How Baby Robots Help Us Understand Complex Dynamics in Development

Understanding infant development is one of the greatest scientific challenges, as this is a massive complex dynamical system. The development of skills can be viewed as pattern formation through the interactions of multiple mechanisms at multiple spatio-temporal scales. Various processes of self-organization make that the concepts of "innate" or "acquired" are not adequate tools for explanation: what is needed is a shift from reductionist to systemic accounts. To address this challenge, it is insightful to build and experiment with robots that model the growing infant brain and body. This type of work can help explain how new patterns form in sensorimotor, cognitive, and social development. This complements traditional experimental methods in psychology and neuroscience where only a few variables can be studied at the same time. This also provides tools to model the mechanisms of development, going further than simply identifying correlations among variables in black-box statistical studies. Moreover, work with robots has enabled researchers to consider the body as a variable that can be systematically changed to study the impact on skill formation, something developmentalists could only dream about decades earlier. More generally, work with developing robots has shed new light on development as a complex dynamical system, leading to formal models that integrate mathematics, algorithms, and robots.