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How we come to know our bodies as our own

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By taking advantage of a "body swap" illusion, researchers have captured the brain regions involved in one of the most fundamental aspects of self-awareness: how we recognize our bodies as our own, distinct from others and from the outside world. That self-perception is traced to specialized multisensory neurons in various parts of the brain that integrate different sensory inputs across all body parts into a unified view of the body.

The findings, reported online on June 16 in Current Biology, a Cell Press publication, may have important medical and industrial applications, the researchers say.

"When we look down at our body, we immediately experience that it belongs to us," said Valeria Petkova of Karolinska Institutet in Sweden. "We do not experience our body as a set of fragmented parts, but rather as a single entity. Our study is the first to tackle the important question of how we come to have the unitary experience of owning an entire body."

Earlier studies showed that the integration of visual, tactile, and proprioceptive information (the sense of the relative position of body parts) in multisensory areas constitutes a mechanism for the self-attribution of single limbs, the researchers explained. But how ownership of individual body parts translates into the experience of owning a whole body remained a mystery.

In the new study, the researchers used a "body-swap" illusion, in which people experienced a mannequin to be their own, in combination with

functional magnetic resonance imaging. Participants observed touching of the mannequin's body from the point of view of the mannequin's head while feeling identical synchronous touches on their own body, which they could not see. Those studies revealed a tight coupling between the experience of full-body ownership and neural responses in brain regions known to represent multisensory processing nodes in the primate brain, specifically the bilateral ventral premotor and left intraparietal cortices and the left putamen.

Activation in those multisensory areas was stronger when the stimulated body part was attached to a body as compared with when it was detached, the researchers reported, evidence that the integrity between body segments facilitates ownership of the parts.

"Our results suggest that the integration of visual, tactile, and proprioceptive information in body-part-centered reference frames represents a basic neural mechanism underlying the feeling of ownership of entire bodies," the researchers wrote. The finding generalizes existing models of limb ownership to the case of the entire body.

The discovery may find practical application, according to the study's senior author, Henrik Ehrsson.

"Understanding the mechanisms underlying the self-attribution of a body in the healthy brain can help in developing better diagnostic and therapeutic strategies to address pathological disturbances of bodily self-perception," Ehrsson said. "In addition, understanding the mechanisms of perceiving an entire body or a body part as belonging to oneself can have important implications for the design and production of mechanical prostheses or robotic substitutes for paralyzed or amputated body parts."

It might also lead to improvements in the fields of telerobotics and virtual reality, he added.

More information: Petkova et al.: "From Part- to Whole-Body Ownership in the Multisensory Brain." *Current Biology*, July 12, 2011.

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