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How Does Explicit Prioritization Alter Walking During Dual-Task Performance? Effects of Age and Sex on Gait Speed and Variability

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Background. Previous studies have demonstrated that the performance of a secondary task during walking alters gait.

Objective. This study investigated the effects of task prioritization on walking in young and older adults to evaluate the "default" prioritization scheme used, the flexibility to alter prioritization and cortical resources allocated to gait and a secondary cognitive task, and any age-associated changes in these abilities.

Design.

Methods. Gait speed and gait variability were evaluated in young adults (n=40) and older adults (n=17) who were healthy during usual walking and under 3 dual-task conditions: (1) no specific prioritization instructions, (2) prioritization of gait, and (3) prioritization of the cognitive task.

Results. Young adults significantly increased gait speed in the gait prioritization condition, compared with gait speed in the no-instruction condition; a similar tendency was seen in the older adults. Gait speed was reduced when prioritization was given to the cognitive task in both age groups; however, this effect was less dramatic in the older adults. In the young adults, prioritization of gait tended to have different effects on gait speed among both men and women. In the older adults, but not in the young adults, all dual-task conditions produced increased gait variability, whereas prioritization did not alter this gait feature.

Limitations.

Conclusions. Even among young adults, the effects of secondary, cognitive tasks on gait speed are strongly influenced by prioritization. This finding was less significant in the older adults, suggesting that there is an age-associated decline in the ability to flexibly allocate attention to gait. Somewhat surprisingly, when prioritization was not explicitly instructed, gait speed in both young and older adults most closely resembled that of the condition when they were instructed to focus attention on the cognitive task.

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In some of the classic publications on gait,[1,2] cognitive function is hardly mentioned. It is only in the last decade or so that we have come to realize the impact of cognitive function on the walking pattern. Gait is no longer considered to be an automatic, biomechanical task; instead, the role of cognitive function is increasingly acknowledged.[3–5] In particular, 2 closely related cognitive domains—executive function and attention—evidently influence gait. It has been demonstrated that even young adults who are healthy walk slower when they are required to walk while performing another task.[4,6–9] Older adults who are healthy and, to a greater extent, patients with neurological impairments (eg, Parkinson disease [PD], chronic stroke) not only slow down and increase double-limb support but also become less stable (ie, increasing gait variability).[10–15] Although the mechanisms underlying these reactions to a dual task are not fully understood,[16] assessment of dual-task abilities may provide important information on gait, its automaticity, and the risk for falls that might not be apparent during a routine examination.[17]

The simultaneous performance of 2 or more tasks may create a conflict and a need to determine which of the tasks receives priority, especially when information processing is limited.[18,19] Bloem and colleagues[10,20,21] reported that both young and older adults who are healthy spontaneously prioritize gait stability over success on the "secondary" cognitive task when no specific prioritization instruction or allocation of attention is given. This "posture-first" strategy, a concept originally introduced by Shumway-Cook et al in 1997,[22] makes sense from an ecologic perspective, as it helps to prevent loss of balance. Interestingly, patients with PD apparently prioritize the cognitive task when they do not receive explicit instructions to prioritize gait, inadvertently increasing their risk for falling.[21] A few studies have examined the effects of explicit instructions (also referred to as the "instructional set") or prioritization on gait and the ability to allocate attention to either the cognitive task or the motor task.[23–25] These initial reports raise interesting questions about the influence of attention on dual-task performance and the ability to successfully manipulate attentional demands and shift focus to and from gait. Several unanswered questions remain, including whether all aspects of gait respond similarly to changes in attention and prioritization.

The main aims of the present study were: (1) to investigate the impact of explicit instructions of task prioritization on 2 different aspects of gait (ie, gait speed and gait variability); (2) to assess which prioritization condition (cognitive or gait) most closely resembles the default, no-priority instruction condition (ie, the spontaneous, self-selected strategy); (3) to evaluate the ability to change prioritization and allocation of cognitive resources during performance of a motor task (ie, gait) and a cognitive task (an ability likely related to executive function[26,27] and flexibility in attention allocation); and (4) to determine the effects of aging on these abilities. In secondary analyses, we explored the possible role of sex and executive function abilities.

