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Impairments in Sensorimotor Control During Pursuit and Compensatory Tracking in Individuals with Multiple Sclerosis

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Abstract: Multiple sclerosis (MS) can cause disabling motor symptoms such as tremor and dysmetria. We previously reported that a possible cause of these symptoms may be a systematic underestimation of limb dynamics during goal-directed movements. Here, we examine the extent to which this result is consistent across task conditions (compensatory and pursuit tracking), and the extent to which internal estimates of limb dynamics correlate with clinical measures of disability. Systems identification techniques were used to characterize subjects' sensory delays and gains, predicted and actual limb dynamics, and neural controller gains during compensatory and pursuit tracking tasks. A cursor and either a stationary (compensation) or moving (pursuit) target were presented on a display. Subjects used elbow flexion/extension to control a 1-D manipulandum while visual or torque perturbations were applied to the cursor or manipulandum, respectively. Four subjects with MS with tremor and dysmetria and four age-matched controls participated in two test sessions. Subjects' individual best-fit models were compared with their tremor assessment, ataxia assessment, and Expanded Disability Status Scale scores to examine the relationship between clinical measures and functional sources of impairment. The two subjects with the most tremor and ataxia (both had tremor/ataxia scores of 3 and 2, respectively) relied on visual information to perform the task ($K = .82 \pm .16$; $K = .99 \pm .03$). Both subjects had poor estimates of limb inertia and stiffness, and one subject also had an increased visual delay ($T = 860 \pm 92$ms; $t = -6.29$; $p < .05$). Similarly, the subject with intermediate tremor and ataxia scores (2 and 2, respectively) slightly underestimated limb dynamics and had a long visual delay ($T = 1061 \pm 220$ms; $t = -6.94$; $p < .05$), but down-weighted visual feedback information ($K = .33 \pm .10$). The MS subject with the largest discrepancy between predicted and actual limb dynamics in both pursuit and compensatory tracking tasks experienced the least tremor and ataxia (tremor assessment = 1; ataxia assessment = 1). However, this subject down-weighted their visual estimate of movement error ($K = .35 \pm .11$) and did not exhibit an increased visual delay (relative to age-matched controls) as was present in other MS subjects ($T = 340 \pm 34$ms; $t = 1.36$; $p > .05$). Together, the results of this study suggest an inability of individuals with MS to correctly predict limb dynamics. However, tremor severity is not directly correlated with this inability, but instead is dependent on additional factors including length of the visual delay and reliance on vision for

error feedback.

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