures to be used with DHH infants.
- The study also aimed to determine if there is a predictive relationship between performance on speech processing tasks and later vocabulary outcomes.

Methods

- Participants included 30 typically-developing hearing infants who completed testing sessions at 6-months, 9-month, and 12-months of age.
- At each visit, participants completed two speech processing tasks (speech preference, vowel discrimination) and one measure of vocabulary (MacArthur-Bates Communicative Development Inventories (MCDI) Words and Gestures)
- Infants typically have a preference for speech over non-speech sound and can discriminate vowel sounds earlier than consonants.

Type of Measure	Visit 1	Visit 2	Visit 3
Speech Processing	I. Speech Preference II. Vowel Discrimination	I. Speech Preference II. Vowel Discrimination	I. Speech Preference II. Vowel Discrimination
Vocabulary	MCDI	MCDI	MCDI

- Participants completed speech processing tasks in a sound booth on a caregivers lap 4 feet from a monitor that played visual stimuli and auditory stimuli was played through speakers.
- A digital camera recorded participant's eyes in order to analyze looking patterns.
- **Task 1 Speech Preference:** Infants were presented with speech trials and speech-shaped noise trials while the visual stimuli remained the same.
- **Task 2 Vowel Discrimination:** Infants were presented with vowel sounds in two conditions, alternating (e.g., [a i a i a i …]) and non-alternating (e.g., [a a a a a a …]) while the visual stimuli remained the same.
- The infants' looking times to the visual display were averaged across test trials of the same kind.
- A Pearson's coefficient was used to analyze test-retest reliability during the speech preference task and the vowel discrimination task across all three visits.
- Additionally, a Pearson's correlation coefficient was used to analyze data from each speech processing task in relation to vocabulary outcomes at each visit.

Results

Correlation Coefficients of Speech Preference and Vowel Discrimination at 6-, 9-, and 12-Months of Age

Comparison	Task	# of Participants	*r*
Visits 1 & 2	Speech Preference	17	-.13
	Vowel Discrimination	18	-.14
Visits 2 & 3	Speech Preference	17	.02
	Vowel Discrimination	18	-.12
Visits 1 & 3	Speech Preference	17	.41
	Vowel Discrimination	18	-.23

*p < .05

Correlation Coefficients of Speech Preference vs. MCDI Score

Visit #	# of Participants	*r*
1	24	.05
2	21	.03
3	18	-.08

*p < .05

Correlation Coefficients of Vowel Discrimination vs. MCDI Score

Visit #	# of Participants	*r*
1	24	.34
2	20	-.27
3	19	.17

*p < .05

- The sample size in each of the eight analyses varied due to participants not yet completing all three visits as well as inability to obtain measures (uncooperative, no baseline, fluid in ears) or non-typical audiometric findings during testing session.

Implications & Conclusions

- Establishing a task baseline for speech processing measures that are reliable would allow us to use these measures with DHH infants and potentially assist in shortening the trial process and in turn provide DHH children with the adequate intervention/amplification much sooner.
- Unfortunately, our data to date suggest that there was no significant correlation of performance on the speech processing measures across the three visits, and thus we were unable to establish test-retest reliability.
- Additionally, there was no significant correlation between performance on the speech processing measures and vocabulary scores.

Directions for Future Research

- Future analyses should be completed on this study once more participants have completed all visits. This study is still ongoing and so data points are still missing.
- Future researchers may need to explore different speech processing measures and continue the search for tasks that will reliably measure individual differences across children and that might be used to examine speech processing abilities in clinical groups, such as DHH children.

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