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Cognitive-motor dual-task affects postural control in MS

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| **Author** **(Year), Title,**  **Study Design** | **Study Purpose** | **Participants** | **Procedures** | **Results (P>0.05)** | **Author's Conclusion** | **Notes** |
| D'Orio VL et al. (2012)  Cognitive and motor functioning in patients with multiple sclerosis: Neuropsychological predictors of walking speed and falls  Retrospective chart review | To evaluate cross-sectional associations between cognitive functions, walking speed, and falls in patients with MS. | 81 subjects. 54 women and 27 men with MS. Former patients of an outpatient clinic. Mean age 47.  Disability mean 11.63 on the Incapacity status scale (ISS)  Fall frequency:  No falls 44.4%  Ocassional 38.3%  Frequent 17.3% | Patient data analyzed regarding:  Walking speed (Timed 25-Foot Walk); Fall frequency; Disability (ISS);  Neuropsychological testing measuring verbal memory, learning, visual memory, verbal fluency, executive function, working memory, IQ, depressive affect. | Fall frequency correlated with cognitive measures including IQ, processing speed, executive functioning, working memory, verbal learning, and verbal memory.  Verbal memory remained a predictor of falls even after age and disability level were controlled for. | Neuropsychological testing may aid in prediction of risk of falls, declining mobility, and subsequent physical injury in patients with MS. | Verbal memory was evaluted by the California Verbal Learning Test - Second Edition |
| Boes MK et al. (2012)  Postural control in multiple sclerosis: Effects of disability status and dual task  Cross-sectional | To compare the effect of simultaneous cognitive task performance on postural control in persons with MS (PwMS) | 45 subjects. 41 women and 4 men with MS.  n=19 with mild disability (EDSS 2.0-3.5) and mean age 46.4.  n=26 with moderate disability (EDSS 4.0-6.5). Mean age 58.2. 54% with mod disability used AD. | Postural control assessed on force platform 1) in quiet standing and 2) with cogntive dual-task of word list generation (WLG). | The cogntive task significantly decreased postural control for all subjects. The sway area increased from 200.6mm2 to 277.3mm2. Median velocity in the medial/lateral and anterior posterior directions also increased with the dual-task condition.  Reduced postural control is correlated to greater disability, not age. | Concurrent cognitive task decreased the performance of postural control in persons with both mild and moderate disability. | No control group was used.  Few statistical comparisons provided for the mild vs moderate disability groups.  Only static standing was assessed so the effect of a cognitive dual-task on dynamic posture is not known. |
| Jacobs JV et al. (2012)  Effects of dual tasking on the postural performance of people with and without multiple sclerosis: a pilot study.  Case-control | To examine the effects of MS and of dual tasking on postural performance, and explored associations among dual-task postural performance, congnitive capacity, fear of falling, and fatigue. | 13 subjects with MS. 13 matched subjects without MS. EDSS 0.0-4.5. Mean age 50.  Subjects with and without MS matched by sex and age within 2 years. | Subjects performed standing tasks on a force platform, both with and without dual-tasking: 1) step initation 2) forward lean to limits of stability and 3) postural response to toes-up perturbation.  Tasks 1 & 2 were cued with a visual "GO".  The cognitive dual-task was the auditory Stroop task (report the tone of the word "high" or "low" that may be recorded with an opposing frequency). | The cognitive task significantly decreased performance of the standing tasks in both groups. However, there was only a significant difference between groups for the TUG and step initiation.  The TUG vs Cognitive TUG time increased more for the group with MS (8.5s vs 10.4s) than the controls (6.2s vs 6.5s).  Step initiation with dual-task resulted in significantly delayed APA and increased step length for the group with MS. MFIS (fatigue scale) also predicted delayed APA. | Clinical interventions for balance needs to account for cognitive interactions during postural transitions and gait activities.  Higher levels of fatigue may also reduce dual-task performance. | The auditory Stroop task may not have been challenging enough to detect a significant difference between groups for tasks 2 and 3. The small sample size also resulted in low power which limited the ability to detect signficance. |
