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Talk Title:

Representations of peripersonal space and body for motor actions

Abstract:

Purposeful motor actions depend on the abilities to perceive the space around one's own body, called the peripersonal space, and to spatially represent the body in the brain, called the body schema. Perceiving the peripersonal space is essential for successful interactions between the body and objects, and the body schema is necessary to control our body parts accurately and safely. In this talk, I show (i) how awareness of one's own body part influences the ability to perceive the peripersonal space, and (ii) how the body schema operates during multiple motor actions. In the first topic, I report a visual motion aftereffect (MAE) that shows spatial selectivity in hand-centered coordinates (Matsumiya et al., *Curr. Biol.*, 2014). The MAE is an illusion of visual motion resulting from adaptation to a moving pattern and normally occurs with retinal overlap between adaptor and test. However, we found that the MAE occurs without retinal overlap between the adaptor and test when they are presented at the same position relative to a seen hand (Fig. 1). This MAE depended on senses of ownership and agency over the seen hand, suggesting that these two senses are required to generate a perceptual representation of the peripersonal space. In the second topic, I report that eye and hand movements made to the same bodily location are guided to different body schemas (Matsumiya, *PNAS*, 2022). In this study, participants simultaneously directed eye and hand movements to the same bodily location of 10 landmarks on their hand (Fig. 2). The analysis of the internal configuration of these landmarks for each movement produced maps of the mental representation of hand shape. This behavioral measurement of the body schema was combined with the cross-modal effect of a computer-generated hand on proprioceptive judgments (Matsumiya, 2019, 2021). The use of this effect allowed me to investigate whether the weighting of visual and proprioceptive cues to

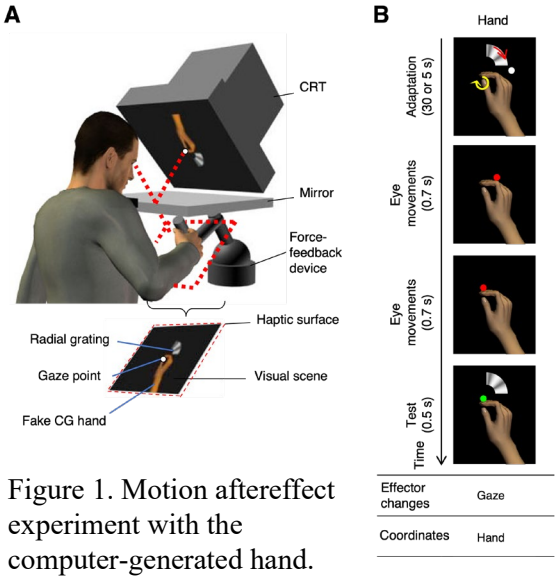

Figure 1. Motion aftereffect experiment with the computer-generated hand.

the location of the landmarks differed between eye and hand movements. Despite eye and hand movements being simultaneously directed to the same bodily location, the resulting hand map (i.e., a part of the body schema) was much more distorted for hand movements than for eye movements. This difference was observed when the computer-generated hand spatially overlapped the participant's invisible hand but not when the computer-generated hand was replaced with a non-body object. Moreover, the distortions of the represented body shape were not correlated between saccade and reach across individuals regardless of whether visual information about the computer-generated hand was available. These results suggest that the body schema is organized as multiple effector-specific body representations and that these body representations differ in the weighting of visual and proprioceptive bodily cues.

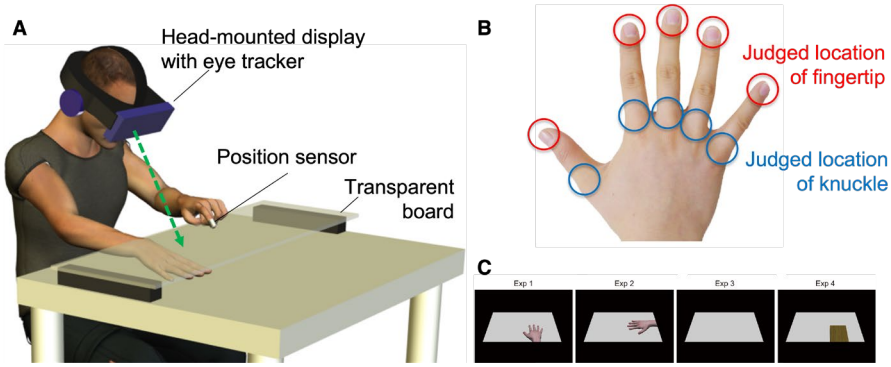

Figure 2. Experimental setups to measure the body schema during multiple motor actions. The body schema was measured by having participants make simultaneous eye and reach (left hand) movements toward the location of 10 landmarks on their right hands.

References

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Biographical Information:

Kazumichi Matsumiya received Ph.D. degree from Tokyo Institute of Technology in 2000. He worked as a postdoctoral fellow at Centre for Vision Research, York University from 2000 to 2001, at Tokyo Institute of Technology from 2002 to 2003, and at ATR from 2004 to 2005.

Then, he moved to Tohoku University in 2005. He also worked as a JST PRESTO researcher from 2016 to 2020. He is now a professor in the Graduate School of Information Sciences, Tohoku University. He won the Japan Society for the Promotion of Science Prize in 2016.