Chapter 16
Self-Body Recognition and its Impairment

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ABSTRACT

Self-body recognition is the ability to recognize one's body parts as one's own. This ability is impaired in some neuropsychiatric patients. The present chapter reviews symptoms that demonstrate impaired self-body recognition. Several studies have repeatedly shown that the parietal lobe plays an important role in self-body recognition. In particular, the superior parietal lobe is involved in maintaining short-term memory about the self-body image that produces the sense of ownership of one's body. The right inferior parietal lobule is crucial for detecting discrepancies among multiple afferent sensory inputs, such as the proprioceptive and visual inputs of the body. The authors suggest that temporal consistency among multisensory feedback inputs is important for self-body recognition, which is most likely integrated in the parietal lobe.

INTRODUCTION

Self-body recognition is the fundamental human cognitive ability to recognize our body parts as our own. We usually have no difficulty distinguishing our own arm from someone else's. However, some neuropsychiatric patients have impairment in this ability. Gallagher (2000) argued that self-body recognition can be reduced to two basic subjective senses of the self: the sense of self-ownership and the sense of self-agency. The sense of self-ownership is the feeling that one's body is one's own, whereas the sense of self-agency refers to the feeling that one's body movement is caused by oneself. These two senses are clearly distinguished in active (voluntary) and passive (involuntary) body movements. In an active body movement, both the sense of ownership and the sense of agency are experienced, whereas in a passive body movement, only the sense of ownership is experienced. This sense of ownership is thought to be realized by the integration of multiple sensory feedback sources from one's own body.

The difference between the senses of ownership and agency lies in whether the internal signal of the motor command (the 'efference copy') is

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available. Self-body recognition is most likely substantiated by a neural process of spatio-temporal integration of bodily visual input, proprioceptive/tactile input, and, if applicable, efference copies of motor commands (and predictions of sensory feedback generated from these). The sense of ownership is considered to emerge mainly from the integration process of visual and proprioceptive/tactile inputs, whereas the sense of agency is based on the integration of the efference copy and reafferent sensory (visual and proprioceptive/tactile) feedback. Previous studies have shown that the temporal contiguity of these signals is crucial for the recognition of one's own body (Botvinick & Cohen, 1999; Franck et al., 2001; Shimada et al., 2005; Shimada et al., 2009). In particular, the synchrony of visual and tactile/proprioceptive feedback seems important (Armel and Ramachandran, 2003; Franck et al., 2001). Because proprioceptive feedback is specific to oneself and relatively invariant under various circumstances, the visual property that coincides with proprioceptive feedback is likely to result in the perception of one's own body.

In this chapter, I will review some neuropsychiatric disorders that cause self-body recognition to malfunction and discuss the plausible neural mechanism that realizes the sense of self-body.

IMPAIRMENT IN SELF-BODY RECOGNITION

Phantom Limb

We can feel the existence of our own limbs and extremities, such as the right hand, with no difficulty. We can see, feel, and move our right hand and be confident that the right hand is our own. This is obvious for healthy adults. However, patients who have had limbs amputated often have difficulty with this sense of ownership of their limbs.

Phantom limb is a phenomenon in which a patient feels the existence of an amputated limb. This phenomenon suggests that the sense of ownership of one's own body is independent of the physical state of the body. Instead, this sense comes from the internal (neural) representation of the body, which is called the body image.

Some phantom limb patients are able to "move" their phantom limb, whereas others are not. In the worst case, the patient has pain 'in' the phantom limb. Because the limb does not exist, there is no direct means of removing or attenuating the pain. Unfortunately, the phantom limb is so robust that it may exist for years or decades. Although the patient has daily visual proof that his/her amputated limb no longer exists, the phantom limb continues to appear. Does body image lack plasticity?

On this point, an interesting experiment was conducted (Ramachandran & Blakeslee, 1988) in which a mirror was set up so that a mirror image of the healthy hand (say, the right hand) was seen as if it was the healthy (left) hand that was in fact amputated. When a patient with an immobile phantom limb moved his/her healthy hand by seeing its mirror-reflected image, the patient felt as though the phantom limb moved. That is, phantom limb patients were able to move their phantom limbs by virtue of the limb's mirror image. This experiment suggests that body image is influenced by the visual input of the body, and recognizing the 'absence' of the body may be insufficient to alter body image.

One reason for the existence of a phantom limb is that the brain region (somatosensory cortex) that was responsible for the processing of the limb prior to the amputation receives afferent nerve input from other body parts. For example, a patient may feel a sensation on a phantom hand when his cheek is touched. It is plausible that these afferent inputs produce the sense of ownership of the phantom limb.