Fibre orientation dispersion in the corpus callosum relates to interhemispheric connectivity

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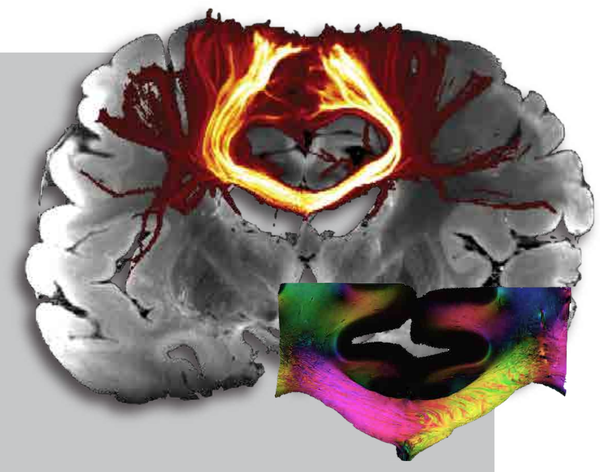
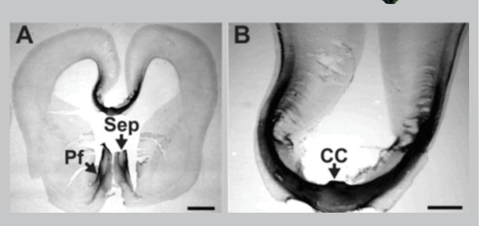
Purpose

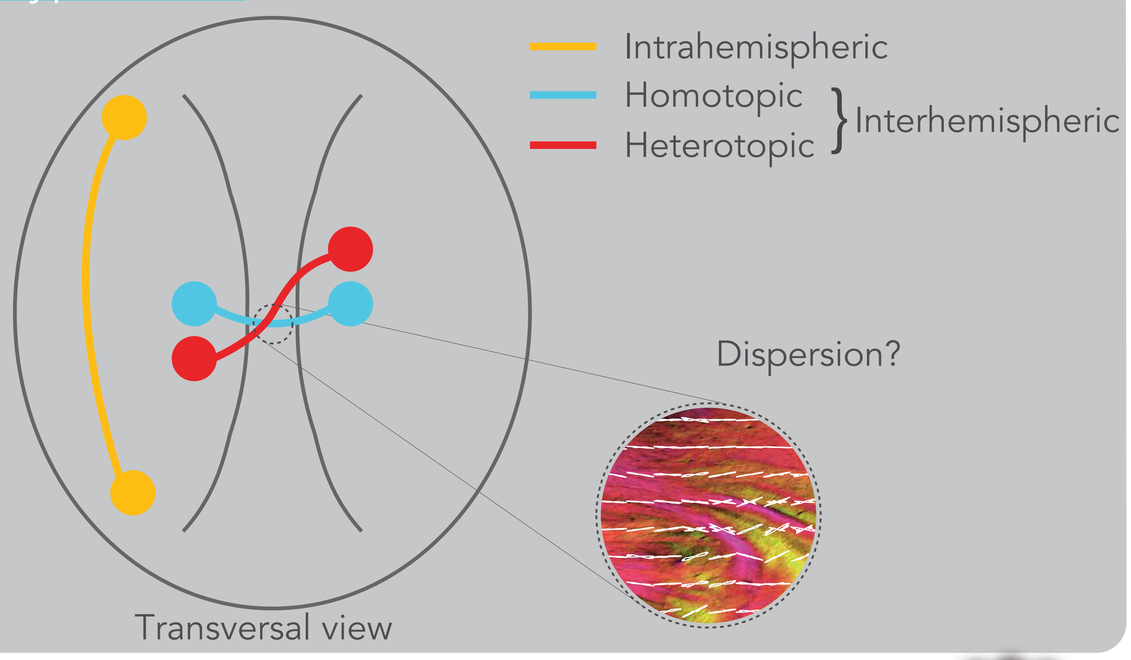
Corpus callosum connects left-and-right hemispheres, what's the reason for fibre orientation dispersion (spread) medially?

