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Walking while talking: Investigation of alternate forms☆

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Abstract

The aim of this study was to develop alternate forms of the walking while talking (WWT) dual task, and to determine whether beginning the WWT in mid-alphabet vs. at the beginning of the alphabet, affects task outcomes. Alternate test forms help reduce practice effects leading to more precise estimates of change over time. We conducted a cross-sectional study in 145 community-residing older adults (mean age, 79.2 ± 6.8 y) without dementia or depression. Subjects performed four WWT trials with a different initial letter (*a*, *b*, *m* or *n*). There were no differences in velocity, correct letters, or errors on WWT trials beginning at shared points in the alphabet (*a* compared to *b* and *m* compared to *n*). However, trials initiating with letters from the beginning of the alphabet compared to mid-alphabet showed significant differences (with higher number of correct letters and fewer errors for *a* and *b* trials) but not for velocity. Thus, starting WWT in mid-alphabet is different from starting at the beginning of the alphabet. Alternate forms of the WWT with two separate initial letters from a shared point of the alphabet (specifically *a* and *b* or *m* and *n*) may be used upon repeated administration to reduce practice effects.

Keywords

Dual task; Alternate forms; Practice effects; Elderly; Walking

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1. Introduction

The walking while talking (WWT) paradigm is an ecologically valid test of divided attention during locomotion. Previously, we reported that WWT (reciting alternate letters of the alphabet while walking) showed incremental validity in predicting falls over normal walking [1].

The use of dual task gait paradigms continues to grow [2,3]. However, alternate forms, required to maintain task properties over repeated administration, are lacking. Increased familiarity and recall of test details from repeated encounters (practice effect) are a concern when retesting individuals using the same version of tests such as WWT. Alternate test forms may reduce practice or learning effects [4] leading to more precise estimates of change over time, enabling clinicians to better determine treatment effects in clinical trials and help reduce bias in research studies with small samples.

The primary aim was to develop alternate forms for the WWT paradigm [4] by varying the starting letter. Previous studies have shown that item difficulty will influence learning [5]. Hence, a secondary aim was to determine whether initiating the WWT at an unfamiliar mid-alphabet start point, (*m'* or *n'*), vs. a familiar alphabet start point, (*a'* or *b'*), affects gait and verbal measurements on this task.

2. Methods

2.1. Study design

Study participants were enrolled in the Einstein Aging Study (EAS), a community-based longitudinal aging study, based in Bronx County, NY. The primary aim of the EAS is to identify risk factors for dementia. Study design has been previously reported [6]. In brief, potential participants (age 70 and over) identified from Bronx County population lists were contacted by letter explaining the purpose and nature of the study, and then by telephone. Participants who gave verbal consent on the telephone interview were invited for in-person evaluation at our research center. Exclusion criteria included severe auditory or visual loss, bedbound because of illness, institutionalization, presence of dementia [7] or depression (self-report or a score of ≥ 10 on the 15-item geriatric depression scale). Informed consent was obtained at enrollment according to protocols approved by the Albert Einstein College of Medicine institutional review board and subjects signed written informed consent.

We collected medical history including arthritis, depressive symptoms [8], diabetes, Parkinson's disease and hypertension. Height, weight and blood pressure were measured. The Blessed Information–Memory–Concentration test (BIMC) was used to test general mental status [9].

176 EAS participants seen between July and November 2009 performed the WWT. For this substudy, we excluded three subjects diagnosed with dementia [7] and 28 with depression [8] leaving 145 eligible subjects. The sample was 49% women, mostly white (82%), well educated (mean 15.4 years), with mean age 79.2 years and a high prevalence of hypertension (Table 1).

2.2. WWT procedures

Subjects were asked to walk at normal pace on a instrumented gait-mat (GAITRite; CIR Systems, Havertown, PA) in a quiet well-lit 'gait room'. The walkway measured $8.5 \text{ m} \times 0.9 \text{ m} \times 0.01 \text{ m}$, ($L \times W \times H$) with an active recording area of $6.1 \text{ m} \times 0.61 \text{ m}$, ($L \times W$). White lines on the floor marked start and stop points, which included 1.2 m from walkway edge for

initial acceleration and terminal deceleration. The GAITRite system has excellent reliability [10]

For the WWT task, subjects walked the same walkway reciting alternate letters of the alphabet (e.g.; *a, c, e, ...*). Subjects were instructed to pay equal attention to both walking and talking [1]. The initial letter options on the WWT task included '*a*,' '*b*,' '*m*,' and '*n*.' Each subject performed four WWT trials; one trial with each of the four initial letters. The order of the trials was randomly varied.

