RELATIONSHIP BETWEEN GAZE BEHAVIOR AND FAILURE TO CROSS A STATIONARY, VISIBLE OBSTACLE

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INTRODUCTION

Successful modification of gait while navigating cluttered environments is aided by vision. Participants tasked with crossing a stationary, visible obstacle occasionally fail and contact the obstacle [1]. Examining the biomechanics of these failures has indicated that foot placement too close to the obstacle resulted in failures, due to inadequate time and space to flex the limb during crossing [2]. Failures also occur with appropriate foot placement, and most of these failures resulted from a progressive decrease in foot clearance with each subsequent trial [1]. One of the reasons for inappropriate foot placement and inadequate foot elevation may be that the participants did not look at the obstacle adequately during the approach, leading to faulty motor behavior. Participants who never contact the obstacle (successful participants) may have different gaze behaviors than those who do contact the obstacle. This study determined if gaze behaviors were different between successful and unsuccessful participants.

METHODS

Thirty-four university aged adults (7 male, 21 ± 1.2 years of age, 1.68 ± 0.10 m) were recruited. Participants walked over a stationary obstacle that was positioned in the middle of a 6.7 m walkway for 150 trials. Obstacle height was approximately 25% of leg length.

Participants were categorized as a function of the number of obstacle contacts during the 150 trials:
· *Non-tripper*: 0 obstacle contacts in 150 trials
· *Single-tripper*: 1 obstacle contact in 150 trials
· *Repeated-tripper*: 2+ obstacle contacts in 150 trials

Gaze behavior (Mobile Eye-XG, ASL) was analyzed up to and including the participant's first contact trial, or to trial 150 if no contacts occurred. Fixation onset and offset were defined as a gaze within a 3 deg. variance with a minimum duration of 100 ms.

Nine areas of interest (AOIs) were examined (Fig. 1): the walkway was divided into 5 segments (including 60 cm in front of the obstacle where the trail foot is placed and 60 cm after the obstacle where the lead foot is placed), and the obstacle was divided into 3 segments (top, middle, bottom). The outside AOI was any area not previously designated but within the participant's field of vision. Measures included duration and frequency of fixations on each AOI, and the total duration and frequency for all AOIs combined.

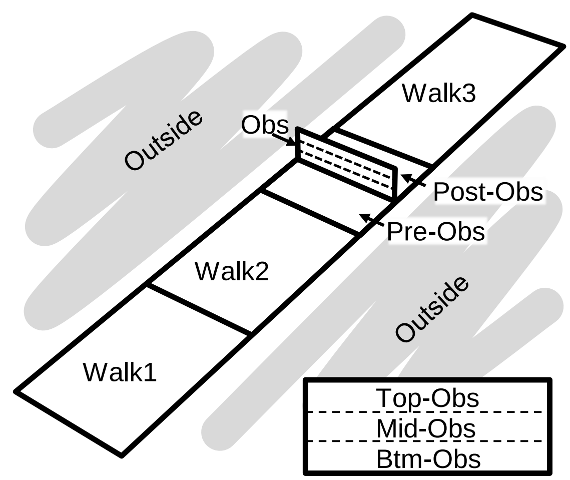

Figure 1: Depiction of walkway and areas of interest (AOIs). Bottom right rectangle indicates the three equal AOIs on the obstacle. Outside AOI included floor, walls, door, etc.

RESULTS AND DISCUSSION

The participants were categorized as follows: 13 non-trippers (38%), 11 single-trippers (32%), and 10 repeated-trippers (29%).

The total number of fixations (i.e. on any AOI) in each trial was not different across the three groups (10.3, 10.3, and 10.7 for non-trippers, single-trippers, and repeated-trippers, respectively; p=0.84). The number of fixations on the obstacle AOI was different as a function of the three groups (p=0.05; Fig. 2a). Post hoc analyses revealed that compared to repeated-trippers, non-trippers fixated on the obstacle in more trials (83 vs 52%, p=0.05). Non-trippers also fixated on the obstacle for a larger proportion of the approach phase relative to repeated-trippers (13 vs 6%, p=0.05; Fig. 2b). Further, relative to repeated-trippers, non-trippers had more frequent fixations on the top of the obstacle (p=0.02), on the walkway region immediately after the obstacle (p=0.02), and had less frequent fixations on AOIs outside the walkway (p=0.01).

The higher fixation frequency on key environmental features provided more opportunity for non-trippers to obtain and process visual information, which may have enhanced obstacle crossing success. Future research will examine how the limb movements were different across the three groups, in order to identify how the gaze fixation on the obstacle optimized motor behavior. These findings warrant a randomized controlled trial to investigate the efficacy of gaze interventions for preventing falls.

CONCLUSIONS

Higher frequency and longer duration of visual fixations on an obstacle in the environment were associated with decreased likelihood of failure. Documenting optimal gaze strategies may lead to the development of gaze interventions to prevent trips, similar to the 'quiet eye' technique that improves athletic performance (Vickers, 2009).

REFERENCES

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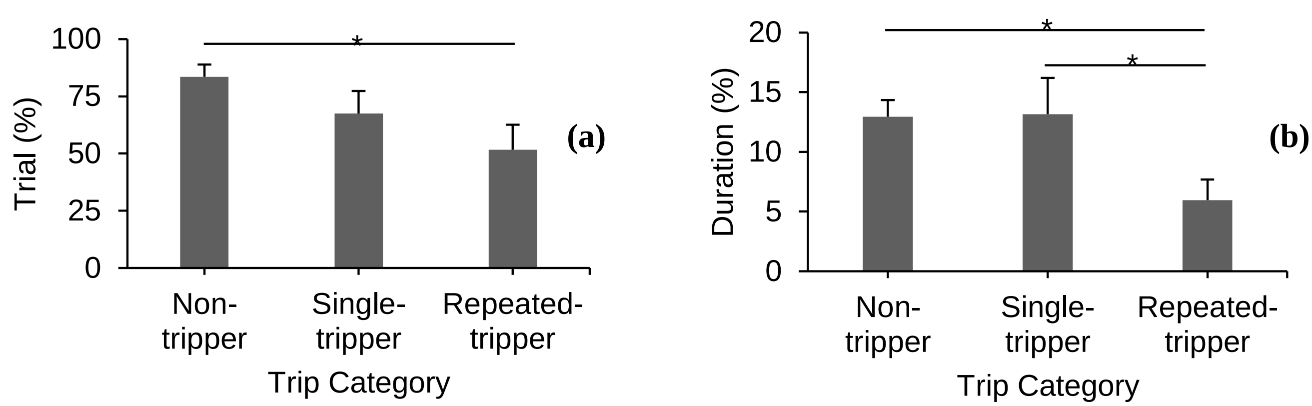

Figure 2: Percentage of trials with obstacle fixations as a function of trip category **(a)** and duration of the trial with a fixation on the obstacle expressed as percentage of trial duration **(b)** (calculated for each trial as total obstacle fixation duration divided by trial duration). Significant differences revealed by post hoc tests are shown with asterisks.