Cortical stimulation of verb processing
Svetlana Malyutina & Dirk den Ouden (Department of Communication Sciences and Disorders, University of South Carolina) s.malyutina@gmail.com

Introduction
• Verbs occupy pivotal roles in sentence construction, reflecting who is doing what to whom
• Disruption of verb processing might be an underlying cause of sentence comprehension and production deficits in individuals with aphasia (language disorder after focal brain damage such as stroke). Improvement on verbs \(\rightarrow\) improvement on sentences (Thompson et al., 2013).
• Brain areas associated with verb processing: angular / supramarginal gyrus (BA 39, 40) (den Ouden et al., 2009; Meltzer-Ascher et al., 2012).
• Brain stimulation can temporarily modify language processing (Monti et al., 2013)
  - In healthy speakers: improved verbal fluency, faster naming, etc.
  - In speakers with aphasia: improved picture naming, improved word repetition, etc.
• The present study:
  - Can brain stimulation modify verb processing speed and accuracy in healthy speakers?
  - Results might inform a follow-up study with speakers with aphasia.

Methods
• High-definition transcranial direct magnetic stimulation (HD-tDCS)
  - Acts on the resting membrane potential, modulating neuronal excitability (rather than directly causing them to fire)
• 21 healthy participants, mean age 22.3 years, 8 m, 13 f
• Electrode setups modeled in HD-Targets software
• Stimulation target varied between participants:
  - Left angular gyrus (area specific to verbs)
  - Left Broca’s area (general speech & language production area)
• Each participant had 3 stimulation sessions (on separate days, ~20 min each):
  - Anodal (supposedly ‘excitatory’)
  - Cathodal (supposedly ‘suppressive’)
  - Sham (=placebo; novel method: stimulation still applied for the full time but in a setup where the current supposedly bypasses the cortex).
• Participants were asked to rate pain & unpleasantness and to guess which session applied sham stimulation.

Results
Lexical decision accuracy: no significant effects of stimulation. Individual data:

<table>
<thead>
<tr>
<th>Stimulation of the left Broca’s area</th>
<th>Stimulation of the left angular gyrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nouns accuracy</td>
<td>Nouns accuracy</td>
</tr>
<tr>
<td>Verbs accuracy</td>
<td>Verbs accuracy</td>
</tr>
</tbody>
</table>

Lexical decision reaction times: no significant effects of stimulation. Individual data:

<table>
<thead>
<tr>
<th>Stimulation of the left Broca’s area</th>
<th>Stimulation of the left angular gyrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nouns reaction times</td>
<td>Nouns reaction times</td>
</tr>
<tr>
<td>Verbs reaction times</td>
<td>Verbs reaction times</td>
</tr>
</tbody>
</table>

Discussion & Future Directions
• HD-tDCS is a safe method with low pain & unpleasantness levels
• New approach to sham stimulation (stimulation applied in a setup supposedly bypassing the cortex) is successful in disguising which session is sham
• Naming data analysis currently in progress
• No behavioral effects in the lexical decision task:
  - Lexical decision task not sensitive enough (ceiling effect in healthy participants)?
  - Future direction: testing individuals with aphasia, who are not subject to ceiling effects
  - Effects of anodal and cathodal stimulation might be opposite depending on individual cortical structure (Datta et al., 2012)
• Statistical analyses accounting for this possibility (individual-level analyses; analyses collapsing over stimulation types; etc.)
• Individualized electrode setup modeling based on MRI scans of participants

References