Method

Participants

Forty young adults who were healthy (20 women, 20 men; mean age [SD]=26.8 [1.6] years) and 17 older adults who were healthy (10 men, 7 women; mean age [SD]=72 [6.8] years) participated in this study. Young adults were included if they were between the ages of 20 and 30 years, were not taking any medications, and were free of acute or chronic disease. Elderly adults were recruited from the community and ongoing studies on older adults who are healthy. They were all between 60 and 90 years of age and able to walk independently without an assistive device. In addition, adults in both age groups were excluded if they had any orthopedic, neurological, or mental disturbances that might directly affect their gait or cognitive function.

Procedure

After providing written informed consent, the participants performed a verbal fluency (VF) task in the seated position (ie, as a single task). They were asked to recall as many words as possible beginning with a predefined letter during 1 minute. This task later served as the cognitive "dual task" in all of the walking conditions. For each condition, a different letter was given; each letter was used only once per participant, randomized across conditions. The VF task was used previously in several dual-task studies[28–31] and has been validated in Hebrew[32] for equivalency of expected frequencies.

Walking protocol. Participants were instructed to walk at their preferred pace on level ground in a well-lit, obstacle-free, 30-m-long corridor (turning at the end each time) for 1 minute under 4 conditions: (1) usual walking with no dual task, (2) while performing VF with no explicit instruction for prioritization of either task (no priority), (3) while instructed to prioritize the cognitive task (cognitive priority) and, (4) while instructed to prioritize the gait task (gait priority). In the latter 2 conditions, participants were told to try and perform the prioritized task as if it were performed alone. Thus, in the gait priority condition, participants were asked to "concentrate mainly on the gait task" while performing the VF task and to walk as if they were not simultaneously per-

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forming a cognitive task (ie, usual walking). Similarly, during the cognitive priority condition, both tasks were performed, but participants were instructed to match their performance on the VF task to the sitting, single-task condition. Testing always started with a practice walk along the walking path, followed by the no-priority dual-task condition. The order of the other dual-task prioritization conditions was randomized.

Gait assessment. An ambulatory recorder and footswitches, similar to those originally described by Perry,[2] were used to quantify the temporal parameters of the gait cycle (ie, stride time and swing time). The system consisted of a pair of insoles* and a recording unit.† Each insole contained 4 footswitches that covered the surface of the sole and measured the vertical forces under the foot. The recording unit (11×7×3 cm, 230 gm) was carried on the waist. Measurements were sampled at a rate of 100 Hz, stored in a memory card during the walk, and later transferred to a personal computer for further analysis.

Fn*
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The following gait parameters were determined using previously described methods[33,34]: average stride time, average swing time (%), stride time variability, and swing time variability. Variability measures were quantified using the coefficient of variation (eg, stride time variability=100×[standard deviation/average stride time]). In addition, average gait speed was determined by measuring the average time a participant walked the middle 10 m of the 30-m corridor.

*B&L Engineering, 1901 Carnegie Ave, Suite Q, Santa Ana, CA 92705.
†JAS Research Inc, 82 Horace Rd, Belmont, MA 02478.

Cognitive tests. In addition to the VF test performed by all participants while seated, several additional tests were administered only to the older adult group. The Montreal Cognitive Assessment was used to obtain a general measure of cognitive function. This test was designed as a rapid screening instrument for mild cognitive dysfunction and dementia.[35] It provides a composite score based on assessment of several cognitive domains: attention and concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations, and orientation. The total possible score is 30 points; a score of 26 or above is considered normal.

