ORIGINAL ARTICLE

Walking While Talking: Effect of Task Prioritization in the Elderly

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ABSTRACT. Verghese J, Kuslansky G, Holtzer R, Katz M, Xue X, Buschke H, Pahor M. Walking while talking: effect of task prioritization in the elderly. Arch Phys Med Rehabil 2007; 88:50-3.

Objective: To examine the effect of 2 instructions on the same walking while talking (WWT) task on task prioritization by nondisabled subjects.

Design: Cross-sectional survey with within subject comparisons.

Setting: Community-based sample.

Participants: Older adults (N=189; mean age, 80.2±4.9y), who did not meet criteria from the *Diagnostic and Statistical Manual, Fourth Edition*, for dementia and were able to independently perform activities of daily living.

Interventions: Not applicable.

Main Outcome Measures: Verbal and gait measures on the same WWT task with 2 different instructions: paying attention to both talking and walking (WWT-C) and paying attention only to talking (WWT-T).

Results: Task prioritization effects were seen on walking but not on talking. Compared with their baseline normal walking velocity (without talking), subjects slowed down more on WWT-T (median change, 28.3%) than WWT-C (median change, 26.4%). Comparing the 2 WWT conditions, velocity and cadence was slower during WWT-T compared with WWT-C, with longer stride length. Verbal output was not significantly different on the 2 conditions.

Conclusions: Changing instructions while maintaining the same cognitive and motor tasks on WWT in older adults result in task prioritization effects.

Key Words: Attention; Elderly; Rehabilitation; Walking.

THERE IS INCREASING INTEREST in developing performance-based tests to assess mobility in older adults, and predict outcomes such as falls and disability.[1] The walking while talking (WWT) paradigm has been studied as a real-world test of divided attention to examine cognitive-motor interactions, especially in the context of identifying fallers.[1-7] It has been suggested that an inability to produce an appropriate postural response may result due to competition for attentional resources between the postural system and the cognitive task, which increases risk of falls in older adults with poor balance.[8] We reported that nondemented older adults who slowed down during a WWT test were at increased risk of falls over the next year.[1] Increasing the degree of difficulty on the cognitive task (reciting letters of the alphabet versus reciting alternate letters of the alphabet) lowered gait velocity during WWT, and showed stronger association with risk of falls.[1] Other studies have reported variable associations between WWT tasks and falls.[2-7] However, WWT protocols are not uniform and have included observing stopping while walking and talking,[2] repeating random digits while walking,[3] or reciting names while walking.[4,5]

WWT requires the ability to divide and switch attention between 2 tasks. Older adults may show an innate preference for preserving gait over talking during the WWT test.[8,9] Not all studies report specific instructions with regard to task prioritization during WWT. Uncontrolled self task prioritization during the WWT test may result in better motor performance, lowering the observed association with outcomes of interest (type II error). The effect of task prioritization on WWT and geriatric outcomes has not been well studied.[10] The aim of this study was to examine the effect of 2 instructions on the same WWT task on task prioritization in older adults without disability or dementia.

METHODS

Participants

We examined WWT in 235 consecutive community-residing adults age 70 and over participating in a gait and mobility substudy of the Einstein Aging Study based in Bronx County, NY.[11,12] Exclusion criteria for the Einstein Aging Study include severe audiovisual loss, being bed-bound, or institutionalization. Clinical evaluations were done at each visit by study clinicians who determined whether gaits were normal or abnormal. A detailed neuropsychologic test battery was administered at study visits. For the purposes of this study, based on associations between gait and cognitive status reported in our sample,[13] we present performance on the Blessed Information-Memory-Concentration test (BIMC),[14] free and cued selective reminding (FCSR) test,[15] Wechsler IQ scales and subtests (digit span, digit symbol),[16] letter fluency test,[17] and category fluency test.[18] Medical history including history of falls over the previous year,[19] depressive symptoms,[20] and medications was obtained using structured questionnaires.[11-13] Information obtained from subjects was corroborated with family members or significant others, when available. We also consulted medical records and primary care physicians to obtain further details. Informed consents were obtained at clinic visits according to study protocols approved by the local institutional review board.

