

# HUMAN MOTOR DEVELOPMENT

**A LIFESPAN APPROACH**

THIRD EDITION

V. GREGORY PAYNE • LARRY D. ISAACS

# HUMAN MOTOR DEVELOPMENT

**A Lifespan Approach**

---

**THIRD EDITION**

**V. Gregory Payne**

San Jose State University

**Larry D. Isaacs**

Wright State University



**Mayfield Publishing Company**

Mountain View, California

London • Toronto

© 1995, 1991, 1987 by Mayfield Publishing Company

All rights reserved. No portion of this book may be reproduced in any form or by any means without written permission of the publisher.

**Library of Congress Cataloging-in-Publication Data**

Payne, V. Gregory.

Human motor development : a lifespan approach / V. Gregory Payne,  
Larry D. Isaacs. — 3rd ed.

p. cm.

Includes bibliographical references and index.

ISBN 1 -55934-379-6

1. Motor ability in children. 2. Child development. 3. Human  
mechanics. I. Isaacs, Larry D. (Larry David).

II. Title

RJ133.P39 1994

155.4'123—dc20

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2

Mayfield Publishing Company  
1280 Villa Street  
Mountain View, California 94041

Sponsoring editor, Serina Beauparlant; production management, The Cowans; copyeditor, Jeanine Ardourel; text designer, Richard Kharibian; cover designer, Joan Greenfield; illustrators, John Foster, Tara Winkler; manufacturing manager, Aimee Rutter. The text was set in 10/12 New Caledonia by The Cowans and printed on 50# Finch Opaque by R. R. Donnelley & Sons.

To Luke, the best motor development professor ever, and our hopes for a bright future. ITAYATT

V.G.P

To my children, Brooke and Timothy.  
No words could ever adequately express my love for each of you.

L.D.I.

## ABOUT THE AUTHORS

**V. Gregory Payne** is beginning his twelfth year at San Jose State University where he is professor in the Department of Human Performance. He received his undergraduate degree from Western Illinois University, a master's degree from the University of Iowa, and a doctoral degree specializing in motor development from Indiana University. Dr. Payne is the 1994-95 president of the California Association for Health, Physical Education, Recreation, and Dance and is currently serving as the Past Chair of AAHPERD's Motor Development Academy. He is a special advisor to California's Governor's Council on Physical Fitness and Sports, has been a fellow in the Research Consortium of AAHPERD since 1983, and has served as co-chair of the Research Committee of the Council on Aging and Adult Development. He recently received the *Research Quarterly for Exercise and Sport* writing award for meta-analysis conducted on children's exercise. He resides in San Jose's Almaden Valley with his wife, Barb, and their 5-year-old son, Luke.

**Larry D. Isaacs** is professor in the Exercise Science Program, Department of Biology, College of Science and Mathematics at Wright State University. Since receiving his doctorate in 1979 from the University of Maryland, Dr. Isaacs has served as a reviewer for many scholarly journals. In addition, he has published numerous scholarly articles and has written six textbooks. Over the past 16 years, his writings have been recognized by many organizations including the American Alliance for Health, Physical Education, Recreation, and Dance where he has received the status of Research Fellow. In 1993 Dr. Isaacs received national certification (Health-Fitness Track) with the American College of Sports Medicine. Presently Dr. Isaacs' research is focusing on the physiological basis of muscular strength development in both prepubescent and elderly individuals. He currently lives in Dayton with his wife, Joy, and two children, Brooke and Timothy, 14 and 10 years old, respectively.

---

# Preface

As in the first two editions of *Human Motor Development: A Lifespan Approach*, this new edition covers well-established undergraduate motor development material. Our approach to this subject is unique in many ways.

## SPECIAL FEATURES AND ORGANIZATION

Unlike traditional motor development texts that present development as a concept that ceases at adulthood, our book approaches motor development as a life-long process. This approach recognizes the dramatic changes occurring within our population and the increasing popularity of movement programs outside the school setting.

Another feature of our book is the underlying philosophy that movement influences *and is influenced by* social, cognitive, and physical aspects of human development. That philosophy is apparent throughout the book, and separate chapters are allocated to each of these areas of human development.

Chapter 15, Youth Sports, and Chapter 18, Planning and Conducting Developmental Movement Programs, present information often omitted in traditional motor development texts. In addition, Chapter 18 provides information for those who are interested in setting up their own developmental movement program.

A number of features assist both the student and instructor. For example, each chapter concludes with a summary and a list of key terms, and complete references, by chapter, are provided at the end of the book. In addition, we have created a new Instructor's Manual. The Manual includes a sample syllabus, multiple choice and essay questions for each chapter (more than 500 test items total), suggested assignments for each chapter, expanded assignments (such as case studies and program critiques), and more than 70 transparency masters highlighting key information.

