Walking seems to be an undemanding task; however, it requires a complex ability to adapt to changing environments. Our body relies on feedback from several sensory systems: visual, proprioceptive, and vestibular. When these systems conflict, the body relies primarily on visual feedback. Asymmetrical walking patterns, in both the spatial (i.e. step length) and temporal (i.e. step time) components may result from aging and disease. Learning how vision contributes to adapting to an asymmetrical walking pattern may prove useful in rehabilitating patients with asymmetric walking patterns. Twenty healthy, young adults participated in this study and were separated into two groups, virtual reality (VR) and non-virtual reality (NVR). Each subject had approximately 5% of their body weight attached to their left leg via an ankle weight and performed four treadmill trials: familiarization, baseline, limb loading, and wash out. A 3-way mixed model ANOVA was used for analysis and showed that optic flow did not produce a significant difference in the rate of adaptation to an asymmetrical walking pattern. However, unilateral limb loading affected both the spatial and temporal components. During late-adaptation, the spatial component returns to symmetry while the temporal component remained asymmetrical indicating that the temporal component was altered to maintain spatial symmetry. Removing the ankle weight reversed the direction of asymmetry. Limb loading affects symmetry differently for the temporal and spatial components; therefore, limb loading could be used during rehabilitation as long as precautions are taken to ensure that the temporal and spatial aspects of walking are being targeted correctly.

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The Effects of Optic Flow on Locomotor Symmetry

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INTRODUCTION

- Walking seems to be an undemanding task; however, it requires a complex ability to adapt to ever changing environments.
- Walking involves feedback from the visual, proprioceptive, and vestibular sensory systems. When these sensory systems conflict, visual sensory information is given primacy.[1]
- Aging and pathology may result in asymmetric walking patterns, which can occur in the spatial domain (e.g. step length) or the temporal domain (e.g. step time) independently or in conjunction.
- Understanding how vision contributes to the adaptation of an asymmetric walking pattern could give valuable insight towards using visual feedback during rehabilitation of asymmetric gait.
- Virtual Reality (VR) has been shown to effect cadence, temporal gait patterns and muscle activation during unilateral limb loading.[2]
- It is not clear how VR effects spatial and temporal symmetry during asymmetrical gait with unilateral limb loading.
- **Purpose:** To determine the effects of optic flow on gait symmetry while adapting to a unilateral limb load.

METHODS

	n	Age	Mass	Height
Subjects	20	23.2 ± 3.0 yrs	68.6 ± 3.6 in	168.6 ± 31.6

Table 1. Subject Demographics

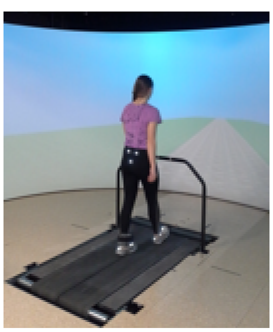
Subjects performed four different treadmill walking trials in a virtual reality environment with or without optic flow:

1. Familiarization 2. Baseline 3. Limb Loading 4. Washout.

Approximately 5% of subject's body weight was added to their left leg via an ankle weight during the loaded trial.

Symmetry Index (SI) was calculated for step length and step time:

$$SI = \frac{Unloaded - Loaded}{Unloaded + Loaded}$$



3-way mixed model ANOVA
Condition: Baseline, Loaded, Washout
Time: Early or Late
Vision: VR or NVR
DV - Spatial SI of step length
DV - Temporal SI of step time

Posthoc comparisons of interest :
Early Adaptation: Loaded Early – Baseline Late
Late Adaptation: Loaded Late-Loaded Early
Early De-adaptation: Washout Early-Loaded Late
Late De-adaptation: Late Washout-Early Washout

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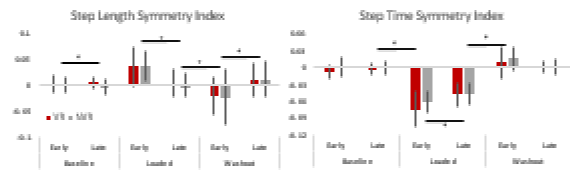
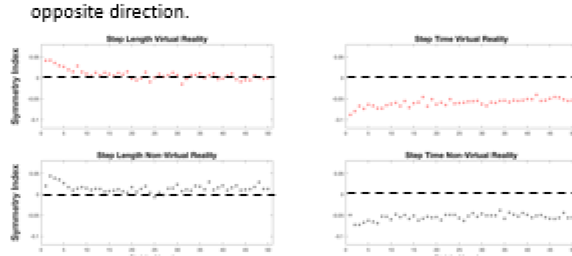
RESULTS and DISCUSSION



- SI of step length: There was a main effect of condition and time but not vision and a significant interaction of time*condition.
- SI of step time: There was a main effect of only condition and significant interaction of time*condition and time*vision.
- During the baseline trial, both step length and time were symmetrical.
- During early adaptation, the loaded limb took shorter, faster steps while the unloaded limb took longer, slower steps.
- Step length returns to symmetry during late adaptation but the unloaded limb still took slower steps and the loaded limb took faster steps. The temporal component was altered to maintain spatial symmetry.
- In de-adaptation: walking pattern became asymmetrical in the opposite direction.



Average step length and step time symmetry index for 50 strides during the limb loaded condition. Step length starts asymmetric and returns to symmetry, while the step time remains asymmetric throughout. Dotted line indicates symmetry.

CONCLUSIONS

- Limb loading affects the symmetry of a walking pattern differently for temporal and spatial components.
- Pathologies, such as stroke, can result in asymmetrical walking patterns in temporal or spatial domains.[3]
- Limb loading could be utilized during rehabilitation to induce a more symmetrical walking pattern. However, care must be taken to ensure that the temporal and spatial aspects of walking are being targeted correctly.
- **Future research:** 1) Compare limb loading to other methods of inducing gait asymmetry, such as walking on a split-belt. 2) Investigate effects of different virtual environments.

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