International Journal Of Advance Research, Ideas And Innovations In Technology

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 5)
Available online at: www.ijariit.com

To study the effects of age and sex on temporal gait parameters due to explicit prioritization during dual task performance in normal healthy individuals

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ABSTRACT

To study the effects of age & sex on temporal gait parameters due to explicit prioritization during dual task performance in normal healthy individuals. 30 healthy young adults between the age group of 20 to 30 years of age and were free from acute or chronic disease and healthy old adults between the age group of 60 to 90 years of age and were able to walk independently without an assistive device. The participants performed a verbal fluency (VF) task in the seated position (i.e. 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. Mean changes in velocity in young adults in dual task having mean 388.33(P < 0.001), cognitive priority having mean 431.95(P < 0.001) and in gait priority 249.64(P < 0.01) less significant result as compared to other, similarly Mean changes in velocity in old adults dual task was 315.33(P < 0.001), cognitive priority was 346.11(P < 0.001) and in gait priority 294.81(P < 0.01). Among the young adults, the effects of secondary, cognitive task on the gait speed are strongly influenced by prioritization. These findings were less significant in the older adults, suggesting that there is an age-associated decline in the ability to flexibly allocate attention to gait. When prioritization was not explicitly instructed, the gait speed in both age group most closely resembled that of cognitive priority condition. In comparison between young male and female, the effect of secondary cognitive task on gait speed are influenced by prioritization more significantly in women than men whose findings closely resemble to that of old adults.

Keywords— *Temporal gait, Dual task, Cognitive task, Prioritization of gait*

1. INTRODUCTION

Gait or human locomotion is described as a translatory progression of the body as a whole, produced by coordinated, rotatory movements of the body segment. Cognitive function is an intellectual process by which one becomes aware of, perceives, or comprehends ideas. It involves all aspects of perception, thinking, reasoning, and remembering[1].

In the classic publications on gait, cognitive function is hardly mentioned. Recently, 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[2].

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. Older adults who are healthy and, to a greater extent, patients with neurological impairments (e.g., Parkinson disease [PD], chronic stroke) not only slow down and increase double-limb support but also become less stable (i.e. increasing gait variability)[3].

Although the mechanisms underlying these reactions to a dual task are not fully understood, 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[4].

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. Bloem and colleagues 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, 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[4].

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. 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[5].

2. AIMS AND OBJECTIVES

2.1 To assess the temporal parameters of gait

(a) During normal walking without a dual task.
(b) During walking with dual-task performance.
(c) During walking with prioritization of cognitive task.
(d) During walking with prioritization of gait.

2.2 To compare the gait parameters between two age group during normal walking with prioritization of cognitive task & prioritization of gait.

3. MATERIAL AND METHODOLOGY

Study Design: Prospective experimental study
Study Setting: Datta Meghe College of Physiotherapy, Wanadongari, Nagpur.
Study Period: 4 months
Sample Population: 30

3.1 Materials used

Ambulatory gait analyzer (consists of a pair of insole, recording unit), computer (Pentium III processor,500 GB, and 650 processor)

3.2 Inclusion criteria

Healthy Young adults between the age group of 20 to 30 years of age and were free from acute or chronic disease. Healthy old adults between the age group of 60 to 90 years of age and were able to walk independently without an assistive device.

3.3 Exclusion criteria

Any orthopedic, neurological, or mental disturbances that might directly affect their gait or cognitive function. Any other condition/disability restricting the participation in the study.

3.4 Procedure

Subjects were selected according to the inclusion criteria and written consent is taken from all the subjects. After providing written informed consent, the participants performed a verbal fluency (VF) task in the seated position (i.e. 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 and has been validated in Hebrew for equivalency of expected frequencies.

3.5 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 to 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 performing a cognitive task (i.e. 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

3.6 Gait assessment

An ambulatory recorder and footswitches were used to quantify the temporal parameters of the gait cycle (i.e. 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. The following gait parameters were determined using previously described methods average velocity, cadence, stride time and stride length. In addition, average gait speed was determined by measuring the average time it took a participant to walk the middle 10 m of the 30-m corridor.

