

Structural disconnection may underlie functional changes after temporal lobe epilepsy surgery

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INTRODUCTION

Epilepsy surgery aims to remove the epileptic focus, the region where seizures originate, and is recommended for patients with drug-resistant focal epilepsy. However, functional MRI (fMRI) studies have found that temporal lobe epilepsy (TLE) surgery leads to widespread changes in brain function¹⁻². We hypothesize that these functional changes may be due to a structural disconnection from the resected epileptic focus. To test this, we first identified regions with fMRI activity changes from pre to post TLE surgery that were highly connected to the epileptic focus. We then related these functional changes to the estimated structural disconnection from the resected epileptic focus in these regions.

METHODS

Participants

- 96 healthy controls (46 female, 37.9 ± 13.4 yrs)
- 36 TLE surgery patients (10 left-sided TLE, 18 female, 41.8 ± 12.3 yrs)
 - 7 anterior temporal lobectomies (ATL); 29 selective amygdalohippocampectomies (SAH)

3T MRI imaging

- All imaging was acquired once for controls and both before and after surgery for TLE patients
- T1-weighted MRI (1x1x1 mm³)
- 107 cortical and subcortical ROIs segmented with MultiAtlas³; anterior and posterior hippocampi segmented with Freesurfer^{6,5} (111 total)
- Two 10-minute resting-state fMRI scans with eyes closed (TR = 2 s, 3x3x4 mm³)
- Diffusion MRI (dMRI) scan (2.5x2.5x2.5 mm³, 92 directions, b = 1600 s/mm²)

Amplitude of low frequency fluctuations (ALFF)

- Standard fMRI preprocessing including RETROICOR
- ALFF obtained by summing the square root of the power across the 0.0083-0.1 Hz frequency band and normalizing across grey matter voxels⁶

dMRI preprocessing

- dMRI data was preprocessed according the PreQual pipeline⁷
- Fiber orientation density (FOD) maps computed with MRtrix³

Healthy anterior hippocampus structural connectivity profile

- Whole-brain tractography was computed in healthy controls from FOD maps
- Mean structural connectivity (weighted streamline count) from the anterior hippocampus to all other brain regions was computed across controls to obtain healthy anterior hippocampus structural connectivity profile

