Relationship of resting state functional connectivity and visual acuity in MS patients with optic neuritis

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Target Audience: MS researchers, MRI users

Purpose

Resting State Functional connectivity (fcMRI) is the correlation of low frequency fluctuations between regions that are functionally connected in the brain [1]. In our study we explored the application of fcMRI in multiple sclerosis (MS) patients with Optic neuritis (ON), between the lateral geniculate nucleus (LGN), and primary visual cortex. ON is a common manifestation of MS, affecting almost 50% of MS patients. It involves inflammatory demyelination of the optic nerve leading to partial or complete loss of vision. Recovery from ON is variable, and a minimum of six months were required to have passed after onset of unilateral ON for recovery to have reached a plateau.

Method

Fifteen MS patients with ON (chronic > 6months) were scanned on Siemens 3T using a 12 channel head coil, and a bite bar to reduce head motion. Scans included T1 MPRAGE at 1x1x1.2mm, T1/TE/TR=900/1.71/1900ms, resting state functional connectivity (fcMRI) at 2x2x4mm, 31 slices, 132 repetitions, TR/TE=2800/29ms. fcMRI corrections included physiological noise removal using RETROICOR [2], motion correction using AFNI [3] command 3dvolreg, followed by removal of signal fluctuation corresponding to voxel level displacement. Data was then spatially filtered with a Hamming filter, and temporarily filtered to include only low frequency fluctuations (< 0.08 Hz). InstaCorr [4] was used to select a voxel within LGN that showed the highest correlation with primary visual cortex (V1). A 6mm diameter sphere was then drawn on the calcarine fissure within V1. This was repeated on each hemisphere. A reference time is computed by taking the arithmetic mean of the identified LGN voxel, and eight in-plane voxels immediately surrounding it, and a cross correlation was calculated between the linearly detrended reference time series, and the linearly detrended corrected resting state time series on a voxel-by-voxel basis. The resulting correlation was converted to Student t. To obtain the fcMRI measures for each subject (i.e. the LGN-V1 connectivity), the mean value within the V1 sphere in the Student t map was calculated. Each patient also underwent high, and low visual acuity clinical assessment with Sloan letter charts at 100% (black on white), 2.5% (gray on white), and 1.25% (very light gray on white) contrast.

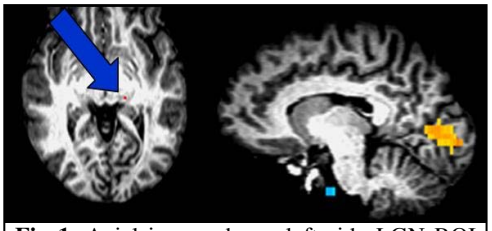

Fig 1. Axial image shows left side LGN ROI seed pointed by arrow, and sagittal image shows corresponding V1 correlation derived using InstaCorr

Results and Discussion

The optic tract for each eye, which carries visual information, is composed of ipsilateral temporal retinal fibers, and nasal retinal fibers from the contralateral eye. So we took the average LGN-V1 connectivity from both the affected, and unaffected eye and calculated the correlation with visual acuity clinical metrics. We observed significant correlation with low contrast visual acuity (2.5% contrast, r=0.53, p<0.03) of the unaffected eye. No significant correlation was observed between visual acuity and the affected eye, however 4/15 patients had a visual acuity score of 0 for that eye. Input to the affected eye in these cases is likely not contributing to visual acuity function.

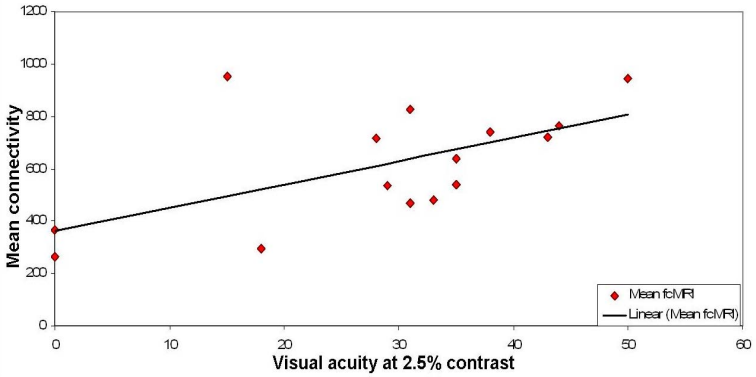

Fig 2. shows significant correlation between LGN-V1 connectivity and visual acuity at 2.5% contrast.

Conclusion

We show that visual acuity is related to LGN-V1 functional connectivity using resting-state fcMRI. This relationship appears to be reduced or non-existent when visual acuity is very poor.

References

[1]Bharat et. al, 1995, MRM, 34:537-541,[2]Glover et. al, 2000, Magn. Reson. Med, 44:162-167,[3]Cox et.al,1997, NMR in Biomed, 10:171-178,[4] Cox et al, 2010, Second Bie. Inter. Conf. on Resting State Func. Brain Connec., 44:839:844