Investigating the relationship of myeloarchitecture and connectivity in the human cortex using MRI

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Introduction

A link between microarchitecture and connectivity has been demonstrated in macaque cortex [1].

We investigate this link in human cortex using high-resolution MRI:

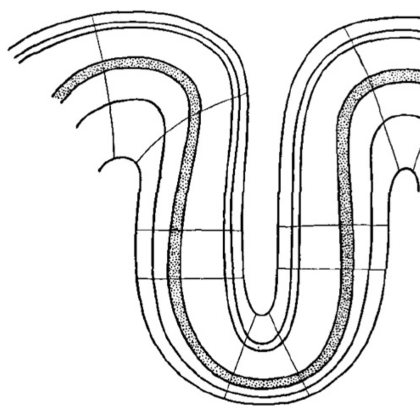
- Resting state functional connectivity (FC)
- T1 maps as *in vivo* proxy for myeloarchitecture [2].

Data

MRI datasets of 8 subjects acquired at 7T

- 4 resting state scans [3] (300 volumes, 70 slices, voxel=1.5 mm^3, TR=3s, TE=17ms, FA=70°, GRAPPA=3)
- Quantitative T1 map [4] (MP2RAGE, voxel=0.5mm^3, TI1/2=900/2750ms, TR=5s, TE=2.45ms, FA1/2=5/3°)

Methods



from Bok (1929) [10]

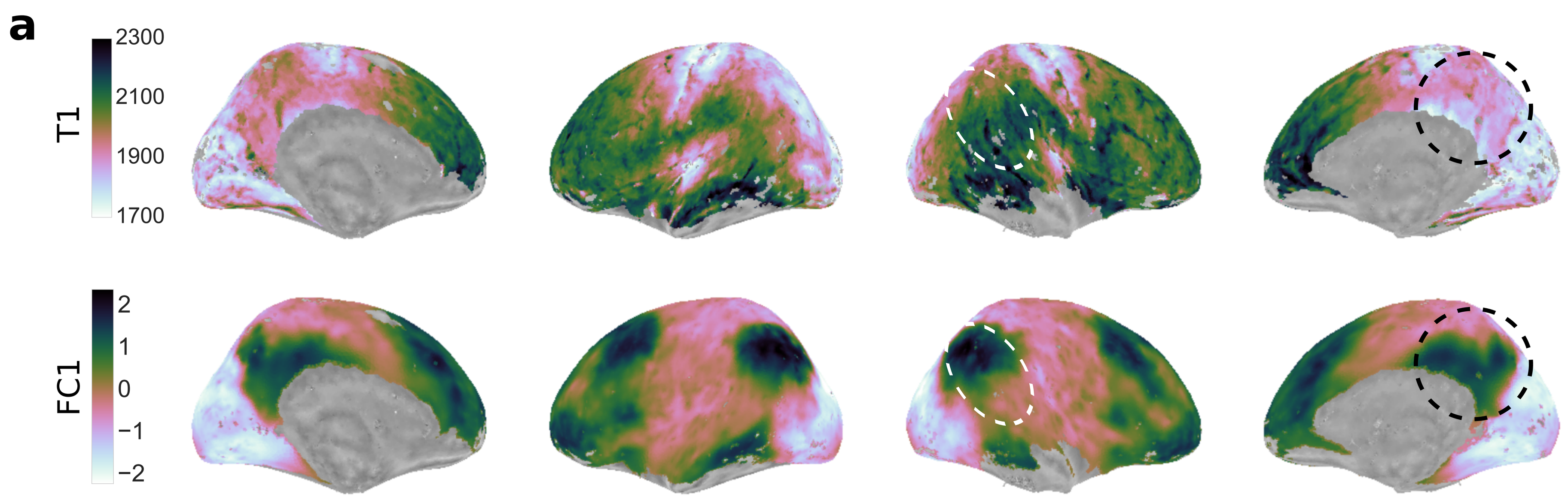
Preprocessing [5-7], sampling and minimal smoothing (FWHM=1.5/3 mm) of T1 and FC on study-specific surface template [8].

