ADULT COMPREHENSION OF CHILD SPEECH

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BACKGROUND

Older adults frequently report increased difficulty understanding speech[1-2]. Speech produced by young children is generally less intelligible than adult talkers with 90% intelligibility typically not achieved until after the age of 5[3]. A common complaint from audiology patients is that they are having difficulty understanding their grandchildren. However, most research on speech intelligibility focuses on speech produced by adult talkers.

Child speech differs from adult speech in a variety of ways. Throughout childhood anatomical and neuromuscular systems continue to develop[4-5]. As a result, the acoustic cues a listener normally relies on to identify speech sounds do not occur within expected categorical boundaries[6-7]. Vowel formant frequencies in child speech are higher frequency and closer together compared to adult formants[4]. Vowel space has been shown to be an important factor in adult speech intelligibility[8-9]. A normal auditory system can distinguish formant frequencies from the background due to the narrow auditory filters that provide fine-grained discrimination in normal hearing. In contrast, an impaired auditory system with broader filters may result in vowels with closely spaced formants falling within the same critical band[10]. The listener is then unable to distinguish between vowels with similar formant frequencies[11-12]. Supporting this theory, a study by Bradlow et al. found that talkers with larger vowel spaces were generally more intelligible than talkers with reduced spaces[13].

METHODS

Nineteen adults aged 23-83 years (M=57) with a range of hearing thresholds (mean PTA= 25.43 dB HL) were recruited. Audiograms for 11 listeners with hearing loss are shown in Fig. 1.

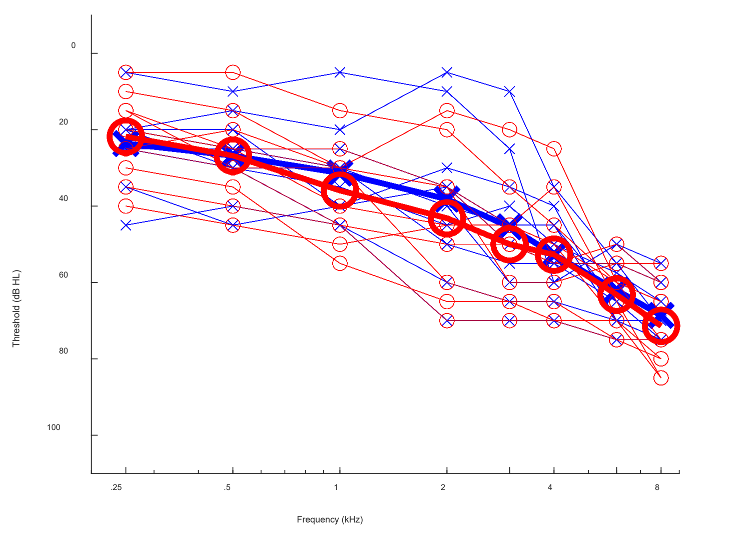

Figure 1: Audiograms for listeners with hearing loss

Child speech drawn from the Speech Exemplars and Evaluation Database (SEED) (Speights Atkins et al. 2020).

Six different child talkers (3 male, 3 female; mean age 4 years) with age-appropriate speech produced a set of single-syllable words.

Words were presented to listeners at audible levels over headphones. Participants were able to replay each word up to three times.

Speech intelligibility scores were obtained by tallying the number of words transcribed correctly relative to the number of target words.

Homophones (i.e. “no” vs “know”) and obvious misspellings (i.e. “sstick” for “stick”) were scored as correct.