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For this study, we excluded 30 subjects who needed walking aids to complete the WWT test (but not all persons with walking aids) and 10 disabled subjects. Disability was defined as inability to independently perform 1 or more of the following activities of daily living: bathing, dressing, grooming, feeding, toileting, walking around home, and getting up from a chair.[21] All available clinical and neuropsychologic information on all subjects were reviewed following study visits at consensus case conferences attended by study neurologists, neuropsychologist, and social worker.[11,12] Dementia diagnosis was assigned using the criteria[22] of the *Diagnostic and Statistical Manual, Fourth Edition*, and was subtyped using established criteria.[11,12] We excluded 6 subjects who met study criteria for dementia. Of the 235 subjects, 189 (80.4%) were eligible for this analysis.

Quantitative Gait

Research assistants conducted quantitative gait evaluations, independent of the clinician's evaluation, using a computerized mat 457×90.2×.64cm (180×35.5×0.25in) with embedded pressure sensors (GAITRite[a]). Subjects were asked to walk on the mat at their normal walking speed for 2 trials in a quiet and well-lit hallway.[12,23] Start-and-stop points were marked by white lines on the floor, and included 0.9m (3ft) each for initial acceleration and terminal deceleration. Monitoring devices were not attached to the participants during the test. The software computes quantitative parameters based on footfalls recorded. Each trial was 1 walkway in length, and values analyzed were the mean of 2 trials computed automatically by the software. Velocity (in cm/s) is the distance covered on 2 trials divided by ambulation time. Step length is distance between heel points of the current footfall and previous footfall on the opposite foot. Cadence is number of steps taken in a minute. Stride length is the distance between the heel points of 2 consecutive footfalls of the same foot. Double support is the time elapsed between first contact of the current footfall and the last contact of the previous footfall, added to the time elapsed between the last contact of the current footfall and the first contact of the next footfall. Excellent reliability and validity for GAITRite assessments were reported in previous research by the authors and others.[12,24]

Walking While Talking

We asked the subjects to walk on the computerized mat while reciting alternate letters of the alphabet (skipping the letter in between), using 2 different instructions. During the "complex" WWT condition (WWT-C), validated in our previous study,[1] subjects were asked by the tester to pay equal attention to both their walking and talking. The subjects in this sample were not the same as those in our pilot study.[1] During the "talking" condition (WWT-T), subjects were asked to pay attention to reciting alternate letters and not to concentrate on their walking. Two trials on each condition were done. Quantitative parameters were recorded as described above.

Prior to both WWT conditions, we told the subjects that they might slow down during the WWT task. If they had to stop walking to think of the next letter, they were instructed to start walking again as soon as they could. Testers did not advise or encourage subjects during the task, intervening only in situations where subject safety was an issue. The trial data were not recorded and a new trial started if the trial was interrupted for any reason such as loss of balance or if subjects asked the tester a question in the middle of the trial. The initial letter on the interference task was randomly varied between "A" (A-C-E) and "B" (B-D-F) between trials. To reduce learning effects, subjects were given one or more practice trials as required on both the single and dual task conditions to familiarize themselves with the procedure, but were not taught strategies. The tester recorded the total numbers of alternate letters correctly recited in sequence and the total number of errors for 2 trials during each condition. If subjects made an error but continued on accurately, the total number of alternate letters correctly recited was counted. A randomization procedure was not done but the test order was more or less equally distributed; the first 101 subjects in this study did WWT-C first followed by WWT-T, and the next 88 did WWT-T first.

Statistical Analysis

We have reported values as median with interquartile ranges instead of means with standard deviation (SD) to account for nonparametric distributions. We made pairwise comparisons of verbal and quantitative gait parameters on the 2 WWT conditions within subjects using the Wilcoxon signed-rank test, which makes no assumptions about the underlying distribution of data being compared.[25,26] The relevant comparisons reported are within subjects and not between subjects. The statistical significance was unchanged when examined using paired *t* tests (data not shown).

RESULTS

Sample

Sample characteristics are presented in table 1. The majority of subjects were women (56.6%), and the mean age was 80.2±4.9 years. The median velocity during normal walking was 103.0cm/s (interquartile range, 89.4–114.3). There was a low prevalence of various chronic medical illnesses, except for hypertension. None of the subjects were on antipsychotic medications. There was a low prevalence of Parkinsonian medica-

