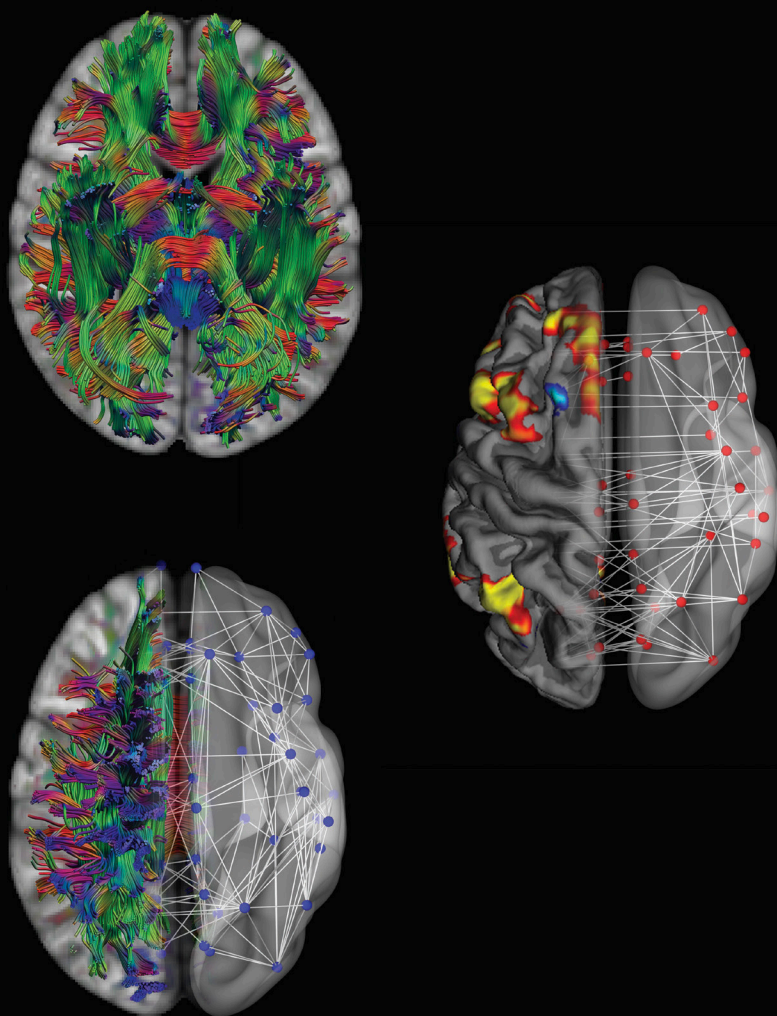


THE CAMBRIDGE HANDBOOK OF
INTELLIGENCE
AND COGNITIVE
NEUROSCIENCE

*Edited by Aron K. Barbey,
Sherif Karama & Richard J. Haier*



The Cambridge Handbook of Intelligence and Cognitive Neuroscience

Can the brain be manipulated to enhance intelligence? The answer depends on neuroscience progress in understanding how intelligence arises from the interplay of gene expression and experience in the developing brain and how the mature brain processes information to solve complex reasoning problems. The bad news is the issues are nightmarishly complex. The good news is there is extraordinary progress from researchers around the world. This book is a comprehensive sampling of recent exciting results, especially from neuroimaging studies. Each chapter has minimum jargon, so an advanced technical background is not required to understand the issues, the data, or the interpretation of results. The prospects for future advances will whet the appetite of young researchers and fuel enthusiasm for researchers already working in these areas. Many intelligence researchers of the past dreamed about a day when neuroscience could be applied to understanding fundamental aspects of intelligence. As this book demonstrates, that day has arrived.

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“This exciting book makes an elegant case that human intelligence is not the result of a test. It is the consequence of a brain. Drawing on state-of-the-art imaging methods, the reader is afforded a comprehensive view of the substrates enabling our most valued mental abilities.”

Scott T. Grafton, Bedrosian-Coyne Presidential Chair in Neuroscience and Director of the Brain Imaging Center, University of California at Santa Barbara

“Our scientific understanding of human intelligence has advanced greatly over the past decade in terms of the measurement and modeling of intelligence in the human brain. This book provides an excellent analysis of current findings and theories written by top international authors. It should be recommended to students and professionals working in this field.”

Sarah E. MacPherson, Senior Lecturer in Human Cognitive Neuroscience, University of Edinburgh

“This handbook focuses on the brain, but also integrates genetics and cognition. Come for a comprehensive brain survey and get the bonus of a panoramic foreshadowing of integrated intelligence research and applications.”

