MEG Coherence Imaging in Stuttering

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Introduction

- MEG was used to explore the neural connections in people who stutter (PWS) compared to people who do not stutter (PWNS)

- Two areas we studied:
  - Activation patterns of the cognitive neural pathways during speech tasks
  - Default mode network – how the brain works at rest
Magnetoencephalography (MEG)

- Noninvasive neuroimaging technique that was used in this study to measure neural networks directly in real-time
- Combines high temporal resolution and high spatial resolution
Neuroimaging Comparisons

- fMRI /PET: high spatial resolution
- EEG: high temporal resolution

- Only MEG has high temporal and spatial resolution
MEG and Stuttering

- MEG has been used to localize brain regions activated during language processing in normal subjects and in PWS.
- Differences in cortical organization between SWS and fluent speakers have been found, but the studies acknowledge that more detailed studies are required to determine the functional roles of the areas affected.

Default Mode Network (DMN)

- Network of brain regions that are active when a person is in a resting state – awake and alert, but not actively involved in a goal-directed task
- Past: most neurons in the brain are quiet until they are needed for some activity
- Now: the brain remains active, even when the body is at rest
Default Mode Network (DMN)

- Frequency of oscillations
- Network = those areas of the brain that are functioning at same frequency at a given time
- DMN = the network that is functioning when a person is at rest
Abnormal DMN

- Schizophrenia
- Alzheimer’s disease/mild cognitive impairment
- Autism Spectrum Disorders
- Attention deficit/hyperactivity disorder
- Epilepsy
- Tinitis
Method

- **Subjects**
  - 9 adults who stutter (AWS)
    - Ages 21 - 52
  - 7 control subjects matched for age and gender

- **Data Collection**
  - Verb generation task
  - Oral reading of single words
  - Rest state data was collected for 10 minutes while subjects were quietly lying on their backs, with eyes open
Results

- Statistically significant (p-value < 0.0001) delay in Broca’s area activation in PWS compared to controls
- Statistically significant (p-value < 0.0001) difference in coherence levels between PWS and controls in Broca’s area
- Stuttering patient population had a mean coherence 2 times greater than the mean coherence of the control subject population (indicating much higher levels of activation at rest)
Activation Amplitude and Timing During Verb Generation

A: Subject Who
Stutters: Latency = 0.44 seconds
B: Control Subject:
Latency = 0.33

Noticeably later
Broca’s activation
In the SWS

Higher amplitude
of Broca’s
Activation in the
SWS
Delay in Broca’s activation

- Statistically significant (p-value < 0.0001) delay in Broca’s area activation in PWS compared to controls

### Broca’s Activation During Verb Generation

<table>
<thead>
<tr>
<th>Group</th>
<th>95% CI</th>
<th>Mean Lat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWS</td>
<td>0.427 to 0.470</td>
<td>0.45</td>
</tr>
<tr>
<td>Controls</td>
<td>0.322 to 0.379</td>
<td>0.35</td>
</tr>
</tbody>
</table>

### Broca’s Activation During Reading Aloud

<table>
<thead>
<tr>
<th>Group</th>
<th>95% CI</th>
<th>Mean Lat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWS</td>
<td>0.414 to 0.453</td>
<td>0.43</td>
</tr>
<tr>
<td>Controls</td>
<td>0.342 to 0.415</td>
<td>0.38</td>
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</tbody>
</table>
Significantly Higher Coherence in Patients Who Stutter vs. Controls
Mean coherence was 2 times greater in PWS than in the control subject population.

DMN Analysis of Broca’s Area

- Stutter
- Control

Mean Coherence

0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5
Higher coherence levels in Broca’s area in the DMN… SO WHAT?

- If Broca’s is already operating when not needed, it is not as easily accessible when needed.
- It then needs to be re-directed, causing a minor delay that may result in difficulty initiating speech production.
- It may then continue to function at a higher amplitude due to continued activity as a result of the DMN as well as initiating speech production.
- Areas of the DMN not functioning as efficiently may be, at least in part, a cause for the dysfluencies experienced.
Implications/Future Research

- Pilot study
- More data needs to be collected to draw more specific conclusions
- A wider variety of age groups need to be explored to determine if the DMN is something that has been effected by the stuttering or if it contributes to the cause of stuttering
- As the DMN is more clearly understood, it can help shape treatment strategies
- The fine spatial and temporal resolution of MEG makes it possible to study brain activation differences that are undetectable with other imaging techniques
Thank you for your Attention

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References for Information on DMN