Because dual-task abilities have been related to executive function,[36,37] several executive function tests were performed to assess their association with prioritization flexibility. The Frontal Assessment Battery (FAB)[38] evaluates 6 aspects of executive function that have been related to frontal lobe function, using a simple battery: conceptualization, mental flexibility, motor programming, sensitivity to interference, and inhibitory control. The Trail Making Test (TMT)[38–40] is a visuomotor timed task used routinely in clinical evaluations that has the dimensions of cognitive flexibility and executive function. The test consists of 2 parts: TMT, part A (TMT-A) and TMT, part B (TMT-B). The TMT-A is a relatively simple visual-scanning task that requires a person to draw a line connecting consecutive numbers from 1 to 25. The TMT-B adds a dimension of cognitive flexibility by requiring a person to draw a line connecting numbers and letters in an alternating sequence. Delta TMT (TMT-B – TMT-A) was calculated as well; this parameter more specifically reflects executive skills, adjusted for performance on the TMT-A.[39]

Data Analysis

To estimate the effect of the secondary tasks on gait, we applied the general linear model for repeated measures to assess main effects (ie, differences among the conditions) and interaction effects. We first compared the no-instruction dual-task condition with the baseline usual walking condition (within groups). We also estimated the effect of prioritization (ie, the instruction set) on gait to evaluate within-group differences among the 3 dual-task conditions (ie, no priority instructions, gait priority, cognitive priority). The dependent variable was the gait measure (eg, speed), and the independent variables were age group and the instructional set (ie, prioritization). If main effects were observed, *post hoc* analyses were performed using paired and unpaired *t* tests (with Bonferroni multiple testing correction adjustments to control for type I errors) to: (1) detect changes within the different conditions and (2) examine the role of age group and sex.

Similar analyses were applied to examine the change in performance of the VF task as a function of condition AQ: 5 and group. In addition, dual-task costs were calculated for the gait priority and cognitive priority conditions for each of the dependent variables. For each measure, cost was calculated as: 100 × (the priority condition – the no-instruction condition)/the no-instruction condition. The total prioritization effect was calculated as the difference between the 2 costs (ie, gait priority cost – cognitive priority cost). Repeated measures were applied to evaluate within- and between-group differences of the dual-task costs and the total prioritization effect. Pearson correlation coefficients were used to test for associations between cognitive measures and these costs (deltas). The P values reported are based on 2-sided comparisons, with a value

Table 1.
Participant Characteristics[a]

Variable	Young Adults (n=40)	Older Adults (n=17)
Age (y)	26.8±1.6	72±6.8
Education (y)	14.7±1.5	13.5±3.9
Height (m)	1.70±0.1	1.67±0.08
Weight (kg)	64.9±11.3	67.5±10.8
Verbal fluency (no. of words generated while seated)	13.3±2.8	9.9±4.0
Frontal Assessment Battery		16.5±1.1
Montreal Cognitive Assessment		26.1±1.7
TMT-A (s)		64±20
TMT-B (s)		128±35
Delta TMT (TMT-B – TMT-A) (s)		76±51
Timed "Up & Go" Test (s)		8.6±1.2

[a] Values are mean±SD. TMT=Trail Making Test; TMT-A=Trail Making Test, part A; TMT-B=Trail Making Test, part B.

of $P \leq .05$ considered statistically significant. All statistical analyses were performed using SPSS software, version 15.0.[‡]

Results

Table 1 summarizes the demographic and clinical characteristics of the study participants. For the older adult group, scores on the cognitive and balance tests were consistent with those of older adults who are healthy. For example, the mean score (SD) on the Timed "Up & Go" Test was 8.6 (1.2) seconds, far below the 13.5-second threshold that indicates a high risk of falls.

[‡]SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

Effects of Dual Task and Instructions for Prioritization on Gait Speed

A significant effect of performance of a dual task on gait speed in the no-priority condition was found in both age groups. Gait speed was lower in the no-priority condition compared with usual walking with no dual task in both the young and older adults ($P<.001$) (Tab. 2 and Fig. 1A).

Prioritization effect. When asked to prioritize gait, the young adults significantly increased their gait speed ($P<.001$). When asked to prioritize the cognitive task, gait speed decreased ($P=.051$), although this reduction tended to be smaller than the increase of speed in the gait prioritization condition (Tab. 3 and Fig. 1A). The older adults had a similar pattern of prioritization, although the magnitude of the effect tended to be smaller. Gait speed generally increased when the older adults were asked to prioritize gait ($P=.052$), and a nonsignificant decrease of speed was seen in the cognitive priority condition ($P=.128$).

