

Influence of Sense of Agency and Sense of Ownership on Body Representation Change of Human Upper Limb

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Abstract—We focused on body representation change of human upper limb and performed experiment with participants on four conditions related to sensitivity of sense of agency and ownership. We measured perceived position change of the elbow and finger by pointing judgement using the motion capture. Our experiment has revealed that sense of agency influence the body representation change on the body parts which was invisible to participants.

I. INTRODUCTION

To improve rehabilitation of the diseases which are caused by the mismatch between the real body and body representation (own model of body in human brain), it is necessary to understand the mechanism of body representation change. Evidence of mirror therapy [1] suggests that sense of agency (SoA) and sense of ownership (SoO) are closely-related with body representation. In this work, we focus on body representation change of body parts which is invisible to the participants. We propose a hypothesis that SoA and SoO have an influence on body representation change on the body parts without visual information.

II. METHODS

To prompt the change of body representation, participants were asked to make some movement and we provided altered visual information to the participants. We designed four conditions that humans felt both of SoA and SoO, only one of them and neither of them. We performed pointing judgement using the motion capture to investigate the perceived position of the finger and elbow as body representation.

Figure 1 shows an experimental setup. First, participants were required pointing judgements (prior judgement). Subsequently, participants moved their right upper limb back and forth on the manipulandum at a constant pace for one minute. During the movement, the virtual hand was displayed on the mirror which seemed to be existing 0.12 m ahead from their real hand. Participants could see only virtual hand and they could not see their right arm. After one minute movement, pointing judgement was performed. Subsequently, participants were required to answer questionnaire about whether the participants felt SoA and

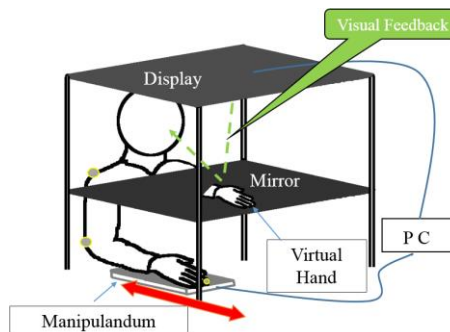


Fig. 1. Experimental device

SoO (+3 - -3). Participants performed one prior judgement and they sequentially repeated movement, pointing judgement and questionnaire ten times for each condition.

The experimental design was 2×2 factorial. The first factor was agent of the movement (*active* or *passive* movement) and the second factor was the posture of the virtual hand (*congruent* and *incongruent*). Human feel SoA easily in active condition and it is opposite in passive condition. In addition, human feel SoO easily in congruent condition and it is opposite in incongruent condition [2]. Eleven right-handed healthy volunteers (mean age 36.8 years, $SD = 10.7$) participated on the basis of informed consent.

III. RESULTS

The results of questionnaire showed that experimental factors affected SoA and SoO just as we designed.

We analyzed the difference between pointing judgement and prior judgement using 2×2 repeated measures ANOVA. In the change of perceived finger position after movement, both of the main effects of movement (SoA) and posture (SoO) condition were significant. On the other hands, only the main effect of movement condition (SoA) was significant in the change of perceived elbow position after movement.

IV. CONCLUSION

Both SoA and SoO influenced body representation change on the visible body parts. On the other hand, when body parts are invisible to the participants, only SoA influenced body representation change. This finding suggests that SoA is strongly related to comprehensive body representation change.

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