Early Development of Body Representations
Edited by Virginia Slaughter and Celia A. Brownell

Because we engage with the world and each other through our bodies and bodily movements, being able to represent one’s own and others’ bodies is fundamental to human perception, cognition and behaviour. This edited book brings together, for the first time, developmental perspectives on the growth of body knowledge in infancy and early childhood and how it intersects with other aspects of perception and cognition. The book is organised into three sections, addressing the bodily self, the bodies of others and integrating self and other. Topics include perception and representation of the human form, infant imitation, understanding biological motion, self-representation, intention understanding, action production and perception and children’s human figure drawings. Each section includes chapters from leading international scholars drawn together by an expert commentary that highlights open questions and directions for future research.

VIRGINIA SLAUGHTER is Professor of Developmental Psychology and a principal researcher in the Early Cognitive Development Centre at the University of Queensland, Australia.

CEILIA A. BROWNELL is Professor of Psychology and Director of the Early Social Development Lab in the Department of Psychology, University of Pittsburgh.
The aim of this series is to provide a scholarly forum for current theoretical and empirical issues in cognitive and perceptual development. As the twenty-first century begins, the field is no longer dominated by monolithic theories. Contemporary explanations build on the combined influences of biological, cultural, contextual and ecological factors in well-defined research domains. In the field of cognitive development, cultural and situational factors are widely recognised as influencing the emergence and forms of reasoning in children. In perceptual development, the field has moved beyond the opposition of ‘innate’ and ‘acquired’ to suggest a continuous role for perception in the acquisition of knowledge. These approaches and issues will all be reflected in the series, which will also address such important research themes as the indissociable link between perception and action in the developing motor system, the relationship between perceptual and cognitive development and modern ideas on the development of the brain, the significance of developmental processes themselves, dynamic systems theory and contemporary work in the psychodynamic tradition, especially as it relates to the foundations of self-knowledge.

Titles published in the series
1. Jacqueline Nadel and George Butterworth, Imitation in Infancy
2. Margaret Harris and Giyoo Hatano, Learning to Read and Write: A Cross-Linguistic Perspective
3. Michael Siegal and Candida Peterson, Children’s Understanding of Biology and Health
5. Antonio M. Battoo, Half a Brain is Enough: The Story of Nico
6. Andrew N. Meltzoff and Wolfgang Prinz, The Imitative Mind: Development, Evolution and Brain Bases
7. Nira Granott and Jim Parziale, Microdevelopment: Transition Processes in Development and Learning
8. Heidi Keller, Ype H. Poortinga and Axel Schölmerich, Between Culture and Biology: Perspectives on Ontogenetic Development
9. Nobuo Masataka, The Onset of Language
10. Andreas Demetriou and Athanassios Raftopoulos, *Cognitive Developmental Change: Theories, Models and Measurement*
11. Kurt W. Fischer, Jane Holmes Bernstein and Mary Helen Immordino-Yang, *Mind, Brain and Education in Reading Disorders*
Early Development of Body Representations

Edited by

Virginia Slaughter and
Celia A. Brownell
Contents

List of figures page ix
List of tables xi
List of contributors xii

Part I The bodily self

1 Primordial sense of embodied self-unity
   PHILIPPE ROCHAT 3

2 The development of body representations: the integration of visual-proprioceptive information
   STEPHANIE ZWICKER, CHRIS MOORE AND DANIEL POVINELLI 19

3 Emergence and early development of the body image
   CELIA A. BROWNELL, MARGARITA SVETLOVA AND SARA R. NICHOLS 37

4 Gulliver, Goliath and Goldilocks: young children and scale errors
   JUDY S. DELOACHE AND DAVID H. UTTAL 59

Commentary on Part I The embodied mini-me: tracing the development of body representations and their role for self-awareness
   MANOS TSAKIRIS 69

Part II The bodies of others

5 Developing expertise in human body perception
   VIRGINIA SLAUGHTER, MICHELLE HERON-DELANEY AND TAMARA CHRISTIE 81

6 Children’s representations of the human figure in their drawings
   MAUREEN COX 101
Contents

7 Understanding of human motion, form and levels of meaning: evidence from the perception of human point-light displays by infants and people with autism  