The organization of our book remains straightforward. Part One provides an overview of human development and includes chapters on the developmental aspects mentioned above. Part Two covers factors affecting development, including the effects of early stimulation and deprivation. Part Three, Physical Changes Across the Lifespan, and Part Four, Movement Across the Lifespan, present the book's core concepts. We conclude with Part Five, Assessing and Implementing a Program, an expanded, two-chapter part.

## NEW FEATURES

All of the chapters have been updated and modified to reflect current research in motor development and to improve readability for students. The following are some major modifications you will find in the new third edition:

- Chapter 1, Introduction to Motor Development, has several new tables. We have also expanded the section on research designs and incorporated a new section on current trends in motor development that discusses the lifespan approach and dynamical systems perspective.
- Chapter 3, Social and Motor Development, has been supplemented with several new tables, figures, and photos, an expanded discussion of the concept of socialization and a new section on the exercise-aging cycle.
- Chapter 4, Perceptual-Motor Development, has much more information on the development of postural control and has been thoroughly updated.
- Chapter 5, Prenatal Developmental Concerns, has many new tables, including a comprehensive table indicating normal fetal development. New sections have been added on maternal diseases, HIV, cystic fibrosis, and diabetes mellitus. The sections on maternal nutrition and exercise during pregnancy have been expanded.
- Chapter 6, Effects of Early Stimulation and Deprivation, now includes a discussion of an important policy statement on infant exercise from the American Academy of Pediatrics, an expanded discussion of classic research conducted by Wayne Dennis, and even more examples of classic cases of extreme deprivation and its effects.
- Chapter 8, Physiological Changes: Health-Related Physical Fitness, now has many more tables as well as expanded information on developmental changes in heart rate. We have also included a section on the effects of exercise on prepubescents and have incorporated important position statements from prominent professional associations concerning children's weight training. Finally, new sections on the elderly and resistance training and gender- and health-related fitness have been included.
- Chapter 9, Movement and the Changing Senses, now provides information about several modalities other than just vision and includes major sections on such senses as proprioception and touch.
- Chapter 10, Infant Reflexes and Stereotypies, now has two new tables and a section discussing the difference between lifespan and infant reflexes.
- Chapter 11, Voluntary Movements of Infancy, has newly expanded sections on attainment of upright posture and early reaching and grasping behavior.
- Chapter 12, Fine Motor Development, includes a number of new photos as well as new sections on current interpretations of the development of prehension and some exciting research on early exploratory hand movements and the development of haptic perception.

- Chapter 13, Fundamental Locomotion Skills of Childhood, and Chapter 14, Fundamental Object Control Skills of Childhood, have been expanded and separated into two chapters for ease of reading. In addition to the many other fundamental locomotor skills included in the previous edition, Chapter 13 now includes developmental information on galloping, sliding, and skipping. Chapter 14 adds one-handed catching to the list of non-locomotor skills that were previously included. Finally, sections have been added concerning gender differences in overarm throwing and the effects of instruction on non-locomotor skills.
- Chapter 15, Youth Sports, now includes many new tables and updated data on children's participation in sports programs. New information is provided about why children participate, and the section on youth sports injuries has been updated and expanded.
- Chapter 16, Movement in Adulthood, now includes more information about adult postural control and a discussion of the classic work of Lehman and age-of-peak proficiency in various movement activities. More importantly, the work of Lehman has been updated to include the nearly fifty years of information since his work was completed. A section on physical activity trends through adulthood has also been incorporated.
- Chapter 18, Planning and Conducting Developmental Movement Programs, now includes sections on playground injuries with many new tables accompanying this information. A section has also been added to address the need for precaution in blood management.

## **ACKNOWLEDGMENTS**

A special thanks to Mayfield Publishing for, again, guiding us through the publication process in a friendly and focused manner. We also appreciate their willingness, upon our request, to solicit many more reviews than usual. These reviews were particularly useful in our efforts to meet the needs of instructors and students of motor development. We're grateful for the constructive comments from all the reviewers: Beverly J. Allen, Alabama State University; Judy M. Bohren, University of Tampa; Allen Burton, University of Minnesota; Stephen E. Butterfield, University of Maine; Nancy L. Carleton, San Jose State University; Tami Benham Deal, University of Wyoming; John L. Haubenstricker, Michigan State University; Robert E. Kraft, University of Delaware; George Luedke, Southern Illinois University at Edwardsville; Louise S. McCormack, Plymouth State College; Sally McGrath, Shippensburg University; and Mary Painter, California State University at Northridge. One reviewer in particular surpassed all expectations. Dr. Allen Burton of the University of Minnesota provided us with supremely constructive comments with detailed rationale and references. Improvements in this edition are, in part, a function of Dr. Burton's critical insights into motor development.