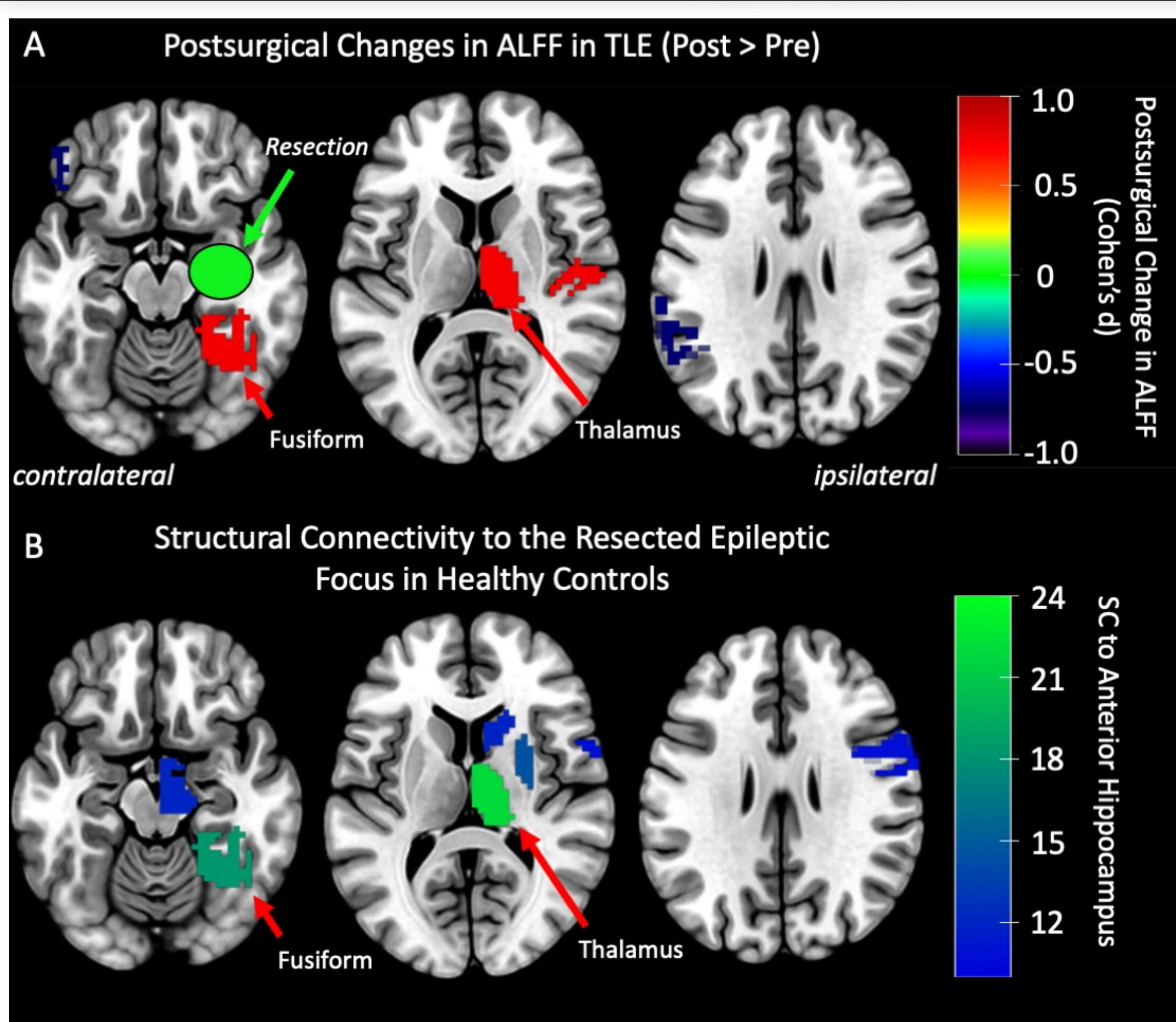
Pre to postsurgical ALFF changes

- Pre to postsurgical changes in ALFF were tested regionally with paired t-tests
- Voxel-wise pre to postsurgical changes in ALFF were tested in the ipsilateral thalamus and fusiform gyrus with paired t-tests

Estimated structural disconnection from the epileptic focus

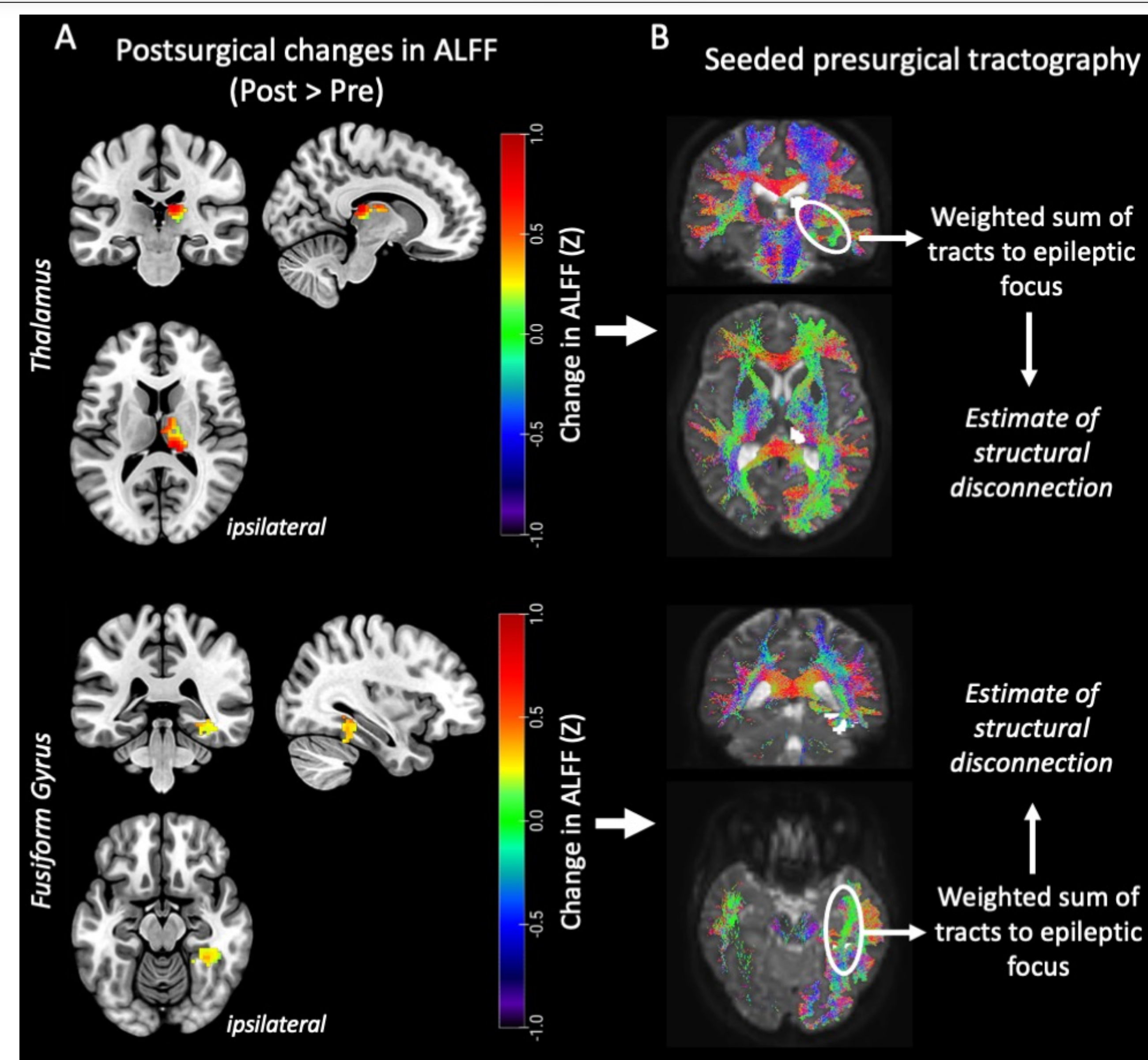
- Voxel-wise clusters of pre to postsurgical ALFF change were seeded for tractography using the FOD maps
- Estimated structural disconnection from the epileptic focus was computed as the weighted streamline count to the ipsilateral anterior hippocampus
- The estimated structural disconnection was related to the ALFF change in both the ipsilateral thalamus and fusiform clusters using right-tailed Spearman correlations with surgery type as a covariate

