State dependent modulation of sensory encoding in the primary somatosensory cortex

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Abstract

Perceptual decision and sensory cortical activity both display a high degree of variability that has been reported to co-fluctuate in the context of perceptual decision making tasks. However, it has recently been reported that a significant amount of neuronal variability across trials could be accounted by behavioral states and a rich repertoire of uninstructed movements. It remains unclear how these signals interact with tactile representations in primary somatosensory cortex (S1). It is debated whether S1 mainly reflects the stimulus properties and to which degree choice related activity is represented. We designed a novel task where rodents performed a two-alternative discrimination of vibrotactile frequencies simultaneously applied to two neighboring whiskers. Mice had to report on which whisker the higher frequency was presented. In parallel, neuronal activity in upper layers of S1 was monitored using two-photon calcium imaging (jRGECO1a), spanning the two corresponding somatotopic cortical columns. We mapped the selectivity of individual neurons to the two deflected whiskers and the modulatory effects linked to distinct behavioral outcomes.A linear decoding analysis revealed that the animal psychometric curve matched to the best neuron neurometric curve, while decoding of hundreds of neurons largely outperformed the animals psychometrics. Interestingly while a very sparse subset of cells displayed early choice related signals, most radical transformation of activity related to the engagement state of the animal, and appeared to arise independently of the evoked sensory response. As neurons displaying choice correlates were highly whisker selective, the ones modulated by engagement were largely un-tuned to a single whisker. As a result, neuronal encoding of tactile inputs through the whole population remained highly reliable across conditions and behavioral repertoire. Together, our results advance the understanding of sensory and non-sensory activity in S1 during perceptual decision making.

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