

Evidence for Functional Reorganization as a General Response to Motor System Injury in Multiple Sclerosis Patients

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Abstract

Brain functional reorganization could contribute to reducing the clinical disability of patients with multiple sclerosis (MS). To test this, we compared the localization of activity for simple hand and tongue movement tasks between healthy controls and MS patients. We found significant shifts in centre of activity throughout the motor cortex, consistent with reorganization of functional activity.

Methods

13 healthy controls and 10 MS patients (mean EDSS 3.7, range 1.0-6.5) were asked to perform hand and tongue motor tasks in the MRI scanner. Subjects were first asked to tap the right hand following a 2Hz visual cue. Then, using the same stimuli, subjects were asked to hold the tongue against the roof of the mouth and move from left to right. Echo-planar volumes were acquired in the sagittal plane (33 slices, 4mm x 4mm x 4mm resolution, TE=30ms, TR=4s, FOV=256x256, Matrix=64x64). Image analysis was done using Oxford Centre for Functional Magnetic Resonance Imaging of the Brain Software Library (FMRIB, Oxford, UK; www.fmrib.ox.ac.uk/fsl) Random effects group analyses were performed and group Z statistic images were thresholded at $Z < 3.0$, with a cluster significance threshold of $P = 0.01$, corrected for multiple comparisons.

Results

Using a group comparison corrected for multiple comparisons, MS patients had activation in the precentral gyrus near the “omega” (Yousry et al 1997) and the supplementary motor area, similar to healthy controls (figure 1). However, the centre of activation for normal controls in this area was 7.6 ± 3.6 mm ($p = .35$, N.S.) distant from the centre of MS patient activation. MS patients also recruited a second area on the precentral gyrus in which activity is expected for movement of the proximal arm in healthy controls (figure 2).

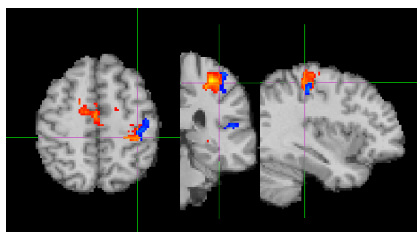


Figure 1. MS patients have similar activation in the omega region of the precentral gyrus Z-score=3.0

■ = MS Patients ■ = Normal Controls

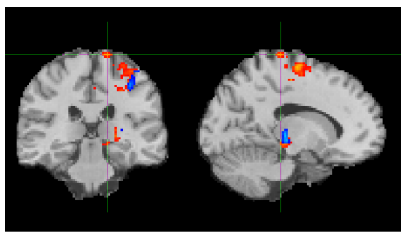


Figure 2. Second area of activation on the precentral gyrus shown in crosshairs. Omega area activation can also be seen on the coronal view Z-Score=3.5

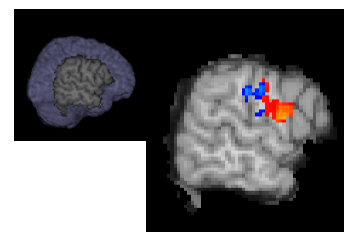


Figure 3. Tongue reorganization. Controls activate pre- and post-central gyrus while MS patients have the majority of activation in the precentral and inferior frontal gyri Z-Score=3.8

MS patients exhibited a shift in localization in the tongue movement task as well. Recruitment was from the inferior frontal gyrus opposed to other areas within the precentral gyrus (shift in activation centre = $14.9 \text{mm} \pm 9.4 \text{mm}$, $p < .05$). Compared to normals, the postcentral gyrus was not involved in tongue movement (figure 3).

Discussion

These results indicate that MS patients show potentially adaptive shifts in functional activity throughout the motor cortex. However, the shifts themselves are heterogeneous. It is possible that as disability increases, the extent of the shift changes. Another possibility that would account for the second area of activation seen in the hand task is that the MS patients were recruiting more or different muscle groups in order to perform the task.

References

Yousry et al. Brain. 1997 Jan;120 (Pt 1):141-57.