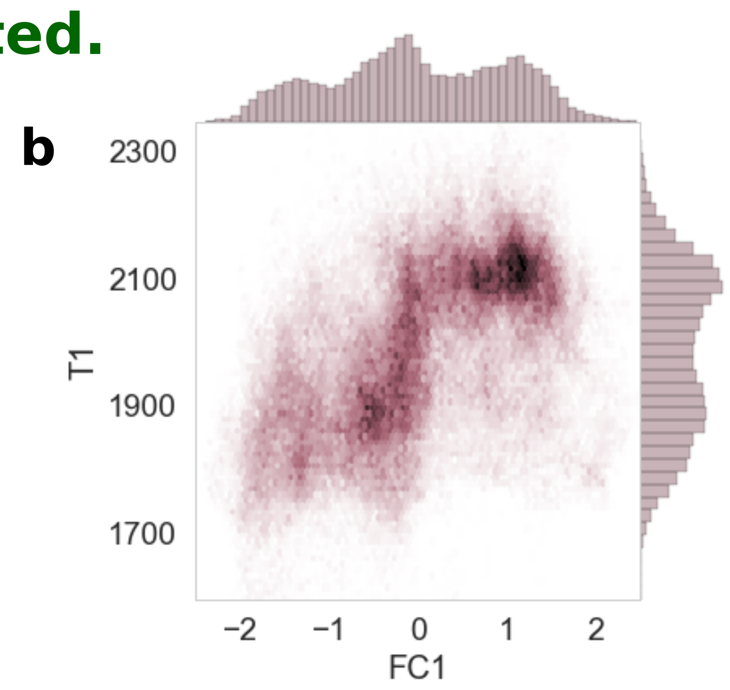
T1 sampled on 11 volume-preserving intracortical surfaces [9,10]. Only 5 central values are used to reduce partial volume effects.

Nonlinear dimensionality reduction of group average FC matrix using diffusion embedding [11].

Results

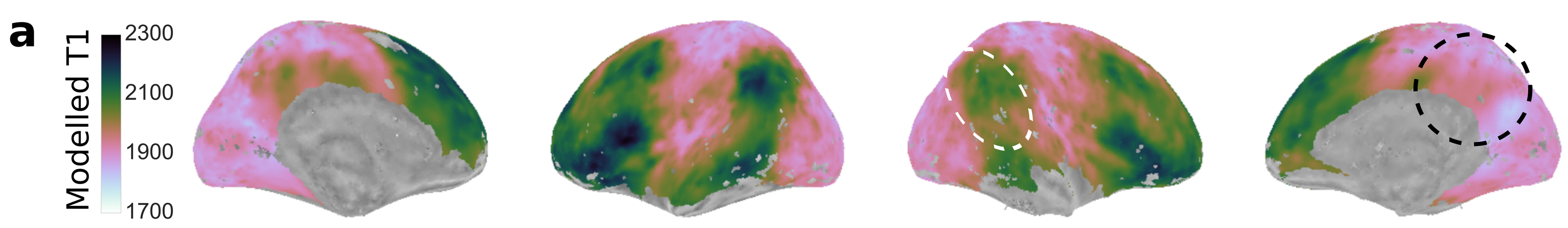
1 Intracortical T1 and FC are systematically related.

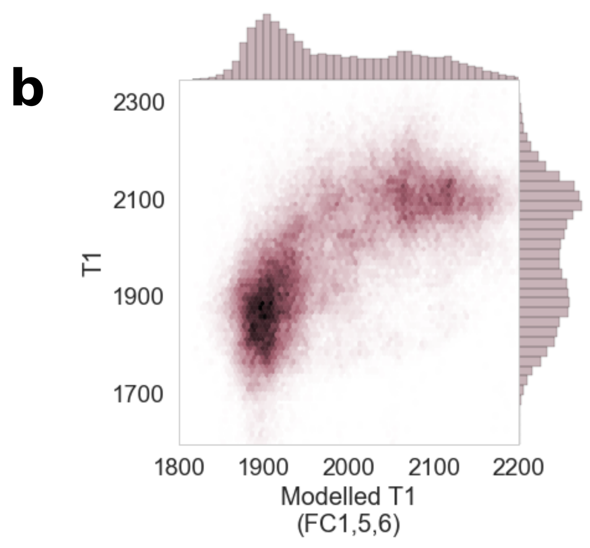




a The T1 map reflects myelin content, with lower T1 indicating higher myelin. The first component of the FC decomposition (FC1) represents the main variance in the FC data (12%). **b** T1 and FC1 are spatially correlated (Pearson's r=.53, R^2=.28).

