Embodiment of a prosthesis through direct optogenetic stimulations of the cortex in the mouse model

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Abstract

Invasive neuroprostheses offer a major opportunity for patients with severe motor disorders. However, these prostheses are presently hampered by the lack of embodiment by the patients, synonymous with discomfort and loss of interest for the prosthesis.
We aim to study the embodiment of a prosthesis in a mouse model, by building on the human illusion of the rubber hand (Botvinick & Cohen 1998). In this embodiment model, the participants are placed in front of a static prosthesis while their own hand is hidden. In optimal conditions, the synchronous tactile stimulation of the prosthesis and the hand induces a strong feeling of embodiment towards the prosthesis.

We succeeded in reproducing this paradigm with the right forepaw of the mouse, by exposing the animals to a static prosthesis touched by a brush simultaneously with their paw. We then threatened the prosthesis, and measured the intensity of the reaction to this threat. It turns out to be significantly stronger after synchronous stimulation, which serves as a measure of prosthesis embodiment.
Based on this new test, and the optogenetic methods mastered by the team (Abbasi et al. 2018), we now plan to explore the conditions of embodiment when tactile stimuli are replaced by direct optogenetic activations of the somatosensory cortex. This study is essential to identify tactile feedback strategies in the context of neuroprostheses that would guarantee an efficient control of the prosthesis, but also an optimal embodiment. Such neuroprostheses may then become tools to limit the development of pain in phantom limbs.

Keywords: embodiment, somatosensory feedback, BMI, prosthesis, limb

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