LISTENER FACTORS

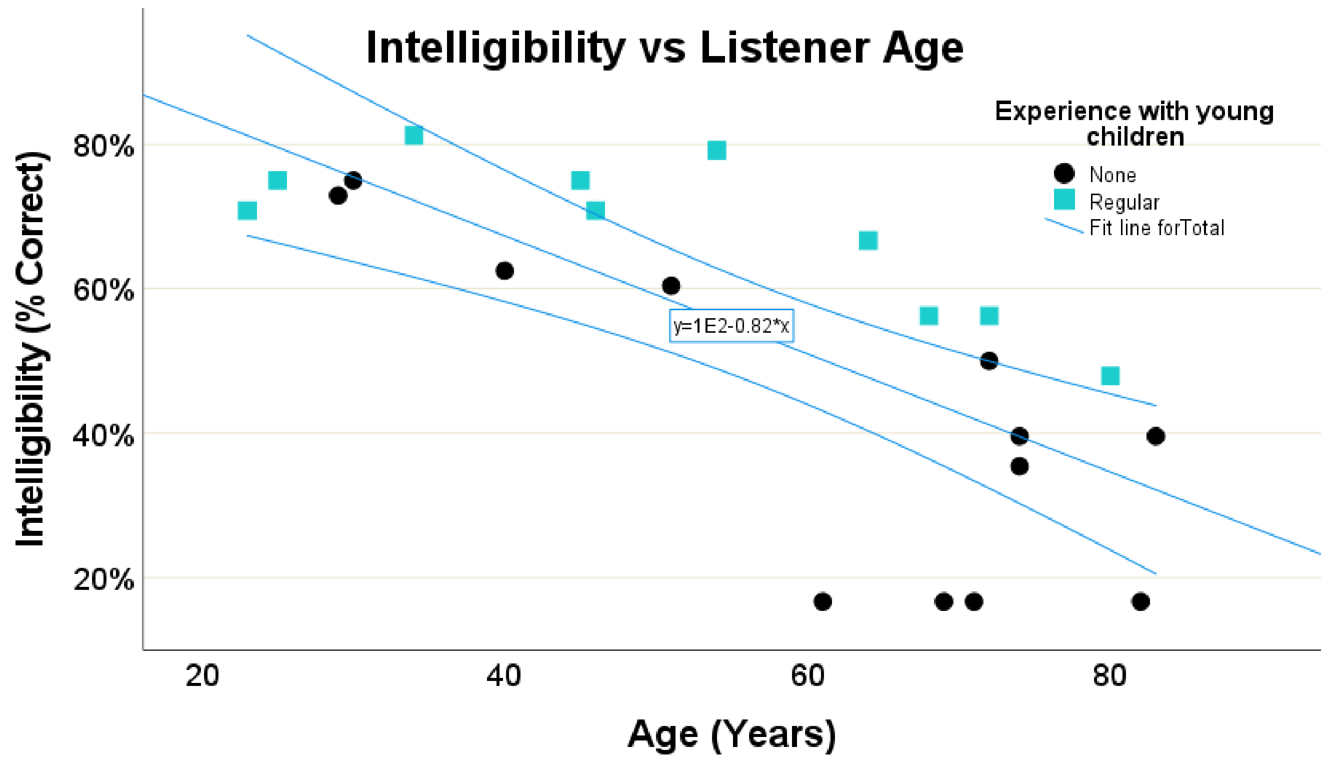

Figure 2: Speech intelligibility as a function of age. Blue squares depict listeners who reported at least weekly interactions with young children.