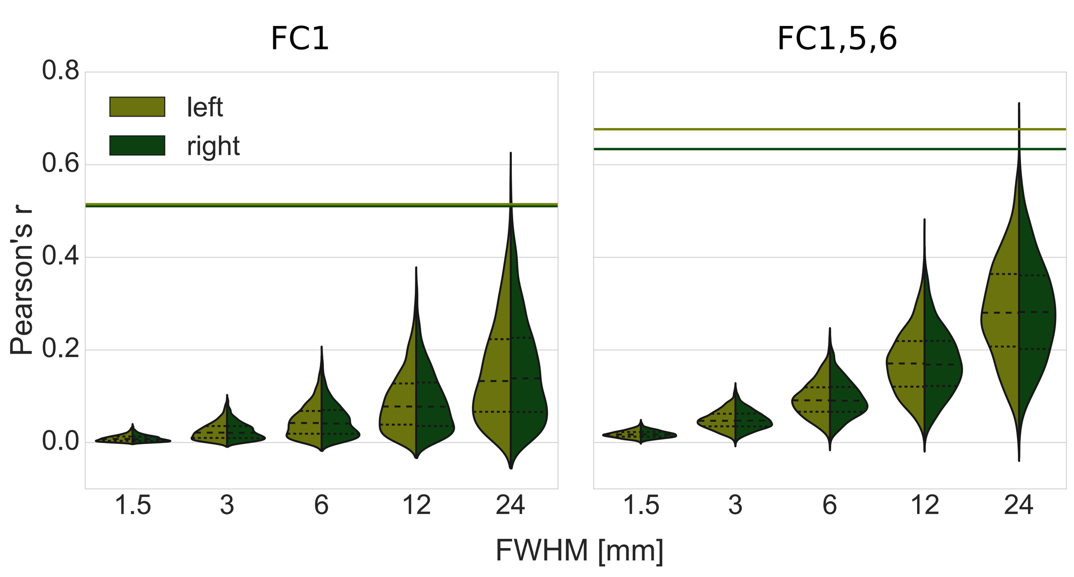
2 Modelling T1 with multiple FC components improves fit.





a Modelling T1 as linear combinations of the first 20 FC components. The most parsimonious model contains FC component 1, 5 and 6. **b** Spatial correlation to original T1 is increased (Pearson's r=.67, R^2=.45).

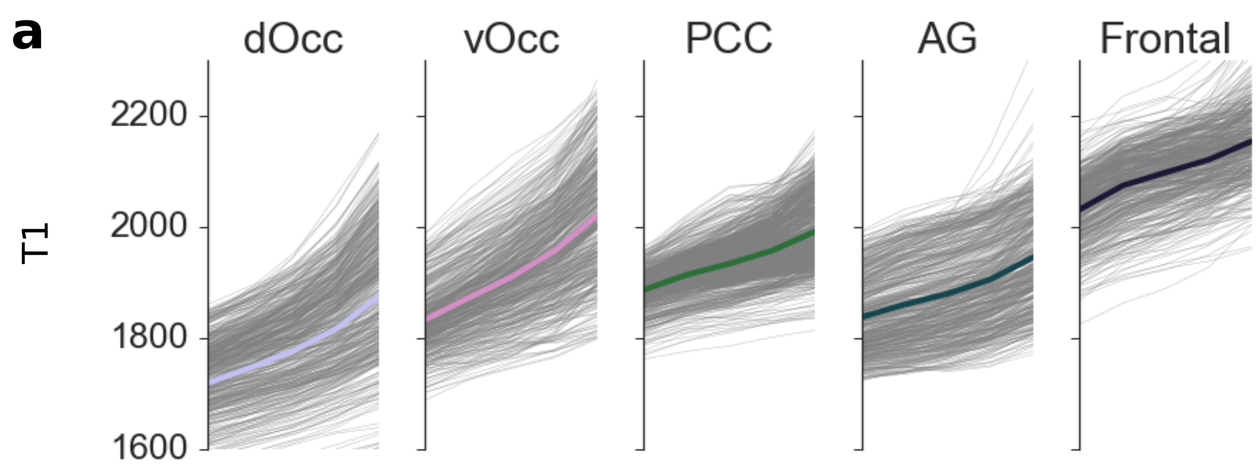
3 Correlation is not explained by data smoothness alone.

