

Self based on the body

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1. Introduction

Recently, it is claimed that recognition of the body is important for the social cognitive function (joint attention, imitation, communication, mind reading, empathy and so on). These cognitive functions are based on discrimination of the bodily self and others; the body consciousness (corporeal awareness). The definition of the corporeal awareness (involved body image and body schema) in this talk is that the consciousness involves internal representation about the spatiotemporal dynamic organization of one's own body.

2. Brain damage induced deficit of bodily consciousness

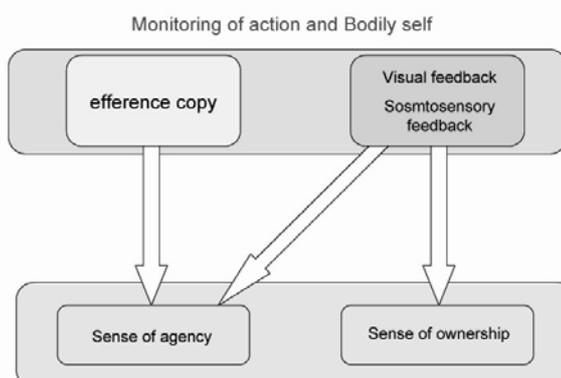
There are two important components in the corporeal awareness. One is ownership of one's own body parts in the sense that one's own body parts belongs to the self. The other one is the sense of agency of action, in which an executed action is recognized as being generated by one's own body parts. It is well known that damage in the parietal cortex often induces impairment of the corporeal awareness. Anosognosia, and asomatognosia have been known to occur in patients with damage of the right parietal cortex. Anosognosic patients show an inability to recognize the presence of their motor and sensory defects, frequently concurrent with asomatognosia (Meador et al., 2000), which is impairment of the ability to recognize one's own body parts. The patient of damage of parietal cortex sometimes showed problem in the recognition of the agency of the action. Then also some of the patients with schizophrenia often experience their intended action as being controlled by someone else (deluted action).

3. Who own the body?

The sense of ownership is based on multimodal sensory integration; visual and somatosensory cues (Botvinick and Cohen, 1998; van den Bos and Jeannerod, 2002). One example of visual-somatosensory integration in the sense of ownership is the rubber hand illusion. There is a feeling of ownership of a fake hand that can be seen in front of the subject, while the subject's real hand is visually occluded. Tapping stimulation is applied synchronously on the real and fake hands. Afterwards, the subject feels a sensation of being touched on the fake hand as well as ownership for the fake hand. Ehrsson et al. (2004; 2005) revealed that activation in the ventral premotor cortex and cerebellum of the human had a correlation with the strength of the rubber hand illusion, implying that these areas are sites for awareness of self-ownership. They also found activation in the inferior parietal cortex. Actually, in the parietal cortex of the monkey there are some neurons that showed response both with visual and somatosensory stimuli (multimodal neurons). Of these neurons in the superior parietal cortex in the monkey were found to be more active when the real arm and visually presented fake arm were in the correspondent positions .

4. Who execute the action?

The sense of agency is the sense that occurs only during voluntary movement. This implies that internal motor signal (efference copy) have a crucial role in the sense of agency. Ongoing limb movement is monitored by actual sensory feedback and the



efference copy to establish more precise movement. However, the system not only controls movement, but also discriminates who generated the action that is visually presented. If the efference copy matches with actual sensory feedback in the comparator simultaneously, the action is detected as self-generated. For example phantom limb patients can feel movement of amputated hand with virtual sensory feedback and intention of movement. In the parietal cortex, some neurons reflect efference copy and visual feedback. The important point is that time contingency with efference and sensory feedback. This system is also related to expanded body image.

5. Brain knows other's body

It is very important to recognize other's behavior or action in the social cognition. Recently, Rizzolatti's group found mirror neurons that discharged not only when the monkey grasped object, but also when the monkey observed the experimenter making a same action. These neurons are considered to be related to recognition of action of others and suggest correlation with joint attention, imitation, communication, mind reading and empathy and so on. We found some multimodal neurons in the parietal cortex that were responded to one's own body parts and also to the same body parts of other's body. The response properties of these neurons may appear to be associable with those of mirror neurons. I suggest that the brain use own body representation to perceive other's body.

Conclusion

- ✓ In the brain, one's own body is primary recognized and distinguish from others'.
- ✓ Integration of visual and somatosensory feedback is important for sense of ownership of the own body parts. Then matching of sensory feedback and motor signal is crucial for sense of agency.
- ✓ Mirror neurons in the brain suggested other's body representation in the brain.

References

Murata A, Ishida H (2007) Representaion of bodily self in the multimodal parieto-premotor network. In: Representaion and brain (Funahashi S, ed), pp 151-176. Springer