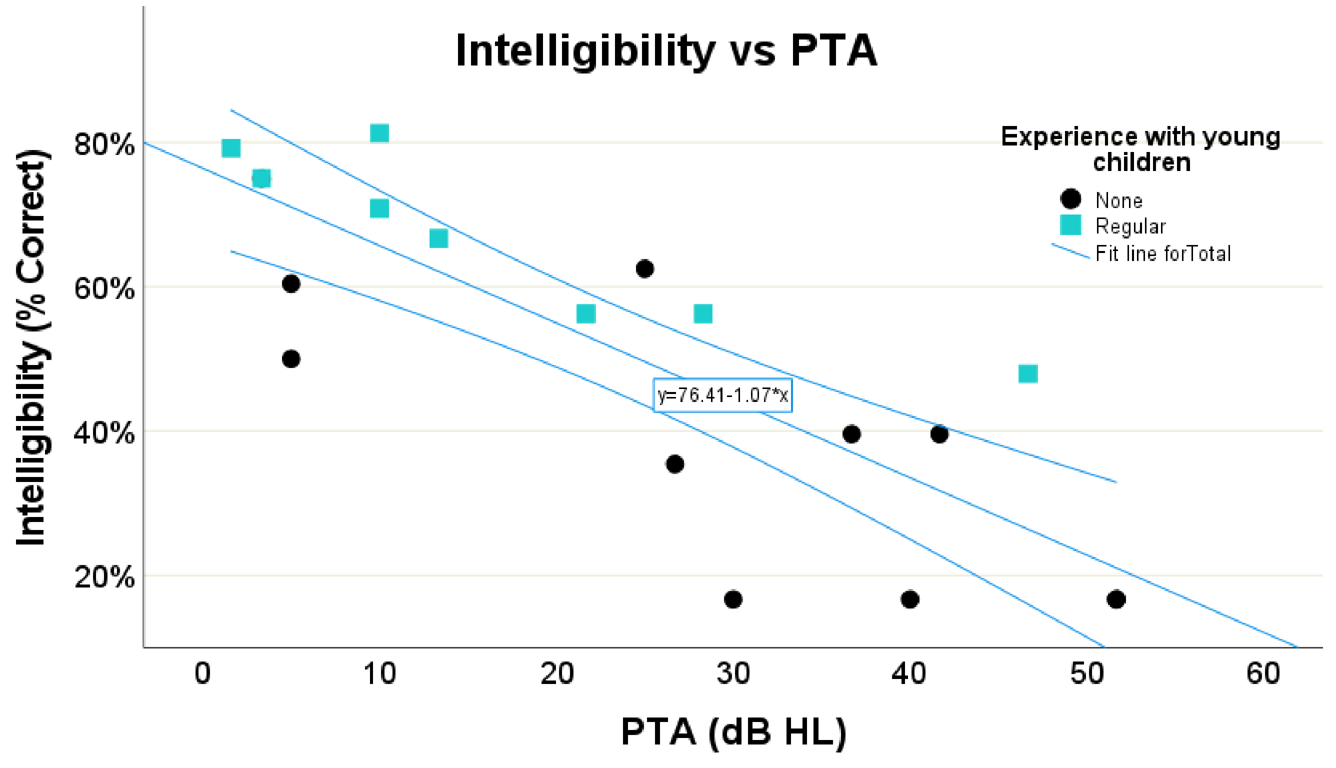

Figure 3: Speech intelligibility as a function of 3-frequency pure-tone average. Blue squares depict listeners who reported at least weekly interactions with young children.

Age

There is a trend of reduced intelligibility of child speech with increasing listener age. Performance variability was greater in listeners older than 60 years. Among older listeners, intelligibility scores were higher for participants who reported regular (daily or weekly) interactions with young children.

Hearing sensitivity

Despite audible levels, listeners with greater amounts of hearing loss demonstrated poorer intelligibility scores. Future goals include separating the effects of aging and hearing loss, and the extent to which hearing aids improve child speech intelligibility.

