Developing a Model of Speech Production Using the Neural Engineering Framework and the Semantic Pointer Architecture

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Introduction

Goal of paper: Developing a biologically inspired large-scale model of speech production using the Neural Engineering Framework (NEF; Eliasmith 2013) and the Semantic Pointer architecture (SPA; Stewart & Eliasmith 2014)

Focus: Introducing a concept for modeling different speaking rates

Fig. 1. The large-scale model (Kröger & Bekolay 2019, Kröger et al. 2020) comprising seven modules; neuron buffers for neural representations of concepts (C), lemmera (L), phonol. forms (P), motor plans (M), gestures (G), somatosensory (S), auditory (A), visual (V) and orthographic states (O). Arrows indicate neural transformations.

The model

Simulation of a three-syllabic nonsense word

Fig. 2. The levels of the mental syllabary: motor plan level (syllable oscillators), SAMU level (gestures oscillators) and level for neural activation of muscle groups (neuron ensembles).

Results of simulations: measuring articulator velocities

<table>
<thead>
<tr>
<th>abbrev.</th>
<th>movement direction &amp; (dimension)</th>
<th>max vel. (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>aa_vow</td>
<td>lowering tongue body (vertical)</td>
<td>100 100 100</td>
</tr>
<tr>
<td>li_clos</td>
<td>closing the lips (vertical)</td>
<td>72 88 100</td>
</tr>
<tr>
<td>vph_open</td>
<td>lowering the velum (vertical)</td>
<td>76 88 100</td>
</tr>
<tr>
<td>gl_open</td>
<td>opening the glottis. (horizontal)</td>
<td>70 94 100</td>
</tr>
</tbody>
</table>

Tab. 1. Maximum movement velocities (rel. units) for different types of gestures

References

More literature: see homepage of Bernd J. Kröger: www.speechtrainer.eu