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Effects of speech rate changes on kinematic movement characteristics and stability of speech movements were assessed in younger and older speakers using electromagnetic midsagittal articulography (EMMA). Several studies have indicated a general decrease in speed and accuracy of speech output in older compared to younger speakers [1-4]. In a previous study investigating repeated productions of syllables /pa/, /sa/ and /ta/ at different speech rates, we found that older adults when slowing down, more prominently increased duration and decreased peak velocity in closing movements compared to younger adults [5-6]. As a possible explanation we proposed that older adults may evidence a mechanism that facilitates a closed loop control system to maintain movement stability, possibly due to a reduced quality of somatosensory input. The aim of the present study is to investigate this phenomenon further using a repeated speech task with target words /api/ and /ipa:/, which regarding jaw and lips, involve three-step movement schemes consisting respectively of one closing and two opening movements and two closing and one opening movement (Tab. 1; Fig. 1).

Method & materials

Table 1: Description of the different phases in movement cycle of bilabial opening/closure for the reiterated productions of /api/ and /ipa:/.

<table>
<thead>
<tr>
<th>Target</th>
<th>Phase description</th>
<th>Duration (ms)</th>
<th>Young</th>
<th>Elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td>/api/</td>
<td>Full closure</td>
<td>330 ± 24</td>
<td>360 ± 28</td>
<td>400 ± 30</td>
</tr>
<tr>
<td></td>
<td>Bilateral closure</td>
<td>200 ± 12</td>
<td>220 ± 15</td>
<td>240 ± 18</td>
</tr>
<tr>
<td></td>
<td>Half closure</td>
<td>100 ± 7</td>
<td>120 ± 9</td>
<td>140 ± 11</td>
</tr>
<tr>
<td>/ipa:/</td>
<td>Full closure</td>
<td>320 ± 25</td>
<td>350 ± 29</td>
<td>400 ± 31</td>
</tr>
<tr>
<td></td>
<td>Bilateral closure</td>
<td>180 ± 13</td>
<td>200 ± 16</td>
<td>220 ± 19</td>
</tr>
<tr>
<td></td>
<td>Half closure</td>
<td>90 ± 6</td>
<td>100 ± 7</td>
<td>120 ± 9</td>
</tr>
</tbody>
</table>

Participants


Speech rate strategy

Speech rate (Fig. 2)

- Both groups successfully changed speech tempo across rate conditions (Rate: [F(2,64,859) = 75.039, p < 0.001]).
- Elderly adults were slower at normal and slow rates compared to young adults, but equally fast at the fast rate (Group [F(1,37,857) = 8.369, p < 0.05]. Group*Rate [F(2,64,859) = 7.945, p < 0.001]).

Movement cycle durations (Figs. 4 & 5)

- In the fast rate condition, no 3-step movement cycles were recognizable in the majority of utterances. Therefore, only the normal and slow rates are analyzable.
- When slowing down speech rate, the elderly adults increased the duration of the full opening from [p] to [a] in /api/ more compared to the young adults (Group [F(1,77,207) = 26.328, p < 0.001]. Group*Rate [F(2,103,748) = 4.544, p < 0.05]. Group*Movement cycle [F(10,54,127) = 5.705, p < 0.001]).

Results

Differences in the duration of bi-labial opening/closing movements between the normal and slow rates

- Elderly adult speakers appear to be capable of slower repetition rates while maintaining the same stability compared to young adults (Fig. 6).
- In contrast to our expectations, the results on 3-step movement cycles showed the most prominent increase for elderly adults compared to younger adults for the duration of the full opening from [p] to [a] in /api/ (Fig. 7).
- However, for both /api/ and /ipa:/, the results also indicate that elderly adults when slowing down, more prominently increased the duration of the vowel-to-vowel transitions compared to younger adults (Fig. 7).
- Together, these results can be interpreted as elderly speakers exploiting a strategy that favors closed loop control.

Discussion & Conclusions

- Elderly adult speakers appear to be capable of slower repetition rates while maintaining the same stability compared to young adults.
- In contrast to our expectations, the results on 3-step movement cycles showed the most prominent increase for elderly adults compared to younger adults for the duration of the full opening from [p] to [a] in /api/ (Fig. 7).
- Moreover, for both /api/ and /ipa:/, the results also indicate that elderly adults when slowing down, more prominently increased the duration of the vowel-to-vowel transitions compared to younger adults (Fig. 7).
- Together, these results can be interpreted as elderly speakers exploiting a strategy that favors closed loop control.

References