Stimulation Induced Speech Effects of Deep Brain Stimulation in Parkinson’s Disease and Essential Tremor

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A look at our experience at UAB: In right handed patients, who have unilaterally placed DBS electrodes for ET or PD, are there stimulation-induced speech effects associated with brain hemisphere and/or target?

Study Design/Methodology:

Retrospective case-control study
200 patients, all right handed, all unilaterally placed electrodes

Outcome: Stimulation induced speech effect during acute provocative testing determined subjectively (pragmatic design)
Exposure: Laterality/Target?

Average of 9 observations per patient across a possible 10 observations:

OR Bipolar Montages: 3-0, 3-1, 3-2
Clinic Bipolar Montages: 3-0, 3-1, 3-2
Clinic Monopolar Montages: c0, c1, c2, c3
# Disease and DBS Target

<table>
<thead>
<tr>
<th></th>
<th>VIM</th>
<th></th>
<th>STN</th>
<th></th>
<th>GPI</th>
<th></th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>L</td>
<td>R</td>
<td>L</td>
<td>R</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>ET</td>
<td>4</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>PD</td>
<td></td>
<td></td>
<td>51</td>
<td>69</td>
<td>11</td>
<td>16</td>
<td>147</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>120</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>
## Univariate significance of hemisphere

<table>
<thead>
<tr>
<th></th>
<th>No SISE (N=1430) [76.43%]</th>
<th>SISE (N=441) [23.57%]</th>
<th>Total (N=1871) [100%]</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.288</td>
</tr>
<tr>
<td>Female</td>
<td>654 (77.6%)</td>
<td>189 (22.4%)</td>
<td>843 (100.0%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>776 (75.5%)</td>
<td>252 (24.5%)</td>
<td>1028 (100.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.323</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>69.542 (10.175)</td>
<td>69.005 (9.304)</td>
<td>69.415 (9.976)</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>37.000 - 92.000</td>
<td>38.000 - 92.000</td>
<td>37.000 - 92.000</td>
<td></td>
</tr>
<tr>
<td><strong>Hemisphere</strong></td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Left</td>
<td>899 (71.9%)</td>
<td>351 (28.1%)</td>
<td>1250 (100.0%)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>531 (85.5%)</td>
<td>90 (14.5%)</td>
<td>621 (100.0%)</td>
<td></td>
</tr>
</tbody>
</table>
Wilcoxon Rank-Signed Test Comparison by Percentage of SISE per Patient by Target and Hemisphere

Hemisphere
- Left
- Right

- GPI: p = 0.68
- STN: p = 1.3e-05
- VIM: p = 0.25

Percentage of SISE per Patient

Target
- GPI
- STN
- VIM
### STN Versus VIM Versus GPi – Odds Ratios

<table>
<thead>
<tr>
<th>Left Hemisphere</th>
<th>Odds Ratio (95% CI)</th>
<th>Right Hemisphere</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unilateral Left STN</strong></td>
<td>14.49*** (13.42, 15.57)</td>
<td><strong>Unilateral Right STN</strong></td>
<td>1.95 (0.73, 3.16)</td>
</tr>
<tr>
<td><strong>Unilateral Left VIM</strong></td>
<td>5.32*** (4.23, 6.42)</td>
<td><strong>Unilateral Right VIM</strong></td>
<td>0.81 (-1.44, 3.05)</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>0.04*** (-0.99, 1.06)</td>
<td><strong>Constant</strong></td>
<td>0.07*** (-1.08, 1.23)</td>
</tr>
</tbody>
</table>

**Observations**: 1,327 | **Log Likelihood**: -697.82 | **Observations**: 679 | **Log Likelihood**: -275.76
**Akaike Inf. Crit.**: 1,403.64 | **Akaike Inf. Crit.**: 559.53 | **Bayesian Inf. Crit.**: 1,424.40 | **Bayesian Inf. Crit.**: 577.61

*Note:*  
* p<0.1; ** p<0.05; *** p<0.01
Probability of SISE with Left Unilateral STN versus Left Unilateral VIM in Right Handed Patients

Using Unilateral Left VIM as a reference

OR = 2.70
p-value = 0.000351*

* = Statistically Significant Difference Relative to Unilateral Left VIM
Contact #'s:
3-1 3-0 3-2 3-1 3-0 C3 C2 C1 C0

Clinic
monopolar

Clinic
bipolar

Clinic
monopolar

Left STN
Left VIM
Left GPi
Right STN
Right VIM
Right GPi

Ventral
Dorsal

OR
bipolar

3 2 1 0

SISE
Conclusions
• Speech effects do lateralize -- theoretically
• Stimulation induced speech effects
  • Left STN > Left VIM > Other four targets are similar
• Left STN is 1 volt more sensitive to speech effects than either GPi (not shown)
• Deeper the contact that is stimulated, the more speech effects

Limitations and Future Directions
• Retrospective case control, good Class III evidence at best
• No objective measure for speech effects
• Low number of right VIM, and right GPi
• No correlation between acute provocation and chronic outcome
• Very difficult to control for pre-existing speech impairment in PD patients
• Currently just hypothesis generating study for future class I/class II studies
• GPi power is 75% at moderate effect size. Could be better.