Speech-in-noise processing in elderly hearing-impaired listeners with or without hearing aid experience: Eye-tracking and fMRI measurements
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INTRODUCTION

Wendt et al. (2014) developed an eye-tracking paradigm for estimating how quickly a participant can grasp the meaning of an acoustic sentence-in-noise stimulus that is presented concurrently with two similar pictures, only one of which depicts the sentence meaning correctly (the ‘processing time’). Previously, we found that hearing-impaired (HI) listeners with hearing aid (HA) experience had shorter processing times than HI listeners without HA experience, despite no differences in speech intelligibility (Habicht et al., 2016, 2017). Peele and Wingfield (2016) suggested that HI listeners recruit regions outside the core speech processing network (comprising middle temporal and inferior frontal gyri) to achieve speech comprehension. Here, we adapted the eye-tracking paradigm for functional magnetic resonance imaging (fMRI) measurements to address the following research question:

Is HI experience associated with reduced recruitment of brain regions core to the speech comprehension network?

EYE-TRACKING MEASUREMENTS

Speech material (Ussal et al. 2013)
Two sentence structures with different levels of linguistic complexity (’low’ and ’high’).

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
</tr>
</thead>
</table>

Picture sets
One picture illustrates the situation described in the spoken sentence (→ target). The other picture illustrates the same situation with interchanged roles (→ competitor).

Task
“Select the picture that matches the acoustic stimulus by pressing a button as fast as possible after the acoustic presentation!”

Outcome
Eye fixation rate over time allows estimating when the participant must have grasped the sentence meaning.

AMPLIFICATION

All stimuli spectrally shaped according to the National Acoustic Laboratories-Revised (Byrne et al. 2001) prescription rule using the Master Hearing Aid (Grimm et al. 2008) and presented via earphones.

RESULTS

Eye-tracking measurements

<table>
<thead>
<tr>
<th>Factor</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ling. complexity</td>
<td>21.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Listener group</td>
<td>5.5</td>
<td>0.026</td>
</tr>
</tbody>
</table>

fMRI measurements

Stimuli
Sentence-in-noise stimuli with corresponding picture sets from eye-tracking (SPIN<sub>corr</sub>, SPIN<sub>uncorr</sub>): Stationary speech-shaped noise with only one picture as baseline.

Task
“Select the target picture by pressing a left or right button after the acoustic presentation!”

Outcome
Brain activation as inferred via blood oxygenation level dependent (BOLD) contrasts.

CONCLUSIONS

Our results support the idea that HA experience (1) positively influences the ability to process noisy speech quickly and (2) reduces the recruitment of brain regions outside the core speech comprehension network, regardless of linguistic complexity.

REFERENCES


Participants

Matched groups of experienced (eHA) and inexperienced (iHA) HA users. Table 1: Mean age, PTA across 0.5, 1, 2 and 4 kHz, reading span (RS), and SRT<sub>50</sub> scores for the two listener groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yr)</th>
<th>PTA (dB HL)</th>
<th>RS (%)</th>
<th>SRT&lt;sub&gt;50&lt;/sub&gt; (dB SNR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>eHA (N = 13)</td>
<td>68.8</td>
<td>33.9</td>
<td>43.0</td>
<td>-1.6</td>
</tr>
<tr>
<td>iHA (N = 14)</td>
<td>68.8</td>
<td>31.1</td>
<td>38.9</td>
<td>-1.7</td>
</tr>
</tbody>
</table>

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