- Remnant of brain development? Glial structures at midline during callosal formation
- Physical bending forces.
- Relation to interhemispheric connectivity? Spread of fibres could fascilitate between non-homologous (heterotopic) areas.



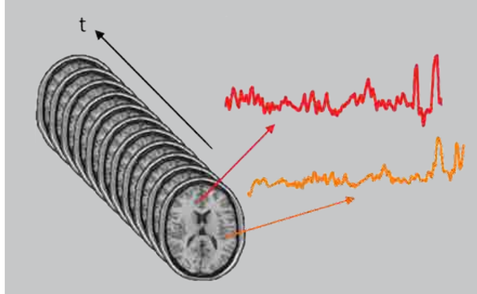


Hypothesis

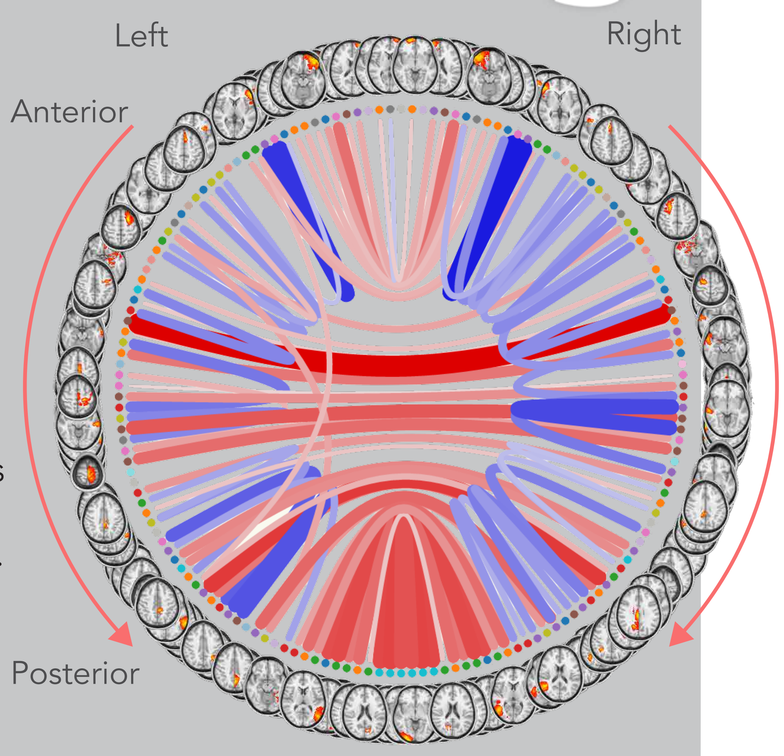


Resting-state fMRI

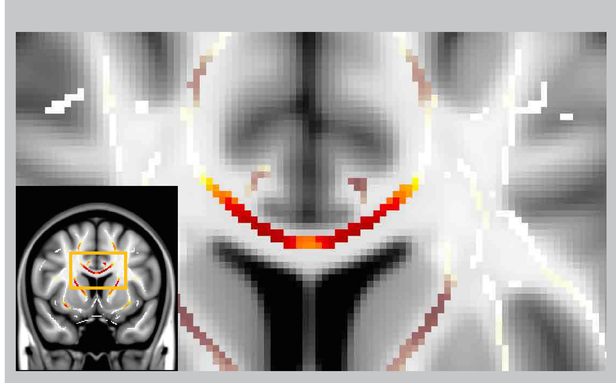
N=4903

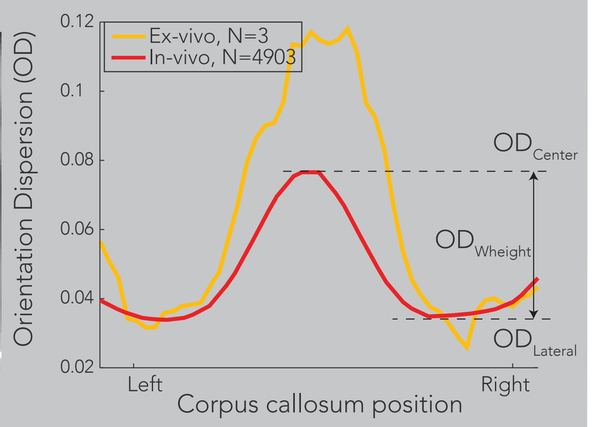


Group-ICA. Yields spatial maps which are functionally active at the same time. Maps were split to obtain a left and right hemisphere component.



