Dynamics and Plasticity of a Neuromechanical System
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A striking feature of biological systems is that small changes in a few components can sometimes have a large overall effect on the entire system, whereas large changes in many components can have little overall effect. This *differential penetrance* of details, which depends on the larger context, distinguishes biological systems from many other physical systems. In nervous systems, differential penetrance underlies the ability of animals to be *persistent* i.e., to neglect some aspects of the environment and their internal state in pursuit of a goal, and to be *flexible*, i.e., to respond to small changes in the environment or their internal state by completely altering their behavior. To study the biomechanical and neural mechanisms of flexibility and persistence, we have focused on the feeding system of the marine mollusk *Aplysia californica*. *Aplysia* are capable of rapid changes in feeding behavior in response to changes in properties of food, and can learn to associate taste and texture with inedibility. By constructing a kinetic model of the feeding apparatus, we have shown how the feeding system can be highly sensitive to the placement of specific muscles relative to two different mechanical fixed points. We have also shown that the effectiveness and the roles of feeding muscles can change based on mechanical context. In turn, this has allowed us to generate new hypotheses about the role of a serotonergic neuromodulatory input to the feeding system, and the role of an identified multiaction neuron in transforming the internal state of the animal as a function of neuronal context. These studies are serving as the basis for understanding the substrate upon which learning and plasticity act, and are serving as the basis for the design of novel, more adaptive robots.

PI Website

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