We also acknowledge the work of Dr. Karyn Nelson of the University of Hawaii, who wrote large portions of our Instructor's Manual. Knowing Dr. Nelson's compassion as an instructor and her interest and expertise in motor development and written-test construction, we were always confident that our Instructor's Manual would be the quality we sought. Dr. Nelson produced a wide variety of carefully constructed test questions with many clever and creative assignments. All of our students will prosper from her work. Thanks, Karyn!

Lastly, we would again like to thank Dr. John Haubenstricker, Dr. Vern Seefeldt, and colleagues at Michigan State University for providing us with the research data and supporting studies pertaining to the "total body approach" for describing developmental sequences (presented in Chapters 13, 14, and 17). Although we had used these sequences in previous editions, we now include even more of the findings from the work conducted at Michigan State University. We would also like to again acknowledge that the film tracings that accompany much of this work were done by Dr. Joy Kiger, a former doctoral student at Michigan State. Dr. Kiger is now a faculty member at the University of Wisconsin, Whitewater.

---

# Contents

Preface xvii

---

## **PART ONE:           An Overview of Development**

<b>CHAPTER 1</b>	Introduction to Motor Development	1
	Motor Behavior	1
	Motor Development	2
	The History of the Field of Motor Development	3
	Current Trends in Motor Development	6
	Dynamical Systems Perspective	6
	Motor Development as a Lifespan Perspective	8
	An Interdisciplinary Approach to Motor Development	9
	Designing Research in Motor Development: Cross Sectional, Longitudinal, or . . . ?	10
	The Domains of Human Development	12
	The Importance of Motor Development	13
	Development, Maturation, and Growth	14
	General Motor Development Terms	15
	Developmental Direction	15
	Differentiation and Integration	16
	Gross and Fine Movement	17
	The Process-Product Controversy	18
	Terms for Age Periods Throughout the Lifespan	18
	Stages of Development	21
	Summary	21
	Key Terms	22
 <b>CHAPTER 2</b>	 Cognitive and Motor Development	 24
	The Term Psychomotor or Motor?	24
	Jean Piaget and Cognitive Development	25
	Piaget's Theory of Cognitive Development	25
	Infancy: The Sensorimotor Stage and Motor Development	27
	Childhood: Preoperations and Motor Development	30
	Later Childhood and Adolescence: Cognitive and Motor Development	32
	Concrete Operational Stage	32
	Formal Operational Stage	33
	Adulthood: Postformal Operations	34

	Adulthood: Two General Theories of Intellectual Development	35
	Total Intellectual Decline Theory	35
	Partial Intellectual Decline Theory	35
	Knowledge Development and Sport Performance	37
	Summary	38
	Key Terms	39
<b>CHAPTER 3</b>	<b>Social and Motor Development</b>	<b>40</b>
	Socialization	40
	Self-Esteem Development and Physical Activity	41
	Social Influences During Infancy	44
	Social Influences During Childhood	45
	Play	46
	Family	47
	Social Influences During Older Childhood and Adolescence	48
	Team Play	49
	Gender Role Identification and Movement Activity	50
	Social Factors of Adulthood	52
	Social Learning and Ageism	53
	Other Social Situations Likely to Affect Motor Development	54
	The Exercise-Aging Cycle	56
	Avoiding the Exercise-Aging Cycle	57
	Summary	59
	Key Terms	61
<b>CHAPTER 4</b>	<b>Perceptual-Motor Development</b>	<b>62</b>
	What is Perceptual-Motor Development?	62
	Other Interpretations of Perceptual-Motor	63
	The Perceptual-Motor Process	65
	Is All Movement Perceptual-Motor?	66
	Balance	66
	Spatial Awareness	68
	Temporal Awareness	69
	Body and Directional Awareness	70
	Perceptual-Motor Theories: Kephart and Delacato	70
	Kephart's Perceptual-Motor Theory	71
	Delacato and Hemispheric Dominance	71
	Researching the Effectiveness of Perceptual-Motor Programs	72
	Summary	73
	Key Terms	74

