GAIT VARIABILITY IS REDUCED BY SUB-THRESHOLD VIBRATIONS TO THE FEET

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INTRODUCTION

Decreases in somatosensory function result in diminished motor performance and falls (DeMott et al., 2007). Increased stride-to-stride variability in stride length, speed, and double-support time is predictive of fall risk (Maki 1997). Subsensory mechanical noise applied to the soles of the feet can enhance sensory function and reduce postural sway in quiet standing via a mechanism called stochastic resonance (Priplata et al., 2003). The goal of this study was to determine whether the application of subsensory noise vibrations to the soles of the feet could reduce gait timing variability, an indicator of fall risk in older adults.

METHODS AND PROCEDURES

41 older adults (ages 76.5 ± 4.7 years) without neurological conditions were recruited from the Mobilize Boston Study, an ongoing population-based study of 800 community-dwelling older adults (Leveille et al, 2007). 22 were recurrent fallers who fell 2 or more times in the last year. 19 were non-fallers who fell 0-1 times (non-fallers) in one-year period, matched by age and sex. 12 healthy young adults (ages 26±5 years) also participated. Participants walked at a self-selected comfortable pace around a 22m elliptical track for 3 trials of 6 minutes each, while wearing custom vibrating sandals. The sandals delivered a white-noise vibration signal that was adjusted to be up to 90% of each individual’s sensory threshold in the feet during each gait phase. During walking, noise was applied during first or second half of each trial, and the application order was randomized. Heel-strike and toe-off events were captured using force-sensing resistors in the sandals. Variability of the stride, stance, and swing time intervals for each half of each trial were quantified as the standard deviation (SD). The effects of the vibrations and the group (faller, non-faller, young) were compared using a mixed-model ANOVA (SAS 9.1).

RESULTS

Sub-threshold vibrations reduced stride time SD (p < 0.04), stance time SD (p< 0.02), and swing time SD (p = 0.06) in all subjects, but did not affect gait speed (p = 0.76). Without the vibratory stimulus, recurrent fallers exhibited greater baseline stride time SD than non-fallers or young adults (p < 0.002; Figure 1). During vibration, stride time SD was significantly reduced only in the faller group (p = 0.025; Tukey LSD). Group by vibration interactions were not present (p > 0.4), Reduction of SD due to the vibration
correlated with baseline SD. This correlation was strongest in stride time variability in fallers ($r = 0.65$, $p < 0.002$) and weaker in non-fallers ($r = 0.45$, $p = 0.051$; Figure 2).

Stance time SD was reduced in both fallers ($p < 0.04$) and non-fallers ($p < 0.03$) during the vibration. Reduction of stance time SD was correlated with baseline SD, but this relationship was stronger in the non-fallers ($r = 0.66$, $p < 0.002$) than in fallers ($r = 0.25$, $p = 0.26$). The correlations in swing time were similar between the two groups.

**DISCUSSION**

Sub-threshold vibratory noise applied to the soles of the feet reduced gait variability. This effect was most prominent in older adults with recurrent falls and with large variability in stride time. Application of noise may increase somatosensation via a mechanism known as stochastic resonance. Older adults with recurrent falls and large gait variability may benefit the most from this novel intervention.

**REFERENCES**


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