Critical Review:
What is the effect of frequency transposition on speech perception in children?

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This critical review examines the effect of linear frequency transposition (LFT) on speech perception in children. Study designs include: single group with repeated measures and one case study. Overall, the research failed to provide sufficient evidence to support the use of frequency transposition to improve the speech perception abilities in children with hearing loss. Future research should include more subjects, more homogenous hearing losses across subjects for group level analysis, valid and reliable procedures for measuring speech perception, and standardized hearing aid fitting and verification procedures.

Children with hearing loss require appropriate amplification for the development of speech and language (Stelmachowicz, 1999). High-frequency phonemes, such as /s/, /sh/ and /z/ are important speech sounds and grammatical markers.

and therefore effect audibility. Technology related speech perception benefit may be different across technologies.

Data Collection

hearing aids in a group of 16 children (aged 1.3 to 21.6 years old) with bilateral sensorineural hearing loss. The children, all previous hearing aid wearers, were fitted with the AVR Sonovation ImpaCt DSR hearing aids with frequency transposition using DSL I/O, RECDs and verified with real-ear measurements. Aided word recognition scores were obtained at 35 dB SL (re: PTA) with the Phonetically Balanced Kindergarten test presented using monitored live voice at fitting and at one month follow-up. Results of conventional hearing aids vs LFT hearing aids were compared using paired t-tests which showed LFT aids performing significantly better than conventional (SD = 15.7, 95% CI = 4–21, p = .006). The children showed a mean improvement of 12.5% in word recognition testing.

Weaknesses in the methodology limit what can be interpreted from the results. Neither the tester nor subject, were blind to the technology, this potentially introduces biases. Baseline measures were made with the children's previous conventional hearing aids. Electroacoustic characteristics of the previous hearing aids compared to the new ones alone could account for the improvement in speech perception seen. The previous hearing aids could have been set inappropriately and therefore only updating the hearing aids could account for the effects seen. The hearing losses were not well matched, making results of a group level analysis difficult to generalize from. There were also large age differences. Therefore, results must be interpreted with caution because of concerns with the methodology and design.

Rees and Velmans (1993) used a single group design to evaluate the effect of transposition on the untrained auditory discrimination of eight children, aged seven to twelve, with congenital high frequency hearing loss. The children were tested using the desk model FRED device coupled to TDH 39 headphones. The FRED device shifts the 4-8 kHz region to the 0-4 kHz region, this device has a traditional amplification channel and a transposition channel. Discrimination was tested with a two-alternative forced choice task, they were asked to pretend two robots could talk, one robot was pointed to while one word was presented, the other robot was pointed to with another word, then one word was repeated and the child had to point to "which robot said it". One list of monosyllabic words was presented under LFT, then two lists under no LFT and then one list under LFT again; repeated procedure using nonsense syllables. Retested between one and seven days after the initial test. Discrimination scores were analyzed using a repeated measures ANOVA with three within-subject factors (transposition vs no transposition, words vs without a soundbooth or audiometer, using live voice and sound level meter. Testing without a soundbooth increases the amount of variables that cannot be accounted for, such as ambient room noise. Testing with monitored live voice is more variable than testing done with a recorded speech signal and harder to compare to previous testing due to this variability. All the children had different teachers and resource teachers, and various amounts of auditory training and lip reading training outside of the study, adding confounds that cannot be accounted for. Double blinding did not occur as the tester was not blinded to whether the hearing aid was in LFT on or conventional processing. Therefore, results must be interpreted with caution because of concerns with the methodology and design.

The evidence provided by these five studies should be interpreted with caution because all of the studies included small sample sizes, ranging from six to sixteen subjects and each study had various methodological concerns that would lead one to question the results. When analyses are completed at the group level and the groups are small and not homogeneous this limits the ability to generalize the findings of the research to the greater population. Although all the studies would suggest a trend that their children benefited from the use of LFT the results could be attributed to various factors, such as developmental effects, training effects and differences in electroacoustic characteristics between baseline and study hearing aids. This testing was primarily done in an acoustically controlled environment which makes it difficult to extrapolate the results to real-world situations. Therefore there is limited evidence to support the beneficial effects of frequency transposition on the speech perception in children.

Future studies should include: larger sample size with well matched hearing losses, group level statistics, controlled acoustic conditions (soundbooth, audiometer, recorded speech sample), multiple valid and reliable outcome measures of speech perception,