Predictive processing of tactile sensory information in mice engaged in a locomotion task

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Abstract

The primary somatosensory area of the mammalian cerebral cortex is known to play a key role in tactile sensory processing and touch perception, which may not be restricted to an efficient analysis of the incoming sensory flow. Indeed, according to predictive coding theories, the cerebral cortex could compute, based on past experience, a dynamic model of our interactions with our environment, allowing to anticipate future sensory inputs. Sensory perception would therefore imply a continuous comparison of the expected sensory inputs with those actually received. The error signals generated in case of deviation between these two types of information would allow to readjust current motor commands, as well as updating the internal model, which is key to optimize future behaviour. We seek for neuronal signatures of these predictive mechanisms in the mouse primary somatosensory cortex, at the mesoscopic scale, in the context of a whisker-guided locomotion task. To do so, we record calcium-sensitive signals over this area through a bundle of optical fibres in mice trained to navigate and avoid obstacles in predictable spatial arrangements, in complete darkness. We record neuronal activity in such familiar contexts, and when an obstacle is suddenly removed, thus creating a mismatch between expected and received tactile inputs. By simultaneously recording the animal's movements and whisking strategy using high-speed videography, we intend to link behavioural markers of tactile prediction with the cortical dynamics recorded synchronously, at the millisecond timescale, whilst the animal is navigating and gathering tactile information in an ethologically relevant manner.

Keywords: Predictive processing, barrel cortex, calcium imaging, freely moving mice

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