Evaluation of Speech Perception and Production Error Patterns in Pediatric Cochlear Implant and Normal Hearing Children

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ABSTRACT

Cochlear implants (CIs) allow deaf children to achieve speech perception and production understandable to normal hearing (NH) listeners. Performance outcomes are associated with a wide variability of scores. It is generally assumed error patterns in speech production in children with hearing loss are driven by perceptual factors. However, the cochlear implant literature suggests complex relationships between perception and production (Kishon-Rabin et al., 2002). Limited information is available regarding associations between perception/production accuracy and error patterns in children with NH and using CIs. This study investigated these error patterns in children with CIs and NH children in order to evaluate relationships between perceptual confusions and production errors and their role in early childhood language development.

METHODS

PARTICIPANTS

• N = 13 NH children (4-7 years of age)
• N = 13 children using CIs (5-9 years of age)

SPEECH PERCEPTION AND PRODUCTION

• Modified version of the California Consonant Test (CCT) (Owens & Schubert, 1977)
• 12 consonants (/f/, /v/, /b/, /d/, /s/, /z/, /ʃ/, /ʒ/, /l/, /r/, /l/, /g/) (initial and final positions)
• Same words used in perception and production experiments
• Productions transcribed and compiled by four speech language pathologists using CASALA (Serry et al., 1997)
• Perception accuracy and error patterns analyzed using MATLAB

PERCEPTION AND PRODUCTION STIMULI

RESULTS

Figure 1. Response displays evaluating perception and production accuracy and error patterns. The words (sail, tail, pail, fail), target word “sail.”

Figure 2. Means and standard deviations for perception and production measures for CI and NH groups are shown. Paired t-tests indicated significantly lower scores for perception and production measures in final position for the CI group compared to NH (p<0.05). Significantly lower scores were observed for perception of final consonants in CI group compared to NH group (p<0.05).

Figure 3. Heat maps of the consonant errors for perception and production in NH and CI participants (darker colors represent greater number of errors). Diagonal elements (i.e., correct responses) have been removed to highlight the error patterns. Consonant error percentages are shown by the bars to the right of each heat map.

CONCLUSIONS

• Performance of the CI group was significantly lower than the NH group only for perception of consonants in final position.
• Initial consonants were perceived more accurately than final consonants in children with CIs but no difference was found for the NH children.
• Significant positive linear relationships were evident between perception and production accuracy across participants for both NH (r=0.75) and CI groups (r=0.70).
• Different error patterns were observed for both perception and production in the NH and CI groups. For example, CI users were more likely than NH children to substitute fricatives for stops, while substitution of stops for fricatives rarely occurred in either group. These error patterns suggest that therapy for CI participants needs to take into account both perception and production abilities.

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