DEREK G. MOORE  

8 How infants detect information in biological motion  

VINCENT REID  

9 The integration of body representations and other inferential systems in infancy  

KIRSTEN O’HEARN AND SUSAN C. JOHNSON  

Commentary on Part II Yet another approach to development of body representations  

KAZUO HIRAKI

Part III Bodily correspondences: integrating self and other

10 Prepared to learn about human bodies’ goals and intentions  

TEODORA GLIGA AND VICTORIA SOUTHGATE  

11 Imitation in infancy and the acquisition of body knowledge  

SUSAN JONES AND HANAKO YOSHIDA  

12 Infants’ perception and production of crawling and walking movements  

PETRA HAUF AND MICHELLE POWER  

13 The body in action: the impact of self-produced action on infants’ action perception and understanding  

JESSICA A. SOMMERVILLE, EMILY J. BLUMENTHAL, KAITLIN VENEMA AND KARA D. SAGE  

Commentary on Part III Body and action representations for integrating self and other  

MORITZ M. DAUM AND WOLFGANG PRINZ

Index
Figures

3.1 Age-related decline in body-size errors for each of three tasks  page 45
3.2 Age-related decline in body-as-obstacle errors for each of two tasks  45
4.1 This child is committing a scale error: he is in all seriousness trying to force his foot into the miniature toy car  62
4.2 Incidence of scale errors by age  66
5.1 Typical and scrambled human body stimuli varying in realism  82
5.2 Proportions of 9-month-olds who discriminate scrambled from typical human body shapes, by stimulus type  89
5.3 Proportions of 12-month-olds who discriminate scrambled from typical human body shapes, by stimulus type  89
6.1 Tentative scribbles at age 1 year (left); side-to-side scribbles at 16 months (centre); and spiralling scribbles at 2 years (Major, 1906)  102
6.2 Amy, aged 1 year 11 months, added arms, legs and a hat to an adult’s pre-drawn head and torso  103
6.3 ‘It’s my Mummy’, by Simon, aged 3 years (left); ‘Mummy and Daddy’, by Simon at 3 years 2 months (right)  104
6.4 Tadpole figures drawn by pre-school children  104
6.5 This figure (left), drawn by a 6-year-old, is in a canonical orientation; this figure (right), drawn by an 8-year-old, is in side-view and appears to be walking: the arm occludes the contour of the torso  107
6.6 Amy, aged 5 years 2 months, drew her family using the same basic schema for each figure  107
6.7 A figure with no outline around the facial features (left), drawn by a 4-year-old; a contour figure (centre), drawn by a boy aged 4 years 3 months; a stick figure (right), drawn by a 4-year-old  109
List of figures

6.8 These figures, drawn by a 9-year-old boy (left) and a 10-year-old girl (right) from Nigeria, display African features and rectangular torsos 111

6.9 These bi-triangular figures were drawn by a 14-year-old Zimbabwean girl 112

6.10 A group of people chatting around a campfire, drawn by an 8-year-old Warlpiri girl, central Australia; the U-shaped symbol has been used for most of the figures but the baby is a conventional western form 113

7.1 How a human point-light display appears as a static image 124

7.2 Still image showing violation of the solidity of a human point-light display 130

9.1 Schematic representation of the tracking task in study (1) 168

9.2 Schematic representation of the individuation task in study (2) 171

9.3 Schematic representation of the goal inference task used in study (3) 174

9.4 Schematic representation of the tracking task used in study (3) 175

C2.1 The humanoid robot ‘Robovie’ 187

C2.2 Geminoid F, developed by Department of Systems Innovation and ATR Intelligent Robotics and Communication Laboratories. Left: Geminoid F; right: real human 188

10.1 Inferential learning of bodily mechanical properties based on the ‘efficacy’ principles 202

12.1 Mean looking duration (ms) for the lower body AOI 238

13.1 Cane-as-tool (CAT) procedure 255

13.2 Looking times to the test outcomes as a function of condition and experiment 257

C3.1 The relationship between how knowledge about the structure and function of body parts is acquired in infancy 275
# Tables

4.1 Examples of parents’ descriptions of scale errors  

5.1 Earliest age at which infants detect the human typical body shape, across stimulus realism conditions  

7.1 Sensitivity to levels of motion and form in human PLDs in infancy and age capacity may emerge  

7.2 Evidence for differential sensitivity to levels of motion and form in human PLDs in people with ASDs  

9.1 Looking time data from study (1)  

9.2 Looking time data from study (2)  

9.3 Looking time data from study (3)
Contributors

EMILY J. BLUMENTHAL is a doctoral candidate studying developmental cognitive neuroscience at the Psychology Department and the Institute for Learning and Brain Sciences at the University of Washington.

