Beta band oscillations during basic sentence comprehension in patients with schizophrenia

Introduction

Beta band oscillations during language processing
• In language comprehension we bind words together into a coherent message-level representation and predict which words are likely to come up next.

"It was windy so the children went out to fly their …" - The gray mouse quickly scurried underneath the dusty rug

Sentences:
• Word by word presentation
• 300 ms word, 100 ms blank
• No task

Methods

Demographic and Clinical Information

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>Male/Female</td>
<td>14/3</td>
<td>17/2</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>26.8 ± 2.39</td>
<td>25.2 ± 2.39</td>
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<tr>
<td>Hollingshead Index</td>
<td>2.58 ± 0.087</td>
<td>2.72 ± 0.08</td>
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<tr>
<td>Education (years)</td>
<td>12.88 ± 2.82</td>
<td>12.68 ± 1.48</td>
</tr>
<tr>
<td>Promontor V4a IQ</td>
<td>111.68 ± 9.04</td>
<td>100.78 ± 11.66</td>
</tr>
<tr>
<td>CF7 Equivalent</td>
<td>N/A</td>
<td>485.45 ± 229.35</td>
</tr>
<tr>
<td>Duration of Illness, y</td>
<td>N/A</td>
<td>18.34 ± 8.16</td>
</tr>
</tbody>
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Recording:
• NeuroMag Vectorview MEG system, 102x3 sensors, only planar gradiometers reported

Preprocessing:
• Removal of eye blink, heartbeat and muscle artifacts
• FieldTrip toolbox and MNE toolbox
• Analysis of power in the lower frequency bands (4-30Hz): Multitapers, 2 Hz half-bandwidth

Analysis:
• Time window: 500 ms around each word, and full length of sentence from 3rd word onwards
• Statistical inference within and between groups with permutation tests and clustering

Source localization in the frequency domain using DICS beamformer

Sensor level analysis (Sentences vs. Wordlists):

Power spectrum (over all sensors)

Controls

Patients

Normalised frequency differences between sentences and wordlists averaged over individual words

Controls: Power increases in the beta frequency band to sentences (> wordlists)

Patients: No such increases to sentences (> wordlists). A hint of increased beta activity to wordlists (> sentences).

15-20 Hz (beta) topographies (over the entire sentence)

Controls vs. Patients

Controls

Patients

* Significant sensors, non-parametric cluster statistics

Results

A parallel fMRI study (same participants, same stimuli)

Controls vs. Patients

Wordlists-Fixation

Sentences-Fixation

This difference is driven by an inappropriate increase in activity within these regions to wordlists in patients, i.e. patients, but not controls, recruit left IFG & superior anterior temporal cortex to wordlists (vs fixation).

Conclusions

• Patients with schizophrenia show an abnormal reduction in beta band activity within temporal & parietal regions to coherent sentences but an abnormal increase in beta band activity to lists of unrelated words.

• The abnormal increase in beta band activity to wordlists localizes to the left IFG— the same region that shows an abnormally increase in BOLD activity to the wordlists in fMRI, and that is thought to mediate semantic unification.

• Patients may inappropriately engage the left IFG to combine and unify the incoherent wordlists into a coherent whole.

• These abnormal patterns of beta activity may contribute to the disorganization of thought and language that characterizes schizophrenia.

Future directions

• Characterize and verify the localisations of beta band modulation obtained within the spatial filter

• Investigation of the alpha band modulation to sentences > wordlists

• Analyses of functional connectivity (fMRI) between frontal and temporal cortices.

References

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