

DECREASED FUNCTIONAL CONNECTIVITY IN SENSORIMOTOR BRAIN NETWORKS IN PERSONS WITH MULTIPLE SCLEROSIS AND UPPER EXTREMITY DYSFUNCTION

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ABSTRACT

Approximately 75% of persons with Multiple Sclerosis (PwMS) exhibit upper extremity dysfunction (e.g., dysmetria, tremor). Rehabilitation strategies to reduce dysmetria and tremor are generally ineffective, due in part to an incomplete understanding of the neurological basis of sensorimotor dysfunction in MS. We recorded electroencephalography (EEG) signals in 7 PwMS and 6 age- and gender-matched healthy controls during a reach and hold task performed with a 1D passive manipulandum. We sought to examine how MS impacts functional interactions between brain areas that support goal directed movement. Participants were asked to move the manipulandum to capture a target on a computer display. In each of ten, 50-second task blocks, a target appeared every 3.0 to 5.5 seconds. We computed average spectral coherence across electrodes epoched relative to visual target displacement and to onset of movement. From each hemisphere, we select 6 regions of interest for analysis (occipital, parietal, sensory, motor, supplementary motor, and premotor cortices). For both evoked responses, PwMS showed at least a 20.30±12.51%. decrease in coherence between sensory integration areas compared to controls. Decreases in functional connectivity relative to movement onset in these areas were correlated with the level of dysfunction ($R^2 \geq 0.47$) in the contralateral hemisphere during reach to target. Visually evoked responses were delayed 76.96±3.81ms in sensory integration areas in PwMS compared to controls. Decreases in functional connectivity in contralateral sensory integrations areas, coupled with delays in the timing of visually evoked responses, suggest that disruptions in the processing of visual feedback contribute to motor impairment during visually guided movements. These findings are consistent with previously reported mismatches between the timing of sensory predictions and the visual consequence of movement in PwMS. Rehabilitation strategies to reduce this temporal mismatch could improve goal directed movement in PwMS.

Keywords: Multiple Sclerosis, sensorimotor, functional connectivity, sensory integration

INTRODUCTION

In persons with Multiple Sclerosis (PwMS), tremor and dysmetria during arm movements are an emergent motor symptom, affecting up to 75% of people diagnosed with the disease [1]. These impairments negatively impact activities of daily living for those afflicted.

Drug therapies and surgical interventions have been used to reduce the effect of tremor but the positive effects diminish with time and the mechanism of action is not well understood [2]. Rehabilitation strategies that manipulate visual feedback during movement have also shown promise for reducing tremor. Feys and colleagues demonstrated that removing visual feedback of movement or reducing the tremor-induced movement error present in the visual feedback can reduce the effects of tremor [3]. Heenan and colleagues applied systems identification techniques to show that mild to severe tremor in PwMS is associated with a mismatch in predicted (vs. actual) visual processing delays [4]. Using a visual delay adaptation task, they demonstrated that the effects of tremor could be reduced by minimizing the visual