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Generalised cognitive motor interference in multiple sclerosis

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ABSTRACT

Researchers have examined cognitive motor interference (CMI) for lower extremity function in MS, but have not examined this in the upper extremity. This study examined CMI for both lower and upper extremity motor tasks in persons with MS and without MS. Eighty-two persons walked on a GAITRite electronic walkway (velocity) and performed the nine-hole peg test (NHPT, seconds) without (single task) and with a cognitive challenge (dual task). The data were analysed with mixed-factor ANOVA and Pearson correlations. When comparing MS and controls, there were statistical significant and exceptionally large Task main effects on gait velocity ($\eta_p{}^2 = .41$; $F_{1,60} = 55.78$; $p < .005$) and NHPT performance ($\eta_p{}^2 = .62$; $F_{1,60} = 127.8$; $p < .005$). When considering disability status among those with MS, there were statistically significant and large Task main effects on velocity ($\eta_p{}^2 = .38$; $F_{1,60} = 37.3$; $p < .005$) and NHPT test ($\eta_p{}^2 = .62$; $F_{1,60} = 95.7$; $p < .005$). The dual task cost of walking and performing the NHPT were significantly correlated in the entire sample, those with MS and controls, and in those with MS who had mild, moderate, and severe disability (all $|r| > .450$). CMI occurs in both the lower and upper extremities, and is comparable between persons with and without MS and across MS disability level.

1. Introduction

Multiple sclerosis (MS) presents with cognitive and motor dysfunction [1,2]. There is an association between cognitive function and motor performance for both the upper and lower extremities (i.e., cognitive-motor coupling) [3]. Researchers have experimentally examined cognitive-motor coupling in MS based on the dual task paradigm resulting in cognitive motor interference (CMI) of lower extremity functioning [4]. Concurrently performing an alternate letter alphabet cognitive task while walking reduced gait velocity by 15% [5] and gait initiation time by 18% [6] on an electronic walkway compared with walking alone in persons with MS. A similar phenomenon has been observed in other populations using an alternate letter alphabet task [7–12].

Researchers have compared CMI between ambulatory persons with MS and healthy controls across different walking and cognitive conditions of the dual task paradigm. Overall, walking performance consistently declines in people with Clinically Isolated Syndrome (CIS), MS, and healthy controls under dual task conditions based on the dual task cost (DTC) metric [13,14–16]. There is some inconsistency in the literature regarding whether DTC differs between persons with MS and healthy controls. Two research groups have reported small, yet statistically significant differences [13,14], whereas other researchers have reported small, non-significant difference in DTC [15,16].

To date, there is no research applying the dual task paradigm for upper extremity motor functioning in MS (for example, does performing the alternate letter alphabet cognitive task reduce performance on an upper extremity motor functioning task such as the nine-hole peg test (NHPT) [17]?). Such an examination is important for multiple reasons. The presence of cognitive-motor coupling based on the dual task paradigm for both upper and lower extremity tasks would indicate, in part, the generality of this phenomenon across motor domains [3]. The co-occurrence for both upper and lower extremity motor function might further direct efforts towards approaches for rehabilitation [18]. If the effect exists for upper and lower extremity functioning, researchers might globally target the co-occurrence or interaction of cognition and motor functioning for reducing CMI. The examination of CMI in the upper extremity further permits an investigation and extension of this phenomenon and its correlates among non-ambulatory persons with MS.

This study examined the presence of CMI for both upper and lower extremity motor tasks in persons with MS. The study adopted an established and refined alternate letter alphabet task [7], recently applied in MS [5,6], and examined the influence on

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performance of upper and lower extremity tasks measured by the Nine Hole Peg Test [17] and GAITrite electronic walkway. The hypotheses were that (a) there would be a reduction in performance for both upper and lower extremity tasks when concurrently performing a cognitive task; (b) the magnitude of reduction for upper and lower extremity tasks would be slightly larger in persons with MS compared with controls; and (c) disability status would not influence CMI in upper and lower extremity tasks, based on previous research in MS [5].

2. Methods

2.1. Sample

The protocol was approved by a University institutional review board and all participants provided written informed consent prior to participation. The protocol was an adjuvant part of a cross-sectional, comparative study of approaches for fitness assessments in therapeutic interventions for MS [19].

