Contents

Contributors	ix
Foreword Preface	xi
	xv
1. Signaling of Predictive and Feedback Information in Purkinje	
Cell Simple Spike Activity	
LAURENTIU S. POPA, MARTHA L. STRENG AND TIMOTHY J. EBNER	
Introduction	1
Purkinje Cell Discharge Signals Many Features of Movements	2
Purkinje Cell Discharge and Motor Errors	3
Computational Framework for Cerebellar Information Processing	5
Predictive and Feedback Signaling in Purkinje Cell Simple Spike Firing	8
Integration of Simple Spike Kinematic and Error Signals	14
Conclusions	15
Acknowledgments	17
References	17
2. Deep Cerebellar Nuclei Rebound Firing In Vivo:	
Much Ado About Almost Nothing?	
•	
DAVIDE REATO, ESRA TARA AND KAMRAN KHODAKHAH	
Introduction	27
The Computational Principles of the Cerebellum	28
The Deep Cerebellar Nuclei: The Cerebellum's Gateway	
to the Brain	28
Rebound Depolarization: A Potential Feature of Spontaneously	
Active Neurons	29
Low-Threshold T-type Calcium Channels and Rebound Firing	29
Rebound Firing: An Intriguing and Effective Coding Mechanism that Converts	
Inhibitory Inputs to Excitatory Ones	30
Rebound Firing in the Deep Cerebellar Nuclei Neurons:	
A Prominent Biophysical Feature	30
Deep Cerebellar Nuclei Rebound Firing: The Devil	
is in the Details	31
Physiological Rebound Firing In Vivo	38
Conclusions	44
References	46

vi CONTENTS

3. Classical Conditioning of Timed Motor Responses: Neural Coding in Cerebellar Cortex and Cerebellar Nuclei H.J. BOELE, M.M. TEN BRINKE AND C.I. DE ZEEUW	
Behavioral Aspects of Eyeblink Conditioning Neural Circuits Engaged during Eyeblink Conditioning Neural Plasticity in the Cerebellar Cortex and Cerebellar Nuclei Conclusions Conflict of Interest Acknowledgments References	53 59 69 82 83 83
4. How the Vestibulocerebellum Builds an Internal Model of Self-model of Self-model and Laurens and Dora E. Angelaki	otion
Introduction Basic Organization of the Peripheral Vestibular System Framework of the Internal Model Tilt- and Translation-Selective Neurons in the Cerebellum Spatiotemporal Tuning Revealing the Internal Model Computations Discussion List of Abbreviations Mathematical Variables References	97 98 99 102 104 108 112 113 113
5. Modeling the Generation of Cerebellar Nuclear Spike Output VOLKER STEUBER	
Introduction Cerebellar Nucleus Neurons as Simple Inverters Modeling Rebound Responses Time-Locking, Synchrony Coding, and the Effect of Irregularity Conclusions References	117 119 122 126 128
6. Cerebrocerebellar Loops in the Rodent Brain CLÉMENT LÉNA AND DANIELA POPA	
Introduction The Corticocerebellar Pathway Mossy Fibers Climbing Fibers Parallel Fibers Cerebellocerebral Connections Functional Manning of the Cerebellocerebral Connections	135 136 138 141 142 143
Functional Mapping of the Cerebellocerebral Connections	1.4-

CONTENTS	vii
Conclusion	146
References	146
7. Cerebellar Neuronal Codes—Perspectives from Intracellular Analysis In Vivo HENRIK JÖRNTELL	
Introduction	155
The Configuration of the Cerebellar Cortical Network	156
The Flow of Information Through the Cerebellar	
Neuronal Network	160
Spike Encoding in the Cerebellar Neurons	165
Distributed Neuronal Representations	167
Conclusions	169
References	169
8. The Role of the Cerebellum in Optimizing Saccades	
ZONG-PENG SUN, SHABTAI BARASH AND PETER THIER	
The Oculomotor Vermis: The Major Cerebellar Site of Saccades	
and Saccadic Adaptation	175
The Caudal Fastigial Nucleus: A Gateway for Saccade-Related Signals	
Originating from the Oculomotor Vermis	183
Summary	191
Acknowledgments	191
References	192
9. Coordination of Reaching Movements: Cerebellar Interactions	
with Motor Cortex	
ERIC J. LANG	
Anatomical Connectivity Suggests Distinct Roles for the Dentate	
and Interpositus Nuclei in the Motor System Hierarchy	198
Deep Cerebellar Nuclei Neurons Have High Spontaneous Firing Rates	
about Which Movement-Related Modulation Occurs	201
Relative Timing of Dentate and Interpositus Activity	
with Respect to Movement Onset	203
Temporal Correlation with Sensory Cues or Motor Responses	205
Deep Cerebellar Nuclei Neurons Tend to Show Increased Activity	221
During Movement	206
The Coding of Movement-Related Parameters in the	200
Deep Cerebellar Nuclei Deep Specific Information about Management Personal Car Sept to	208
Does Specific Information about Movement Parameters Get Sent to Motor Cortex from the Deep Cerebellar Nuclei?	209
MOUNT COLUMN TIONS THE DOOP COLUMNIAL INDUCTION	407

viii CONTENTS	
Future Directions and Concluding Thoughts Acknowledgments References	211 213 213
10. A Spatiotemporal Hypothesis on the Role of 4- to 25-Hz Field Potential Oscillations in Cerebellar Cortex RICHARD COURTEMANCHE AND ARIANA FREDERICK	
Introduction Synchronization and Oscillations in Cerebellar Circuits Cerebellar Cortex 4- to 25-Hz Oscillations Spatiotemporal Aspects of Granule Cell Layer Synchronization Circuit Interactions—A Potential Efference Copy Role? Conditions Supporting A Predictive Sensorimotor Dialog Granule Cell Layer Oscillations and Internal Models Conclusion—and Back to the Hockey References	219 221 222 224 226 229 231 232 233
11. Single-Neuron and Network Computation in Realistic Models of the Cerebellar Cortex EGIDIO D'ANGELO, STEFANO MASOLI, MARTINA RIZZA AND STEFANO CASALI	
Introduction Biophysically Detailed Models of the Cerebellar Neurons and Microcircuits	239 242
Large-Scale Spiking Models of the Olivocerebellar Network Real-Time Models for Closed-Loop Robotic Simulations of Cerebellar Learning and Control Conclusions List of Abbreviations References	249 251 254 254 255
Index	261