

An Embodied Neuroscience for Cognition and Emotion

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Research objective. The overarching objective of this proposal is to make fundamental advances in our basic scientific understanding of cognitive and emotional intelligence as inherently embodied phenomena.

Approach. The work involves several conceptual, experimental, technical, and computational innovations. Conceptually, we pursue the idea that intelligence is fundamentally embodied and thus cannot be understood without a comprehensive characterization of brain-body interactions. Experimentally, we innovate a novel “Table-top” experimental platform for nonhuman primates. Current experiments involve highly reduced behavioral tasks implemented on digital platforms. This setup deviates significantly from monkeys’ behavioral repertoire and does not allow them to express their natural intelligence. The Table-Top platform accommodates naturalistic tasks involving interactions with real objects allowing us to study the computational basis of embodied cognition and emotion without relinquishing precise experimental control. Technically, we augment the state-of-the-art in primate research with large-scale brain-wide recording and comprehensive non-invasive measurements of somatic and autonomic body responses. Computationally, in the cognitive domain, we aim to create multi-compartmental neural network models with novel architectures that would yield latent states most similar to the primate brain and can thus learn rapidly and generalize flexibly. In the emotional domain, we will introduce a new computational framework to explain the brain and body responses to emotional stimuli as components of an internal model that exerts control over closed-loop brain-body interactions. **Anticipated outcomes.** We expect to develop a detailed computational model of embodied cognition that explains key aspects of intelligence, including inference through exploration, rational reasoning, simulation of outcomes, rapid learning, and flexible generalization. Additionally, we expect to develop a novel and computationally rigorous understanding of embodied emotional states and their impact on behavior in terms of precise closed-loop brain-body interactions with detailed information about the corresponding brain dynamics and the associated autonomic body responses.