



# Contribution of Extended High Frequencies to Speech-in-Noise Perception and Cognition

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## Introduction

- Hearing loss is highly prevalent in older adults.<sup>1</sup>
- Growing evidence suggests hearing loss in speech frequencies (0.5 to 4 kHz) is linked to:
  - difficulties in perceiving speech-in-noise (SiN)<sup>2</sup>
  - cognitive changes, including cognitive control<sup>3</sup>
- Emerging evidence suggests that hearing abilities in the extended high frequencies (EHF), 8 to 16kHz, also aids SiN perception and cognitive control performance.<sup>4,5</sup>
- The relationship of EHF to SiN and cognition in older adults is highly understudied and needs further examination.

## Purpose

- To examine the following relationships in older adults with varying hearing abilities:
  - EHF hearing (above 8kHz) and SiN perception
  - EHF hearing (above 8kHz) and cognitive control

## Methods

### Participants

40 older adults with varying hearing ability (26 F/14 M)

### Demographics

Age (years)	69.7 ± 7.3
Education (years)	17.7 ± 2.3
Better ear pure-tone average (PTA; dB HL)	24.7 ± 10.1

Cell values represent mean ± standard deviation

### Study Inclusion/Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> <li>&gt; 55 years of age</li> <li>Native English speakers</li> <li>Right-handed</li> <li>Minimum of high school education</li> <li>Both sexes</li> </ul>	<ul style="list-style-type: none"> <li>History of:               <ul style="list-style-type: none"> <li>Communication disorders</li> <li>Neurological diseases</li> <li>Major medical illness</li> <li>Major psychiatric disturbance in past year</li> <li>Alcohol or substance abuse</li> </ul> </li> <li>Learning disabilities</li> <li>Other known etiologies of hearing loss (e.g., injury induced, Meniere's disease)</li> <li>Unilateral, bilateral continuous tinnitus</li> <li>Major vision problems</li> <li>Geriatric Depression Score &gt; 5</li> <li>Montreal Cognitive Assessment score &lt; 26</li> </ul>

## Methods (cont'd.)

### Procedures

#### Audiological Assessments

- External ear examination using otoscopy
- Middle ear examination using tympanometry and reflexometry
- Pure-tone audiometry between 0.25 to 16 kHz
  - Better ear pure-tone average (PTA): average of hearing thresholds obtained between 0.5 to 4 kHz
  - EHF better ear average: average of hearing thresholds obtained between 8 to 16 kHz
- Speech audiometry, including Quick Speech-in-Noise (QuickSiN) test<sup>6</sup>

