Finding Appropriate Solutions to Treat Reduced Audibility in Kids: FASTRAK Conditioned Play and Listening Effort

Allison Duplain[1], B.A., Hailey Kingsbury[1], B.S., Elizabeth Walker[1], Ph.D., Ryan McCreery[2], Ph.D.
[1]Pediatric Audiology Lab, Communication Sciences and Disorders, The University of Iowa [2]Audibility, Perception, and Cognition Lab, Boys Town National Research Hospital

INTRODUCTION

- Approximately 30% of children with hearing loss have mild hearing loss (MHL)
- Current audiometric approaches make it difficult to differentiate normal hearing from MHL
  - Audiometric evaluations do not account for ear-canal acoustics or self-generated noise on threshold elevation (Buss et al., 2016; Voss et al., 2000; Voss & Hermann, 2005)
  - Speech recognition measures are not sensitive to mild hearing loss (McCreery et al., 2015).
- Children with MHL are often identified later and receive later intervention compared to children with other degrees of hearing loss (Fitzpatrick et al., 2010, 2014, 2016; Johnson et al., 2005; Walker et al., 2014, 2017)

RESEARCH QUESTIONS

1. How is threshold accuracy affected in preschoolers when using audiometric procedures that calibrate signal level in the ear canal?
2. How much does self-generated noise contribute to threshold variability in 3- to 5-year-olds?
3. What impact do speech maskers, spatial separation, and reverberation have on speech recognition thresholds and listening effort?

METHODS

STUDY 1

Participants: N = 36

- Parents did not report permanent hearing loss, visual impairment, or developmental delays

Behavioral Testing Conditions

1. Experimental FASTRAK CPA audiometry testing: 0.5, 1, 2, and 4 kHz
   1. FASTRAK software measures (1) ear-canal acoustics and (2) ambient noise level in dB SPL 100ms before and after the stimulus during hearing assessment
2. Clinical CPA audiometry testing: 0.5, 1, 2, and 4 kHz

STUDY 2:

Participants

- N = 32
- Parents did not report permanent hearing loss, visual impairment, or developmental delays

Conditions:

- Speech Shaped Noise (SSN) Co-located
- Two-Talker masker, Co-located, No reverberation
- Two-Talker masker, Co-located, reverberation
- Two-Talker masker, spatially separated

RESULTS

STUDY 1

- Linear mixed models were used to compare thresholds for children by condition and frequency, controlling for noise level, age, and listener sex
- Significant predictors of thresholds: (1) age and (2) noise

Age:

- Thresholds improved by 4.5 dB/year

Noise:

- Number of noisy trials decreased by 2.1 trials/year

Interaction of Condition & Frequency:

- FASTRAK dB HL and clinical audiogram thresholds were only significantly different at 500 Hz
- FASTRAK dB SPL thresholds were significantly higher than both the FASTRAK dB HL and clinical dB HL thresholds across all frequencies
  - Greatest difference was found at 500 Hz

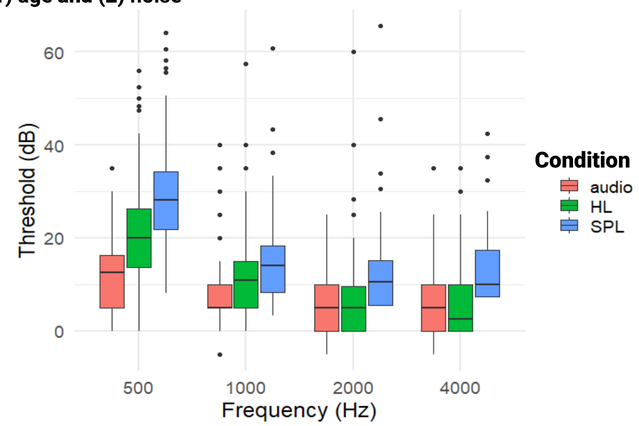


Figure 1. Interaction of threshold by frequency and condition. The three conditions are: (1) the clinical audiogram in dB HL (pink), (2) the FASTRAK audiogram in dB HL (green), and (3) the FASTRAK audiogram in dB SPL (blue).

STUDY 2

Speech Recognition Threshold:

Difficulty of speech recognition conditions were in the expected direction

- Hardest condition: two talker, co-located, with reverberation
- Easiest condition: Two talker, spatially separated

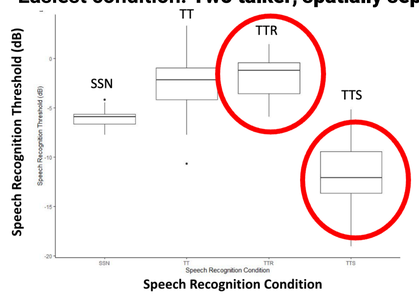


Figure 2. Speech recognition threshold by listening condition (lower scores mean better speech recognition threshold).

Subjective Listening Effort Ratings:

- No significant effects of listening effort on listening condition
- Significant variance in listening effort ratings across conditions

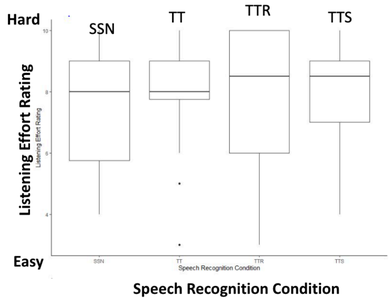
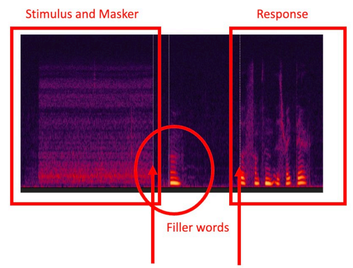


Figure 3. Listening effort ratings by condition

Results



- Verbal response time measured as a proxy for listening effort using Adobe Audition.
- Measured time between end of stimulus/masker and beginning of participants response
- Filler words (e.g., "um") not considered beginning of response

Verbal Response Time:

- There was a significant difference between speech shaped noise, co-located condition and two talker, co-located, no reverberation condition.
- No significant differences between other conditions

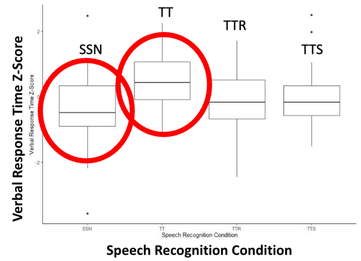


Figure 4. Verbal Response Time by condition

CONCLUSIONS AND CLINICAL IMPLICATIONS

STUDY 1

- Audiometric procedures that account for self-generated noise and ear canal acoustics provide more accurate threshold measures
- FASTRAK dB HL thresholds give a more accurate picture of threshold changes over time than those captured by the clinical audiogram
- Preschool-aged children have difficulty suppressing self-generated noise
  - Older children in this age group still had difficulty monitoring noise levels and produced higher levels of noise than younger children

STUDY 2

- FASTRAK SRT battery appears to be a sensitive measure of speech recognition in children
- Verbal response time measures, as a proxy for listening effort, suggest that the two-talker masker condition is more effortful than the speech-

FUNDING SOURCE & CONTACT INFORMATION

This project was funded by the NIH-NIDCD R01 DC 018330 (PI: Ryan McCreery).
Contact Information: Allison Duplain, allison-buerschen@uiowa.edu and Hailey Kingsbury, hailey-kingsbury@uiowa.edu