Arthur S. Iberall Distinguished Lecture on Life and the Sciences of Complexity

December 6, 2013 ⌘ University of Connecticut ⌘ 4:00 p.m.

A106, Bousfield Psychology Building

Actions and Interactions in a Complex World

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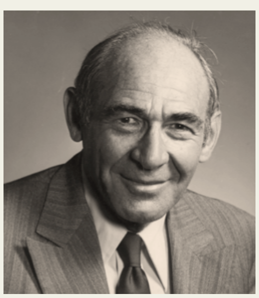
Abstract

Perceptual-motor action skills such as drinking a glass of water or throwing a ball are key to human existence and enable functional actions and interaction with our environment. In fact, learning and testing ourselves in new challenging skills appears to be a uniquely human drive: Seemingly "useless" skills, such as skateboarding or playing soccer, have wide-spread appeal, both for performers and spectators. Hence, revealing the fundamental principles of motor control and skill learning is an important issue. This question becomes even more vital when such functional skills are lost (e.g., in the case of a stroke). To develop interventions that restore or reverse the degradation of functional behavior requires a rigorous understanding of the healthy neuro-mechanical system.

Our approach analyzes how task dynamics constrain and enable sensorimotor actions and their change with practice. Key concepts that drive our inquiry are variability and stability. Characteristic of our approach is to start with a mechanical model of the task and render it in a virtual environment. As such, the human interacts with a fully known task environment. Based on stability analyses of the modeled human-environment system, we study how humans develop dynamically stable solutions to meet complex task demands. Analysis of distributional and temporal properties of variability sheds light on how humans explore and establish their individual solutions to task challenges. Using three model tasks, we show that developing skill means: (1) exploiting solutions with dynamical stability; (2) finding the most error-tolerant strategy, and channeling sensorimotor noise into task-irrelevant dimensions; and (3) optimizing safety margins and predictability of solutions. Based on these insights into healthy function, we have started to test new intervention techniques that facilitate learning and relearning of motor tasks.



Arthur S. Iberall Distinguished Lecture Series

Dedicated to the exploration of connections between physical processes and their manifestations in nature, life, humankind, mind, and society. The series honors the physicist, Arthur S. Iberall (1918-2002), whose intellectual legacy includes homeokinetics, a method of applying the laws of thermodynamics to all self-organizing systems. His applied research contributed significantly to the development of the first space suit, the high-speed dental drill, stove surface burners, the fancy-stitch sewing machine, and the electric knife.

Dagmar Sternad is Professor in the Departments of Biology, Electrical and Computer Engineering, and Physics at Northeastern University. She is also Member of the Center for the Interdisciplinary Research of Complex Systems. Her research examines the organizational principles of movement coordination, and the perceptual information used to coordinate the complex neuromechanical system. She uses a theoretical framework that interprets the actor as a dynamical system that is high-dimensional, nonlinear, and capable of producing coordinated and adaptive behavior. Dr. Sternad is a Fellow of the German National Foundation of Science; a Fellow-at-Large of the Santa Fe Institute; she was an Invited Researcher at the Institute for Interdisciplinary Research in Bielefeld, Germany, and the National Academies Keck Futures Initiative on Complex Systems, Arnold and Mabel Beckman Center, Irvine, CA. She has been Executive Editor of Journal of Motor Behavior since 2005 and Regular Member of the NIH Study Section on Motor Function, Speech and Rehabilitation since 2010. Her research has been continuously funded by NIH, NSF, AHA and the Army since 1997. She has published over 100 papers in peer-reviewed journals and 5 popular books and 1 edited volume.