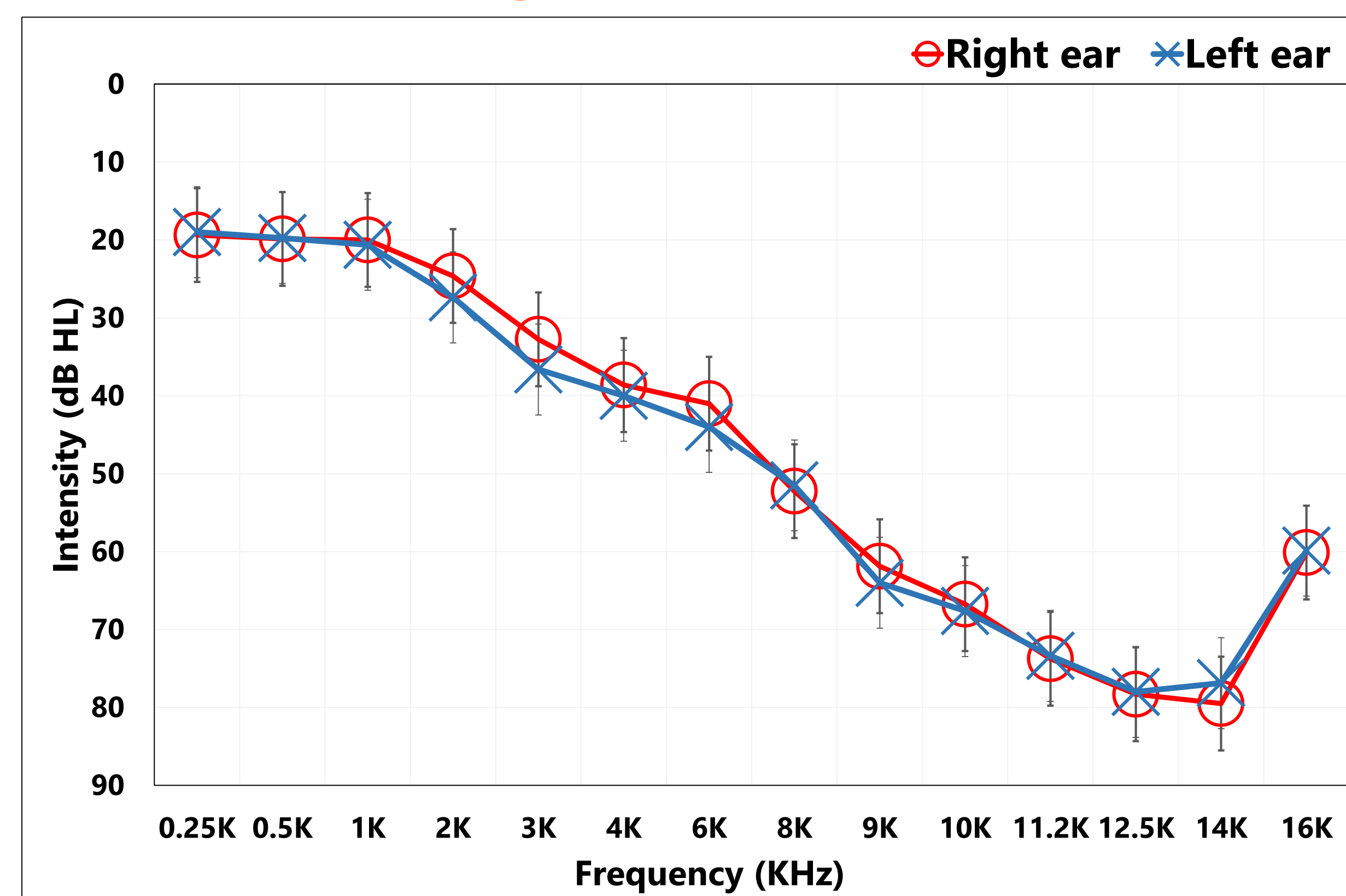
#### Cognitive Assessments

- Montreal Cognitive Assessment (MoCA) for screening cognition<sup>7</sup>
- Cognitive control assessments
  - Two Go/NoGo tasks: Single Car and Object Animal<sup>8,9,10,11</sup>
  - Trail-Making Test-B (TMT-B)<sup>12</sup>
  - Stroop: Color-word interference and color-word interference/switching<sup>13</sup>
  - Verbal Fluency: Category and Letter Fluency<sup>14,15</sup>

## Statistical Analyses

- SPSS Version 27
- Pearsons partial correlations between:
  - EHF better ear average and QuickSiN score
  - EHF better ear average and cognitive control measures
    - Controlled for PTA

