

Variability in Speech Sound Production: Covert Contrasts in the Speech of Children with Cochlear Implants

Plenary speech by

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Covert contrast is often used as evidence against the traditional view that pronunciation shifts in children are caused by solely phonological changes (Scobbie, et al., 1996). As such, covert contrasts represent intermediate productions that are their own stage of learning, allowing us broader insight into how children acquire a phonological system (Hewlett & Waters, 2004). Additional support for this idea comes from the fact that children with speech sound disorders who produce covert contrasts have much better prognoses than those who do not (Byun, et al., 2015). The fact that a child produces a covert contrast between two phonemes suggests that he/she can perceive some difference between them (Byun, et al., 2015). The perception of subtle differences in speech sounds is essential for individuals who may receive a distorted or diminished speech signal, such as children who use cochlear implants (CIs).

This presentation will describe two projects in the area of covert contrast with children who use CIs. The first study focuses on the accuracy of speech sound productions in young children with CIs when compared to their speech age-matched normal hearing (NH) peers. The second project is a pilot investigation that considers the utility of different scales in the assessment of covert contrast.

Study 1. Nine children (mean age = 57 months) who were implanted by age 3 and had used their CIs for one year were matched by articulation age to 9 typically developing NH peers (Gonzalez, 2013). Speech sound testing revealed that phonetic inventory size and intelligibility were comparable across groups. Covert contrast analysis focused on the production of VCV non-words containing /t, d, tʃ/ taken from the OlimSpac (Boothroyd et al., 2006). Two different listening experiments were conducted that focused /t-d/ and /t-tʃ/ contrasts. Thirty-three graduate students in speech-language pathology rated the phonetic accuracy of the C produced in the VCV syllable using a visual analogue scale (VAS).

A confusion matrix of the children's productions on the OlimSpac indicated that /t/ productions in children with CIs were frequently distorted, despite phoneme mastery. The results of a 3-way repeated measures ANOVA revealed that children with NH showed a typical pattern of speech sound acquisition. The earlier developing /d/ had a large, well-developed contrast, however the later developing /tʃ/ showed little contrast with /t/. Children with CIs demonstrated the opposite trend. The t/d substitutions were much

more /t/-like, indicating that they were not making sufficient covert contrast and that /t/ was less developed than in children with NH. Children with CIs displayed a larger contrast for /t/ and /tʃ/ than the children with NH. This finding suggested that children with CIs struggled more with voicing than affrication. Children with CIs also showed a larger contrast for /tʃ/ than children with NH, supporting previous findings revealing earlier emergence of /tʃ/.

Taken together, these results suggest that children with CIs approach the speech acquisition task differently than children with NH. They may be attending to acoustic cues (such as aspiration) in an idiosyncratic way, or weighting these cues inappropriately. These perceptions may be a learned behavior, acquired from several years of aural habilitation, or a tendency that all children with CIs have due to the nature of the sound-processing in CI technology.

Study 2. This pilot study was designed to test the utility of different scales in measuring covert contrast. One scale was similar to a traditional VAS; it was a single line with "r" and "l" at the end points and "w" at the center. The other scale was triangular, with "r", "l", and "w" at each corner. Given the acoustic similarity of these phonemes and the common substitution patterns among them, the utility of a traditional VAS versus the new triangular rating scale was investigated. The goal was to evaluate the sensitivity of these scales in identifying covert contrast across participant group and phoneme.

Productions of /r, l, w/ were extracted from single words produced by the same participants in Study 1. These phones were arranged in listening experiments, each testing a different rating scale (VAS versus triangular). Students in speech-language pathology listened to the phones and rated the quality of production. Differences in scale utility were determined across speaker group and phonemes.

Results indicated that both rating scales were sensitive to subtle acoustic differences in speech sound production. However, listeners preferred the triangular scale for the /r, l, w/ contrast because it provided greater response sensitivity. Results also indicated more variability in sound production within CI users.