CELIA A. BROWNELL is Professor of Psychology and Director of the Early Social Development Lab in the Department of Psychology, University of Pittsburgh.

TAMARA CHRISTIE is a developmental psychologist working within the Department of Education and Training, Queensland, Australia.

MAUREEN COX is Emeritus Reader in the Department of Psychology, University of York, UK.

MORITZ M. DAUM is Head of the Infant Cognition and Action research group at the Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.

JUDY S. DELOACHE is William Kenan Professor of Psychology at the University of Virginia.

TEODORA GLIGA is a research fellow at the Centre for Brain and Cognitive Development, Birkbeck College, UK.

PETRA HAUF is Canada Research Chair in Cognitive Development and Principal Researcher in the Infant Action and Cognition Lab in the Department of Psychology at St. Francis Xavier University, Canada.

MICHELLE HERON-DELANEY is a postdoctoral research fellow at the Centre of National Research on Disability and Rehabilitation Medicine in Brisbane, Australia.

KAZUO HIRAKI is a professor in the Department of General Systems Studies and Center for Evolutionary Cognitive Sciences in the Graduate School of Arts and Sciences at the University of Tokyo, Japan.

SUSAN C. JOHNSON is a cognitive scientist who studies infant social cognition at The Ohio State University.
List of contributors

SUSAN JONES is Professor of Psychological and Brain Sciences and the Program in Cognitive Science at Indiana University.

CHRIS MOORE is Professor of Psychology and director of the Early Social Development Laboratory in the Department of Psychology, Dalhousie University, Canada.

DEREK G. MOORE is Professor of Developmental Psychology and Director of the Institute for Research in Child Development at the University of East London, UK.

SARA R. NICHOLS is a doctoral candidate studying developmental and clinical psychology at the University of Pittsburgh.

KIRSTEN O’HEARN is a developmental psychologist studying visual processing in autism at the University of Pittsburgh.

DANIEL POVINELLI is Professor of Biology at the University of Louisiana and Director of the National Chimpanzee Observatories Initiative.

MICHELLE POWER is Manager of Ann Bigelow’s Infant Development Lab and a researcher in Petra Hauf’s Infant Action and Cognition Lab in the Department of Psychology at St. Francis Xavier University, Canada.

WOLFGANG PRINZ is Director Emeritus at the Department of Psychology of the Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.

VINCENT REID is a lecturer in the Department of Psychology at Durham University, UK.

PHILIPPE ROCHAT is Professor of Psychology and Head of the Emory Infant and Child Laboratory at Emory University, Atlanta, Georgia.

KARA D. SAGE is a graduate student in developmental psychology and Manager of Dr. Dare Baldwin’s Acquiring Minds Lab at the University of Oregon.

VIRGINIA SLAUGHTER is Professor of Developmental Psychology and a principal researcher in the Early Cognitive Development Centre at the University of Queensland, Australia.

JESSICA A. SOMMERVILLE is an associate professor in the Psychology Department and at the Institute for Learning and Brain Sciences at the University of Washington. She also directs the Early Childhood Cognition Lab.

VICTORIA SOUTHGATE is a Research Fellow at the Centre for Brain and Cognitive Development, Birkbeck College, UK.
Margarita Svetlova is a doctoral candidate studying developmental psychology at the University of Pittsburgh and is a guest researcher in the Department of Developmental and Comparative Psychology at the Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.

Manos Tsakiris is Reader in Neuropsychology at the Department of Psychology, Royal Holloway University of London, UK.

David H. Uttal is Professor of Psychology and Education at Northwestern University, where he studies spatial and symbolic development.

Kaitlin Venema is a research coordinator at the University of Washington Autism Center in Seattle, Washington. She formerly worked in the Early Childhood Cognition Lab under Jessica Sommerville.

Hanako Yoshida is an assistant professor in the Department of Psychology at the University of Houston and directs the Cognitive Development Laboratory.

Stephanie Zwick is a doctoral candidate in the Department of Psychology, Dalhousie University, Canada. She is conducting her PhD research on the temporal parameters of visual-proprioceptive intermodal integration.