Sex differences among the young adults. *Post hoc* analysis revealed sex differences among the young adults for the prioritization effect (Fig. 2). Among the young women, gait speed while performing VF task in the cognitive priority condition was similar to that in the no-priority condition ($P=.31$). Conversely, when prioritizing gait, speed was significantly higher than in the no-priority or cognitive priority condition ($P<.001$) (Fig. 2). This effect was blunted in young men, where

Table 2.
Effects of Dual-Task Performance on Gait and Performance of the Cognitive Task[a]

Variable		Usual Walking	No-Priority Condition	Main Effect (*P* Value)	Interaction (Group × Priority Condition) (*P* Value)	Between-Group Effect (*P* Value)
Gait speed (m/s)	Young adults	1.45±0.14	1.28±0.16 (<.001)	<.001	.987	.042
	Elderly adults	1.35±0.24	1.18±0.23 (<.001)			
Stride time variability (%)	Young adults	1.59±0.57	1.74±0.56 (.141)	<.001	.012	.008
	Elderly adults	1.73±0.48	2.46±1.12 (.0)			
Swing time variability (%)	Young adults	1.92±0.56	2.00±0.60 (.40)	<.001	<.001	<.001
	Elderly adults	2.42±0.41	3.46±1.12 (.001)			
No. of words generated	Young adults	While seated: 13.3±2.80	13.7±4.02 (.430)	.06	.304	.002
	Elderly adults	9.9±4.0	11.5±3.4 (.084)			

[a] Values are mean±SD. *Post hoc P* values for within-group comparisons are shown in parentheses.

gait speed in the gait priority condition was not significantly different from the no-priority condition. For men, gait speed tended to be lower in the cognitive priority condition than in the no-priority condition (P=.06). Nonetheless, the observed decrease in speed in the cognitive priority condition was significantly lower than the speed in the gait prioritization condition (P=.03) for both men and women. The interaction effect of sex × dual-task condition among the young adults was borderline significant (P=.057). Due to sample size limitations, we could not fully explore sex differences in the older adults.

Effects of Dual Task and Prioritization on Gait Variability

In the young adults, performance of the VF task did not significantly affect stride time variability or swing time variability (Tab. 2 and Fig. 1B) in any of the conditions (P>.146). In contrast, in the older adults, VF task performance increased both measures of gait variability in all dual-task conditions (P<.01). Interestingly, this effect was not influenced by explicit instructions for gait or cognitive prioritization.

Effect of Prioritization on VF Task Performance

In both the young and older groups, VF task performance tended to change according to the prioritization instructions, as expected, but this change did not reach significance (Tab. 3). On average, only one additional word was generated during the cognitive priority condition.

T4 Dual-task costs of prioritization conditions are summarized in Table 4. For gait speed, the gait priority effect tended to be 50% larger in the young adults compared with the older adults. For all measures, differences between the young and older adults were not statistically different, perhaps due to the large within-group variability. Among the older adults, the cognitive measures assessed in the present study (ie, FAB, Montreal Cognitive Assessment, TMT-B, delta TMT, VF task) were not significantly correlated with the difference between gait speed in the no-priority condition and in the other 2 priority conditions (or the dual-task costs). That is, dual-task costs related to prioritization were not associated with these tests of executive or cognitive function in the older adults.

