Karolinska Institutet

Department of Neuroscience

Investigating the multisensory representation of the hand and the space around it using fMRI

AKADEMISK AVHANDLING
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ABSTRACT

The human brain incessantly receives a staggering amount of information from all our senses. The dynamic integration of relevant multisensory signals is an evolutionarily optimal strategy to assist adaptive behavior. Arguably, one physical object stands out as the unique recipient of internal and external multisensory signals alike: the body. Recent progress within neurology, psychology, and neuroscience has emphasized the role of multisensory mechanisms in the construction of a coherent neural representation of the body and its surrounding space. In turn, this representation supports essential defensive and goal-directed behaviors, facilitates the processing of incoming sensory signals, and may lead to the emergence of the feeling of ownership of the body, a foundation of self-awareness. However, the experimental accounts of the neural mechanisms underlying the construction of this central multisensory representation of the body and its link to self-perception remain unclear.

The aim of the work presented in this thesis was to employ functional magnetic resonance imaging to pinpoint the neural multisensory representation of the hand and the space around it. Furthermore, this thesis aims at relating these multisensory mechanisms to the self-perception of the hand through the interpretation of converging behavioral, neural, and physiological measures. In **Studies I**, **II**, and **V**, we used a combination of ecologically valid paradigms and setups based on virtual reality technology to characterize a set of interconnected premotor, posterior parietal, and subcortical regions that integrate congruent visual, somatosensory, and proprioceptive signals from the upper limb. Furthermore, we provided evidence for the idea that the representation of the hand forms multisensory predictions about self-specific incoming sensory events. In **Studies III** and **IV**, we implemented an fMRI-adaptation paradigm to gain evidence of the existence of neuronal populations in the hand-related multisensory areas with visual receptive fields restricted to the space close to the hand and anchored to the upper limb.

Complementary neural, behavioral, and physiological measures consistently related these multisensory mechanisms to the feeling of ownership of the hand, which is contingent upon the spatio-temporal congruence of multisensory signals within the perihand space. In conclusion, the experiments presented in this thesis describe a set of multisensory brain regions that draw from multiple sensory modalities to build a self-specifying representation of the hand and the space around it. These results are interpreted with respect to earlier findings in non-human primates and humans, and the key functions of this representation, including its role in supporting essential behaviors and the multifaceted self-perception of the hand.

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