3.7 Cognitive tests
In addition to the VF test performed by all participants while seated, several other 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. It provides a composite score based on an assessment of several cognitive domains: attention and concentration, executive functions, memory, language, Visio-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, several executive function tests were performed to assess their association with prioritization flexibility. The Frontal Assessment Battery (FAB) evaluates 6 aspects of executive function that have been related to frontal lobe function, using a simple battery: conceptualization, mental flexibility, motor programming, and sensitivity to interference, inhibitory control, and environmental autonomy.

4. STATISTICAL ANALYSIS

Table 1: Mean velocity in young adults and old adults

	Normal walking without dual task	Walking with dual-task without priority	Walking with the dual task with cognitive priority	Walking with the dual task with gait priority
Young adults	852.57±254.94	464.24±161.85	420.62±220.13	602.93±248.56
Old adults	734.19± 195.11	418.71±157.96	387.99±131.85	439.29±150.93

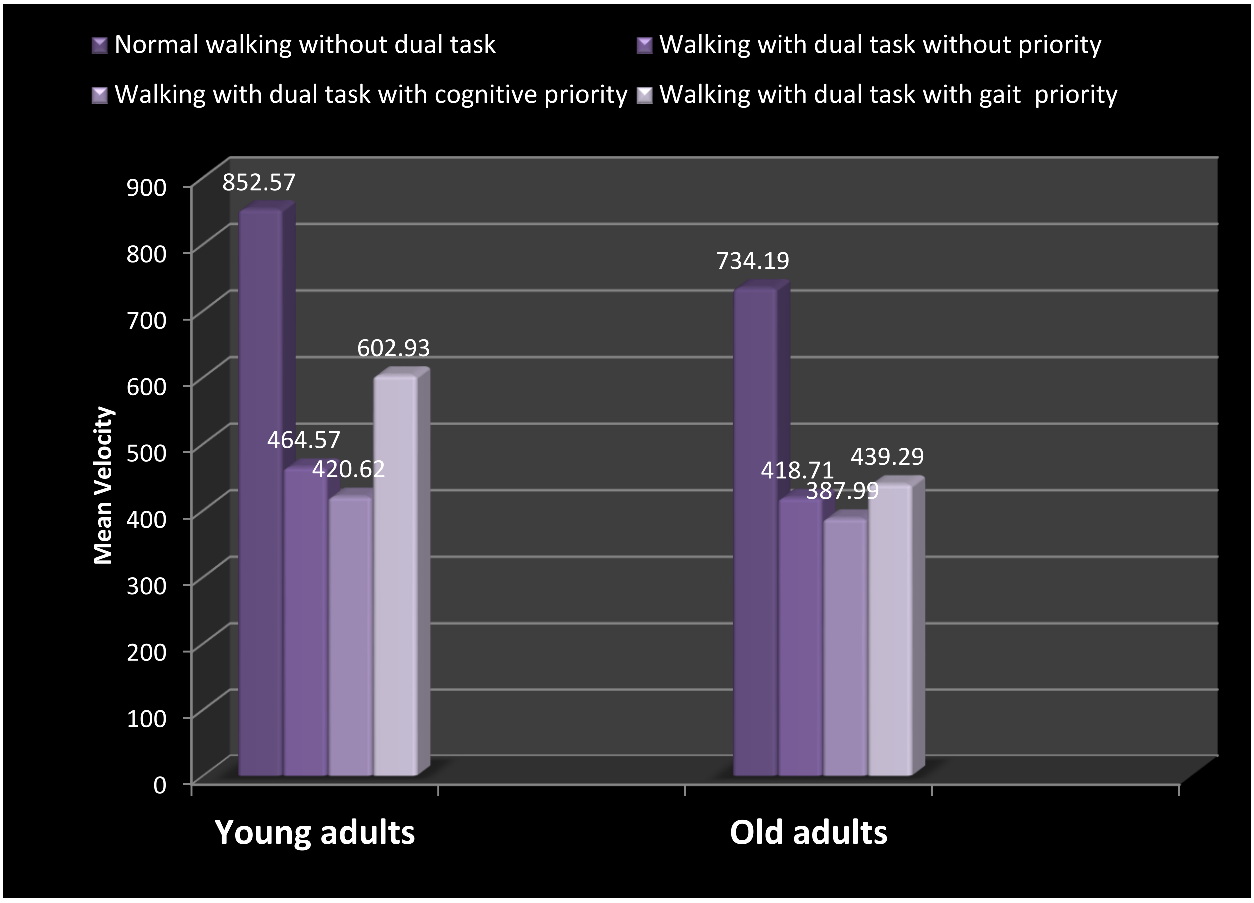

Table 2: Mean changes in velocity in young adults and old adults in other tasks as compared to normal walking

	Dual-task	Cognitive priority	Gait priority
Young adults	388.33 P < 0.001	431.95 P < 0.001	249.64 P < 0.01
Old adults	315.39 P < 0.001	346.11 P < 0.001	294.81 P < 0.01

5. RESULTS
Result Mean changes in velocity in young adults in dual-task having mean 388.33(P < 0.001), cognitive priority having mean 431.95(P < 0.001) and in gait priority 249.64(P < 0.01) less significant result as compared to other, similarly Mean changes in velocity in old adults dual task was 315.33(P < 0.001), cognitive priority was 346.11(P < 0.001) and in gait priority 294.81(P < 0.01).

6. DISCUSSION

We observed that performance of a dual task reduced gait speed in both young and older adults who are healthy when explicit instruction regarding prioritization was not given, further supporting the idea that cortical function influence the gait. The previous study by Canning & associates (2005) has demonstrated that when older adults or patients with PD focus attention on a cognitive task, rather than on walking, the gait speed and stride length are reduced.

The present study further extended these findings to young adults who are healthy and show the effect of task prioritization on gait speed and other temporal gait parameters as a function of age and sex. Our findings suggest that task prioritization tends to alter the gait speed more in young adults than in older adults, whereas stride time is affected by the performance of a dual task only in older adults. Changes in gait speed are more marked in young women as compared to young men when asked to prioritize either task. Changes in the gait speed resembled in young men and old adults, whereas the changes were more pronounced in young women.

