

# Effect of Visual Perturbations and Dual Task on Treadmill Walking of Older and Younger Adults

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## INTRODUCTION

The ability to process and integrate sensory information is critical to maintaining balance during everyday activities, especially during transition between different sensory environments (e.g. walking from a narrow corridor to large lobby). In order to maintain balance during sensory perturbations, the body adjusts the relative contributions of the different sensory systems, an effect commonly known as sensory re-weighting [1]. Previous research has indicated that older adults may have more difficulty suppressing inaccurate sensory information [2-4]. Older adults have been shown to be particularly sensitive to visual perturbations during standing [4], indicating that older adults may be more visually dependent.

The purpose of this study is to observe the effects of visual perturbations on the walking balance of older and younger adults. Additionally, adaptation effects resulting from a repeated exposure to these perturbations will be examined. Finally, this study will also observe dual task effects on walking balance when exposed to visual perturbations.

## METHODS

For this study, 8 younger adults (mean age: 24.0 y, range: 22-30 y.) and 5 older adults (mean age 78.5 y, range: 75-80 y.) participated. The subjects were consented and the study was approved by the Institutional Review Board.

Subjects were immersed in a custom-built virtual reality environment with visual information being projected on three screens surrounding the subject and providing a full 180° view. The subjects walked on a treadmill with a velocity set at either 1 or 0.8 m/s based on the natural walking speed of the subject. The visual environment was modeled as a long hotel hallway, and generated using Unreal Tournament 2004 with the CaveUT mutator used to display the scene in a multi-screen environment.

The velocity of this optic flow relative to the speed of the treadmill could be controlled using the data collection software. A sensor was placed on the subject's back at the height of the T10 vertebrae to measure the position of this marker.

A total of eight treadmill walking trials were collected in randomized order. Each trial lasted 3 minutes. These trials consisted of two different dual task conditions (no dual task, dual task) by four different optic flow conditions. In the dual task conditions, subjects were asked to distinguish between high and low tones that were played into their ear. They were instructed to push a button as quickly as possible after hearing the high tone. No response was required after hearing the low tone. The four optic flow conditions were the following: baseline in which the optic flow was congruent with the speed of the treadmill (same direction and speed); a sinusoidal condition where a sinusoid was superimposed on the baseline condition; a step condition where the optic flow was stepped down from the treadmill velocity to 0 (gave the appearance of not moving) and then back to the treadmill velocity in 20s intervals; and a reverse/forward condition where the optic flow reversed directions (between congruent and anti-congruent with walking speed) in 20s intervals. The sinusoidal, step and reverse/forward perturbations were repeated during the entire walking trial (3 minutes). The largest responses were seen in the reverse/forward conditions, which were further analyzed.

Typically, subjects reacted to the reverse/forward condition by moving anteriorly towards the front of the treadmill while the scene was moving anti-congruent to the treadmill and then moved posteriorly towards the back of the treadmill when the scene velocity switched back to be congruent with the treadmill velocity (Fig. 1). Therefore, the primary measure, termed anterior excursion, was the maximum anterior displacement as a percentage

of the total possible anterior displacement. The total possible anterior displacement was the difference between the furthest anterior point that subjects could reach due to slack in the harness and the location of the subject at the start of the perturbation (Fig. 1). The perturbations in which the subjects started in the front 40% and therefore had little additional room to move forward (13 out of 88 perturbations) were not considered in this analysis. An ANOVA analysis was performed using the combined baseline and reverse/forward data to determine the effects of the optic flow condition, age group and their interaction on the anterior movement percentage. An additional ANOVA analysis was performed using just the data from the reverse/forward condition to determine the primary and interaction effects of age group, dual task, exposure to the same visual perturbation in a previous trial (between trial habituation), exposure to the stimulus within a trial (within trial adaptation) and the interaction effects of these fixed factors. In addition, subject was considered a random factor.

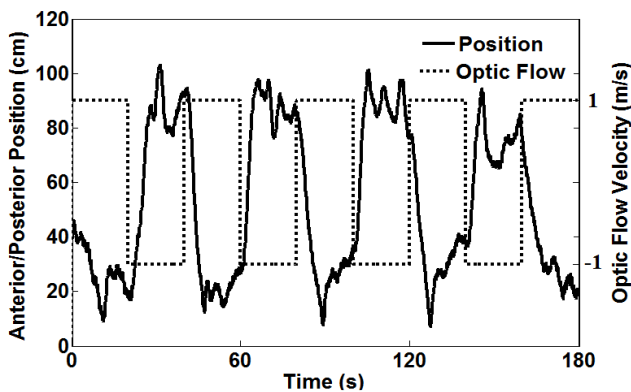


Figure 1: Anterior/posterior movement (solid line) for a reverse/forward optic flow (dashed line).

## RESULTS AND DISCUSSION

Subjects had a significantly larger anterior movement percentage during the reverse/forward trials (Mean: 42.6%) compared with the baseline trial (Mean: 24.5%) ( $p < 0.01$ ). In addition, older adults (Mean: 45%) were found to have larger anterior movement percentages than younger adults (Mean: 27.6%) ( $p < 0.05$ ) and a significant age group  $\times$  trial type interaction effect was found ( $p < 0.01$ ) indicating that the trial type affected the age groups differently.

While analyzing just the reverse/forward trials, the primary factors affecting the anterior movement percentage were dual task ( $p < 0.01$ , Fig. 2), between

trial habituation ( $p < 0.05$ , 1<sup>st</sup> exposure mean: 42.6%; 2<sup>nd</sup> exposure mean: 26.7%), and age group ( $p < 0.05$ ). Specifically, the older subjects experienced a larger response to the perturbation in the reverse/forward trials than the younger subjects. An interaction effect between age group and repetition number was also observed ( $p < 0.05$ ). Younger subjects exhibited a slight increase in response while older subjects exhibited a slight decrease in response.

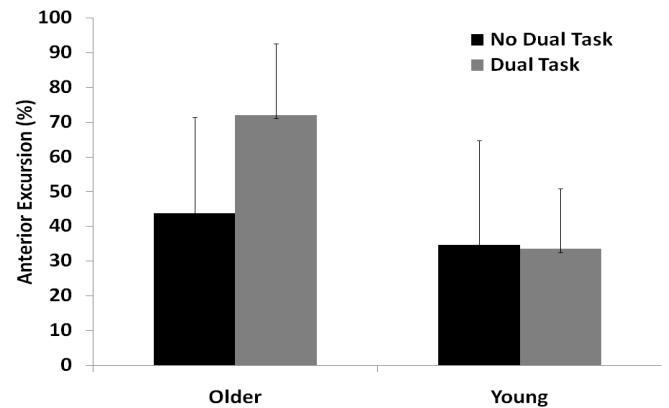


Figure 2: Effect of age group and dual task on anterior excursion.

## CONCLUSIONS

This study showed that the older adults had a stronger response to an optic flow perturbation, indicating that the older adults may be more visually dependent on their surrounding environment. The older adults, however, may have also been able to show some adaptation and habituation as they experience repeated exposures to the stimulus. This dependence on vision while walking, may make them at risk for falls when visual information is either unavailable or unreliable.

## ACKNOWLEDGEMENTS

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