Contents

Acknowledgments Introduction	xv xix
PART 1	
METHODS OF ASSESSING NEUROMARKE	RS
1.1. Theory of Measurement	
True and Observed Scores, Errors Reliability Validity Distribution Across Population Percentiles and z Scores	3 4 5 5 5
Sensitivity and Specificity Effect Size Requirements for Introducing a Neuromarker into Clinical Practice	6 7 8
1.2. Psychometrics and Neuropsychological Assessment	
Psychological Models Neuropsychological Testing Supervisory Attentional System Model Operations of Attentional Control Dual Mechanisms of Cognitive Control General Factor	9 10 10 10 11 11
Reaction Time Reaction Time Variability Continuous Performance Tasks Infraslow Fluctuations in Performance Big 5 Model	12 15 15 15
1.3. Functional Magnetic Resonance Imaging	
Talairach Atlas Montreal Neurological Institute Atlas Physical Basis of Magnetic Resonance Imaging Functional Magnetic Resonance Imaging	18
Bold Response	19

vi	CONTENTS

Bold Infralow Fluctuations	2	20
0.1-Hz Hemodynamic Oscillations	2	20
Processing Steps in Functional Imaging	2	22
Activation Maps of fMRI	2	22
Model-Dependent Correlational Methods	2	23
Model-Free Correlational Methods	2	23
Task-Negative and Task-Positive Networks	2	23
Functional Connectivity and Diffuse Tensor Imaging	2	24
Test-Retest Reliability	The management of 2	25
fMRI in Neurological Practice	2	25
Challenges for Clinical fMRI	2	25
The base and september his positionable consider in his my		
1.4. Positron Emission Tomography		
Physical Basis of Positron Emission Tomography		27
Neuroreceptors		28
Test-Retest Reliability		28
Neurotransmitters and Receptor Imaging in Clinics	STREET, TO THOSE I	29
1.5. Spontaneous Electroencephalogram		
	and the same and the	31
How an Electroencephalogram is Measured		31
Montages		33
Electrical Events in the Cortex		34
10–20 International System		35
Frequency Bands	auni sai emano suo	,,
Electroencephalograms as a Reflection of Cortical Self-Regulation		37
Voltage-Gated Ion Channels	The Solutemontake, T.	37
Nonbrain Events (Artifacts) in Electroencephalograms	HalsoM labreolado	37
Spectral Analysis of Electroencephalograms	wirepresent leaded ordered treatment	40
Interindividual Differences	and the second second	41
Wavelet Transformation	Vancture MA de anolices	42
Coherence	Mechanisms of Landon	44
Neuronal Sources of Electrical Currents	Second Page 1	44
Intracortical Connectivity	sanit more	45
Cortical Focus and Spikes	sanithen Vent Tourist	47
Volume Conductance	The Thomas ments I account to	47
Inverse Problem: Dipole Approximation	freslow Plus materials as Per	49
Inverse Problem: Nonparametric Solutions		49
Current Source Density		51
Blind Source Separation		52
Independent Component Analysis		53
Individual Electroencephalogram Decomposition Into		
Independent Components		54
Group ICA Decomposition		56
Test-Retest Reliability		57