Table 1: Study Sample Characteristics

Variable	Value
Mean age ± SD (y)	80.2±4.9
Women (%)	56.6
Mean education ± SD (y)	11.1±2.6
Mean normal gait velocity ± SD (cm/s)	101.8±16.5
Medical illness (% of sample)	
Diabetes	14.6
Hypertension	54.5
Myocardial infarction	6.9
Parkinson's disease	0.6
Strokes	6.4
Arthritis	15.9
Falls	27.9
Mean cognitive tests ± SD	
BIMC test* (range, 0–32; >7 abnormal)[14]	2.2±2.7
Verbal intelligence quotient (mean, 100±15)[16]	110.7±16.9
Performance intelligence quotient (mean, 100±15)[16]	101.8±7.5
FCSR total recall† (range, 0–48; <45 abnormal)[15]	46.2±1.9
Total digit span (high score better)[16]	15.6±3.8
Digit symbol (high score better)[16]	48.7±14.3
Letter fluency (high score better)[17]	38.5±12.9
Category fluency (high score better)[18]	38.9±13.1
GDS (range, 0–15; >5 abnormal)[20]	1.9±1.7

Abbreviation: GDS, Geriatric Depression Scale.
*The BIMC test is a test of general mental status similar to the Mini-Mental State Examination.[14]
†The FCSR test is a test of verbal memory.[15]

Table 2: Quantitative Gait and Verbal Parameters During Normal Walking, WWT-C, and WWT-T in 189 Nondisabled and Nondemented Older Adults

WWT Variables	Normal Walking Median (IQR) (N=189)	WWT-C Median (IQR) (N=189)	% Change*	WWT-T Median (IQR) (N=189)	% Change*	Mean Difference WWT-C and WWT-T†	P‡
Velocity (cm/s)	104.7 (92.3−115.8)	76.7 (58.1−94.5)	−26.4	72.2 (54.5−92.5)	−28.3	2.2±0.8	.005
Cadence (steps/min)	104.0 (96.4−110.4)	87.9 (68.2–101.2)	−17.5	87.2 (67.3−100.0)	−19.2	1.3±0.6	.03
Step length right (cm)	60.1 (54.8−65.5)	53.2 (47.0−59.6)	−7.9	53.1 (47.0−58.3)	−9.0	0.3±0.3	.12
Stride length right (cm)	119.3 (106.4−131.5)	105.7 (95.2−118.9)	−9.3	106.0 (93.9−116.7)	−9.9	−1.1±0.5	.03
Double support time (%)	26.1 (24.2−28.1)	27.9 (24.4−32.5)	4.7	27.9 (23.5−31.8)	6.2	0.5±0.4	.10
WWT errors (total)		2 (0−4)		1 (0−4)		0.2±0.2	.26
WWT letters (total)		14 (12−18)		14 (12−18)		0.2±0.1	.39

NOTE. Values are median with interquartile range (IQR) from the 25th to 75th percentile.
*Percentage change (median) of gait parameters between WWT conditions and normal walking within subjects.
†Mean difference ± standard error of mean of gait and verbal parameters between WWT-C and WWT-T. Units for differences in study variables in both WWT conditions are the same as for the individual variables in column 1.
‡*P* values are for pairwise comparisons of gait and verbal parameters during WWT-C and WWT-T using the Wilcoxon test.

tion (0.6%), antidepressant (1.7%), and chronic benzodiazepine (3.4%) use in this nondisabled sample. While mean values on cognitive tests for subjects in this sample were within normal limits and none met clinical criteria for dementia,[22] there was a range of performance as indicated by the SDs on individual tests in table 1. For instance, only 6 of the 189 subjects had scores in the abnormal range on the BIMC test[14] (>7 points). None of the subjects had abnormal total recall scores (<45) and 16 had free recall scores less than 24 on the FCSR test.[15] None had significant depressive symptoms on the Geriatric Depression Scale[20] (>5 points).

Walking While Talking

We found significant effects for task prioritization on WWT. All subjects completed both trials on both WWT conditions without stopping. Table 2 shows the quantitative gait and verbal outcomes during the 2 WWT conditions. Overall, quantitative gait parameters were worse during WWT than during normal walking. Table 2 shows that compared with baseline normal walking velocity (without talking), subjects show a more unstable pattern of walking with decreased velocity, cadence, and step length but increased double-support time during both WWT conditions. When comparing the 2 WWT conditions, velocity and cadence was significantly slower on WWT-T, which requires subjects to pay more attention to talking than WWT-C. Stride length was longer during WWT-T than during WWT-C. Median values in both WWT conditions are similar and are provided for descriptive purposes. The total number of errors while reciting alternate letters was lower on WWT-T, but the difference was not significant. The number of letters accurately recited did not differ between the 2 WWT conditions.

