Age, hearing loss and cognition: susceptibility to hearing aid distortion

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Response to hearing aids continues to be quite variable, with some individuals reporting more benefit than others. This variability is particularly evident among older listeners. Recent work suggests that variable response to complex signal processing may be related to patient factors, including cognitive abilities. For example, older adults with good cognition benefit from fast-acting wide dynamic range compression (WDRC), while those with lower cognition do not1-2. We propose that the relationship between patient factors (including cognition) and benefit will also apply to other signal processing algorithms (e.g., frequency compression) that cause significant manipulations to the speech signal.

Purpose

This study investigated the contributions of age, cognition and hearing loss to intelligibility and quality of frequency-compressed speech.

Participants

40 older listeners classified as normal hearing through 4 kHz (n=14, 60-78 yrs) or hearing loss (n=26, 62-92 yrs).

Tests

1. Working memory (Reading Span Test, RST3-4). The participant is asked to recall – in correct serial order - either the first or the last words of a sequence of sentences shown on a computer screen.

Fig. 1. Test ear audiograms for hearing-impaired (left) and normal hearing (right) participants.

Cognitive and hearing

The plots at left illustrate the relationship between RST and intelligibility. Participants with high RST scores also had higher intelligibility scores. This is most evident in high-distortion conditions for listeners with hearing loss. Consider the data shown in panels 5 and 8, which represent the conditions with the greatest distortion (i.e., lowest HASIQ values). In both cases, Pearson r=.49 (p=.005). The effect disappears at high SNRs (data not shown).

Fig. 7. Intelligibility as a function of CR for speech in quiet. Each panel shows a different CR/CF combination (see Table 1).

Consistent with trends shown in Fig. 7, multiple regression models indicate that RST and hearing explain a significant proportion of the variance, accounting for up to 20% of the variance in quiet, and up to 50% of the variance in noise. In general, adding age did not significantly improve the model fit.

Summary

Quality ratings show similar patterns to intelligibility: hearing loss, RST and signal distortion all play a role.

Fig. 8. Quality as a function of CR and CF. In each panel, low and high (re: median) RSTs are compared. Top panels show normal hearing, bottom panels show impaired hearing.

Quality

Quality ratings show similar patterns to intelligibility: hearing loss, RST and signal distortion all play a role.

Table 3. p values for quality

<table>
<thead>
<tr>
<th>Conditions</th>
<th>SNR -10 dB</th>
<th>SNR 0 dB</th>
<th>SNR +10 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
<td>0.11</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Hearing</td>
<td>0.01</td>
<td>0.004</td>
<td>0.006</td>
</tr>
<tr>
<td>RST</td>
<td>0.05</td>
<td>0.002</td>
<td>0.007</td>
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<tr>
<td>Hearing x RST</td>
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<td>0.002</td>
<td>0.007</td>
</tr>
<tr>
<td>Hearing x RST x SNR</td>
<td>0.02</td>
<td>0.002</td>
<td>0.007</td>
</tr>
</tbody>
</table>

References


Notes: Error bars are 95% confidence intervals.

Acknowledgments

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