The present findings also suggest that for both age groups, gait speed in the no priority instruction condition is similar to that seen in the cognitive priority condition.
In agreement with a previous study by Siu KC & colleagues (2008), 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 flexibility allocate attention among different tasks. This was due to an age-associated decline in mental flexibility.

The changes in gait speed in response to the explicit instructions were not significantly related to any of the cognitive tests in the older adults. These findings are consistent with previously published study results by Siu KC & associates (2008). The stride time in young adults was not affected by the performance of a dual task or by prioritization. This finding supports the idea that young adults who were healthy have the cognitive capacity to handle even the most challenging dual-task conditions without altering stride time.

In contrast, the older adults significantly increased their stride time in all dual-task conditions.

A possible explanation for observed response among the young adults is that gait stability (represented by stride time) always receive unconscious priority, despite competition for information processes on.

Alternatively, for young adults who are healthy, regulation of stride time may be largely automatic or subcortical, and thus it might not depend on attentional resources or prioritization.

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 no priority condition). It could be suggested that women are more flexible or that gait speed in men is less sensitive to the instructional set. Hancock & colleague (2003) compared the driving performance of men & women while responding to an in-vehicle phone. Women had significantly longer brake response time when distracted by the phone in comparison with men & their stopping accuracy was dramatically reduced when distracted. However, women also had faster brake response time and higher accuracy compared with men when tested without distraction. Changes in gait speed in young women were more pronounced than young men, this suggests that women are better dual tasker than men.

7. CONCLUSION

Among the young adults, the effects of secondary, cognitive task on the gait speed are strongly influenced by prioritization. These findings were less significant in the older adults, suggesting that there is an age-associated decline in the ability to flexibly allocate attention to gait. When prioritization was not explicitly instructed, the gait speed in both age group most closely resembled that of cognitive priority condition. In a comparison between young male and female, the effect of secondary cognitive task on gait speed is influenced by prioritization more significantly in women than men whose findings closely resemble that of old adults.

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