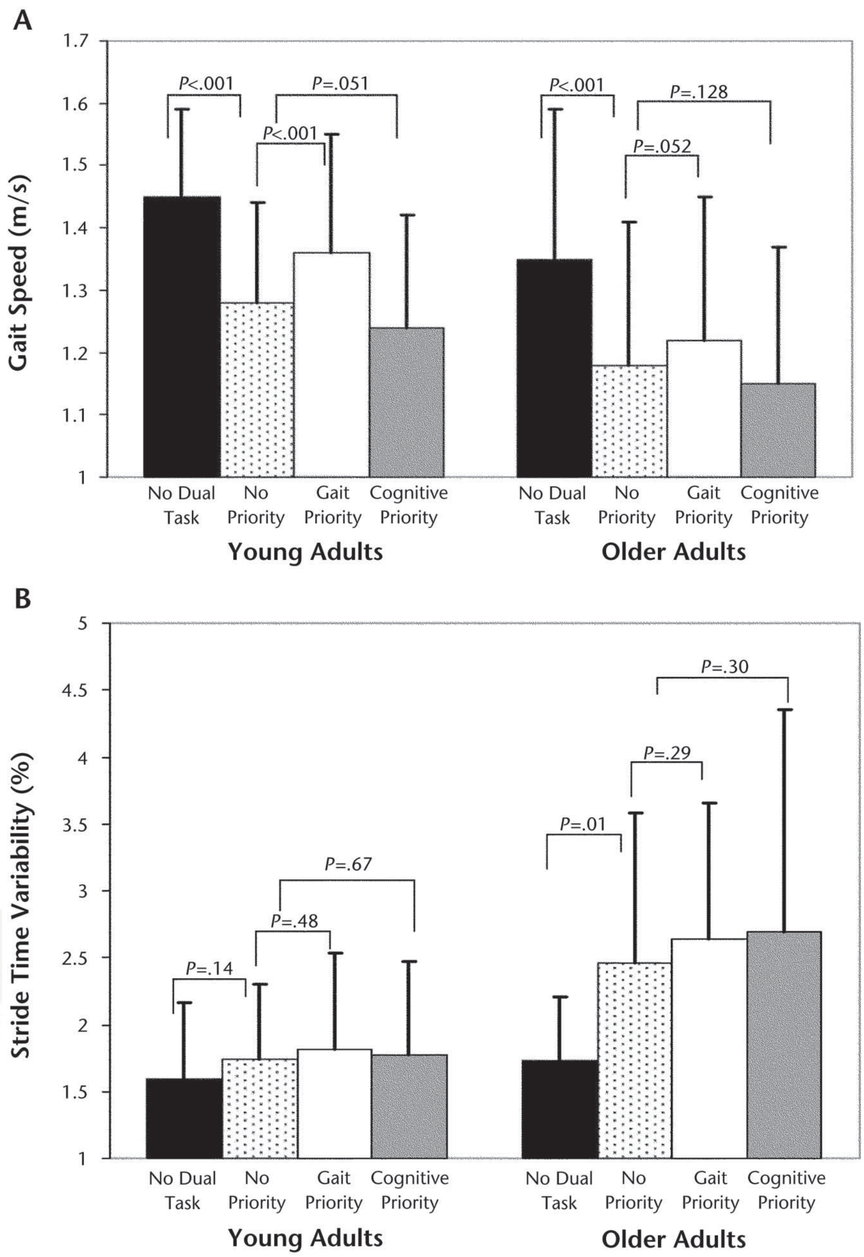

Figure 1.
Effects of dual task and prioritization on (A) gait speed (B) and variability in young and older adults who were healthy. The no-priority dual-task condition is compared with usual walking (baseline). The cognitive priority and gait priority conditions are compared with the no-priority condition.

Table 3.
Effects of Task Prioritization on Gait and Performance of the Cognitive Task During Dual-Task Performance[a]

Variable		No Priority	Gait Priority	Cognitive Priority	Main Effect	Interaction (Group × Priority Condition)	Between-Group Effect
Gait speed (m/s)	Young adults	1.28±0.16	1.36±0.19	1.24±0.18 (<.001)	<.001	.282	.036
	Elderly adults	1.18±0.23	1.22±0.23	1.15±0.22 (.002)			
Stride time variability (%)	Young adults	1.74±0.56	1.82±0.71	1.77±0.70	.442	.742	.001
	Elderly adults	2.46±1.12	2.64±1.02	2.69±1.66			
Swing time variability (%)	Young adults	2.00±0.60	2.03±0.61	2.00±0.65	.612	.543	<.001
	Elderly adults	3.46±1.12	3.26±0.79	3.29±1.22			
No. of words generated	Young adults	13.7±4.0	12.9±3.2	14.1±3.4	.081	.662	.082
	Elderly adults	11.5±3.4	11.4±4.2	12.7±5.5			

[a] Values are the mean±SD. *Post hoc P* values for within-group comparisons between the gait priority condition and the cognitive priority condition are shown in parentheses. Only those that were significant are shown.

