Dual Task Performance in a Healthy Young Adult Population: Results from a Symmetric Manipulation of Task Complexity and Articulation

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INTRODUCTION

The ability to execute and maintain gait, while performing simultaneous cognitive, verbal, or motor tasks is presumably beneficial in a multitude of ways (e.g., walking while talking). Gait performed concurrently with a secondary task is termed 'dual-tasking' and it is well-documented that simultaneous task performance can result in cognitive or motoric interference. Dual-task interference typically results in a decrement within gait performance, as well as impairment of performance on the secondary task (Woolacott & Shumway-Cook, 2002). Due to the fact that most cognitive secondary tasks involve a substantial articulation component (i.e., they involve speaking aloud), it is important to identify the extent to which this factor interacts with the cognitive complexity of the task (Bloem et al., 2001; Dault, Yardley, & Frank, 2003; Pellecchia, 2003; Yardley, Gardner, Leadbetter, & Lavie, 1999).

The goal of this project, therefore, was to manipulate both complexity and articulation within a single working memory task, in order to examine the respective impact of these factors on continuous gait parameters.

METHODS AND PROCEDURES

Fourteen healthy young adults (3 men and 11 women) were recruited from a pool of students at the University of Western Ontario (age: M = 22.14, SD = 2.28). Participants were asked to memorize a random, non-repeating, sequence of 3, 5, or 7 digits. Articulation was manipulated by either having participants rehearse the digits aloud, or rehearse the digits silently during the performance of the gait task. For the gait task, participants were asked to walk down a 20-foot instrumented walkway (GAITRite). Articulation (i.e., articulation versus no articulation) was completely crossed with complexity (i.e., 3, 5, and 7 digits), and participants were asked to perform three trials within each experimental block. Experimental blocks were randomized for each participant.

RESULTS

Data were analyzed using 3x2 (complexity and articulation) multivariate analyses of variance. Temporal properties of gait (velocity, cadence, step time, swing time, and stance time) were evaluated separately from spatial properties of gait (step length, stride length, and base of support). Descriptives for all spatial-temporal measures are presented in Table 1.

The multivariate analysis of the temporal properties demonstrated a statistically significant interaction term [$F(10,46)=4.42$, $p < .05$]. This multivariate effect was further evaluated at the univariate level, and all temporal measures demonstrated a statistically significant interaction effect. The means of each variable were parsed by evaluating the simple main effect of articulation at complexity, and these post-hoc evaluations consistently demonstrated that articulation had a greater effect at higher levels of complexity.

The multivariate analysis of the spatial properties demonstrated a statistically significant main effect for both complexity [$F(6,50)=2.39$, $p < .05$] and articulation [$F(3,11)=7.44$, $p < .05$], but no significant effect was demonstrated for the interaction between these factors. Univariate analysis revealed that step length and stride length showed a statistically significant main effect for both complexity and articulation, but neither of these variables demonstrated a statistically significant interaction effect. Post hoc analysis of these significant main effects suggested that articulation constrains the spatial properties of gait, and also suggested that these spatial parameters became significantly smaller with each successive level of complexity.

DISCUSSION

Overall these results suggest that articulation produces a substantive change in the spatial and temporal properties of gait, above and beyond the effects of memory demands. This is particularly important when one considers the nature of most cognitive secondary tasks (i.e., the fact that most include some auditory verbal content). While the etiology of this effect cannot be explicitly evaluated within the present paradigm, it is possible that this effect may be due to the respiratory demands of articulation, or it may also be due to the increased cognitive complexity of the task, due to the addition of a verbal component. Future research should focus on the dissociation of these articulation effects on the spatial-temporal properties of gait.

REFERENCES

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Table 1: Means (and standard deviations) across all conditions.

	LC/NA	LC/A	MC/NA	MC/A	HC/NA	HC/A
Velocity	144.0 (10.7)	139.2 (10.9)	145.4 (11.0)	138.1 (12.0)	140.4 (11.1)	128.3 (13.5)
Cadence	119.5 (7.3)	116.3 (6.1)	120.2 (7.3)	116.0 (7.4)	117.9 (8.5)	109.3 (8.6)
Step Time	0.5 (.03)	0.5 (0.03)	0.5 (0.03)	0.5 (0.03)	0.5 (0.04)	0.6 (0.04)
Swing Time	0.4 (.03)	0.4 (0.02)	0.4 (0.02)	0.4 (0.03)	0.4 (0.03)	0.4 (0.04)
Stance Time	0.6 (.04)	0.6 (0.04)	0.6 (0.04)	0.6 (0.04)	0.6 (0.04)	0.7 (0.05)
Step Length	72.5 (6.4)	72.0 (6.3)	72.75(6.03)	71.5 (6.0)	71.7 (6.0)	70.5 (6.1)
Stride Length	145.3 (12.9)	144.2 (12.5)	145.8 (12.1)	143.1 (11.8)	143.7 (11.8)	141.2 (12.0)
Base of Support	10.0 (3.2)	9.8 (4.3)	10.6 (3.0)	10.3 (3.3)	10.1 (3.2)	10.2 (3.2)

Notes: LC=low complexity; MC=medium complexity; HC=high complexity; NA=no articulation; A=articulation