Cognitive and auditory factors underlying the ability to understand speech-in-noise: clinical implications for diagnosis and rehabilitation

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## Early Indicators of Noise Injury

### STUDY DESIGN

<table>
<thead>
<tr>
<th>Behavioural</th>
<th>Electro-physiology</th>
<th>Hearing Experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 122 participants</td>
<td>• 62 participants</td>
<td>• 52 participants</td>
</tr>
<tr>
<td>• Online survey</td>
<td>• Five tests [CAEP’s, IRN, speech ABR, click ABR, EFR]</td>
<td>• Interviews &amp; online survey</td>
</tr>
<tr>
<td>• Audiology processing</td>
<td>• Designed to support behavioural measures</td>
<td>• Exploring listening difficulties, impacts and strategies</td>
</tr>
<tr>
<td>• Cognitive skills</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Results

**BEHAVIOURAL**

X No clear link between participants’ lifetime noise exposure and performance on auditory processing (AM, TFS, TEN) or speech-in-noise tasks (LISN-S, NAL-DCT).

- Musical training was associated with better performance on the auditory processing tasks, but not on the speech-in-noise tasks.

- The results indicate that:
  - sentence closure skills (TRT)
  - working memory (RST)
  - attention (TEA)
  - extended high frequency hearing thresholds
  - medial olivocochlear suppression strength
  - are related to speech-in-noise performance.

**ELECTROPHYSIOLOGY**

- Noise exposure and ABR amplitude

**HEARING EXPERIENCES**

- Inconvenience, self consciousness,
- Online communication training
Objectives

THE PROBLEM / OUR MOTIVATION

- Which factors predict the ability to understand speech in noise?

- Can we develop a clinical tool for predicting / confirming which normal hearing adults will experience difficulty understanding speech in noise?
Composite speech-in-noise score (CSS)

SELF REPORT PLUS TWO SPEECH-IN-NOISE MEASURES

CSS used to identify LOW and HIGH performing subgroups
Composite speech-in-noise score (CSS)

LOW AND HIGH PERFORMING GROUPS

No differences

- Education
- Exposure to ototoxic chemicals
- Noise exposure
- Musical training
- Amplitude modulation (4 Hz)
- MOCR strength
- Non-verbal intelligence

Significant differences

- Age
- Gender
- Hearing level (LF, HF, EHF)
- Temporal fine structure (TFS1)
- Amplitude modulation (90 Hz)
- TRT
- Attention
- Working memory
## Results

EXTENDED HIGH FREQUENCIES & WORKING MEMORY

### Multiple regression weights

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Performing</th>
<th></th>
<th>High Performing</th>
<th></th>
<th>Composite Speech Score</th>
<th>b</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>48.47</td>
<td>6.65</td>
<td>42.33</td>
<td>4.79</td>
<td></td>
<td>-0.02</td>
<td>0.05</td>
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<tr>
<td>Gender (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.21</td>
<td>0.05</td>
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<tr>
<td>LF hearing</td>
<td>7.67</td>
<td>4.29</td>
<td>5.10</td>
<td>3.84</td>
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<td>-0.01</td>
<td>0.47</td>
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<tr>
<td>HF hearing</td>
<td>14.53</td>
<td>8.35</td>
<td>8.58</td>
<td>6.14</td>
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<td>-0.01</td>
<td>0.54</td>
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<tr>
<td>EHF hearing</td>
<td>36.96</td>
<td>19.96</td>
<td>11.06</td>
<td>9.57</td>
<td>0.01</td>
<td>0.0062</td>
<td></td>
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<tr>
<td>TFS</td>
<td>66.65</td>
<td>44.04</td>
<td>36.46</td>
<td>25.36</td>
<td></td>
<td>-0.0023</td>
<td>0.08</td>
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<td>AM90</td>
<td>-22.93</td>
<td>4.31</td>
<td>-25.11</td>
<td>3.91</td>
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<td>-0.01</td>
<td>0.53</td>
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<tr>
<td>TRT</td>
<td>61.00</td>
<td>2.70</td>
<td>58.59</td>
<td>3.21</td>
<td>0.0004</td>
<td>0.06</td>
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<tr>
<td>Attention (TEA)</td>
<td>7.13</td>
<td>2.05</td>
<td>8.35</td>
<td>2.03</td>
<td></td>
<td>-0.01</td>
<td>0.70</td>
</tr>
<tr>
<td>Working memory (RST)</td>
<td>44.82</td>
<td>10.47</td>
<td>55.68</td>
<td>8.98</td>
<td>0.02</td>
<td>0.0006</td>
<td></td>
</tr>
</tbody>
</table>

Model Strength ($r^2 = .46$, $p < .001$)
Preliminary diagnostic criterion

TRANSLATING OUR RESULTS TO THE CLINIC

Low performers:
- 12.5 kHz threshold $\geq 25$ dB HL
- Reading span score below mean

High performers:
- 12.5 kHz threshold $\leq 25$ dB HL
- Reading span score above mean
Individual case

WHY IS THIS PARTICIPANT A LOW PERFORMER?
Rehabilitation options

DEVICES AND/OR WORKING MEMORY TRAINING

• No action

• Training
  – easy to do & achievable
  – feedback
  – sustainable

• Devices
  – extended bandwidth,
  – assistive listening, smart phone apps

• Reduce the noise source

https://www.flickr.com/photos/buckaroobay/3721809183
Thank you for listening!

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