## PART TWO: Factors That Affect Development

<b>CHAPTER 5</b>	Prenatal Development Concerns	75
	Drugs and Medications	76
	Recreational Drugs	76
	Prescriptive Drugs	81
	Nonprescriptive Drugs	81
	Obstetrical Medications	82
	Maternal Diseases	82
	Rubella	82
	Human Immunodeficiency Virus	83
	Toxoplasmosis	83
	Rh Incompatibility and Erythroblastosis Fetalis	84
	Diabetes Mellitus	84
	Genetic Factors	85
	Chromosome-Based Disorders	85
	Gene-Based Disorders	86
	Prenatal Diagnostic Procedures	87
	Maternal Nutrition	90
	Birth Weight	92
	Exercise During Pregnancy	94
	Summary	97
	Key Terms	97
 <b>CHAPTER 6</b>	 Effects of Early Stimulation and Deprivation	 99
	Effects of Early Stimulation	99
	Programs to Enhance Early Motor Development	100
	Gymboree	102
	Swim Programs for Infants and Preschoolers	103
	Suzuki Method of Playing the Violin	106
	Head Start Programs	107
	Infant Walkers	108
	Johnny and Jimmy	108
	Effects of Early Deprivation	111
	Hopi Cradleboards and Infant Development	111
	Deprivation Dwarfism	112
	Anna and a Case of Extreme Isolation	112
	The “Young Savage of Abeyron”	113
	Concepts Concerning Stimulation and Deprivation	114
	Critical Periods	115
	Readiness	116
	Catch-Up	117
	Summary	119
	Key Terms	120

## **PART THREE: Physical Changes Across the Lifespan**

<b>CHAPTER 7</b>	Growth and Maturation	121
	Measuring Growth in Length and Stature	121
	Growth in Length and Stature	123
	Measuring Body Weight	129
	Growth in Body Weight	129
	Stature and Weight: Interrelationship with Motor Development and Performance	130
	Adolescent Awkwardness	132
	Measuring Changes in Body Proportions	135
	Changes in Body Proportions	135
	Changes in Sitting Height	135
	Growth in Shoulder and Hip Width	136
	General Body Configuration	138
	Changes in the Center of Gravity	138
	Physique	138
	Body Proportions: Interrelationship with Motor Performance Exercise and Bone Growth: Interrelationships	140
	Maturation and Developmental Age	141
	Skeletal Maturity	141
	Dental Maturity	142
	Age of Menarche	143
	Genitalia Maturity	144
	Maturation: Interrelationship with Motor Performance	144
	Summary	146
	Key Terms	146
<b>CHAPTER 8</b>	Physiological Changes: Health-Related Physical Fitness	147
	Cardiovascular Fitness	147
	Heart Rate	148
	Stroke Volume	148
	Cardiac Output	149
	Maximal Oxygen Consumption	149
	Physical Activity and Cardiovascular Fitness in Childhood	150
	Cardiovascular Endurance Field-Test Data on Children and Adolescents	151
	Physical Activity and Cardiovascular Fitness in Adulthood	152
	Muscular Strength	154
	Defining and Measuring Muscular Strength	154
	Age-Related Changes in Muscular Strength Based on Laboratory Tests	154

Age-Related Changes in Muscular Strength/Endurance Based on Field Tests	155
Muscular Strength Training	157
Mechanisms of Increasing Muscular Strength	160
Flexibility	161
Flexibility: Performance Trends	161
Declining Flexibility and Aging: Causes and Therapy	163
Body Composition	163
Defining Obesity	163
General Growth Trends of Adipose Tissue	164
Field-Test Measures of Body Fat	165
Relationship of Obesity to Motor Development and Performance	166
Gender Differences in Health-Related Physical Fitness	168
Factors Associated with Physiological Fitness in Children and Adolescents	168
Points of Controversy and Concern	169
Summary	169
Key Terms	170

<b>CHAPTER 9</b>	<b>Movement and the Changing Senses</b>	<b>171</b>
	Understanding the Mechanics of Vision	171
	Physical Development of the Eye	172
	Development of Selected Visual Traits and Skilled Motor Performance	172
	Visual Acuity	173
	Binocular Vision and Depth Perception	175
	Field of Vision	177
	Effects of Aging on Depth Perception and Field of Vision	178
	Eye Dominance	179
	Tracking and Object Interception	179
	Motor Development of Blind Children	181
	Head and Trunk Control	181
	Independent Sitting	181
	Creeping	181
	Independent Walking	182
	Prehension	182
	Play Behavior of Blind Children	183
	The Nonvisual Senses	183
	The Proprioceptive System	184
	The Cutaneous System	185
	Summary	186
	Key Terms	187

