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Self-Organizing Ontogenetic Development for Autonomous Adaptive Systems (SODAS)

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Biological organisms show an amazing ability during their ontogenetic development to adaptively develop strategies and solutions to the various problems of survival that their environments present to them. Dynamical and embodied models of cognition are beginning to offer new insights into how the numerous, heterogeneous elements of neural structures may self-organize during the development of the organism in order to effectively form adaptive categories and increasingly sophisticated skills, strategies and goals (Kelso 1995; Thelen & Smith 1994; Port & Van Gelder 1995; Clark 1997; Hendriks-Jansen 1996; Franklin 1995). This development during the maturation of biological organisms, and the flexibility to adaptively modify behavior even in mature individuals in order to effectively survive in their environment, all without explicit instruction or prior representations of the world, represents a significant level of increased performance over the current symbolic and neural models.

We propose to build on neurologically inspired, bottom-up, dynamic approaches to embodied category formation such as those done by Freeman (1975, 1999), Freeman & Kozma (2000), Kozma & Freeman (2000) and Almassy et al. (1998). We believe that building on such mechanisms from an embodied dynamical perspective will produce autonomous agents that display greatly increased flexibility in their behavior while also decreasing the amount of effort needed in order to program and train such agents to effectively perform the desired tasks. Such models will represent a better understanding of how the brain of biological organisms not only forms perceptual categories of its environment during development, but also form patterns of behavior based on such environmental categories.

This work explores how well dynamical models of category formation can be thought of as mechanisms of embodied, situated category acquisition. It will also see if such mechanisms are suitable models of the phenomenon of affordances (Gibson 1979) in which such representations provide and inform opportunities for action for the organism given the current situation and its past experience. Such results will shed light on how biological organisms manage the complexity of their environmental niches through self-organizing chaotic dynamics.

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