If subjects made an error during the task but continued on accurately, the total number of alternate letters correctly recited was counted [11]. A new trial was started if the trial was interrupted for any reason. Only the completed trial was used for analysis.

The WWT outcomes (one trial per start letter) included velocity (cm/s), total numbers of alternate letters correctly recited and the total errors. Velocity was measured in steady state walking, recorded on the portion of the walkway with sensors (6.1 m), whereas letters and errors were recorded over the entire walkway (8.5 m) as the recording surface on the walkway was not visible.

Velocity on the four WWT trials within subjects was compared using linear mixed effect models. Correct letters and errors on the four WWT trials were compared using Poisson regression models with random effects and the log of time as the offset variable, where time is estimated by distance divided by velocity. All analyses are adjusted for age, sex, race, education and trial order. Expected differences in velocity and risk ratios for correct letters and errors among trials are reported.

All statistical analyses were performed in SAS 9.2 (SAS Institute Inc., Cary, NC)

3. Results

All subjects completed all four WWT trials with the four start letters. Within subject comparisons of verbal and motor outcomes on the four WWT trials are presented in Tables 2 and 3. All four WWT trials showed dual task effects with slowing of gait velocity (mean 66.20 cm/s for all four conditions) compared to the common single task normal pace walking condition (mean 95.82 cm/s).

There were no significant differences in velocity or verbal outcomes when comparing WWT trials with initiating letters from shared points in the alphabet ('*a*' vs. '*b*' and '*m*' vs. '*n*').

Compared to trials initiating, at the beginning of the alphabet, trials initiating at mid-alphabet were associated with significantly ($P < 0.05$) lower rates of correct letters (risk ratios from 0.84 to 0.89 for '*m*' vs. both '*a*' and '*b*' and '*n*' vs. '*b*', and significantly higher rates of error for '*n*' vs. both '*a*' and '*b*' (risk ratios 1.30 and 1.37, respectively). WWT velocity was not different between the four trials. Thus, the possibility of learning effect is minimized but not completely eliminated.

4. Discussion

Varying the initial letter in the WWT between two letters from a shared point (beginning or middle) in the alphabet resulted in comparable gait and verbal outcomes. Therefore, we recommend using alternate forms of the WWT with initial letters from shared points in the alphabet (either '*a*' and '*b*' or '*m*' and '*n*') in order to reduce practice effects upon repeated administration.

WWT tests with initial letters from different alphabet start points are not comparable, and may represent different levels of cognitive challenge. The predictive validity of WWT for predicting falls with different alphabet start points should be studied prospectively.

This study included reliable study procedures with [1] subjects serving as their own controls which reduces bias. Additionally, the study utilized a community-based sample and therefore results can be better generalized. No difference in WWT velocity for the four trials was seen. This may be because the versions of WWT differ in cognitive, not motor, demands. Individuals might also prioritize walking over cognitive tasks [11]. We showed that practice effect is reduced by alternating between letters from shared points in the alphabet. Moreover, the trial sequence within individuals did not show any significant difference on the study outcomes. We acknowledge that despite our large sample size the possibility of learning effect is minimized but not completely eliminated. Alternate forms of WWT provide a reliable longitudinal assessment of cognitive motor dual tasking ability in the elderly.

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Table 1

Study sample characteristics.