CONTENTS	vi
1.6. Event-Related Potentials	
Definition .	59
Information Flow	59
Montages	60
Averaging	61
Number of Trials	62
Information Flow in Visual Pathways	63
Information Flow in Local Network	64
Two Packets of Information Flow	65
Canonical Visual Event-Related Potential	66 68
Event-Related Potential Paradigms Multiple Sources of Event-Related Potentials	68
Separating Components: Subtraction Approach	69
Separating Components: Single Trial Independent Component Analysis	71
Separating Components: Group Independent Component	e io in
Analysis in Multiple Tasks	72
Separating Components: Group Independent Component	racoff.
Analysis in a Single Task	72
Separating Components: Joint Diagonalization of Covariance Matrixes	74
Test–Retest Reliability	76
Interindividual Variability	77
A Roadmap for the Development and Validation of Event-Related Potential Neuromarkers	78
PART 2	
NEUROMARKERS OF CORTICAL SELF-REGULATION	
2.1. Infraslow Electrical Oscillations	
Arrhythmic Electroencephalograms	81
Power-Law Function of Electroencephalogram Spectra	81
Infraslow Electrical Oscillations: History	83
Infraslow Fluctuation in Thalamic Neurons	83
Nonneuronal Origin of 0.1-Hz Oscillations	84
Responses to Tasks	85
Preparatory Slow Fluctuations Neuronal Mechanisms	85
	86 87
Functional Meaning	01
2.2. Alpha Rhythms	
Historical Introduction	89
Types of Alpha Rhythms	90
Alpha Rhythms in the Somatosensory Cortex	90
Alpha Rhythms of the Visual System	91

VIII CONTENTS	
Functional Reactivity	01
Parietal Alpha Rhythm	91
Negative Correlation with BOLD Signals	94
Age Dynamics	95
Frontal Alpha Asymmetry	97
Alpha Rhythms in the Dysfunctional Brain	98
No Alpha Rhythms: Low-Voltage Fast Electroencephalograms	100
Heritability	101
Neuronal Mechanisms	101
Model	104
2.3. Beta and Gamma Rhythms	
Historical Introduction	107
The Mystery of Multiple Beta Rhythms	109
Rolandic Beta Rhythms	109
Correlations With BOLD fMRI	111
Frontal Beta Rhythms	111
Vertex Beta Rhythms	113
Occipital Rebound Beta Rhythms	114
Arrhythmic Beta Activity as an Index of Cortical Activation	116
Neuronal Mechanisms	117
Gamma Activity	117
Abnormal Beta Rhythms	119
2.4. Frontal Midline Theta Rhythm	
Historical Introduction	121
Functional Features	122
Localization	123
Prevalence	124
Genetic Factors	125
Age Dynamics	125
Personality Traits	126
Cortical Metabolism	126
Working Memory	127
Conflict Monitoring and Anxiety Model	129
Abnormal Theta Rhythms	130
Burse Pioleton, Scamon Services School Services	132
PART 3	
INFORMATION FLOW WITHIN T	HE BRAIN
.1. Sensory Systems and Attention Modulation	
ntroduction	uched Fadel A harman
eparation of Ventral and Dorsal Visual Streams by fMRI	137
ttention Modulation Effects in fMRI	139
ision as an Active Process	140 142

CONTENTS	ix
----------	----

Bottom-up and Top-Down Selection Operations	142
Bottom-up Operations in the C1 Wave of Event-Related Potential	145
N1 Wave as Index of Visual Discrimination	145
Visual Mismatch Negativity as Index of Regularity Violation	146
Visual N170 Reflects Activation of Personal Memory	148
Visual N250 Repetition Effect	151
Visual P2 Discrepancy Effect	153
Latent Event-Related Potential Components of Visual Processing	154
A Neuronal Model	157
Principles of Information Flow in the Visual System	
What and Where Streams in the Auditory Modality	
Auditory N1/P2 Wave	
Independent Components	161
Auditory Mismatch Negativity	
Orienting Response	165
Role of Dopamine in Orienting Response	
Loudness Dependence of Auditory N1/P2 Waves	168
3.2. Executive System and Cognitive Control	
Introduction	171
Operations of Cognitive Control	1 = 0
Modes of Cognitive Control	
Prepotent Model of Behavior	
Behavioral Paradigms	
Stroop Tasks	
Models of Cognitive Control	
Representations in Working Memory	178
Preparatory Cortical Activities	179
Frontal Lobe Functions	183
Basal Ganglia-Thalamo-Cortical Loops	183
Neuronal Correlates of Cognitive Control in the Basal Ganglia	186
fMRI of Cognitive Control	188
ERP Correlates of Cognitive Control	190
Independent Components of Cognitive Control	192
Lesion Studies	193
Correlation with Neuropsychological Parameters	195
Latent ERP Components of Reactive Cognitive Control	197
Functional Meaning of Latent Components	198
Target P3 (P3b) in Oddball Tasks	202
P3b and Noradrenaline	204
Cortical Dopamine and Working Memory	205
Striatal Dopamine as Regulator of Flexibility	205
3.3. Affective System, Emotions, and Stress	
Introduction	207
Emotions as a Separate Dimension	209
Emotions as Habitual Responses	209
Classification of Emotions	209
Classification of Emotions	209