## **PART FOUR: Movement Across the Lifespan**

<b>CHAPTER 10</b>	<b>Infant Reflexes and Stereotypies</b>	<b>188</b>
	Importance of the Infant Reflexes	188
	Infant versus Lifespan Reflexes	189
	Role of the Reflexes in Survival	189
	Role of the Reflexes in Developing Future Movement	189
	The Reflexes as Diagnostic Tools	191
	Pinpointing the Number of Infant Reflexes	192
	Primitive Reflexes	193
	Palmar Grasp	193
	Sucking Reflex	194
	Search Reflex	194
	Moro Reflex	195
	Startle Reflex	196
	Asymmetric Tonic Neck Reflex	196
	Symmetric Tonic Neck Reflex	196
	Plantar Grasp Reflex	196
	Babinski Reflex	197
	Palmar Mandibular Reflex	197
	Palmar Mental Reflex	199
	Postural Reflexes	199
	Stepping Reflex	199
	Crawling Reflex	200
	Swimming Reflex	200
	Head- and Body-Righting Reflexes	201
	Parachuting Reflexes	202
	Labyrinthine Reflex	203
	Pull-Up Reflex	203
	Stereotypies	204
	Summary	206
	Key Terms	206
<b>CHAPTER 11</b>	<b>Voluntary Movements of Infancy</b>	<b>207</b>
	Categorizing the Voluntary Movements of Infancy	208
	Head Control	208
	Body Control	208
	Prone Locomotion	211
	Upright Locomotion	213
	Reaching, Grasping, and Releasing	214
	Anticipation and Object Control in Reaching and Grasping	218
	Bimanual Control	218
	Summary	220
	Key Terms	221

<b>CHAPTER 12</b>	Fine Motor Development	222
	Assessing Fine Movement	223
	Categorizing Manipulation	223
	The Development of Prehension	225
	A New View of the Development of Prehension	226
	Exploratory Procedures and Haptic Perception	229
	Holding a Writing Implement	231
	Cross-Cultural Comparison of Development of the Dynamic Tripod	234
	The Dynamic Tripod from 6 to 14 Years	235
	Drawing and Writing: Movement Products	235
	Drawing: The Product	235
	Handwriting: The Product	237
	Finger Tapping	239
	Fine Motor Slowing in Late Adulthood	240
	Summary	241
	Key Terms	242
 <b>CHAPTER 13</b>	 Fundamental Locomotion Skills of Childhood	
	Walking	243
	Dynamic Base	244
	Foot Angle	244
	Walking Speed	246
	Running	247
	Selected Improvements in the Running Pattern	247
	Developmental Sequences for Running	248
	Developmental Performance Trends for Running	248
	Jumping	254
	Preparatory Phase	254
	Takeoff and Flight Phases	254
	Landing Phase	254
	Developmental Sequences for the Standing Long Jump	255
	A Variation of Jumping: Hopping	255
	Combining Fundamental Movements: The Gallop, Slide, and Skip	259
	Summary	265
	Key Terms	267
 <b>CHAPTER 14</b>	 Fundamental Object-Control Skills of Childhood	
	Overarm Throwing	268
	Developmental Stages of Throwing	268
	Developmental Performance Trends for Overarm Throwing	272
	Factors that Influence Overarm Throwing Performance	274
	Accounting for Gender Differences in Overarm Throwing	278



	Catching	279
	Developmental Aspects: Two-Handed Catching	279
	Developmental Sequences for Two-Handed Catching	280
	Developmental Aspects: One-Handed Catching	281
	Factors That Influence Catching Performance	285
	Striking	287
	Developmental Aspects of One- and Two-Handed Striking	287
	Stationary Ball Bouncing	288
	Kicking	290
	Punting	294
	Summary	294
	Key Terms	297
<b>CHAPTER 15</b>	<b>Youth Sports</b>	<b>298</b>
	Where Children Participate in Sports	299
	Why Children Participate in Sports	299
	Participation: Competence Motivation Theory	300
	Why Children Drop Out of Sports	301
	Sport Participation: Controversies	302
	Medical Issues	302
	Psychological Issues	309
	Youth Sport Coaching	311
	Who's Coaching Our Children?	311
	A Need for Educating Coaches	312
	Current Coaching Certification Requirements	312
	Arguments Against Mandatory Coaching Certification	312
	Current Coaching Certification Programs	313
	Evaluating Coaching Effectiveness	313
	Guidelines for Effective Coaching	314
	Rights of Young Athletes	314
	Summary	314
	Key Terms	317
<b>CHAPTER 16</b>	<b>Movement in Adulthood</b>	<b>318</b>
	Balance, Postural Sway, and Falls	319
	Walking Patterns of Adulthood	321
	Adult Performance on Selected Motor Activities	323
	Age of Peak Proficiency	323
	Adult Performance During High Arousal	326
	Movement Speed in Adulthood	326
	Running Speed	326
	Reaction and Response Time	327