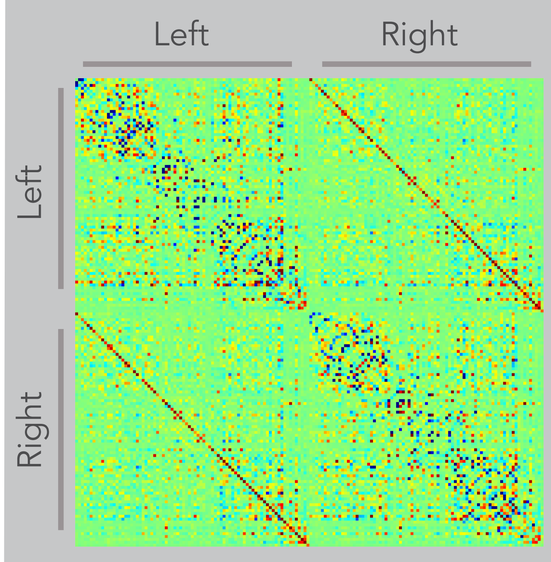
Diffusion MRI



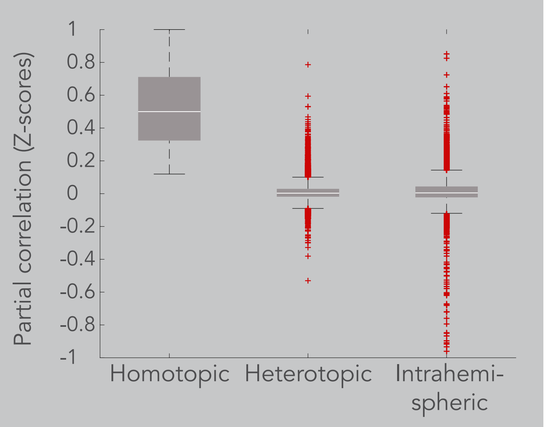


NODDI (Neurite Orientation Dispersion and Density Imaging) model was fit to the diffusion MRI data of each subject. Orientation dispersion (OD) values were projected onto a TBSS skeleton.

Results

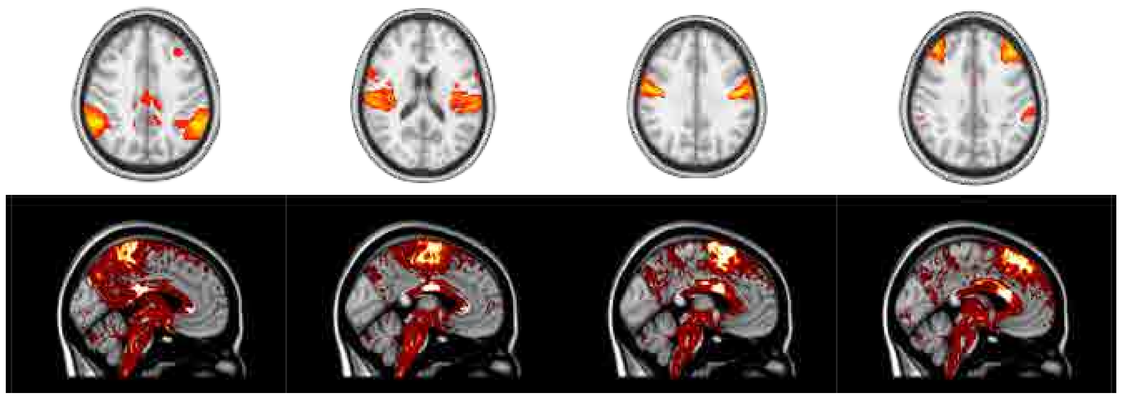


Network matrix for functional connectivity. Z-scores indicate correlation in activity of brain regions and thus the strength of functional connectivity between them.



