

---

# Development of Normal Fetal Movements



---

Alessandra Piontelli

# Development of Normal Fetal Movements

The Last 15 Weeks of Gestation

 Springer

Alessandra Piontelli  
Department of Maternal/Fetal Medicine  
Clinica Mangiagalli  
Fondazione IRCCS Ca' Granda  
Ospedale Maggiore Policlinico  
University of Milan  
Milan  
Italy

With the assistance of:

Stefano Acerboni, Florinda Ceriani,  
Isabella Fabietti, Roberto Fogliani,  
Elisa Restelli, Sarah Salmons,  
Laura Trespidi, Beatrice Tassis,  
and Alessandra Kustermann

Department of Maternal/Fetal Medicine  
Clinica Mangiagalli  
Fondazione IRCCS Ca' Granda  
Ospedale Maggiore Policlinico  
University of Milan  
Milan  
Italy

ISBN 978-88-470-5372-4      ISBN 978-88-470-5373-1 (eBook)  
DOI 10.1007/978-88-470-5373-1  
Springer Milan Heidelberg New York Dordrecht London

Library of Congress Control Number: 2015932966

© Springer-Verlag Italia 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media ([www.springer.com](http://www.springer.com))

*To Filippo and Roberto, my sons.*

*To Nicolò, my grandson.*

*And*

*To all those who will come.*



---

## Acknowledgments

The help and support of many individuals were critical in making this work a reality. These include former and current staff, students, and nurses of the Department of Maternal-Fetal Medicine, Clinica Mangiagalli, University of Milano. I am greatly indebted to Prof. Fedele for allowing me full access to the clinic. Without the help and the teachings of the late Umberto Nicolini, and of Alessandra Kustermann and the following, in alphabetical order: Stefano Acerboni, Luisa Bocconi, Chiara Boschetto, Elena Caravelli, Florinda Ceriani, Isabella Fabietti, Umberto Fogliani, Leo Gallo, Elisa Restelli, Sarah Salmona, Beatrice Tassis, Laura Villa, and Cinzia Zoppini, this book could not have seen the light of day. Most of them will be further acknowledged in each chapter for helping me collect the material and for independently viewing it. Thank you Lucy for being there always and for being so kind. The pregnant mothers who so generously accepted to be part of all these studies have obviously been essential for this work. I am greatly indebted to all of them.

This work could not have been made possible without the help of Carlo Castellano and his enormous generosity in allowing ESAOTE to lend me various equipments, each specifically chosen for the various requirements of this work. Carlo and Ileana you have been marvellous friends. All the technicians and local directors of ESAOTE have been excellent in solving the many problems of ultrasonographic research.

My first infant observations were started many years ago in London, where I was teaching at the Tavistock Clinic. During my English years, I had some outstanding teachers, and this particular realm I will always be grateful to the late Esther Bick, the late Martha Harris, and the late John Bowlby who taught me to observe babies and gave me unfailing support.

Heinz Prechtl and Christa Einspieler have been fundamental teachers in learning to observe fetal motions, during their special training courses. Heinz and Christa have been so kind to ask me to speak at two meetings in Graz. These symposia were invaluable for meeting extraordinary people and for learning and testing out some of my thoughts. I am particularly grateful to Peter Wolff for some long discussions in Graz, Boston, and Milano.

Many other special colleague friends have been at my side at various stages of my work. Silvano Ponzi read and commented several versions of the manuscript, and his remarks have been precious. Thank you Silvano for being such a special colleague and friend. A particular thank to Antonio d'Elia, Colwyn Trevarthen, Elizabeth Spillius, Jerry Bruner, the late Mauro Mancia,

and the late Elizabeth Bryan, to Diane Garcia, and to all my friends in LA. Giannis Kugiumuzakis in Crete has always provided a wonderful arena to test out my ideas and share them with him and with an exceptional audience. I am also grateful to the anonymous reviewers of the manuscript for their precious suggestions.

A very special thanks to my editors, Donatella Rizza and Alessandra Born, for being so available, helpful, and encouraging. Working with them and with all the staff at Springer-Verlag has been a real pleasure.

Chris Benton as usual has carefully revised my English. Andrea Sommaruga has helped me skilfully and patiently with computer work, including preparing tables and figures.

Luigi, with Filippo, and Roberto have been always lovingly and unfailingly by my side.

Ultimately the responsibility for what I say in this book remains mine only.