RESULTS

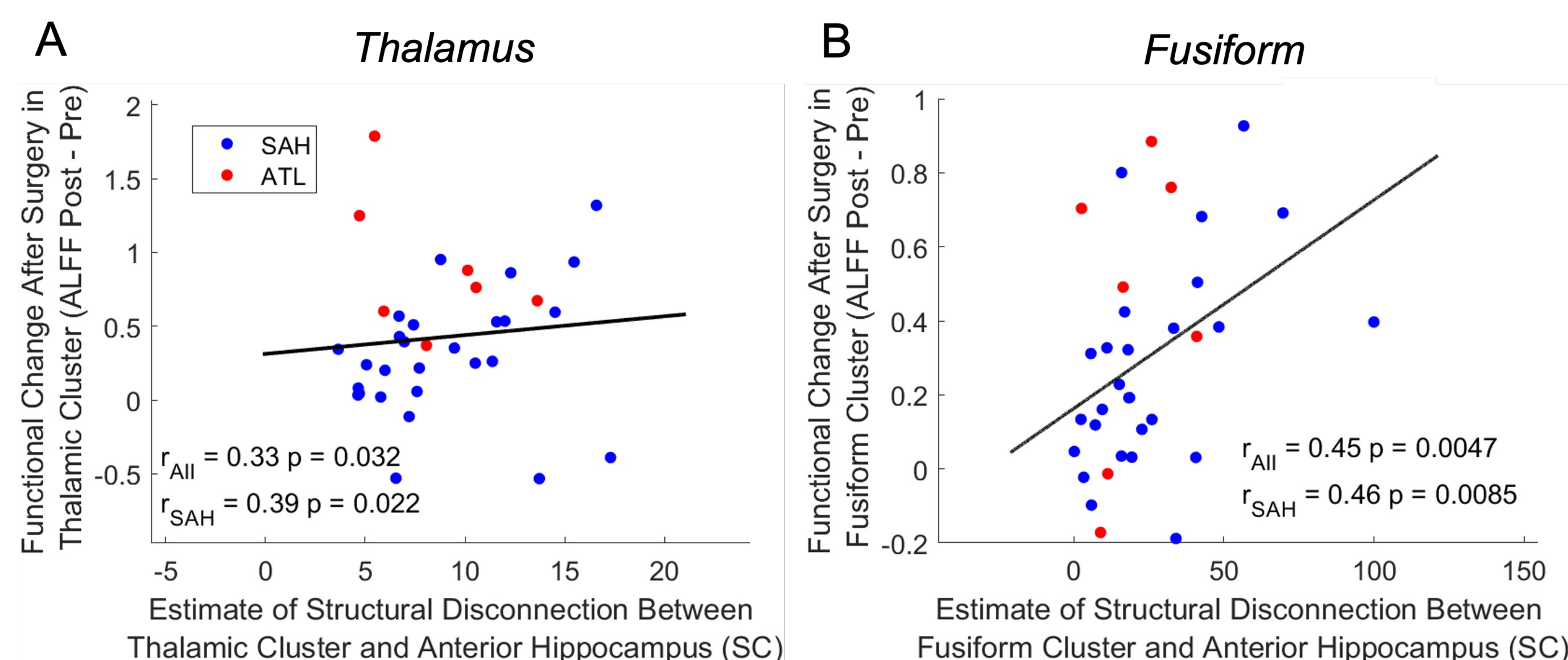


Ipsilateral thalamus and fusiform gyrus have increased ALFF from pre to post surgery and are the highest structurally connected regions to the resected epileptic focus

RESULTS



Estimation of the thalamic and fusiform structural disconnection from the resected epileptic focus from presurgical dMRI



Increases in ALFF from pre to post surgery in the ipsilateral thalamus and fusiform increase with a greater structural disconnection from the resected epileptic focus

CONCLUSIONS

- TLE surgery leads to widespread changes in brain function
- Functional changes after TLE surgery are related to the structural disconnection from the resected epileptic focus
- This study found a novel link between brain structure and function

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