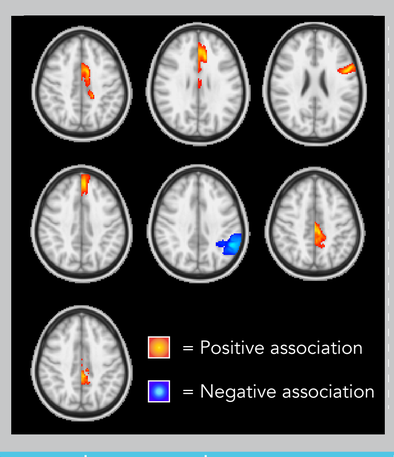
Define asymmetry index (AI): AI indicates how a certain brain region is connected with heterotopicareas relative to its homotopic connection strength.

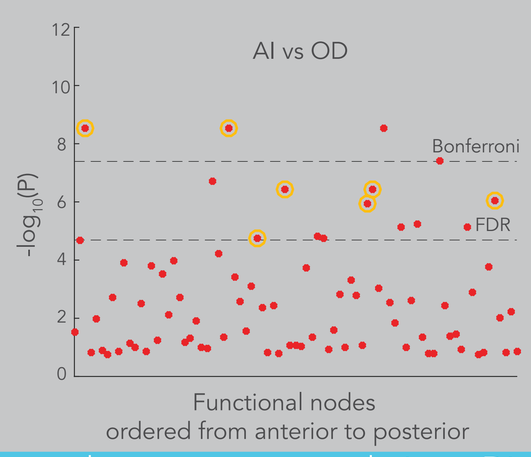
Use tractography to determine corpus callosum area that interconnects the homotopic regions.



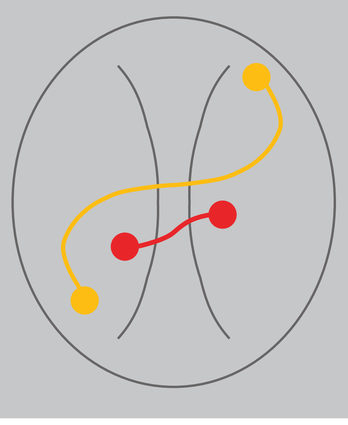
Permutation test for significant associations

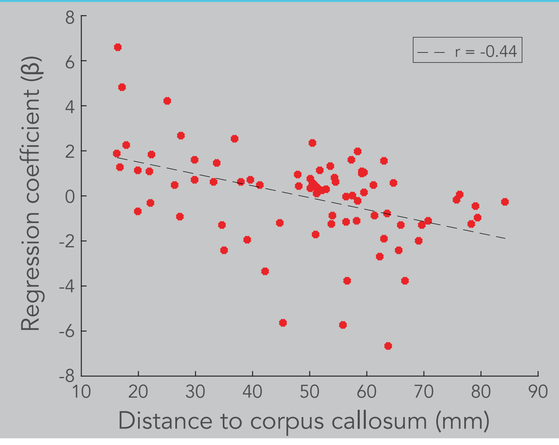
Randomly divide subjects into two groups.
Test for significant associations between dispersion (OD) and functional asymmetry (AI). Check for reproducibility.





Regions close to the corpus callosum show stronger correlations. Distal regions show weaker correlations, possibly due to projections via other tracts





Conclusion

Higher dispersion in corpus callosum at midline in healthy subjects, except at the splenium.

Significant associations between AI and OD found in regions close to the corpus callosum.

Dispersion in the CC is more crucial for medial brain areas to project to nearby heterotopic regions, while more distant nodes can form a path to heterotopic areas via other tracts.

1. Mikula S. et al. Nature Methods (2012). 2. Ronen I. et al. Brain Structure and Function (2014). 3. Budde M.D. et al. Frontiers in integrative neuroscience (2013). 4. Mollink J. et al. ISMRM (2016). 5. Miller K.L. et al. Nature Neuroscience (2016). 6. Zhang H. et al. Neuroimage (2012).

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