


# Toward a Unified Theory of Development: Connectionism and Dynamic Systems Theory Re-Considered (Oxford Series in Developmental Cognitive Neuroscience)

*By John Spencer, Michael S.C. Thomas, James L. McClelland*

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From William James to Sigmund Freud to Jean Piaget to B.F. Skinner, scholars (and parents!) have wondered how children move from the blooming, buzzing confusion of infancy, through the tumult of childhood and adolescence, into adulthood. Does development occur continuously over time or in a series of dramatic stages? Is development driven by learning or by biological maturational processes? What is the nature of experience, and how does it generate change? The study of development has always been organized around these big questions. And answers to these questions have a profound influence on daily life, forming a framework for how parents think about their own children, and influencing both national policy and educational curricula.

This book defines and refines two major theoretical approaches within developmental science that address the central issues of development--connectionism and dynamical systems theory. Spencer, Thomas, and McClelland have brought together chapters that provide an introduction, overview, and critical evaluation of each approach, including three sets of case studies that illustrate how both approaches have been used to study topics ranging from early motor development to the acquisition of grammar. They also present a collection of commentaries by leading scholars, which offer a critical view from both an"outsiders's" and an "insider's" perspective. The book is unique in the range of its treatment--it begins to delineate how developmental science can incorporate advances within neuroscience and computational modeling, and brings the new ideas of connectionism and dynamic systems theory into sharper focus, clarifying their usefulness and explanatory power.

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- Sales Rank: #1263438 in Books
- Published on: 2009-06-17
- Original language: English
- Number of items: 1
- Dimensions: 6.90" h x .80" w x 10.10" l, 2.65 pounds
- Binding: Hardcover
- 416 pages

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## Editorial Review

Review

"What is knowledge and how is it acquired? Radical answers to these questions are proposed by the world's leading exponents of dynamical systems theory and connectionist modeling. The volume represents the first comprehensive review of the theoretical relationship between these two frameworks for understanding development. Readers will gain a thorough appreciation of the complementary nature of connectionism and dynamical systems, and receive guidance on how they might be unified in the service of a grand theory. If you are interested in the mechanisms of developmental change, you ignore this book at your peril."
--Kim Plunkett, Professor of Cognitive Neuroscience, University of Oxford

"There is no more complex construction project on earth than the development of the human brain. This integrated collection of chapters offers a new perspective on how development manages to accomplish the seemingly conflicting goals of maintaining stability while orchestrating massive changes as the brain grows into a human mind."
--Terrence Sejnowski, Salk Institute for Biological Studies and University of California, San Diego

"There are many good reasons for presuming that a theory of development should guide inquiry into perception, action and cognition. Unfortunately no developmental theory of the requisite scope and depth has been forthcoming. In the present volume we are given the opportunity to evaluate whether the desired level of theory could emerge from the perspectives of connectionism and dynamical systems, singly or in combination. Minimally, the volume makes us acutely aware of the challenges confronting efforts to formalize human development."
--Michael Turvey, Board of Trustees' Distinguished Professor Emeritus, Department of Psychology, University of Connecticut and Senior Research Scientist, Haskins Laboratories

About the Author

**John P. Spencer** is a Professor of Psychology at the University of Iowa and the founding Co-Director of the Iowa Center for Developmental and Learning Sciences. He received a Sc.B. with Honors from Brown University in 1991 and a Ph.D. in Experimental Psychology from Indiana University in 1998. He is the recipient of the Irving J. Saltzman and the J.R. Kantor Graduate Awards from Indiana University, the Early Research Contributions Award from the Society for Research in Child Development, and the Robert L. Fantz Memorial Award from the American Psychological Foundation. His research examines the development of visuo-spatial cognition, spatial language, working memory, and attention, with an emphasis on dynamical systems and neural network models of cognition and action. He has had continuous funding from the National Institutes of Health and the National Science Foundation since 2001.

**Michael S. C. Thomas** is a Reader in Cognitive Neuropsychology at Birkbeck College, University of London, and the director of the Developmental Neurocognition Lab at the Centre for Brain and Cognitive Development. He is part of a team awarded the Queen's Anniversary Prize for Higher and Further Education in 2006. Dr. Thomas received his B.Sc. in psychology from the University of Exeter, an M.Sc. degree in cognitive science from the University of Birmingham, and a D.Phil. in Experimental Psychology (on behavioral and computational studies of bilingualism) at the University of Oxford, UK. His research focuses on language and cognitive development, and specifically neurocomputational explanations of the variability seen in typical children and in children with developmental disorders. His work combines behavioral methods, computational modeling, and structural and functional brain imaging (see www.psyc.bbk.ac.uk/research/DNL/).

**James L. McClelland** received his Ph.D. in Cognitive Psychology from the University of Pennsylvania in 1975. He served on the faculty of the University of California, San Diego, before moving to Carnegie Mellon in 1984, where he became a University Professor and held the Walter Van Dyke Bingham Chair in Psychology and Cognitive Neuroscience. He was a founding Co-Director of the Center for the Neural Basis of Cognition, a joint project of Carnegie Mellon and the University of Pittsburgh. He served as Co-Director until 2006, when he moved to Stanford University, where he is now Professor of Psychology and is the founding Director of the Center for Mind, Brain and Computation.

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**Benjamin Holmes:**

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