In-vivo imaging of the human thalamus with multimodal 7T MRI

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INTRODUCTION

- Imaging the thalamus and its different nuclei would be highly valuable to neuroscience and neuroradiology, but has remained challenging;
- Conventional MRI modalities (TI, T2-weighted) show negligible contrast;
- New modalities at 7T have shown promising, unprecedented capabilities for thalamic imaging [1];
- In this work, we initiated a comprehensive practical review of 7T thalamic imaging approaches, all acquired in the same brain, at sub-mm resolution.

RESULTS: imaging contrasts

- The structural modalities covered in this work yielded a rich, diverse range of contrasts and anatomic features:

<table>
<thead>
<tr>
<th>Modality</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>T₁, w</td>
<td>conventional MPRAGE</td>
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<tr>
<td>T₁, map</td>
<td>conventional MPRAGE</td>
</tr>
<tr>
<td>WMnull</td>
<td>WM-suppressed MPRAGE</td>
</tr>
<tr>
<td>IR TSE</td>
<td>inversion-recovery variable flip-angle TSE [3]</td>
</tr>
<tr>
<td>SWI</td>
<td>single-echo 3D GRE COSMOS reconstruction</td>
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<tr>
<td>QSM</td>
<td>multi-echo 3D GRE</td>
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</tbody>
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METHODS

- Data acquisition: A healthy participant underwent several scans at 7T (Siemens Terra) – total TA ~2.5h; see Results for sequence details;
- Data processing: Registration for alignment with two thalamic atlases:
  - Simplified Morel (THOMAS approach [2]);
  - Schaltenbrand [3] (MNI space, slice z = 3.5 mm);
- Anatomical analysis: The aligned images were separately evaluated by two imaging experts, by visual inspection, and compared to the atlases.

RESULTS: thalamic anatomy

- Convventional T₁, w and T₂, w confirmed to be of limited value;
- Dedicated modalities (esp. GWMopt & QSM) can differentiate almost every pair of nuclei

CONCLUSION

- The results indicate that QSM and GWMopt are the most valuable modalities currently available to differentiate thalamic nuclei;
- Future work will include additional subjects and more quantitative metrics.