| Sosnoff JJ et al. (2011)  Walking and thinking in persons with multiple sclerosis who vary in disability.  Cohort | To examine the effect of a cognitive task on spatiotemporal paramenters of gait in persons with multiple sclerosis with varying disability. | 78 subjects with MS. 21 subjects with mild disability (EDSS 2.0-3.5). 25 with moderate disability (EDSS 4.0-5.5). 32 with severe disability (EDSS 6.0-6.5). | Subjects walked at a comfortable pace along a 26-foot electronic walkway (GAITRite). A word list generation task was added on trials 3 and 4.  The GAITRite calculates a functional ambulation profile score (FAP) and measures spatiotemporal gait characteristics. | The cognitive task significantly decreased ambulatory performance in 6/8 gait measures in the whole cohort: FAP, velocity, cadence, step length, step time, and double support.  The effect of the dual-task was 2-3 times greater in the moderate and severe disability groups compared to mild disability for FAP, velocity, and cadence. The effect remained when age was controlled for. | There is a decrease in walking function while simulataneously performing a cognitive task in MS.  Reduction in walking function was greatest in persons with severe disability compared with persons with mild disability. | No control group was used.  The dual-task trials were always completed after the single-task trials. The possibility of fatigue as a confounding factor was not accounted for. |
| Hamilton F et al. (2009)  Walking and talking: an investigation of cognitive-motor dual tasking in multiple sclerosis  Cross-sectional | To investigate the effects of performing a concurrent cognitive task when walking in people with MS (PwMS). | 36 subjects.  18 subjects with MS.16 women, 2 men. EDSS up to 5.5. Able to walk 100m without AD.  18 healthy controls; 12 women, 6 men. Mean age 39. | Subjects walked, preferred speed for 90s, on an 18m circuit with a 3.6m GAITRite walkway.  In dual-task trials, subjects heard then repeated a series of digits: either 7 digits (fixed demand) or a predetermined length determined in baseline testing (titrated demand).  The cognitive task was also assessed alone as a single-task. | Gait speed decreased with both titrated and fixed tasks. 9% and 11%, respectively, for PwMS and 2% and 2% for healthy controls.  Increased swing time variability in PwMS by 30% and controls by 5% in titrated task and 19% and 7% in the fixed task. (Significant difference for titrated task; near significant for fixed p<0.68)  Fatigue was correlated to reduced walking speed in the fixed-demand condition. | People with MS have greater declines in dual-task performance due to cognitive deficits and fatigue. | Immediately before and after the protocol, participants completed three repetitions of a timed 10m walk to determine any impact of fatigue on walking performance. |
| Kalron A et al. (2011)  Effect of a cogntive task on postural control in patients with a clinically isolated syndrome suggestive of multiple sclerosis. | To assess postural control and determine the effect of a cognitive task on balance in patients with a clinically isolated syndrome (CIS) suggestive of MS, within 3 months of onset. | 52 subjects with CIS. 36 women and 16 men. Mean age 35. Mean EDSS 1.7.  28 control subjects. 20 women, 8 men. Mean age 32.8 | Stability in quiet stance evaluated on a force plate. Three conditions included eyes open, eyes closed, and eyes open with modified Stroop test (reading names of colors printed in the wrong color ex. "red" printed in blue) | The sway deviation and sway rate reported in reference to SD from the control group mean using the scale: normal < 1SD, below average 1-2 SD, Poor 2-4 SD, very poor > 4 SD.  In all conditions, about 50% of subjects with MS scored normal. 40% scored poor or very poor. Compare to only 1 subject in the control group scoring poor. The Stroop task resulted in the greatest difference in groups. | Only 50% of patients performed normally. Thus, reduced postural stability is evident in very early stages of the MS disease process. | The introduction cites evidence that 53.7% of patients with CIS had cogntive impairment, most frequently verbal and attention deficits. However, the cognitive status of subjects in this study was not reported. |

Conclusion

Postural control is commonly impaired in persons with MS (PwMS) and can be attributed to weakness, spasticity, fatigue, and deficits related to somatosensation, vision, and vestibular systems. Research shows that cognitive deficits also affect postural control and gait in PwMS1-6. As the cognitive demand of a task increases, the performance of a dual-task activity decreases. Some decrease in performance is normal with dual-tasking, but the decrease is much more significant in PwMS and has negative implications for functional mobility. In particular, the risk of falls is increased when gait characteristics are affected. This is especially problematic when other impairments are also challenging mobility, which is almost always the case for PwMS. Approximately 50-65% of PwMS develop cognitive deficits and nearly 85% report significant limitations in gait2. Additionally, deficits in cognition or postural control may not be individually significant early in the disease process6. Unless dual-task is specifically evaluted, deficits may be overlooked during a physical therapy evaluation. Patients may appear safe with gait and balance activities in a clinic setting may be challenged by activities in their normal environment that require divided attention such as crossing the street or grocery shopping5.

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2. Boes MK, Sosnoff JJ, Socie MJ, et al. (2012). Postural control in multiple sclerosis: Effects of disability status and dual task. Journal of the Neurological Sciences;315:44-48.

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