Spatial Hearing Deficits in Normal-Hearing Listeners that Self-Report Hearing Difficulties.

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Introduction

There is growing interest in understanding why listeners with pure tone thresholds within the normal range might nevertheless report hearing difficulties in a variety of complex listening situations. Emerging evidence suggests that such individuals may suffer from a form of “hidden hearing loss” thought to be related cochlear synaptopathy that can result from noise exposure (Kujawa & Liberman, 2009). This form of hearing loss could negatively impact speech perception in adverse listening conditions such as when there is background noise, or when the speech signal is modified to be reverberant and time-compressed (Liberman et al., 2016). Currently, however, there are no reliable ways to diagnose hidden hearing loss (Bramhall et al., in press). This study evaluates the potential for using measures of spatial hearing abilities for this purpose, reasoning that such measures may be sensitive to the (binaural) distortions of auditory temporal information resulting from synaptopathy.

The objective of this study was to determine whether a sample of audiometrically-normal listeners with self-reports of hearing difficulties show deficits in objective measures of spatial hearing ability.

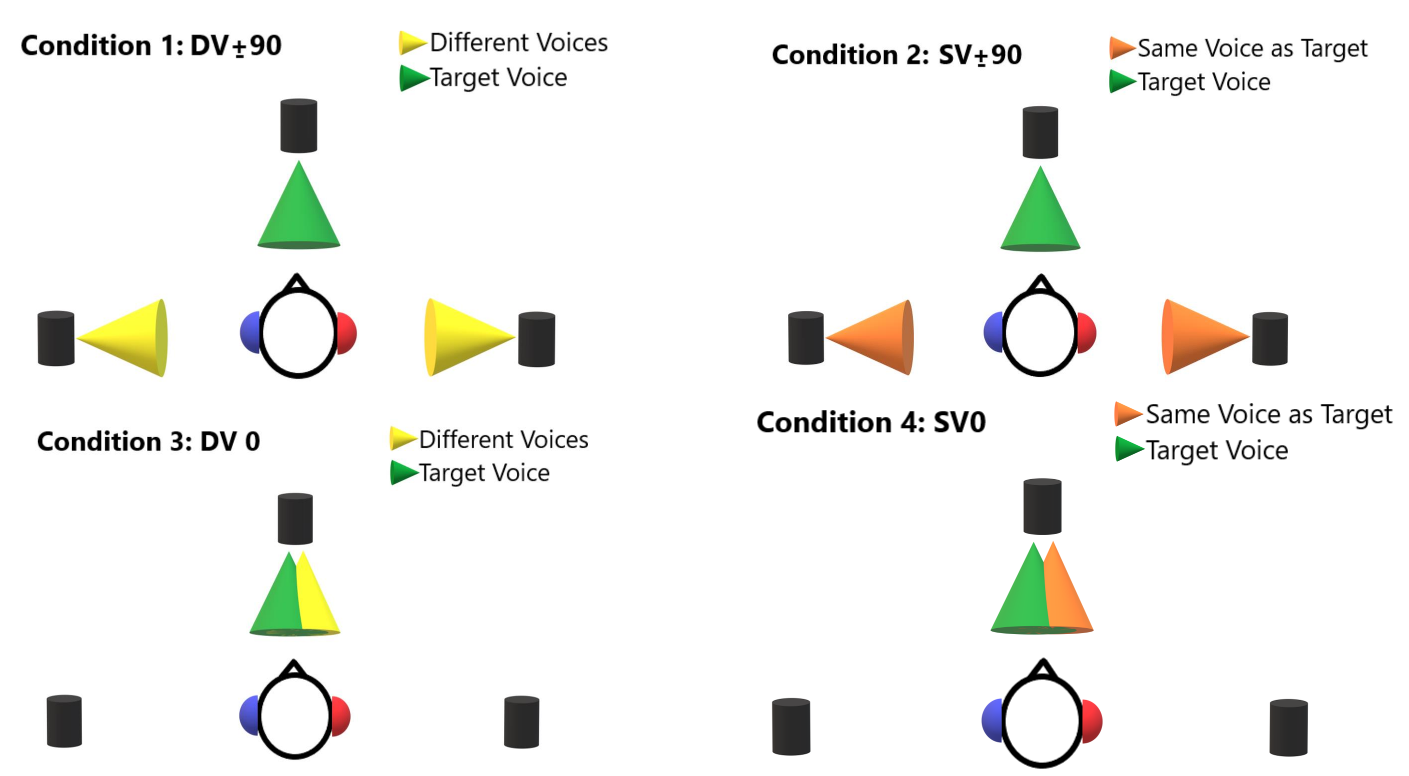
Methods

__Subjects__

- 26 adults (18-53 years of age) reporting hearing difficulties but normal (≤ 20 dB HL) or near normal (one subject, ≤ 25 dB HL) pure tone thresholds through 8,000 Hz

