INTRODUCTION
Moving obstacles present a unique challenge to the motor control system as to avoid a collision, ongoing gait patterns must be quickly adapted to accommodate specific obstacle properties (i.e. height/position in travel path) [1]. These alterations require changes in body segment position in relation to the changing obstacle location and are heavily influenced by visual information [2]. Investigation of gaze behavior in these dynamic situations may reveal how the central nervous system (CNS) uses visual input to adapt ongoing gait and could serve as a tool to enhance obstacle avoidance in this demanding situation. Knowing the potential risks associated with a trip, and subsequent fall, the purpose of this investigation was to examine the gaze patterns of healthy young adults as they negotiate a dynamic obstacle with varying time delays.

METHODS
Five young adults performed 36 randomized walking trials over an obstacle that, when triggered by a laser beam, rotated with varying time delays (zero delay, short delay, long delay) to a height of 45 percent of leg length (high position) or to a height 10 centimeters lower (low position). Visual patterns (gaze) were recorded using a head mounted eye tracking system (ISCAN, MA, USA; 30 Hz), while simultaneously recording head kinematics (i.e. pitch) using Optotrak (NDI, Inc. Waterloo, 60 Hz). Walking trials were windowed three steps prior to, and two steps following, obstacle crossing. Within the course environment, six points of interest (POI) were identified (wall ahead, travel path pre-obstacle, foot position pre-obstacle, obstacle, foot position post-obstacle, and travel path post-obstacle). POI was coded within this window and converted to a percentage of trial time. Magnitude and onset of the maximum and minimum head pitch angles (rotation about the medial/lateral axis) were also determined. Repeated measures ANOVA examined the effects of final obstacle height and time delay on the onset of head motion, the magnitude and timing of head pitch angle and POI. Linear regression analysis explored a potential relationship between head pitch angle and POI for maximum and minimum pitch angles.

RESULTS
A significant effect of time delay for POI was not observed. Additionally, no significant effect of final obstacle height or time delay was found for magnitude of head pitch angle (p > 0.05). A significant interaction between final obstacle height*POI was observed (p = 0.02). Participants directed gaze to the obstacle when it moved from a low position to a high position. In contrast, gaze was directed to the post-obstacle foot position when the obstacle moved from a high position to a low position. Time at which maximum, minimum, and onset pitch angles occurred were consistent for both final obstacle positions; maximum angle (head extension) occurred early in the trial, and minimum (head flexion) pitch angle occurred just prior to the obstacle crossing. Of interest, a significant difference in POI at each pitch angle was observed (p < 0.01). At maximum pitch angle, 29% of fixation time was directed to a position on the ground where the lead foot would land after crossing the obstacle, while at onset of head motion, 58% of fixation was on the lead foot position, and at minimum pitch angle 46% of fixation time was spent on this point. Finally, a significant relationship between POI and minimum pitch angle was found (p < .01; R = 0.38).

DISCUSSION
Overall, young adults directed their gaze to either the obstacle or the lead foot position post obstacle on all trials with little fixation spent pre-obstacle. Results indicate that final obstacle position, rather than reduced response time (time delay), influence where young adults direct their gaze. In addition, findings suggest a relationship exists between head angles and POI when participants approach the moving obstacle. Head pitch angles facilitate movement of the eyes when gaze is required beyond the range of eye motion. Future research will examine gaze behavior of older adults to assess if age related differences are present in gaze behavior during dynamic obstacle avoidance and whether these differences relate to increased falls risk. This work may have important implications for reducing fall risk in older adults.

REFERENCES