X	CONTENTS

Three Dimensions of Temperament	211 212
Brain Model	214
Model of Left–Right Asymmetry in Emotions	216
Big Five Model Eysenck's and Gray's Models	217
Behavioral Paradigms	218
Amygdala as Detector of Fearful Stimuli	218
Anxiety is a State of Preparing to Fear	220
Hypothalamus is Involved in Expression of Emotions	220
Orbitofrontal Cortex as a Map of Rewards and Punishers	221
Ventral Anterior Cingulum and Anxiety	222
Connections to Cognitive Control System	223
fMRI of Emotions	224
Stages of Reactions of Affective System	225
Event-Related Potentials to Emotional Stimuli	226
Anxiety Enhances Visual N1 Wave	228
Neuromodulators of Affective System	228
Neuromodulators of Afrective System	
3.4. Memory Systems	
Introduction	231
Temporal Aspects of Memory	231
Working Memory Representations	233
Types of Long-Term Memory	233
Hippocampus as a Reference to Episodic Trace	235
Functional Neuromarkers of Episodic Memory	237
Neuronal Model of Episodic Memory	238
Retrieval Operations	238
Acetylcholine as Neuromodulator of Declarative Memory	239
Procedural Memory System	240
Neuromodulators of Procedural Memory	242
Reliable of Proceeding Processing Control of the Co	
PART 4	emp.) The
METHODS OF NEURO-MODULATION	
4.1. Pharmacological Approach	
Historical Introduction	245
Current Crisis of Psychopharmacology	246
4.2. Neurofeedback	
Definition	247
4.3. Electroconvulsive Therapy	
Historical Introduction	267
Parameters of Electroconvulsive Therapy	268
Neuronal Model	269

CONTENTS	X
Mechanisms Efficacy	269 270
	270
Contraindications	270
Side-Effects	, makes A 271
4.4. T	Reaction Time Variability Interference With Dahalt M
4.4. Transcranial Direct Current Stimulation	
Historical Introduction	273
Procedure Difference From Electroconvulsive Therapy	274
Neurophysiological Basis	275
Nonlinear Collective Short-term Effects of tDCS	277
Long-Term Post-tDCS Effects	277
NMDA Involvement in Long-Lasting After-Effects	279
Safety and Side-Effects	280
Limitations and the second of	
4.5. Transcranial Magnetic Stimulation	
Introduction	281
Physical Principles	281
Physiological Effect	281
rTMS at Low and High Frequency	283
Model	283 283
Safety	sinsulgosidae 200
4.6. Deep Brain Stimulation	
Introduction	285
Procedure	286
Neuronal Mechanism	286
Advantages and Limitations	287
DADT C	
PART 5	America Art
NEUROMARKERS IN PSYC	CHIATRY
5.1. Attention Deficit Hyperactivity Disorder	
Historical Introduction	291
	292
	293
Prevalence Age Onset	295 295
D	295
	295
0 1:1:	296
F	296
Genetic Factors	296