__Tests and Procedures__

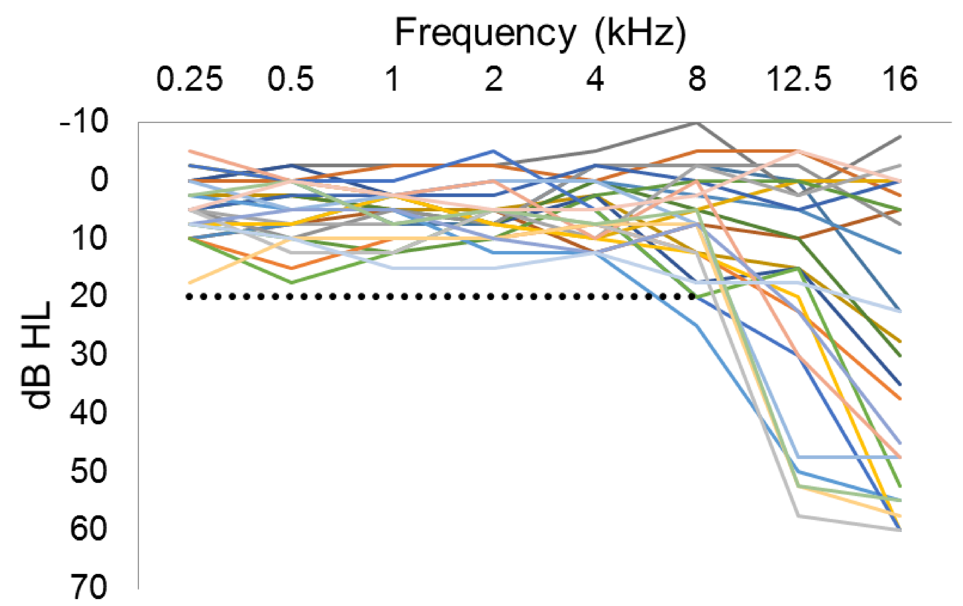
1. **Audiometry:** Pure tone audiometric thresholds were measured in each ear from 125 Hz to 16,000 Hz.
2. **Listening in Spatialized Noise – Sentence (LiSN-S) Test** (Phonak, Warrenville, IL):
   - Assesses listener ability to differentiate speech in spatialized background noise.
   - SNR 50% is measured in 4 different listening conditions:



3. **Interaural Phase Difference (IPD) Sensitivity:**
   - Measured the highest frequency (limit frequency) at which listeners could discriminate (75% correct) the difference between tonal signals with IPD of 0 degrees and 180 degrees.
   - Test similar to Füllgrabe et al. (2018), except that Bayesian procedure was used to adaptively vary tone frequency.
4. **Time-Compressed Sentence Intelligibility in Reverberation:**
   - Lists of six QuickSIN (Killion et al., 2004) sentences with five key words per sentence are presented at 70 dB HL in four-talker babble noise at a signal-to-noise ratio of +25 dB.
   - In each list the sentences were progressively time compressed, ranging from no time compression to 75% time compression in 15% compression steps.
   - The percentage of time compression that produced 50% correct performance was measured.
   - Three listening conditions: an anechoic room (Lists 9-12), a room with broadband reverberation time (T60) of 0.5s (Lists 1-4), and a room with T60 = 1.0s (Lists 5-8).