Variable	Value
Mean age $\pm$ SD (y)	79.2 $\pm$ 6.8
Women <i>n</i> (%)	71 (49.0)
White race <i>n</i> (%)	119 (82.1)
Mean education $\pm$ SD (y)	15.4 $\pm$ 3.2
Mean normal gait velocity $\pm$ SD (cm/s)	95.8 $\pm$ 22.0
Mean height $\pm$ SD (cm)	162.3 $\pm$ 13.8
Mean weight $\pm$ SD (kg)	81.8 $\pm$ 25.3
Mean systolic blood pressure $\pm$ SD (mm Hg)	127.9 $\pm$ 15.3
Mean diastolic blood pressure $\pm$ SD (mm Hg)	74.4 $\pm$ 9.5
Blessed Information-Memory-Concentration test score (range, 0–32; >7 abnormal)	1.2 $\pm$ 1.5
Mean geriatric depression scale score (range, 0–15; >5 abnormal) $\pm$ SD	1.6 $\pm$ 1.6
Medical illness <i>n</i> (% of sample)	
Arthritis	60 (46.2)
Diabetes	26 (23.4)
Hypertension	86 (64.7)
Parkinson's disease	0 (0)

Table 2

a, *b*, *m* and *n* trial outcomes.

Outcome	Initial letter of WWT trial		Effect (mean difference [*] or risk ratio ^{**}) (<i>b</i> vs. <i>a</i>)	Lower CI	Upper CI	<i>P</i> value
	<i>a</i>	<i>b</i>				
Velocity (cm/s)	66.71 ± 28.77	66.72 ± 27.60	-0.08 [*]	-1.83	1.67	0.93
Number of correct letters	9.05 ± 3.22	9.42 ± 3.99	1.06 ^{**}	0.98	1.14	0.14
Number of errors	1.30 ± 1.36	1.15 ± 1.39	0.95 ^{**}	0.75	1.15	0.62

Outcome	Initial letter of WWT trial		Effect (mean difference [*] or risk ratio ^{**}) (<i>n</i> vs. <i>m</i>)	Lower CI	Upper CI	<i>P</i> value
	<i>m</i> vs. <i>a</i>	<i>n</i> vs. <i>a</i>				
Velocity (cm/s)	64.16 ± 28.20	66.19 ± 27.51	1.06 ^{**}	-0.69	2.81	0.24
Number of correct letters	8.43 ± 3.90	8.51 ± 3.97	1.05 ^{**}	0.97	1.14	0.23
Number of errors	1.40 ± 1.61	1.60 ± 1.87	1.19 ^{**}	0.96	1.41	0.08

P values were calculated using linear mixed effects models for velocity, and Poisson regression models with random effects for letter and error outcomes, adjusting for age, sex, race, education (years), and trial order.

^{*} Effect is the expected difference in velocity between different initial letters for the velocity outcome;

^{**} risk ratios for error and letter outcomes.

Table 3

Comparison of WWT trial outcomes.^a

Outcome	Initial letter of WWT trial				<i>n</i> vs. <i>a</i>			
	<i>m</i> vs. <i>a</i>	Effect (mean difference [*] or risk ratio ^{**})	Lower CI	Upper CI	<i>P</i> value	Effect (mean difference [*] or risk ratio ^{**})	Lower CI	Upper CI
Velocity (cm/s)	-1.64 [*]		-3.38	0.11	0.07	-0.58 [*]	-2.33	1.17
Number of correct letters	0.89 ^{**}		0.82	0.96	0.01 [†]	0.94 ^{**}	0.87	1.01
Number of Errors	1.09 ^{**}		0.87	1.31	0.39	1.30 ^{**}	1.04	1.55
								0.01 [†]
Outcome	Initial letter of WWT trial				<i>n</i> vs. <i>b</i>			
	<i>m</i> vs. <i>b</i>	Effect (mean difference [*] or risk ratio ^{**})	Lower CI	Upper CI	<i>P</i> value	Effect (mean difference [*] or risk ratio ^{**})	Lower CI	Upper CI
Velocity (cm/s)	-1.56 [*]		-3.31	0.19	0.08	-0.50 [*]	-2.25	1.25
Number of correct letters	0.84 ^{**}		0.78	0.91	<0.001 [†]	0.89 ^{**}	0.82	0.96
Number of errors	1.15 ^{**}		0.91	1.39	0.18	1.37 ^{**}	1.09	1.64
								0.003 [†]

^{*} Effect is the expected difference in velocity between different initial letters for the velocity outcome;

^{**} risk ratios for error and letter outcomes.

^a All results are from linear mixed effects models for velocity and Poisson regression models with random effects for correct letter and error outcomes, adjusting for age, sex, race, education (years), and trial order.

[†] Indicates significant *P* value (<0.05).