	CONTENTE
X11	CONTENTS

Rolandic Focus	297
Executive Functions	297
Heterogeneity of Neuropsychological Profile	298
Inhibition Deficit	299
Delay Aversion	300
Reaction Time Variability	300
Interference With Default Mode	301
State Regulation and Energization Function	302
Hypoarousal Hypothesis	302
Maturation Delay in Neurodevelopment	303
Theta/Beta Ratio	304
QEEG Endophenotypes in ADHD	307
Frontal Beta Synchronization in Childhood ADHD	309
Magnetic Resonance Imaging Correlates	310
fMRI Correlates	310
Decreased P3b Wave	310
ERP Correlates of Cognitive Control in Children	311
Event-Related Potential Correlates of Cognitive Control in Adult ADHD	313
Pharmacological Treatment	315
Event-Related Potential Predictors of Response to Psychostimulants	317
Dopamine Hypothesis	318
Neurofeedback	319
tDCS	320
Transcranial Magnetic Stimulation	321
5.2. Schizophrenia	
Historical Introduction	323
Symptoms	323
Prevalence	325
Timecourse	325
Neurodevelopment	326
Heterogeneity	328
Heritability	328
Environmental Risk Factors	329
Treatment	329
Neuropsychological Assessment	329
Volumetric Studies	330
Motor Abnormalities	330
Spontaneous Electroencephalography	330
Sensory-Related Neuromarkers	332
Automatic Predicting Ability Failure	335
Object Recognition Deficit in N170	336
P3b as Endophenotype	337
P3b as a Predictor of Psychosis	338
Proactive Cognitive Control Deficit	339
Reactive Cognitive Control in Schizophrenia	340
Hypofrontality—fMRI Studies	340
Hypofrontality as Predictor of Response to Medication	343

CONTENTS	xiii
Neurotransmitters	343
Neuronal Model	344
tDCS	348
Transcranial Magnetic Stimulation	348
5.3. Obsessive-Compulsive Disorder	
Historical Introduction	351
Symptoms	352
Prevalence	352
Development	353
Heterogeneity	353
Heritability	353 354
Comorbidity Neuropsychological Profile	354
Lesions	355
Structural Magnetic Resonance Imaging	355
fMRI in Symptom Provocation	355
fMRI in Conflict Conditions	356
Quantitative Electroencephalography	357
Error-Related Negativity and N2 Event-Related Potential Waves	357
Latent Components of Cognitive Control	359
Neuronal Model	359
Neurotransmitters	361
First-Line Treatment	361
Psychosurgery and Deep-Brain Stimulation	362
Neurofeedback	362
Transcranial Magnetic Stimulation	363
Transcranial Direct Current Stimulation	364
PART 6	
ASSESSING FUNCTIONAL NEUROMAR	KERS
6.1. Working Hypothesis	
The Control of the Co	267
Reasons for Assessment	367
Conventional Diagnostic Categories as a Starting Point	368
Multiple Causes of ADHD Theses to Test	369 370
Prognostic Power	370
1 logilostic 1 owei	310
6.2. Technical Implementation	
Arrangement of the Working Space	371
QEEG/ERP Databases	371
Arsenal of the 21st Century Psychiatrist	313
Selecting the Behavioral Paradigm	374
Correcting Artifacts	374

xiv CONTENTS	
6.3. Testing Working Hypotheses: Spontaneous EEG	
Rolandic Spikes	377
Excessive Theta/beta Ratio	379
Excess of Frontal Beta Activity	380
Excessive Frontal Midline Theta Rhythm	382
Excessive Alpha Activity	383
Individual Independent Components for Neuromodulation Protocols	384
6.4. Testing Working Hypotheses: Event-Related Potentials	
Independence from Other Functional Neuromarkers	387
Selective Deficit of Cognitive Control	388
6.5. Monitoring Treatment Effects	
Pharmaco-Electroencephalography	391
Pharmaco-Event Related Potentials	392
Neurofeedback	392
PART 7	
THE STATE OF THE ART: OVERVIEW	amonaski A
7.1. Objective Measures of Human Brain Functioning	
7.2. Rhythms of the Healthy Brain	
7.3. Information Flow in the Healthy Brain	
7.4. Current Treatment Options in Psychiatry	
7.5. Functional Neuromarkers in Diseased Brain	
7.6. Implementation in Clinical Practice	
Postscriptum	421
References	423
Further Readings	431
Subject Index	447