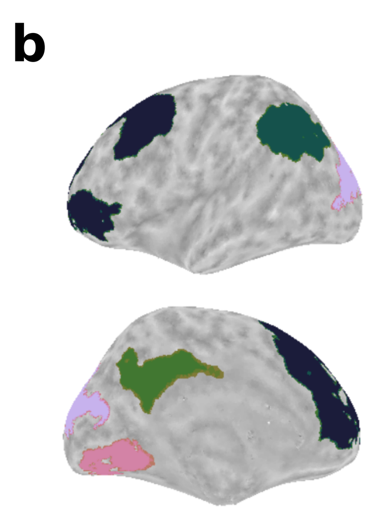


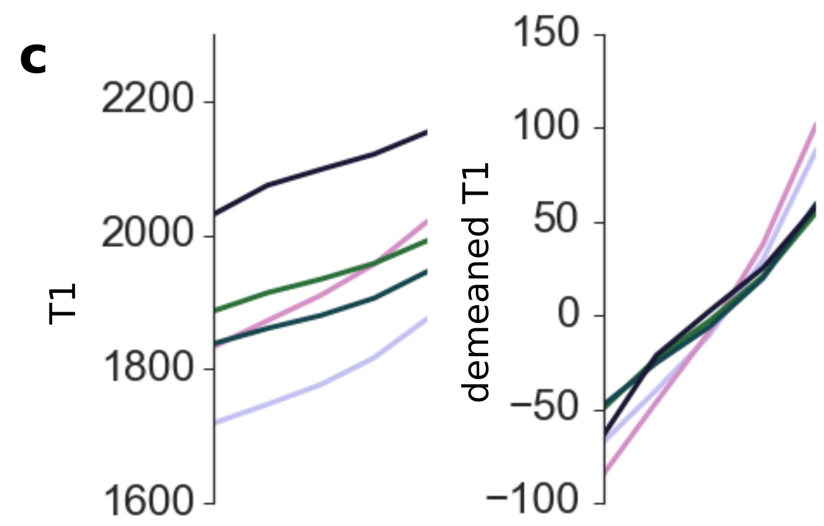
1000 random datasets per hemisphere, smoothed with different kernel sizes. When modelling the random maps with FC1 (*left*) or FC1,5,6 (*right*) correlation values are much lower than for the real data (horizontal lines).

4 T1 profile shapes link diverging regions.

a T1 values at 5 levels of cortical depth for each vertex in high (PCC/precuneus, AG, frontal) and low (dorsal and ventral occipital) FC1 peak clusters. **b** Cluster locations in the left hemisphere. **c** Average profiles (*left*) and demeaned average profiles (*right*) of the five clusters. Shape, but not mean, discriminates clusters from either side of the spectrum.







Discussion

We demonstrate a systematic relationship between *in vivo* measures of intracortical myelin and functional connectivity in human cortex.

Similar myeloarchitecture may reflect simultaneous evolution of distributed areas upon common environmental demands, resulting in interconnected functional entities [1].

Superimposed connectivity gradients and laminar myelin distribution provide additional information but also pose methodological challenges.

Integrating these complex data in an interpretable way will be a crucial next step.

References

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OHBM 2106