Background

- Psychosis is associated with impaired cognition, altered brain activation, and abnormal cortical micro-circuitry\(^1\)\(^,\)\(^2\)\(^,\)\(^3\).
- We used neurate orientation dispersion and density imaging (NODDI)\(^4\), a method for quantifying grey matter integrity, and working memory (WM) fMRI to test the following hypotheses:
  - Brain activation during WM maintenance is reduced in psychosis;
  - Grey matter integrity is reduced in regions showing altered WM brain activity; and
  - Grey matter integrity is associated with WM activation and cognition.

Methods

Procedures

Multi-shell diffusion-weighted imaging (DWI) and event-related spatial WM fMRI collected on 53 healthy subjects and 103 individuals with a psychotic disorder during a single scanning session on a 3T MR scanner.

Spatial Working Memory (WM) Task

![Spatial Working Memory Task](image)

Neurate Orientation Dispersion and Density Imaging

NODDI applies a 3 compartment tissue model (intracellular, extracellular, CSF)\(^2\) to multi-shell DWI data to characterize:

- Intracellular Volume Fraction (Vic): Fraction of tissue volume restricted within neurites, a measure of neurite density.
- Orientation Dispersion Index (ODI): Spectrum of neurite orientation from highly coherent (low ODI) observed in white matter to complex dendritic processes (high ODI) observed in grey matter.

![Neurate Orientation Dispersion and Density Imaging](image)

* Image from Jespersen et al., 2007

Image Analysis

Brain regions involved in WM maintenance were identified by contrasting WM delay vs. control trial delay period (all subjects \(n=156\), correct trials only). Mean activation, Vic, and ODI extracted from each region for group comparisons.

Results

Spatial Working Memory (WM) Task Performance

![Accuracy vs. Reaction Time](image)

Brain Activation: WM Delay > Control Delay

![Brain Activation](image)

Neurate Orientation Dispersion and Density Imaging

![Intracellular Volume Fraction (Vic) vs. Orientation Dispersion Index (ODI)](image)

Sample Demographics

<table>
<thead>
<tr>
<th></th>
<th>Healthy Controls</th>
<th>N=53</th>
<th>Psychosis</th>
<th>N=103</th>
<th>Statistic</th>
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</thead>
<tbody>
<tr>
<td>Age (SD)</td>
<td>29.53 (9.81)</td>
<td></td>
<td>28.41 (9.99)</td>
<td>(1154)=67, (p&lt;.01)</td>
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</tr>
<tr>
<td>Gender (F/M)</td>
<td>19/34</td>
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<td>39/64</td>
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<td>Race (B/W/O)</td>
<td>10/376</td>
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<td>22/783</td>
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<td>Personal Education</td>
<td>16.00 (1.95)</td>
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<td>13.84 (1.95)</td>
<td>(1154)=6.54, (p&lt;.001)</td>
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<tr>
<td>Paternal Education</td>
<td>14.87 (2.34)</td>
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<td>14.63 (2.56)</td>
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<td></td>
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<tr>
<td>Paternal Education</td>
<td>15.33 (2.82)</td>
<td></td>
<td>15.01 (3.37)</td>
<td>(1150)=58, (p&lt;.56)</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

- Activation in fronto-parietal regions is reduced in psychotic disorders during WM maintenance.
- Grey matter microstructure is largely intact in brain regions demonstrating reduced BOLD response.
- Grey matter integrity is unrelated to BOLD response during WM maintenance and task performance.
- Next steps include investigation of diagnostic (i.e. SSD, BPD) and illness stage effects (i.e. chronic, early stage)

References