The direction of the results on secondary analyses in different subgroups was similar, although the significance levels varied across subgroups and on individual gait parameters in these smaller samples compared with our full sample. For instance, velocity was slower on the WWT-T condition when subjects with cognitive impairment defined as free recall scores less than 24 (WWT-C median velocity, 75.1cm/s vs WWT-T median velocity, 71.8cm/s; $P=.005$) or subjects with a history of previous falls (WWT-C median velocity, 75.0cm/s vs WWT-T median velocity, 73.2cm/s; $P=.08$) were excluded from the analyses.

The task order did not show learning effects; on the contrary, it resulted in significantly slower velocity on the WWT-C when done as the second task. The median change in velocity on WWT-C compared with normal walking was 18.8% (WWT-T median change over normal walking, 28.4%) (WWT-T vs WWT-C, $P<.001$) in the 101 subjects who did WWT-C first. The median change in velocity on WWT-C compared with normal walking was 27.6% (WWT-T median change over normal walking, 26.4%) (WWT-T vs WWT-C, $P=.01$) in the 88 subjects who did WWT-T first.

DISCUSSION

Changing task instructions on the WWT task resulted in reduced motor performance in the WWT-T than in the WWT-C condition but in no significant changes on the cognitive task in our study. Both WWT conditions used the same cognitive and motor tasks, and differed only in the instructions. Subjects walked slower when they were asked to focus on talking (WWT-T), diverting attention away from the walking. Uncontrolled self-task prioritization during WWT-C, where subjects were asked to pay attention to both walking and talking, did not slow down gait to the same extent as WWT-T. Subjects took longer strides in WWT-T than WWT-C, which may be a compensatory response (albeit unsuccessful) to the slower cadence and velocity. While subjects made fewer errors reciting alternate letters on the WWT-T, as predicted by shifting the focus to the verbal task, the difference was not significant. In future studies, increasing number of trials or increasing the difficulty on the verbal task may improve the sensitivity of the WWT test to detect differences on the verbal task during different test conditions.

There is a dynamic interplay between the cognitive and motor tasks during divided attention tasks such as the WWT. Walking at normal pace is said to require minimal cognitive involvement, and relies on automatic motor control processes.[27] When additional cognitive demands are introduced during walking, attentional resources have to be shared between both the cognitive and the motor tasks as suggested by decrements on gait performance during our WWT conditions. In subjects with balance problems, poor or limited attentional resource reallocation may result in postural instability and increase risk of falls.[8] Older adults are reported to show an innate preference to maintaining posture while attempting to simultaneously balance and perform a cognitive task.[8,9] A previous study suggested that older adults prioritized walking over a secondary memory task.[10] An interesting age related behavior was seen in this study; when given compensatory external aids during the dual task, older adults optimized walking, whereas younger adults optimized memory performance.[10] Our findings show that when instructions on the WWT cognitive task were experimentally manipulated, subjects attempted to compensate by slowing down their gait to avoid instability.

Strengths of this study include the large sample size and reliability of study procedures.[1,11-13] Selection bias was reduced by having subjects serving as their own controls. While age, sex, cognitive status, or nature of the cognitive task may influence overall WWT performance,[10,28-30] in this study subjects served as their own controls for the 2 task conditions. We did not attempt to normalize gait variables by using transformations because this would make the results difficult to interpret, and also because the relevant comparisons were within and not between subjects. Performance bias was minimized because the WWT tests were done by clinical assistants independent of clinical and cognitive assessments, and blinded to study aims. The magnitude of gait slowing was similar for WWT-T irrespective of task order. While WWT-C velocity was slower done second, supporting task order effects, this should bias against the mean. Hence, the statistical differences represent a conservative estimate. Perhaps, subjects were primed by the WWT-T to divert less attention to their gait during the WWT-C condition that followed. Future studies may choose to employ either WWT-T or WWT-C depending on their outcomes of interest. If both conditions are used we suggest that WWT-C be done first to minimize possible task order effects.

CONCLUSIONS

Based on our findings, we recommend that clinicians and researchers pay attention not only to the nature of the single tasks used in WWT but also consider and report specific instructions with regard to task prioritization or emphasis to single tasks given during the WWT. This will also facilitate more informed comparisons between different studies. Our results may have important implications for the clinical or research applications of the WWT test for screening or predicting adverse outcomes. The effect of task prioritization on WWT should be studied prospectively for predicting incident falls as well as other outcomes such as frailty and disability.

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