---

# Contents

<b>1 Introduction</b> . . . . .	1
1.1 Brief Historical Survey on the Late Stages of Pregnancy . . . . .	2
1.2 The Research Environment and Its Difficulties . . . . .	5
1.3 Investigating Fetal Motions with New Technologies. . . . .	6
1.4 Reconstructing Fetuses from Premature Infants and Babies Born at Term . . . . .	9
1.5 Animal Preparations. . . . .	11
1.6 Other Fields . . . . .	11
1.7 Outline of the Book . . . . .	11
References. . . . .	12
<b>2 General Movements</b> . . . . .	15
References. . . . .	23
<b>3 Localized or Isolated Movements</b> . . . . .	25
3.1 Head Movements . . . . .	27
3.2 Hand Movements . . . . .	28
3.3 Leg and Feet Movements. . . . .	31
References. . . . .	32
<b>4 Fetal Breathing Movements and Shallow Fetal Breathing Movements.</b> . . . . .	33
4.1 Lung Development and Possible Functions of Fetal Breathing Movements. . . . .	33
4.2 Fetal Breathing Movements: Trends, Apneic Intervals and Tuning or Less with Other Motions . . . . .	37
4.3 Shallow Fetal Breathing. . . . .	39
References. . . . .	40
<b>5 Swallowing, Sucking, and Mouthing</b> . . . . .	41
5.1 Swallowing. . . . .	41
5.2 Sucking . . . . .	43
5.3 Lip Puckering, Regular (or Rhythmical) Mouthing, and Other Mouth Movements . . . . .	45
5.4 Clustering and Coordination with Other Behavioral Displays. . . . .	48
5.5 Why Do Fetuses Suck and Swallow? . . . . .	49
References. . . . .	50

<b>6</b>	<b>Startles, Twitches, and Clonuses</b> . . . . .	53
6.1	Startles . . . . .	53
6.2	Twitches . . . . .	58
6.3	Clonuses . . . . .	59
	References . . . . .	60
<b>7</b>	<b>Seemingly Trivial Fetal Motions: Yawning and Hiccups</b> . . . . .	63
7.1	Yawning: A Brief Survey of the Main Possible Explanations . . . . .	63
7.2	Why Do Fetuses Yawn? . . . . .	64
7.3	Hiccups . . . . .	70
7.3.1	General Facts . . . . .	70
7.3.2	Hiccups: A Brief Survey of the Main Possible Explanations . . . . .	71
7.3.3	Hiccups in the Fetus . . . . .	72
	References . . . . .	73
<b>8</b>	<b>Fetuses: Facial Motions or Facial Expressions?</b> . . . . .	75
8.1	Brief Historical Survey . . . . .	75
8.2	Fetuses: Facial Motions or Facial Expressions? . . . . .	76
8.3	Face Attraction and Face Imitation at Birth . . . . .	83
	References . . . . .	85
<b>9</b>	<b>Fetal Behavioral States</b> . . . . .	87
9.1	Brief Historical Survey . . . . .	87
9.2	Sleep in Young Children and Premature Infants . . . . .	88
9.3	Are Fetuses Ever Awake? . . . . .	89
9.4	Do Fetuses Sleep REM Sleep? . . . . .	94
9.5	Fetal Behavioral States Development . . . . .	95
	References . . . . .	97
<b>10</b>	<b>Twin Fetuses: Facts and Late-Pregnancy Twin Myths</b> . . . . .	99
10.1	Twin Pregnancies and the Twin Fetus . . . . .	99
10.2	Facts . . . . .	100
10.2.1	Twins in Utero as Experiments in Nature . . . . .	100
10.2.2	Beginnings and Evolution of Tactile and Proprioceptive Sensitivity . . . . .	101
10.2.3	Never Behaviorally Identical and Increasingly Dissimilar . . . . .	102
10.3	Behavioral Individuality . . . . .	103
10.3.1	Coincidence/Noncoincidence of Rest–Activity Cycles . . . . .	103
10.3.2	Sensorimotor Inhibition and Refractory Periods . . . . .	104
10.4	Comparing Two Different Worlds . . . . .	104
10.5	Late-Pregnancy Myths and Fiction . . . . .	104
10.5.1	Social Life in Utero . . . . .	104
10.5.2	Unrestrained Meaning . . . . .	106
10.6	Longing and Loss in the Twin Fetus . . . . .	108
	References . . . . .	110

---

<b>11 Fetal Sensory Abilities</b> .....	111
11.1 General Considerations .....	111
11.2 The Somatosensory System.....	113
11.2.1 Touch or Tactile Perception .....	113
11.2.2 Proprioception .....	115
11.2.3 Pain or Nociception .....	116
11.3 Vestibular and Auditory Functions .....	119
11.3.1 Vestibular Function .....	119
11.3.2 Auditory Function or Hearing .....	121
11.4 The Chemical Senses.....	122
11.4.1 Olfaction or Smell .....	122
11.4.2 Taste or Gustation.....	124
References.....	125
<b>12 Conclusions</b> .....	127
12.1 Fetal Motions: Bottom-Up Building Blocks of the Organism .....	127
12.2 Seemingly Trivial and Unexplained Phenomena.....	130
12.3 Fetuses as Unborn Newborns.....	132
References.....	140
<b>Index</b> .....	143