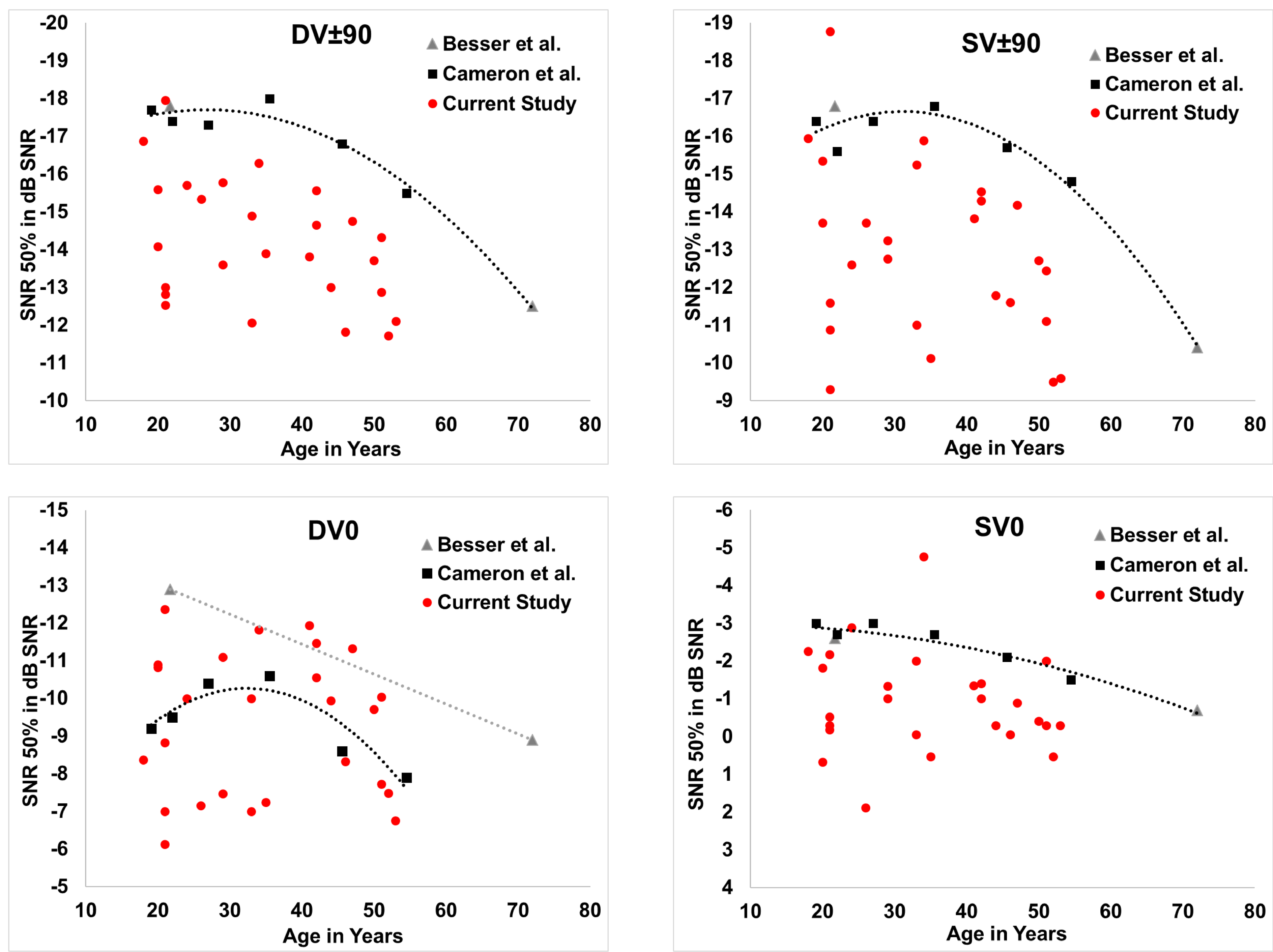
Results

1. Audiometry. Results from pure-tone audiometry (L & R ear average) demonstrate that all listeners fell within the normal or near normal (1 subject) range through 8 kHz. Results from high frequency audiometry were more variable, but controlling for age, did not predictably relate to any of the other measures reported here (LiSN-S, IPD, or Time-compressed speech in reverberation).



