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

December 1, 2006 ⌘ University of Connecticut ⌘ 4:00 p.m.

Alvin M. Liberman Room, Bousfield Psychology Building

Dissecting Coordination Dynamics

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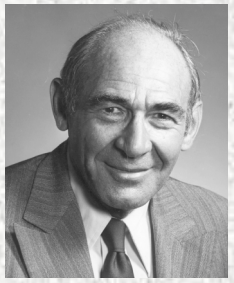
Abstract

Coordinated movement—a primary quality of living systems—is the product of a complex biological organization subject to physical laws; it represents a focal point in the development of a "physics of life." In the last two decades or so, this enterprise has been fueled by (among other approaches) coordination dynamics, that is, the application of dynamical systems theory to the study of how human movements come about, persist, and change. The approach is predicated on the insight that the human action system is composed of billions of neurons and hundreds of muscles and joints, all with considerable anatomical variation and specific functional capabilities, endowing it with the capacity of spontaneous pattern formation. This rich, heterogeneous composition allows a given task goal to be achieved in multiple ways while precluding exact replication of a particular movement pattern. Invariably, multiple dynamical processes underlie, and are reflected in, the time-varying properties of coordinated movement. In consequence, by scrutinizing those time-varying properties, patterns of coordinated movement may be decomposed into constituent processes or components, deterministic and stochastic. Such decompositions or "dissections" expose the origin of the dynamics of movement and thus supplement the more general kind of understanding as gained through the identification of coordination laws at the behavioral level. The dissection may be effectively pursued by combining several methods, including strategic experimental manipulations, measurements at different levels of description (e.g., kinematics, kinetics, EMG, EEG/MEG), advanced methods of data analysis, numerical simulations, and theoretical analyses.

In the lecture two lines of investigation will be discussed that testify to the dynamical multiformity of coordinated movement, one focusing on the stability properties of rhythmic interlimb coordination, and the other on the stochastic properties of isometric force production, postural control, and goal-directed arm movements. Recently obtained experimental results will be reviewed showing that the dynamics of coordinated movement is, in fact, a multifaceted phenomenon composed of multiple functional components and interactions, constituting rich resources for task-specific adaptations. Contours of models will be drawn for capturing those results. The promise of the approach is an integrative account of how coordinated movement is continuously wrestled afresh out of the biological complexity of the human action system, dependent on prevailing task and boundary conditions.

The advocated approach is fully in the spirit of the intellectual heritage of Arthur Iberall in that it strives to unpack the laws of coordination dynamics across scales and heterogeneous subsystems, using the mathematical representations and operational concepts of dynamical systems theory as an expedient window into the physical-biological reality of coordinated movement.



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.

Peter J. Beek is the Professor of Coordination Dynamics in the Faculty of Human Movement Sciences at the Vrije Universiteit of Amsterdam. His research focuses on the control and coordination of human movement using concepts and tools of dynamical systems theory and nonlinear time-series analysis, and covers a broad range of tasks (e.g., posture, gait, bimanual coordination, prehension, interceptive actions), topics (e.g., perception-action, learning, expertise), and domains of application (e.g., sport, rehabilitation). He is editor-in-chief of *Human Movement Science* and Chairman of the Board of the Institute for Fundamental and Clinical Human Movement Sciences.