Gaze behavior changes during locomotor learning

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INTRODUCTION

Vision plays a vital role in motor task execution and motor learning. Gaze behavior describes where the eyes look during a task. Measuring gaze behavior provides insight into the amount and type of visual information sought by an individual during a task. During walking, an individual's gaze behavior depends on the complexity of the environment[1]. When walking across a flat, unrestricting terrain, individuals look an average of 2 step lengths ahead. However, in complex environments, such as rocky terrain, individuals look only 1 to 1.5 steps ahead on average, emphasizing the visual feedback necessary to actively modulate stepping behavior. Populations with different gait abilities, such as older adults[2] and elite athletes[3] exhibit similar shifts in gaze behavior, towards their immediate step and farther ahead respectively, when compared to young adults. These findings suggest that locomotor ability is associated with gaze behavior. However, research examining the relationship between gaze behavior and upper limb motor ability has been mixed. Sailer and colleagues[4] found gaze behavior to shift during upper limb motor learning, with a focus on maximizing feedback with low skill and maximizing task completion with high skill. In contrast, Mathew and colleagues[5] found a consistent fixation point, with little change in fixation distribution throughout a similar upper limb motor learning paradigm.

The present study examines how gaze behavior changes during a locomotor learning paradigm. We hypothesize that participants will emphasize feedback-driven fixations when they are learning the task and shift gaze forward toward task completion fixations (fixations farther forward) as they become experienced with the task.

METHODS

We recruited 5 healthy young adults (mean age 25.2, 3 women) to complete a locomotor learning task[6]. Participants were required to walk at 0.9 m/s on a treadmill while stepping targets were projected onto the treadmill belt surface. Targets were presented in 10 blocks, with each block consisting of 17 repetitions of a 6-step sequence made up of short, medium, and long steps. The distance between steps was set at 80%, 100%, and 120% of participants' natural step length. One block (block 7) acted as a catch trial with a random sequence of step lengths to check sequence learning.

RESULTS AND DISCUSSION

The results (presented in Figure 1) show the distribution of visual fixations binned based on how many steps ahead the fixation was from the participant. The results exhibit the hypothesized shift forward of fixation distribution from the first to last trial These results suggest individuals select gaze fixations to provide more feedback early in the learning process to aid in accurate stepping on the targets. As they learn the task, their gaze shifts forward, which should emphasize task completion and help with motor planning.

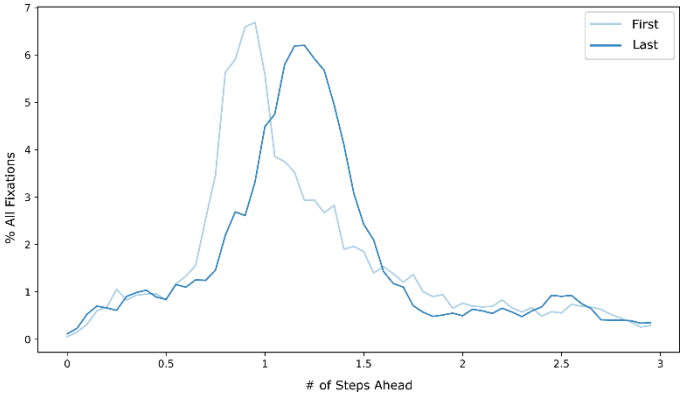

Figure 1: Shift in Gaze Fixation. Results showing the mean fixation distribution across 5 participants during the first and last trial blocks. Results show a clear shift forward in fixation distribution as participants learn the task

The results suggest that gaze behavior changes with locomotor learning. Importantly, the shift in gaze behavior seems to indicate changes in motor planning, as information from farther ahead is preferentially sampled. Such changes may reflect a shift towards more energetically efficient stepping behavior if the individual is able to use this information to plan more efficient movement patterns. Future research should continue to explore the relationship between gaze behavior and locomotor ability, particularly with an examination of accompanying changes in gait mechanics and stepping accuracy.

CONCLUSION

The present pilot study demonstrates a forward shift in participant gaze behavior during a locomotor learning task. The gaze behavior shift suggests people emphasize visual feedback early in locomotor learning moving towards an emphasis on task completion late.

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