Relating Speech-in-Noise Tests with Different Sensory Demands to a Proxy of Cochlear Synaptopathy

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Participant Demographics

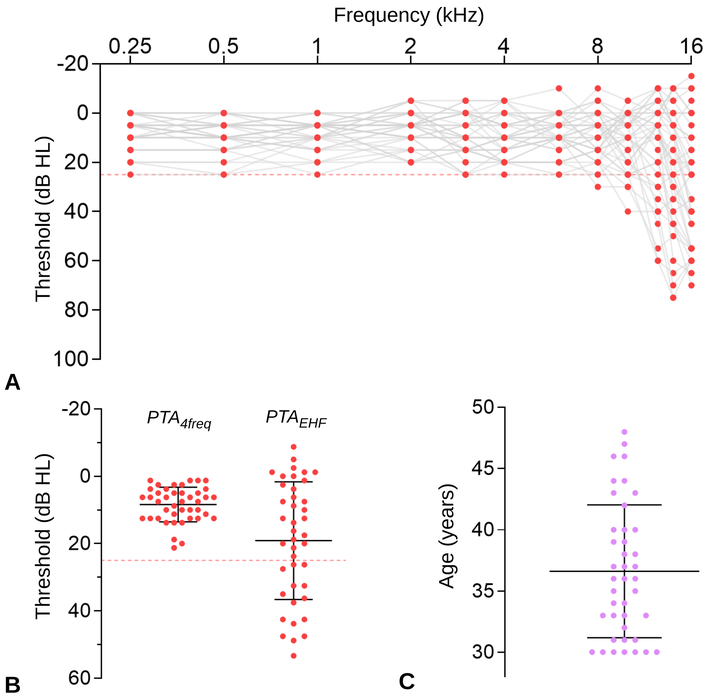

Figure 1. A) Right-ear thresholds from 0.25-16kHz. **B)** 4-frequency (4freq; 0.5, 1, 2, 4 kHz) and extended high frequency (EHF; 10, 12.5, 14, 16 kHz) puretone averages (PTA). **C)** Age distribution.

Speech-in-Noise Measures

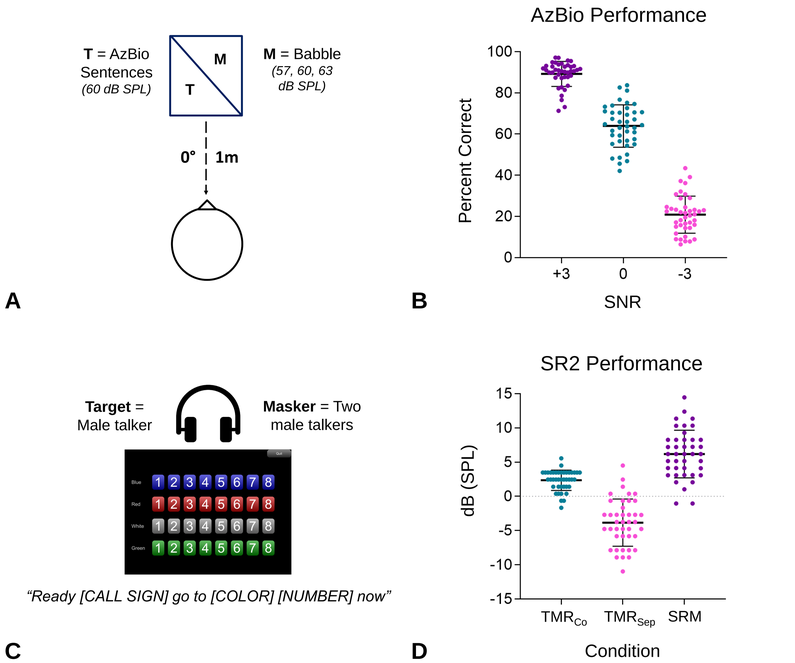

Figure 2. A) Schematic of AzBio presentation in soundfield. **B)** Performance distribution on AzBio at each SNR. **C)** Schematic of SR2 presentation on the iPad over headphones. **D)** Performance distribution on SR2. TMR = Target-to-masker ratio; Co = colocated condition; Sep = separated condition (maskers at ±45° azimuth). SRM = spatial release from masking.

Introduction

Deficits in understanding speech in background noise – despite clinically defined normal hearing – is suggested to be a perceptual manifestation of inner hair cell-spiral ganglion synapse degradation, known as cochlear synaptopathy. As the existence of cochlear synaptopathy in humans remains inconclusive, it is important to evaluate the tools used to assess both cochlear synaptopathy and speech-in-noise (SIN) deficits. SIN tests vary in the sensory, cognitive, and perceptual processes they engage, each uniquely influencing performance. A SIN test that employs top-down cognitive processes may result in compensation of existing sensory deficits, including the putative effects of cochlear synaptopathy. Thus, a SIN test that minimizes non-sensory factors and maximizes reliance on discrete sensory temporal cues should provide a stronger association with proxies of cochlear synaptopathy. To test this hypothesis, the current study compares two SIN measures with different demands to a proxy of cochlear synaptopathy in humans.