Discussion

Consistent with earlier studies,[7,37,41] we observed that performance of a dual task reduced gait speed in both young and older adults who were healthy when explicit instructions regarding prioritization were not given, further supporting the idea that cortical function influences gait. Previous studies also have demonstrated that when older adults or patients with Parkinson disease focus attention on a cognitive task, rather than on walking, gait speed and stride length are reduced.[25,42] The results of the present study further extend these findings to young adults who are healthy and show the effects of task prioritization on gait speed and variability as a function of age and sex. Our findings suggest that task prioritization tends to alter gait speed more in young adults than in older adults, whereas gait variability is affected by performance of a dual task only in older adults. Young women, more than young men, change their gait speed when asked to prioritize either task. Thus, in some sense, the young men who are healthy behave more like older adults than do young women who are healthy. Interestingly, the present findings also suggest that for both age groups, gait speed in the default, no-priority instruction condition is similar to that seen in the cognitive priority condition. Thus, the "posture-first" concept apparently does not apply equally to all aspects of walking.

In agreement with other studies,[23] our findings show that changes in gait speed in response to different instructions generally were smaller in the older adults, suggesting a reduced ability to prioritize and flexibly allocate attention among different tasks. An age-associated decline in mental flexibility[39,43] could explain these findings. Somewhat surprisingly, however, changes in gait in response to the explicit instructions were not significantly related to any of the cognitive tests in the older adults. This finding is consistent with previously published results.[23] Perhaps the small number of older adults or the nature of the group prevented us from observing the hypothesized associations. AQ: 7

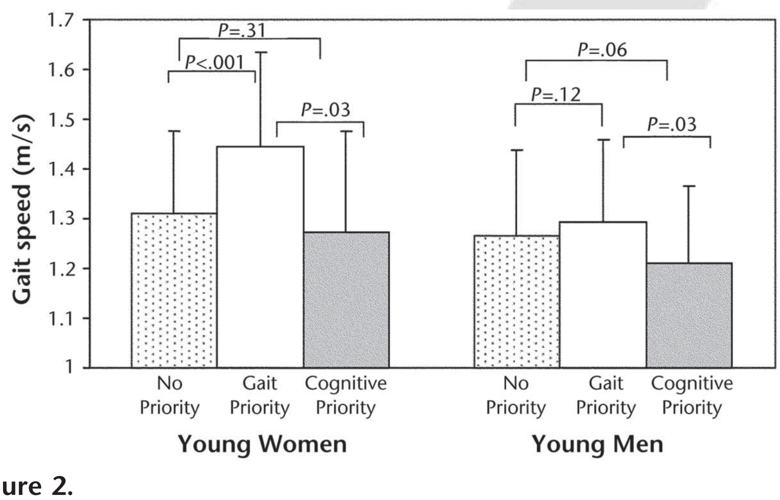

Figure 2.
Effects of dual-task instructional set on gait speed. Young men and women who were healthy apparently responded differently to prioritization.

Disparate findings were obtained for gait variability. The young adults were not affected by performance of a dual task or prioritization. This

Table 4.
Dual-Task Costs of Prioritization[a]

Variable		Young Adults	Elderly Adults	Between-Group Effect (*P* Value)
Gait speed (m/s)	Gait priority	6.5±9.1	3.9±8.2	.31
	Cognitive priority	−3.15±10.8 (<.001)	−2.1±5.4 (.004)	.70
	Total prioritization effect	9.7±13.1	6.0±7.4	.28
Stride time variability (%)	Gait priority	12.2±58.1	11.9±22.6	.97
	Cognitive priority	7.1±38.7 (.55)	8.9±27.4 (.71)	.86
	Total prioritization effect	5.7±59.1	2.9±32.7	.85
Swing time variability (%)	Gait priority	6.01±36.0	−1.2±25.6	.45
	Cognitive priority	3.2±28.4 (.66)	−3.0±20.2 (.74)	.42
	Total prioritization effect	2.4±34.9	1.7±22.5	.94
No. of words generated	Gait priority	−1.6±27.7	0.56±29.2	.79
	Cognitive priority	7.5±36.1 (.057)	12.4±44.2 (.30)	.66
	Total prioritization effect	−9.13±29.4	−11.9±46.2	.78

