

## Symposium

### 22. My body + my movement is = me? Body ownership, agency and the bodily self

Organizer: Lorenzo Pia, SAMBA (SpAtial, Motor & Bodily Awareness) Research Group Psychology Department & Neuroscience Institute of Turin (NIT) University of Turin (Italy)

The bodily self is at the root of human nature and pivotal in our interactions with the environment. Recent advances in cognitive neuroscience have challenged our understanding of the experience of the body as our own, i.e., the immediate and self-specific representation of body-related information.

At present, there is a wide consensus that at least two fundamental components contribute to the experience of the bodily self: body ownership (i.e., the sense that bodily states are perceived as mine) and sense of agency (i.e., the feeling of intending and controlling willed actions). Both are omnipresent during movements but denote different aspects of bodily experience. Indeed, whereas the sense of agency is only present during voluntary actions, thus seems dependent on efferent signals, the sense of ownership seems to rely primarily on afferent signals.

For this proposal, we will address the issue of the complex interplay between body ownership and agency, which have implications for understanding both the neurocognitive mechanisms underpinning bodily self and a variety of neurological and psychiatric diseases affecting the experience of the own body. In order to obtain a full picture of the issue, we will have speakers with different theoretical point of views and/or methodological approaches.

### **23. Delusional ownership and its relationships with the sense of agency**

Lorenzo Pia, SAMBA (SpAtial, Motor & Bodily Awareness) Research Group Psychology Department & Neuroscience Institute of Turin (NIT) University of Turin (Italy)

A key approach to the understanding of bodily self-consciousness is inferring from patients those information that might help to explain intact brain functioning.

In the present talk, I will present a novel, neurologically-based monothematic delusion of body ownership (i.e., patients who misattribute someone else's arm to themselves) which shows abnormalities at the level of the integration among different aspects of body ownership. I will also examine whether and how such altered body ownership affects conscious awareness of movements. This evidence suggests that studying the interactions between body ownership and sense of agency could be key step for the understanding the nature and the neurocognitive mechanisms underpinning human bodily self-consciousness.

## **24. The body of my own? The sense of ownership and agency in bodily self-recognition**

Andreas Kalckert, Brain , Body & Self Lab, Department of Neuroscience, Karolinska Institute, Stockholm (Sweden)

Recent research in psychology and cognitive neuroscience suggests that the experience of the own body can be experimentally manipulated. Paradigms like the rubber hand illusion have revealed the basic cognitive and perceptual mechanisms of the so-called sense of ownership, the feeling that the body we experience is part of my own. In this experiment participants experience a sense of ownership as a consequence of the manipulation of visual and tactile stimulation to the hand. We have recently introduced a new version of this experiment, the moving rubber hand illusion. These experiments have shown that movements can produce a similar ownership illusion and that the illusion relies on similar perceptual principles like the classical paradigm. Crucially though, this experiment complements and extends the classical illusion with the sense of agency, the sense that we are in voluntary control of our actions.

Here, I like to review the basic concepts of these experiments and summarize how ownership and agency contribute to the experience of the own body. I will also briefly introduce potential implications for research on psychopathological conditions. A careful distinction between both these aspects might help us to understand conditions, which affect the experience of the own body and its actions.

## **25. Bimanual coupling: an effective tool to investigate the sense of ownership and agency in pathological conditions**

Francesca Garbarini. SAMBA (SpAtial, Motor & Bodily Awareness) Research Group, Psychology Department & Neuroscience Institute of Turin (NIT), University of Turin (Italy)

When people move both hands simultaneously, each motor program imposes constraints to the other (bimanual coupling). Here, I will review the basic principles of bimanual paradigms and I will pinpoint how they are useful to understand the bodily-self within those pathological conditions in which motor and bodily awareness are altered. In the motor domain, I will focus on brain-damaged patients affected by anosognosia for hemiplegia who, despite the presence of severe left paralysis, obstinately claim that they can still move their contralesional limbs. By using bimanual tasks, both in the spatial and the temporal domain, it has been shown that despite the absence of movements, an effective motor intentionality and a spared sense of agency can be present. In the body domain, I will focus on brain-damaged patients affected by a specific monothematic delusion of body ownership, namely the pathological belief that other people's body parts belong to their own body. By using a modified version of a bimanual task, it has been shown that an altered sense of body ownership profoundly affects the patients' sense of agency (i.e., patients ascribed the alien limb movements to themselves). In summary, these evidences show that bimanual tasks are effective tools to investigate body ownership and the sense of agency in pathological conditions, unveiling specific aspects, otherwise, hidden in normal functioning brain.

## **26. Probing agency and sensation of movement**

Mark Schram Christensen, Copenhagen Neural Control of Movement, Department of Neuroscience and Pharmacology & Department of Nutrition, Exercise and Sports, University of Copenhagen (Denmark)

Sense of agency (SoA) has been, within the framework of the comparator model, been explained by the matching of prior intentions of goals of actions with the actual outcome of the movements. Thereby both the formation of action goals and sensory feedback become critical for the experience of SoA and of Sensation of Movement (SoM). In this talk I will review some of my recent findings pointing towards the importance of either sensory feedback or efferent information in the formation of SoA and SoM performed under experimental settings using transcranial magnetic stimulation and EEG. Suggesting that the mechanisms involved in SoA and SoM cannot solely be explained by the comparator model, but may be much more context sensitive and thereby less simple than previously thought.