Douglas K. Detterman, Louis D. Beaumont University Professor Emeritus of Psychological Sciences, Case Western Reserve University

“This handbook captures the conceptualization and measurement of intelligence, which is one of psychology’s greatest achievements. It shows how the advent of modern imaging techniques and large-scale data sets have added to our knowledge about brain–environment–ability relationships and highlights the controversy in this rapidly expanding field.”

Diane F. Halpern, Professor of Psychology, Emerita, Claremont McKenna College

“This handbook assembles an impressive group of pioneers and outstanding young researchers at the forefront of intelligence neuroscience. The chapters summarize the state of the field today and foreshadows what it might become.”

Lars Penke, Professor of Psychology, Georg August University of Göttingen

“This book is a tribute to its topic. It is intelligently assembled, spanning all aspects of intelligence research and its applications. The authors are distinguished experts, masterfully summarizing the latest knowledge about intelligence obtained with cutting-edge methodology. If one wants to learn about intelligence, this is the book to read.”

Yulia Kovas, Professor of Genetics and Psychology, Goldsmiths University of London

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*For all those who inspire us – without reference to success or failure –
to understand the origins of intelligence and the diversity of talents
that make us all equally human.*

And for Michelle, who inspires me, beyond compare.

Aron K. Barbey

To my son, Alexandre, who enriches my life.

*To my father, Adel, who has taught me not to let the dictates of my
passions interfere with my assessments of the facts and of the weight
of evidence.*

To the mentors that have shaped my career and approach to science.

Sherif Karama

*Dedicated to all the scientists and students who follow intelligence
data wherever they lead, especially into the vast uncharted recesses
of the brain.*

Richard J. Haier

Contents

<i>List of Figures</i>	page x
<i>List of Tables</i>	xiii
<i>List of Contributors</i>	xv
<i>Preface</i>	xix
Part I Fundamental Issues	1
1 Defining and Measuring Intelligence: The Psychometrics and Neuroscience of <i>g</i> THOMAS R. COYLE	3
2 Network Neuroscience Methods for Studying Intelligence KIRSTEN HILGER AND OLAF SPORNS	26
3 Imaging the Intelligence of Humans KENIA MARTÍNEZ AND ROBERTO COLOM	44
4 Research Consortia and Large-Scale Data Repositories for Studying Intelligence BUDHACHANDRA KHUNDRAKPAM, JEAN-BAPTISTE POLINE, AND ALAN C. EVANS	70
Part II Theories, Models, and Hypotheses	83
5 Evaluating the Weight of the Evidence: Cognitive Neuroscience Theories of Intelligence MATTHEW J. EULER AND TY L. MCKINNEY	85
6 Human Intelligence and Network Neuroscience ARON K. BARBEY	102
7 It's about Time: Towards a Longitudinal Cognitive Neuroscience of Intelligence ROGIER A. KIEVIT AND IVAN L. SIMPSON-KENT	123

8	A Lifespan Perspective on the Cognitive Neuroscience of Intelligence	147
	JOSEPH P. HENNESSEE AND DENISE C. PARK	
9	Predictive Intelligence for Learning and Optimization: Multidisciplinary Perspectives from Social, Cognitive, and Affective Neuroscience	162
	CHRISTINE AHRENDTS, PETER VUUST, AND MORTEN L. KRINGELBACH	
	Part III Neuroimaging Methods and Findings	189
10	Diffusion-Weighted Imaging of Intelligence	191
	ERHAN GENÇ AND CHRISTOPH FRAENZ	
11	Structural Brain Imaging of Intelligence	210
	STEFAN DRAKULICH AND SHERIF KARAMA	
12	Functional Brain Imaging of Intelligence	235
	ULRIKE BASTEN AND CHRISTIAN J. FIEBACH	
13	An Integrated, Dynamic Functional Connectome Underlies Intelligence	261
	JESSICA R. COHEN AND MARK D'ESPOSITO	
14	Biochemical Correlates of Intelligence	282
	REX E. JUNG AND MARWA O. CHOCHAN	
15	Good Sense and Good Chemistry: Neurochemical Correlates of Cognitive Performance Assessed In Vivo through Magnetic Resonance Spectroscopy	297
	NAFTALI RAZ AND JEFFREY A. STANLEY	
	Part IV Predictive Modeling Approaches	325
16	Predicting Individual Differences in Cognitive Ability from Brain Imaging and Genetics	327
	KEVIN M. ANDERSON AND AVRAM J. HOLMES	
17	Predicting Cognitive-Ability Differences from Genetic and Brain-Imaging Data	349
	EMILY A. WILLOUGHBY AND JAMES J. LEE	
	Part V Translating Research on the Neuroscience of Intelligence into Action	365
18	Enhancing Cognition	367
	MICHAEL I. POSNER AND MARY K. ROTHBART	