[a] Values are the % change with respect to the no-priority condition and the total effect, as indicated. Numbers in parentheses are the *post hoc P* values for within-group comparisons between gait priority cost and cognitive priority cost.

finding further supports the idea that young adults who are healthy have the cognitive capacity to handle even the most challenging dual-task conditions without altering gait variability (ie, during cognitive prioritization, where presumably fewer resources are allocated to gait). Moreover, young adults have the ability to preserve and maintain the "posture-first" strategy even when the focus of attention is directed toward cognitive tasks. In contrast, the older adults significantly increased their gait variability in all dual-task conditions. However, prioritization did not have any specific effect on gait variability, which again might reflect a reduced flexibility to allocate attention to the prioritized task.

A possible explanation for observed response among the young adults is that perhaps gait stability (represented by gait variability) always receives unconscious priority, despite competition for information processes. Alternatively, for young adults who are healthy, regulation of gait variability may be largely automatic or subcortical, and thus it might not depend on attentional resources or prioritization. In contrast, our findings suggest that aging curtails the ability to maintain the automatic "posture-first" strategy. This suggestion is consistent with the results of a previous study that examined the general effects of dual-task performance (without manipulation of the instructional set).[20] It is important, nonetheless, to keep in mind that no participants fell at any time under any dual-task conditions. Although the propensity and predisposition to a fall apparently increased, as evidenced by the increased variability, all of the older adults maintained sufficient postural control to prevent a fall, perhaps by using compensatory mechanisms.

Effect of Sex on Dual Task and Prioritization

Compared with usual walking, all participants, men and women, reduced their gait speed when they performed a cognitive task (in the no-priority condition). Sex, however, apparently plays a role in task prioritization and its effect on gait speed in young adults who are healthy. It could be suggested that women are more flexible or that gait speed in men is less sensitive to the instructional set. Although sex effects have been reported during other dual-task activities, this is, to our knowledge, the first evidence of sex differences in dual-task effects on gait. Hancock et al[44] compared the driving performance of men and women who drove while responding to an in-vehicle phone. Women had significantly longer brake response times when distracted by the phone in comparison with men, and their stopping accuracy was dramatically reduced when distracted. However, women also had a faster brake response time and higher accuracy compared with men when tested without the distraction.

In the present study, we found that young men demonstrated less dramatic prioritization effects, especially in the gait prioritization condition, compared with young women. One possibility is that perhaps the young men were less adherent to the prioritization instructions (ie, less motivated) compared with the young women and, therefore, did not alter their gait speed. However, men (as well as women) showed a tendency of prioritization effects in the cognitive priority condition (P=.06), as well as changes in the performance of the cognitive task (see the VF task results in Tab. 2), so this motivation claim seems unlikely. Another possibility relates to dual-task abilities. In the gait priority condition, women could both increase their gait speed and perform the cognitive task on the same level as men, perhaps confirming the old myth that "women are better dual taskers." A third possibility is that the VF task was easier for women, leaving them more cognitive resources to devote to the prioritization effects. Some cognitive tests have different sex biases.[45] However, previous studies and the present results did not demonstrate sex effects on a VF task in the seated position, supporting the rejection of this explanation. Nonetheless, in the future, it might be helpful to compare the effects of prioritization across sexes while also taking into account possible sex effects on the cognitive task.

For young adults who are healthy, prioritization probably does not have any clinical implications. We reason that the effect of prioritization is stronger in patient populations where gait or the cognitive task (or both) are more attention demanding. This might be especially true in conditions such as when individuals may pay more attention to "outside distractors" than to gait. Based on this assumption, it might be appropriate to instruct patients to always prioritize gait to ensure safety and minimize fall risk.

