DUAL TASK AND THE POSTURAL STIFFNESS MODEL IN OLDER ADULTS: THE MOBILIZE BOSTON STUDY

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INTRODUCTION

Cognitive distractions that divert attentional resources seem to impair postural control, and thus may increase fall risk. However, the mechanism by which dual-task affects postural sway or fall risk is not clear, as inconsistent effects on postural sway has been reported [1]. Standing posture is hypothesized to be controlled mainly through maintaining postural stiffness [2]. During dual task, the lack of attentional resources may lead to the inability to maintain adequate muscle tone to maintain upright standing. Decreased muscle tone would reduce postural stiffness, and would increase sway. We tested the effect of dual task on postural stiffness, damping and sway in a representative sample of community-dwelling older adults.

METHODS

The MOBILIZE Boston Study (MBS), which stands for "Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly of Boston" is a prospective study examining risk factors for falls, including pain, cerebral hypoperfusion, and foot disorders in the older population [3]. The study includes a representative population sample of 765 elderly volunteers age 70 or above from the Boston area. COP data were available in 725 participants, who were 77.9±5.3 years old, with height of 1.63±0.10 m and weight of 74.1±19.7 kg. 64% were female.

Subjects stood barefoot with eyes open on a force platform (Kistler 9286AA). The center of pressure (COP) data were sampled at 240 Hz in anteroposterior (AP) and mediolateral (ML) directions. Subjects performed two sets of five quiet standing trials, 30 seconds each. One set included a serial subtractions task.

Postural stiffness was calculated as previously described [2], where the postural system is modeled as an inverted pendulum with stiffness and damping. Movement of center of mass (COM) was estimated. Fourier transform of the difference between COP and COM was fit to a damped oscillator model to determine K_e (stiffness) and B (damping). Velocity of the inverted pendulum at vertical V_o was also calculated. RMS amplitudes for COP and COM (COP_{rms}, COM_{rms}) K_e, B, and V_o values were determined for each trial using MATLAB 7.4. The effect of dual task on these parameters was assessed using a mixed-model analysis of variance, with empirical standard error estimation and unstructured covariance using SAS 9.1.

RESULTS AND DISCUSSION

Sway amplitudes and B increased with the dual task. K_e decreased only in ML, while V_o increased only in AP directions (Table 1). Dual task could still independently explain increases in COM_{rms} ($p \leq 0.005$) after including V_o or K_e as a covariate. Thus changes in V_o or K_e did not fully explain increase in sway due to dual task.

Reduction in stiffness in the ML direction may mean a decrease in postural tone. The brain may be prioritizing the maintenance of postural tone in AP direction given the limited attentional resources because the feet may provide "free" stability in ML but not in AP direction. The inverted pendulum model did not fully explain the increase of sway with the dual task. A more sophisticated model of postural control may better explain the role of attention.

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Table 1: Dual task effects on postural sway and stiffness model parameters (mean ± SD)

		Quiet stance	Dual task	p-value
AP	COP_{rms} (mm)	4.65 ± 1.75	5.03 ± 2.17	p<0.001
	COM_{rms} (mm)	4.08 ± 1.70	4.29 ± 1.93	p<0.001
	K_e (N-m/rad)	876.5 ± 654.0	885.3 ± 683.3	p = 0.32
	B (N-m-s/rad)	228.3 ± 101.9	242.8 ± 117.2	p<0.001
	V_o (mm/s)	13.44 ± 6.59	13.81 ± 6.40	p = 0.016
ML	COP_{rms}	3.17 ± 1.57	3.57 ± 2.06	p<0.001
	COM_{rms}	2.82 ± 1.71	3.11 ± 1.98	p<0.001
	K_e	712.4 ± 489.1	624.8 ± 460.0	p<0.001
	B	164.3 ± 73.9	182.3 ± 89.6	p<0.001
	V_o	8.25 ± 4.91	8.36 ± 4.89	p = 0.36