Voice discrimination in cochlear implant users

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Abstract

Due to the limited processing of spectral cues, voice discrimination might be restricted in cochlear implant (CI) users. A very basic representation of different voices is given by the speaker gender. Important characteristics are the fundamental frequency (f0) and the vocal tract length (VTL) which influences formant frequencies. Based on a natural utterance these parameters were explicitly modified and the resulting psychoacoustic effects were assessed in a speaker gender discrimination and a gender identification experiment. It could be shown, that CI-users need about two times higher changes in f0 and more than three times higher changes in the formant frequencies (F1 – F3) to discriminate different voices.

Methods

Stimuli were generated from an original utterance (male voice: f0 = 134 Hz; VTL = 13,5 cm). A short phrase (“Die Krankenschwester isst einen Apfel.”) was manipulated in terms of lowering or increasing f0 and/or modifying the length of the vocal tract and thus changing the formant frequencies, as can be seen in Fig. 1.

Experiment 1 (gender discrimination):

Stimuli were presented in a 3 AFC-procedure. Participants were advised to listen to three stimuli and to indicate the one which differed from the original. Minimum changes were 4 Hz in f0, 6 Hz in F1, 36 Hz in F2, and 60 Hz in F3.

Experiment 2 (gender identification):

Stimuli were presented in a 2 AFC-procedure. Participants were instructed to indicate whether the sentence was spoken by a male or a female voice.

Tab. 1 shows the set of nine different stimuli (labeled 2 to -2) used with the gender identification paradigm.

<table>
<thead>
<tr>
<th>Female</th>
<th>Original</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>f0</td>
<td>134</td>
<td>134</td>
</tr>
<tr>
<td>F1</td>
<td>756</td>
<td>756</td>
</tr>
<tr>
<td>F2</td>
<td>1407</td>
<td>1407</td>
</tr>
<tr>
<td>F3</td>
<td>2568</td>
<td>2568</td>
</tr>
</tbody>
</table>

Participants were 6 CI patients and a control group of 6 normal hearing listeners (NL).

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