Abstract:

Developmental decorrelation of cortical population activity enables emergent sensorimotor representations

Neural circuit function emerges through developmental transitions in population activity. A conserved feature of this process across species and brain regions is the progressive decorrelation of activity patterns, yet its computational relevance remains poorly explored. Here, we examine how this transition shapes early cortical function using longitudinal in vivo two-photon calcium imaging in superficial and deep layers of the somatosensory cortex in pups from P8 to P12, spanning a critical window of network reorganization. In parallel, we record spontaneous movements to assess the emergence of behavioural representations in cortical activity. We find that the progressive decorrelation of spontaneous activity is required for the emergence of behaviourally relevant neural representations. Decoding of spontaneous movements improves across development and is specifically supported by the emergence of a subpopulation of neurons that are weakly coupled to global population dynamics (“soloist” cells). These neurons preferentially encode movement-related information, enabling reliable extraction of behavioural signals from cortical activity. Together, these results establish decorrelation as a key computational transition during development, linking circuit maturation to the emergence of functional sensorimotor representations.