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Sensory Integration Model of Pedestrian by Vection and Somatosensory Stimulation

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Abstract

In this study, we clarify the integration mechanism of sensory information of vision and somatosensory sensation in walking. In this experiment, we evaluated the possibility of affecting walking by attenuating a somatosensory sensation by giving vibration stimulation to the feet, and by presenting optic flow to the peripheral visual field to generate a self-motion sensation of vision superiority. Experimental results confirmed that walking in the direction opposite to the self-motion sensation is presented by presenting the optic flow and vibration stimulation. Based on the results of this experiment, we propose that sensory devices such as vision and somatosensory sensation are not exclusive in walking, but are integrated by superposition.

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1 Introduction

In recent years, development of walking navigation technology to avoid various risks during using mobile devices has been desired. As a current walking navigation technology, it depends on visual information obtained from explicit instruction information such as signs and arrows. However, there are many illusions such as "When sending wind to the face of a stationary subject watching an image, the illusion that the subject is moving forward is strengthened[5]", "When a next train starts to move, the stationary subject feels moving in the opposite direction". Not only explicit information but also possibility of pedestrian guidance by implicit input from various sensor such as vision, somatosensor, tactile, equilibrium, etc. are conceivable. However, it is not necessarily clear from the viewpoint of the integration between these senses and the characteristics of the sensory-motor system as to how these implicit stimuli influence our walking.

As an example, a research using optic flow in a direction 90deg orthogonal to the traveling direction was reported, and it was impossible to induce walking such as detecting a statistically

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significant difference although induction of standing condition was possible[8]. Watanabe and colleagues have succeeded in causing a certain amount of walking induction effect by presenting of optic flow causing lateral self-movement sensation to peripheral visual field and suppressing of self-movement sensation of somatosensory [6]. In this regard, Lishman reports that vision, somatosensory, vestibular, etc. have an influence on self-movement sensation but vision prevails over other senses[3]. However, if ”exclusive integration” gives visual dominance over other senses, pedestrian guidance should be possible without reduction processing of self-motion sensation caused by somatosensory. However, there are no such reports in Watanabe’s research. They presented lateral optic flow stimulation to own forward walking, whereas Lishman deals only with forward and backward movements (opposite self-motion perception). Differences in this experimental condition are conceivable.

In addition, Watanabe used eight compact disk type motors weighing less than $1g$ as a vibration stimulus device, but each motor was independent, the vibration phases did not match and the gain of vibration was small. To realize effective guidance, it is considered necessary to present stronger vibrations such as using a single vibration motor. Furthermore, because the fixed motion capture device was used to measure the subject ’ s movement, the measurement range was narrow. And the induction effect could be confirmed but it was not clear how long the effect of the phenomenon would continue[6].

Therefore, in this research, we measure the pedestrian guidance that improves precision and reliability. Improvements from previous research are as follows.

1. Extend walking time from a few seconds to a few tens of seconds (because walking is slightly unstable for a few seconds of walking start).
2. Change from ”toe” to ”heel” as the position measurement part (it seems that fluctuation in the lateral direction is small).
3. Switch an optic flow in the lateral direction of striped stimulus figure so as to move an optic flow of rectangular stimulus figure from forward direction to lateral direction (to make the figure of forward and backward movement and the lateral movement the same).
4. Two panels placed on the side are not used for stimulus presentation (as it is an optic flow of rotational motion rather than optic flow of lateral movement).
5. Late the speed of visual stimulus from $157deg/s$ to $65.5deg/s$.
6. Changed from $1g$ small disk type vibration motor to 1 larger vibration motor.
7. Change to image measurement that extracts the difference value (slope gradient) for each step on the same side from the absolute position measurement by motion capture.
8. Compare the data for a relatively long period before and after optic flow presentation.

By conducting experiments based on these improvements, we aim to elucidate the relationship between sensory consciousness related to pedestrian guidance and self-motion sensation and walking control.

2 Sensory Integration Affecting Walking

Our walking behavior is not just a foot movement. At least our senses accompany our walking.

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