Effect of virtual visual space on gait behavior

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Background

It is assumed that pedestrians continuously pay attention to visual information on the walking path and that safe walking is maintained by the dynamic interaction between the body and perceived visual information.Predictive gait control is used to alter gait characteristics, such as walking speed and step rate, in order to avoid obstacles when visual information about the obstacle is available. Since movement difficulties in confined spaces and improved gait due to visual cues can be observed in certain populations such as Parkinson's disease, this study focused on the width and narrowness of space as visuospatial information and analyzed its effect on walking behavior.

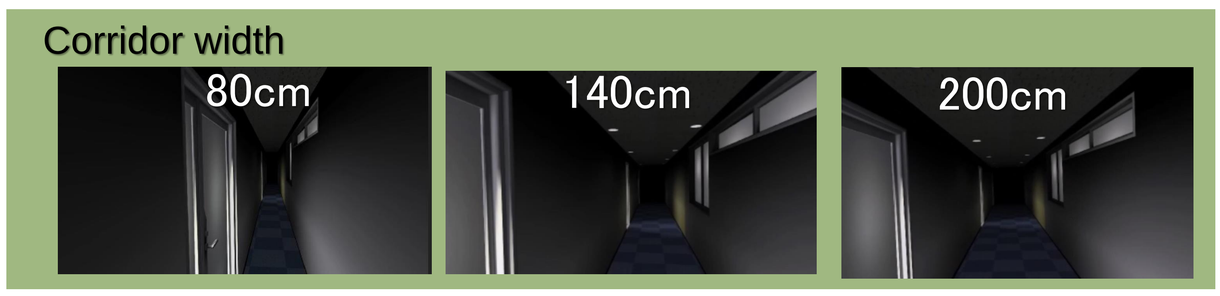
Objective

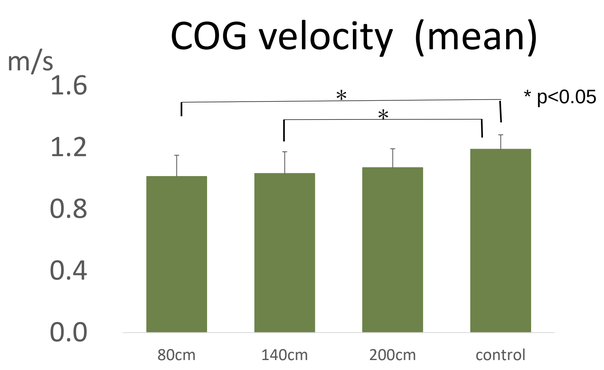
The purpose of this study was to examine the effects of changes in visual information using virtual reality technology on gait movement among healthy adults.

Method

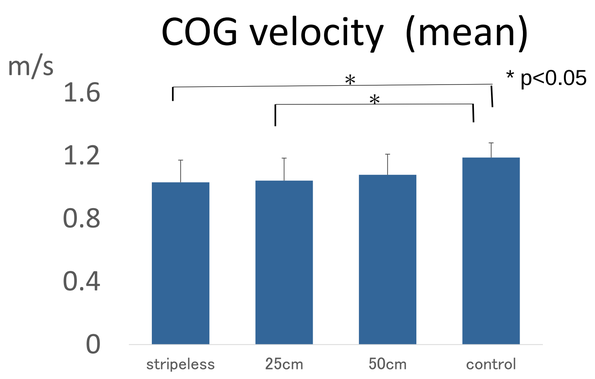
(1) Three levels of corridor width in the virtual space (80 cm, 140 cm, and 200 cm) were set for the width of the visual space. (2) Three types of floor surfaces of the 140cm width corridor in the virtual space were set as visual stimuli (stripeless floor, 25cm striped floor, and 50cm striped floor). Fifteen subjects (9 males, mean age 21.8+1 years) were participated. They were instructed to walk through a virtual space using a head-mounted display (HTC,Vive Pro Eye). Walking without virtual space was performed on a walking path in a physical measurement room of approximately 10 square meters, which served as the control condition. A three-dimensional motion analysis system(Motion Analysis Corporation, MAC3D) was utilized. Continuous gait data was segmented by each gait cycle, normalized, and the velocities of the Center of Gravity (COG) were calculated. Average velocities of the COG were calculated.

Results





(1) The average COG velocities were higher in the wider corridor setting, while they were significantly lower in the 80 cm and 140 cm corridor width groups compared to the control group.



(2) The average COG velocities for each visual stimulus condition increased in the following order: stripeless floor, 25 cm striped, 50 cm striped, and control groups. They were significantly lower in the stripeless floor and 25 cm striped floor groups compared to the control group.

Discussion

Parkinson's disease is one of the diseases that cause gait disturbance. Patients with advanced Parkinson's disease are known to experience freezing of gait when passing through doors or in crowds, as well as temporary improvement of gait disturbance due to visual cues.

These symptoms are difficult to treat with drugs. Higuchi et al. showed that gait is under predictive control during gap passage, and noted a relationship between visuospatial cognition and gait.

Therefore, we hypothesized that these symptoms observed in Parkinson's disease are influenced by visual space, and that visual conditions such as narrow spaces and cues can cause changes in gait even in normal indivisuals.

We investigated the effects on tracing the COG by varying the width of the corridor and the visual stimulus of the floor in the virtual visual space, and observed a slowing down of walking motion in the narrow corridor and the condition with narrow stripes or no stripes.

It was proposed that certain space widths might have minimal impact on walking speed. Additionally, it was suggested that specific visual stimuli on the floor surface could significantly affect walking speed.

Keywords: Virtual reality, Gait analysis, motion capture, spatial cognition, visual stimulation

Conclusion

The narrowness of the visual space and a plain or thinner-striped floors in the virtual environment suggested a deceleration in gait motion.

References

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