TALKER FACTORS

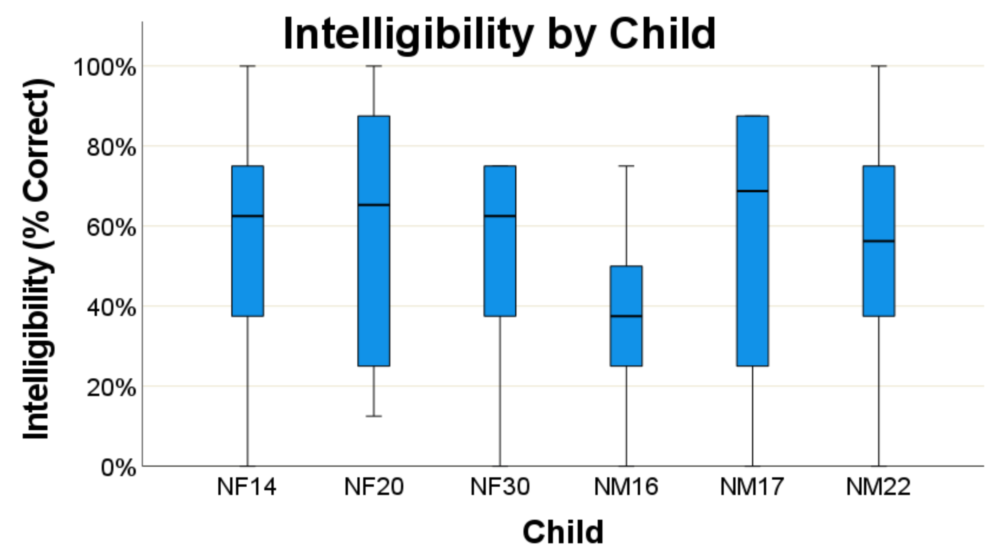

Figure 4: Individual talker intelligibility

Individual talker intelligibility

Some child talkers were more intelligible than others. Graph 3 (box plot) shows intelligibility by child talker based on performance of all listeners.

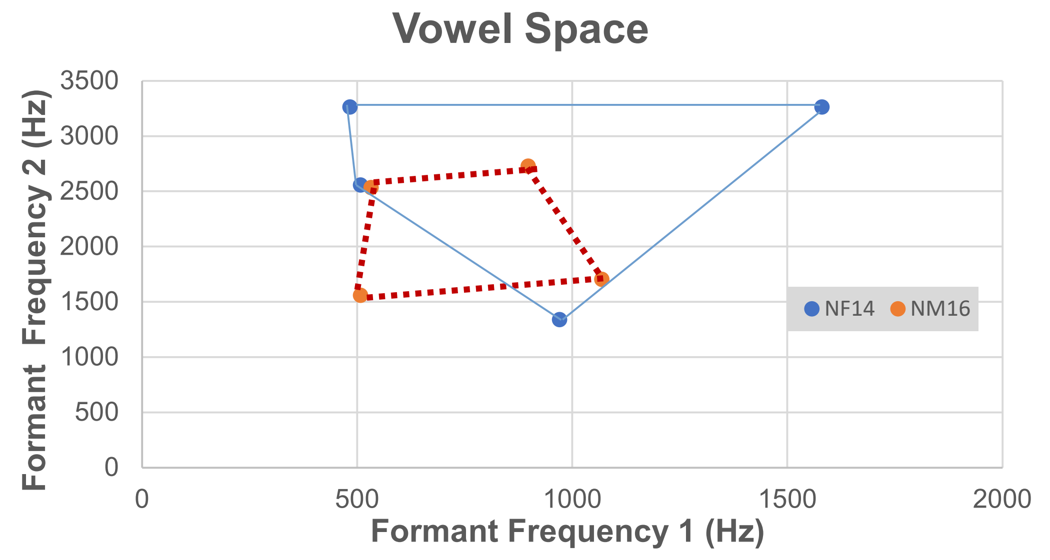

Figure 5: Illustration of vowel space

Vowel Space

Vowel space for one of the least intelligible talkers (NM16) and one or the more intelligible talkers (NF14) is depicted to the left. The F1 and F2 formants were calculated for the vowels “ee” , “oo” , “ae”, and “ah.” Each vowel was then graphed, with F1 on the x axis and F2 on the y. While the overall space of NM16 appears smaller, some of the vowels for NF14 are closer together. More analysis is needed.

CONCLUSIONS AND NEXT STEPS

1. Intelligibility scores for child speech are reduced when a listener is older and/or has more hearing loss. More frequent interaction with young children appears to mitigate the negative impacts of hearing loss and/or age.
2. Young normal hearing listeners perform well regardless of their level of interaction with young children.
3. Preliminary acoustic analysis is consistent with poorer intelligibility scores for children with smaller vowel space (i.e., more closely spaced formants). Detailed acoustic analysis of these effects and their impact for older listeners is underway in our laboratories.

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