Persons with MS were recruited through flyers distributed within the North American Research Committee on Multiple Sclerosis (NARCOMS) registry. Flyers were distributed to participants from previous research studies in our laboratory who had expressed interest in future opportunities. Criteria for inclusion were (a) diagnosis of MS; (b) Expanded Disability Status Score (EDSS) score <8.0; (c) age 18–64 years; (d) able to visit our laboratory on two testing occasions; (e) minimal risk for engaging in physical activity (i.e., reported 'yes' to less than two questions on the Physical Activity Readiness Questionnaire); and (f) physician approval for undertaking exercise testing. Of note, an equivalent number of participants with mild, moderate, and severe MS disability were recruited, this facilitated comparison of outcomes across the MS disability spectrum; disability was initially based on a self-reported EDSS performed over the phone and then confirmed with a neurological examination in person. Persons without MS were recruited through university wide recruitment emails. Inclusion criteria involved items c-f listed above, and control participants were age- (within 5 years), sex-, height- (within 3″) and weight- (within 5 lbs) matched with one of the MS participants. The flow of participants through stages of the research is presented in Fig. 1. Sixty-two participants with MS were enrolled in the study and completed testing. Eleven persons with MS completed the walking task using an assistive device (i.e., cane or walking-frame); gait data were not collected from two participants with MS due to severe ambulatory impairment. Fifty-two individuals without MS contacted our research coordinator, 29 were screened for inclusion. Twenty participants without MS completed all testing.

2.2. Disability status

Disability status was based on the Expanded Disability Status Scale (EDSS)[20] score determined through a clinical examination that was performed by Neurostatus certified examiners. Disability groups were represented as mild (EDSS score of 1.0–3.5), moderate (EDSS score of 4.0–5.5), and severe (EDSS score of 6.0–7.5) disability.

2.3. Dual task (DT) paradigm

Cognitive motor interference (CMI) was determined during one lower extremity (i.e., walking) and one upper extremity (i.e., NHPT) motor task. To reduce task familiarisation, participants completed the walking task and NHPT on 2 separate days separated by 7 days, and the order of walking task and NHPT test administration was randomised.

2.4. Lower extremity dual task (DT) paradigm

Participants completed four walking trials at a self-selected, comfortable pace across a 4.6 m GAITRite walkway (CIR systems, Havertown, PA, USA) as a measure of lower extremity function. Participants started walking 1.5 m in front of the mat and ending 1.5 m past the end of the mat. The GAITRite automatically collected data on walking velocity (cm/s).

Single-task (ST) walking (i.e., only walking) was performed during the first two walking trials, with executive attention challenged in the second dual-task (DT) walking trials (i.e., walking with a cognitive task). The DT involved all participants reciting alternate letters of the alphabet while walking following established protocol [8]. In brief, after the ST walks, a DT example was provided by a researcher and participants then completed a practice of the cognitive task only. During the DT walk, participants were asked to recite alternate letters of the alphabet starting with the letter M for the first walk and N for the second; participants were asked to pay equal attention to reciting alternate letters and walking. A mean value for velocity for the ST and DT walks independently was computed, as done in previous research [21].

CMI is expressed during walking as the dual task cost (DTC). This was calculated as the percent change in velocity between ST and DT conditions, such that $DTC = 100 \times ((ST - DT)/ST)$, as done in previous research [14].

2.5. Upper extremity dual task (DT) paradigm

Participant completed eight trials of the NHPT as a measure of upper extremity function. The NHPT was performed according to standardised instructions [22]. The test was timed (s) from when

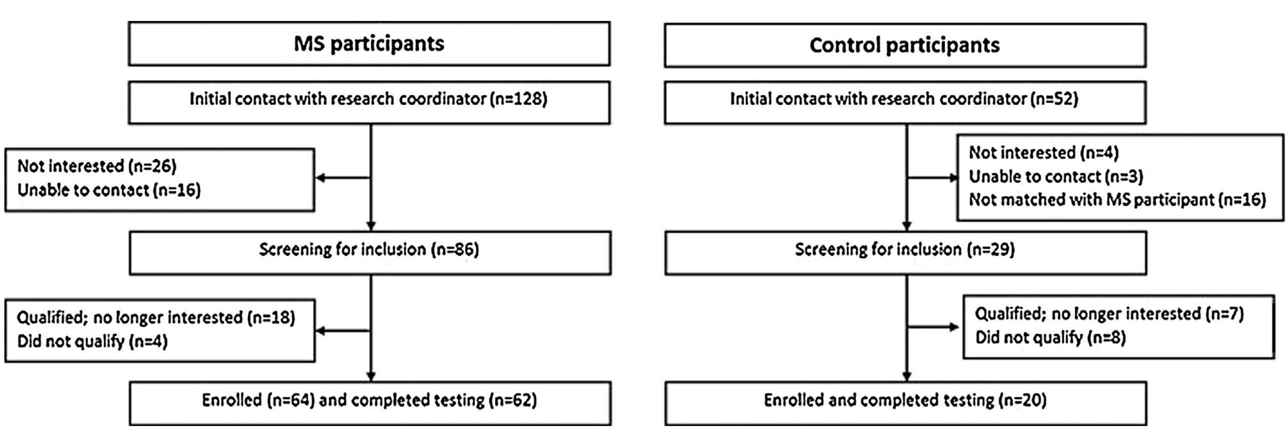

Fig. 1. Flow diagram of participant recruitment and enrollment.