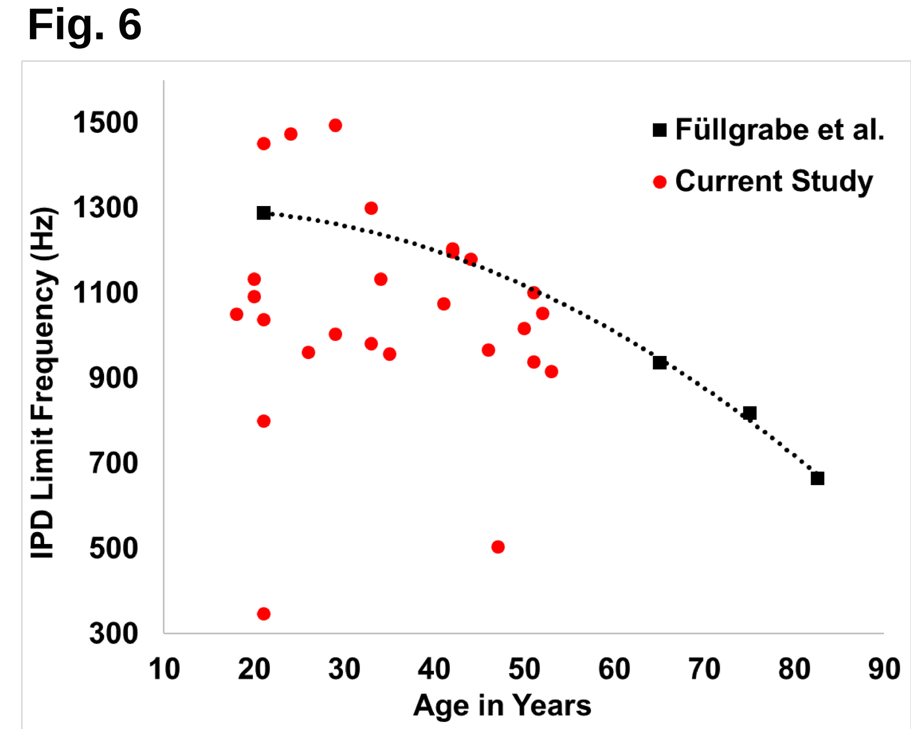
2. LiSN-S. Our study group means for each of the LiSN-S conditions were compared to predicted scores based on age (Figs. 1-4) from two sets of normative data (Besser et al., 2015; Cameron et al., 2011). Our participants scored significantly worse in all LiSN-S conditions (DV±90: $p<.00001$, SV±90: $p<.0005$, DV0: $p<.00001$, SVO: $p<.00001$).

Figs. 2-5



3. IPD Sensitivity. Similarly, our study group means for IPD Limit Frequency were compared to predicted scores based on age (Fig. 5) from normative data (Füllgrabe et al., 2018). Our participants had significantly lower IPD limit frequencies ($p<.005$).