Methods

Participants

The presented data include **41 participants** *(mean age = 36.6 years; 21 female)*. All participants were native English speakers and had bilateral thresholds ≤ 25dB across standard audiometric frequencies.

Primary measures

1. **AzBio Sentence Lists**
   - Colocated at +3, 0, -3 dB signal-to-noise ratios (SNR)
   - *Outcome measure:* Percent correct

2. **Spatial Release from 2-talkers (SR2)**
   - Colocated and separated (±45° azimuth)
   - *Outcome measures:* Target-to-masker ratio (TMR) in colocated and separated conditions and spatial release from masking (SRM).

3. **Electrocochleography (ECochG)**
   - 90 dB SPL alternating click presented at 9.1/s and 21.1/s
   - *Outcome measure*: Change in compound action potential (cAP) peak-to-trough amplitude as a function of increasing click rate

Data Analysis

Associations between each SIN measure and cAP change in amplitude was determined through Pearson correlations. All statistics and data visualization were performed in GraphPad Prism v8.0.2.

Summary & Conclusion

No significant correlations were found between either SIN measure and our proxy of cochlear synaptopathy (cAP amplitude change with increasing click rate). This disproves our hypothesis that speech-in-noise tests with limited non-sensory factors and an emphasis on discrete sensory temporal cues are better related to measures of cochlear synapse integrity. Based on these results, we conclude that 1) the SR2 still had enough non-sensory cues to compensate for any existing sensory deficit, and/or 2) the chosen proxy for cochlear synaptopathy was not sensitive enough.

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ECochG: cAP Peak-to-Trough Amplitude

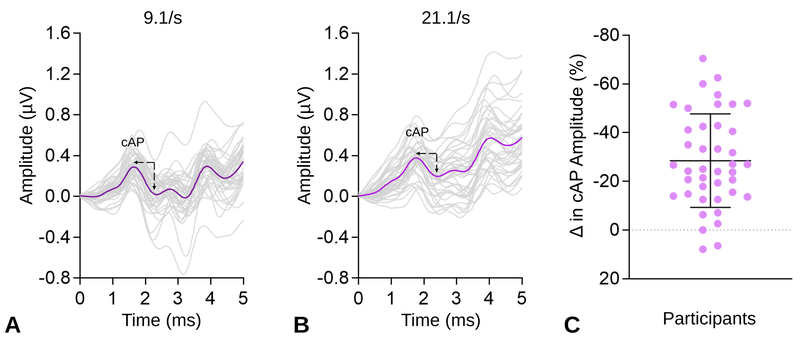

Figure 3. Grand average waveforms (n = 41) of electrocochleography responses to 100-μs 90 dB SPL alternating click presented at **A)** 9.1/s and **B)** 21.1/s. Grand averages are in bold; Individual traces shown in grey. Black arrows indicate the peak and trough used to measure cAP amplitude. **C)** Distribution of percent change (Δ) in cAP amplitude as a function of increasing click rate.

Results

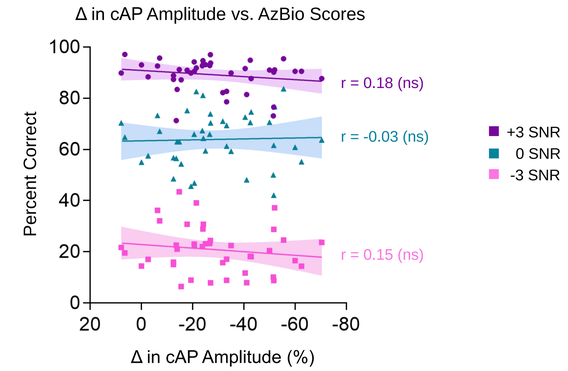

Figure 4. Correlation plot of change in cAP amplitude vs AzBio scores. Purple data = Individual data points and linear regression line for +3 dB SNR condition. Blue data = 0 dB SNR condition; Pink data = -3 dB SNR condition. No significant (ns) correlations found between proxy of cochlear synaptopathy and performance on AzBio across all SNRs.

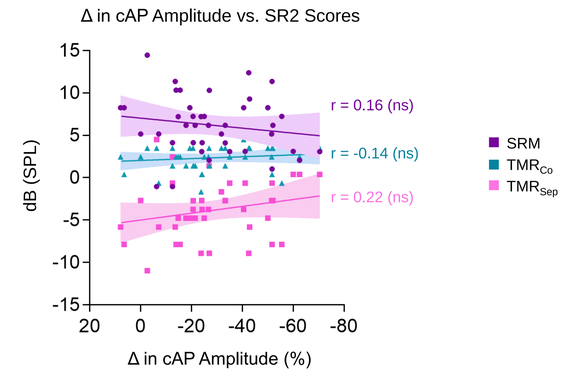

Figure 5. Correlation plot of change in cAP amplitude vs SR2 scores. Purple data = Individual data points and linear regression line for calculated SRM benefit. Blue data = Target-to-Masker Ratio in the colocated condition; Pink data = Target-to-Masker Ratio in the separated condition. No significant (ns) correlations found between proxy of cochlear synaptopathy and performance on SR2 across conditions.