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Decoding multi-limb trajectories of naturalistic running from calcium imaging using deep learning

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Decoding neural activity into behaviorally-relevant variables such as speech or movement is an essential step in the development of brain-machine interfaces (BMIs)and can be used to clarify the role of distinct brain areas in relation to behavior. Two-photon (2p) calcium imaging provides access to thousands of neurons withsingle-cell resolution in genetically-defined populations and therefore is a promising tool for next-generation optical BMIs. However, decoding 2p calcium imagingrecordings into behavioral variables for use in real-time applications has traditionally been challenging due to the low sampling rate of the signal as well as the indirectand non-linear relationship between the underlying neural activity and the slow fluorescent signal. Here, we show an approach using deep learning to decode thenaturalistic multi-limb trajectories of running mice from neural recordings made with 2p calcium imaging over the sensorimotor cortex in a single hemisphere. Thework demonstrates the feasibility of using deep learning methods to identify and characterize populations of neurons that encode behaviorally-relevant variables. Thisapproach will be critical in the future implementation of neural decoding for next-generation optical BMIs that will improve the lives of patients suffering fromneurological injury and disease.

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