Fig. 6

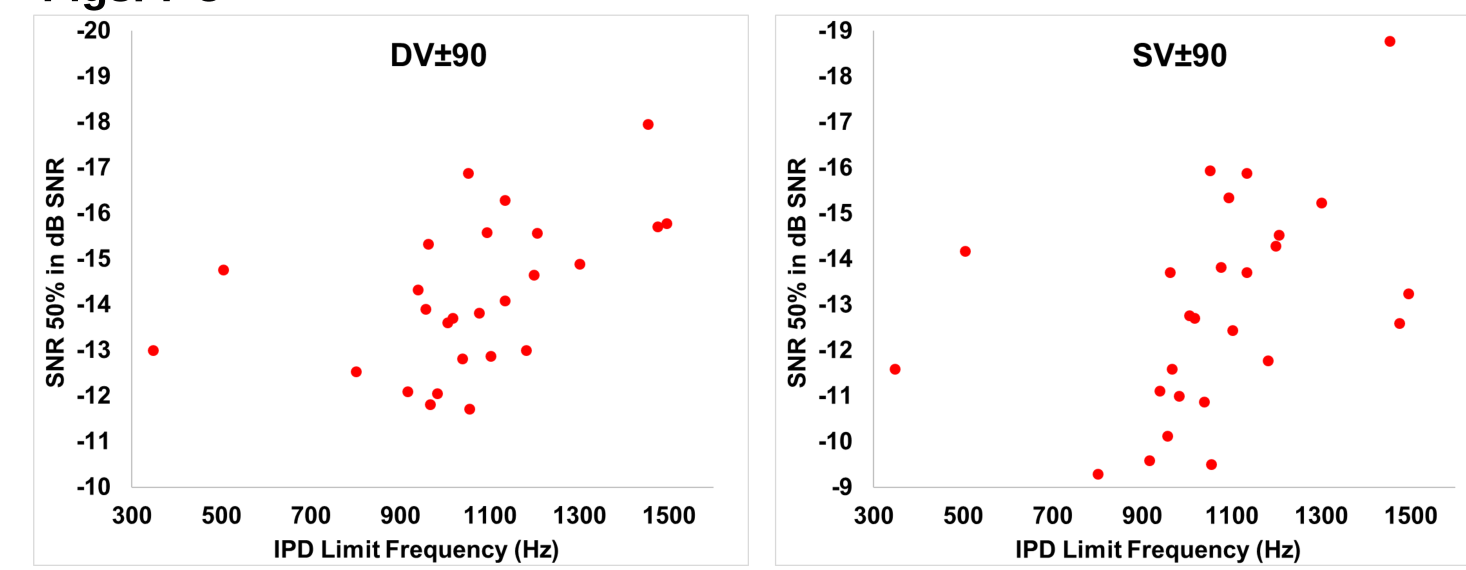


Poster available online:

Results Continued

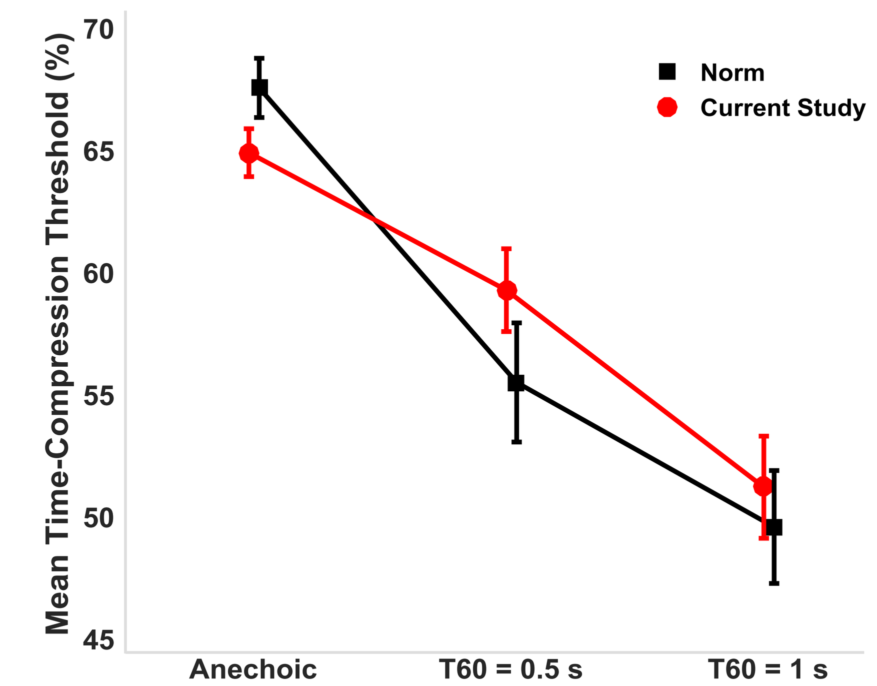
IPD limit frequency significantly correlated with the two LiSN-S conditions for which the target and masker voices are spatially separated: DV±90 (r_s = -.524, p = .006) and SV±90 (r_s= -.544, p = .004).

Figs. 7-8



4. Time-Compressed Sentence Intelligibility in Reverberation. Our study group's speech reception thresholds did not differ from normative data reported by Nunn & Zahorik (2018), p = .229 (means ±95% CIs shown below).

Fig. 9



Conclusions

This population was found to score significantly worse than norms on all LiSN-S conditions. Listeners also had significantly lower interaural phase sensitivity than norms, and these results correlated with the LiSN-S results in conditions that included spatially separated signal and maskers. This correlation is possibly linked to degraded binaural processing of temporal information in both cases. Intelligibility for time-compressed speech in reverberation was similar to that from a normative population, however. Overall, these results suggest that both the LiSN-S and IPD sensitivity tests may have diagnostic potential.

Acknowledgements

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