

The Effects of Müller-Lyer Illusions on Toe Height Clearance When Walking Up Stairs

BENJAMIN SIMS, JAEHO SHIM, JENNY TRAVERS, and JONATHAN RYLANDER

Biomotion Lab; Health and Human Performance; Baylor University; Waco, TX

Category: Masters

Advisor / Mentor: Shim, Jaeho (Joe_Shim@baylor.edu)

ABSTRACT

Tripping when walking over a stair can lead to a serious injury, especially to the elderly. Vision plays an important role when walking up stairs and increasing foot clearance is a common strategy used to avoid tripping. **PURPOSE:** The purpose of this study was to determine if Müller-Lyer illusions can affect one's foot clearance height and possibly reduce the risk of tripping. **METHODS:** The study was conducted both indoor and outdoor. In indoor lab setting, fifteen healthy individuals performed action task of walking up the stairs and perception task of judging stair height. The participants walked up a custom built three-step staircase (.61 m width x 20.3 cm height) to a 2 m x 2 m platform at the top. Toe clearance height was measured with a motion capture system that consists of 14 cameras (Vicon Motion Systems) for motion capture and 2 Vicon Bonita cameras for basic video. Forty reflective markers were placed on participants using the Plug-In gate model to measure and collect the kinematic data. There were four display conditions: Control, Line, Fins In, Fins Out. Each condition was repeated three times, with a ± 5 cm starting position that was randomized between trials. After each condition in the action task, the participants performed perception tasks that had them estimating the height of the first staircase by holding a white stick and pointing the tip of the thumb on the stick to match the height of the perceived staircase. In the outdoor setting, a camera was set up 20 m from a stair that measured 14 cm in height. The camera was positioned 20 cm above the ground which is the general foot clearance height. The camera was zoomed in to capture the leg and foot. In the video recordings, only the trials where the foot was stepped on the top of a particular area 20 cm in width was analyzed. Using a motion analysis software (Tracker), a 2-d analysis was conducted to determine the foot clearance height of a stair in the same 4 display conditions as in the lab. **RESULTS:** In the lab setting, the participants judged the stair height in fins out condition to be significantly taller than all other conditions ($P < .01$). However, their toe clearance height was not different among conditions ($P > .05$). In outdoor setting, toe clearance height with Fins Out condition was significantly higher than Fins In condition ($P < .01$). **CONCLUSION:** The results are in line with the two visual pathway hypothesis and Müller-Lyer illusion occurs and increases the toe clearance height in longer tread as the foot lands further from the target.