## Mean Hearing Thresholds



## Audiological and Cognitive Measures

### Pure Tone Audiometry Measures

PTA (dB HL)	24.71 ± 10.10
EHF average (dB HL)	64.93 ± 14.99

### QuickSiN Scores

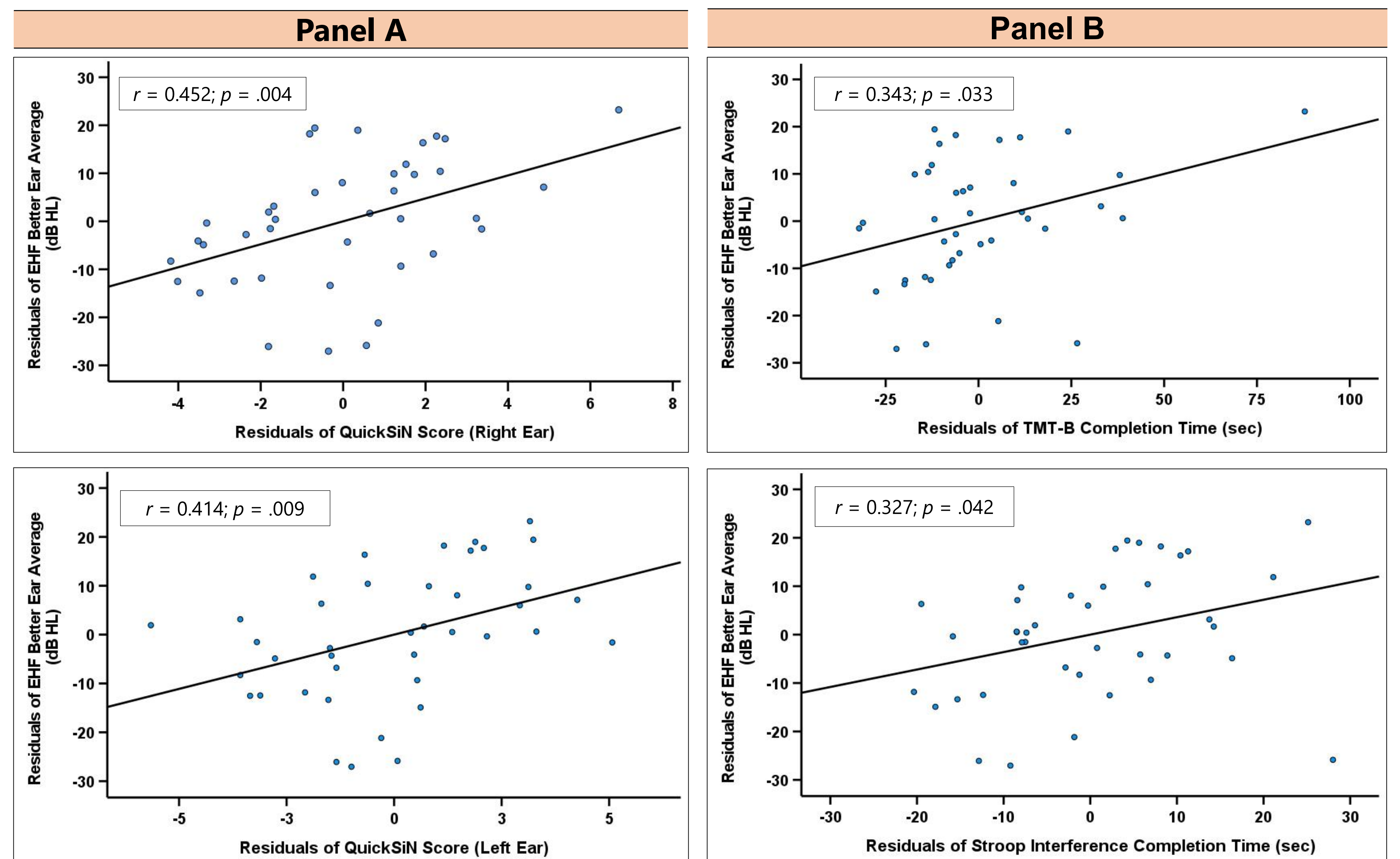
Right ear score	4.38 ± 3.01
Left ear score	4.37 ± 2.91
Binaural score	2.66 ± 2.39

### Cognitive Measures

Stroop interference completion time (sec)	57.17 ± 12.40
TMT-B completion time (sec)	69.41 ± 22.49
Stroop switching completion time (sec)	63.20 ± 17.07
Single Car Go accuracy (%)	0.93 ± 0.12
Single Car NoGo accuracy (%)	0.88 ± 0.08
Object Animal Go accuracy (%)	0.95 ± 0.06
Object Animal NoGo accuracy (%)	0.87 ± 0.16
Composite Letter Fluency	46.35 ± 12.27
Category Fluency - Animals	21.12 ± 4.56
MoCA score	27.42 ± 2.06

Cell values in both tables represent mean ± standard deviation

## Results



Pearson correlation plots. (A) represents correlation plots for EHF better ear average and QuickSiN scores in right and left ear after controlling for PTA. (B) represents correlation plots for EHF better ear average and cognitive control performance after controlling for PTA.

## Conclusion

- Worse hearing in the EHF is associated with worse recognition of SiN and poorer performance on cognitive control tasks in older adults.
- Our findings supports the importance of exploring the role of EHF in complex listening situations and cognition.
- Findings contribute to the emerging body of work on EHF, SiN, and cognition.

## Acknowledgements

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