Limitations and Further Research

This study had a number of limitations. The number of older adults studied was relatively small, and this factor may have affected some of the findings. Further studies should investigate the sex effect and age-associated changes in a larger and more heterogeneous sample, perhaps supplemented with more detailed cognitive testing. The manner in which instructions are phrased has an important role in the way individuals perceive the meaning of prioritization. The translation or understanding of instructions could be a determining factor in the performance of the task; women apparently translated the instructions into speed more than men did. Only one participant (male) asked for clarification of the instructions, mentioning that he never thinks about gait. Other studies phrased the instruction for prioritization slightly different. Verghese et al,[25] for example, asked the subjects to "pay attention to reciting alternate letters and not to concentrate on their walking." Different instructions likely create different effects, but subtle effects of nuance need to be further evaluated. As suggested, further studies should test the prioritization effect in patient populations with cognitive or motor impairments and in older adults with a broader spectrum of abilities and evaluate the implications of prioritization on gait and fall risk.

The trend of enhanced VF task performance while walking compared with performance of the task while seated also is of interest and raises questions for future investigations. There are at least 3 possible explanations for this trend: (1) a general practice effect, (2) a specific letter effect, and (3) a dual-task benefit. Regarding the practice effect, the literature generally suggests that use of alternate letters minimizes any practice effect.[46] We examined this issue in another group of young subjects who performed a VF task several times with alternate letters. A practice effect was not observed. Still, we cannot completely rule out this possibility, because seated testing always came first. Regarding the letter effect, as mentioned above, the 3 letters used during walking were chosen based on a previous study that indicated that they have similar levels of difficulty.[32] Another letter was used during sitting. Additional pilot data suggest that all of the letters used have the same difficulty level. Regarding the dual-task benefit, somewhat paradoxically, some studies have shown that performance of a dual task may enhance function, especially if the dual task is relatively easy and not demanding of much attention.[47,48] In addition, exercise has been shown to improve cognitive function tasks under certain conditions.[49] Thus, although unexpected, it is possible that the trend toward improved performance of the VF task was a result of the walking. In the present study, mean values of the VF task were similar across all walking conditions, supporting the idea that all letters had similar levels of difficulty and that there was no practice, letter, or dual-task performance effect with respect to prioritization. Nonetheless, the question of whether walking enhances VF remains to be studied more fully.

We have learned many things about the relationship between cognitive function and gait since classic works on gait analysis were written in the 1990s. The present findings demonstrate that the effects of prioritization and the instructional set on gait are feature specific (ie, variability differs from speed), that they may be sex-dependent, and that they are relatively preserved with healthy aging. We speculate that in certain patient groups (eg, poststroke or other neurological conditions), the decreased ability to prioritize tasks during walking in response to the instruction set will be further impaired. This lack of "mental flexibility" might have ramifications for the design of optimal rehabilitation programs, for the way in which therapists train patients, and perhaps for how we instruct patients to carry out their activities of daily living. However, many questions remain about these relationships and their clinical implications. We remain surprised and lacking a good explanation regarding the apparent increased sensitivity to prioritization instructions observed in the young women. Hopefully, work over the next decades will set out to give us new insight into these relationships and eventually lead to new ways of minimizing the effects of dual-task performance on gait and fall risk.

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AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES 1

1—AQ1: Please specify each author's degrees and job title for each affiliation listed.

2—AQ2: Abstract has been reformatted to include sections and section headings currently required in all abstracts of observational studies published in PTJ. Please include sentences on study design and limitations, as applicable.

3—AQ3: In the third aim of the study, change of "among" to "during performance of" OK?

4—AQ4: Explored the possible role of sex and executive function abilities on what? Please clarify.

5—AQ5: You state that the FAB evaluates 6 aspects of executive function, but only 5 are listed. Is one omitted?

6—AQ6: Any reference available for cognitive and balance test scores of older adults who are healthy in this comparison?

7—AQ7: In sentence beginning "In agreement with other studies . . . ," additional references needed for "other studies"?

8—AQ8: Editorial staff will insert rolling credits statement, specifying authors' roles in the work (as shown in the copyright transfer statements), after author review of the rapid proof.

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12—AQ12: The values shown in the last 3 columns of Tables 2 and 3 are all **P values, correct?**