19	Patient-Based Approaches to Understanding Intelligence and Problem-Solving	
	SHIRA COHEN-ZIMERMAN, CAROLA SALVI, AND JORDAN H. GRAFMAN	382
20	Implications of Biological Research on Intelligence for Education and Public Policy	
	KATHRYN ASBURY AND DIANA FIELDS	399
21	Vertical and Horizontal Levels of Analysis in the Study of Human Intelligence	
	ROBERT J. STERNBERG	416
22	How Intelligence Research Can Inform Education and Public Policy	
	JONATHAN WAI AND DREW H. BAILEY	434
23	The Neural Representation of Concrete and Abstract Concepts	
	ROBERT VARGAS AND MARCEL ADAM JUST	448
	<i>Index</i>	469

Figures

- | | | |
|-----|---|----------------|
| 2.1 | Schematic illustration of structural and functional brain network construction and key network metrics. | <i>page 29</i> |
| 2.2 | The brain bases of intelligence – from a network neuroscience perspective. | 32 |
| 3.1 | Regions identified by the Parieto-Frontal Integration Theory (P-FIT) as relevant for human intelligence. | 46 |
| 3.2 | Variability in the gray matter correlates of intelligence across the psychometric hierarchy as reported in one study by Román et al. (2014). | 48 |
| 3.3 | Workflow for voxel-based morphometry (VBM) and surface-based morphometry (SBM) analysis. | 52 |
| 3.4 | Top panel: three left hemisphere brain surfaces from different individuals. | 53 |
| 3.5 | (A and B) Distribution and variability of cortical thickness computed through different surface-based protocols: Cortical Pattern Matching (CPM), Brain-Suite, and CIVET. | 54 |
| 3.6 | (A) Pearson's correlations among cortical thickness (CT), cortical surface area (CSA), and cortical gray matter volume (CGMV) obtained from a subsample of 279 healthy children and adolescents of the Pediatric MRI Data Repository created for the National Institute of Mental Health MRI Study of Normal Brain Development (Evans and Brain Development Cooperative Group, 2006). (B) Topography of significant correlations ($q < .05$, false discovery rate (FDR) corrected) between IQ and cortical thickness (CT), cortical surface area (CSA), and cortical gray matter volume (CGMV). | 55 |
| 3.7 | Summary of basic analytic steps for connectome-based analyses (A). The analytic sequence for computing the structural and functional connectivity matrices (B). | 58 |
| 3.8 | Structural and functional correlates of human intelligence are not identified within the same brain regions: “the dissociation of functional vs. structural brain imaging correlates of intelligence is at odds with the principle assumption of the P-FIT that functional and structural studies on neural correlates of | |

intelligence converge to imply the same set of brain regions” (Basten et al., 2015, p. 21).	59
3.9 Mean (A) and variability (B) of cortical thickness across the cortex in two groups of individuals (Sample A and Sample B) matched for sex, age, and cognitive performance. The regional maps are almost identical. Pearson’s correlations between visuospatial intelligence and cortical thickness differences in these two groups are also shown (C).	61
6.1 Small-world network.	105
6.2 Intrinsic connectivity networks and network flexibility.	107
6.3 Dynamic functional connectivity.	112
7.1 Simplified bivariate latent change score model illustrating the co-development of intelligence scores (top) and brain measures (bottom) across two waves.	125
7.2 An overview of longitudinal studies of brain structure, function, and intelligence.	130
8.1 Lifespan performance measures.	151
8.2 A conceptual model of the scaffolding theory of aging and cognition-revisited (STAC-r).	152
9.1 The pleasure cycle, interactions between experience and predictions, as well as how learning might occur.	164
9.2 The pleasure cycle, on its own, during circadian cycles, and over the lifespan.	166
9.3 Parameter optimization of learning models.	169
9.4 Hierarchical neuronal workspace architectures.	171
9.5 Reward-related signals in the orbitofrontal cortex (OFC) unfold dynamically across space and time.	173
10.1 The top half depicts ellipsoids (left side, A) and tensors (right side, B) that were yielded by means of diffusion-weighted imaging and projected onto a coronal slice of an MNI brain.	194
10.2 White matter fiber tracts whose microstructural properties were found to correlate with interindividual differences in intelligence.	196
12.1 Brain activation associated with the processing of intelligence- related tasks, showing the results of the meta-analysis conducted by Santarnecchi, Emmendorfer, and Pascual-Leon (2017).	238
12.2 Intelligence-related differences in brain activation during cognitive processing.	239
12.3 Brain activation as a function of task difficulty and intelligence.	248
13.1 Brain graph schematic.	265
14.1 Representative spectrum from human voxel obtained from parietal white matter.	284

- | | | |
|------|---|-----|
| 14.2 | Linear relationship between size of study (Y axis) and magnitude of NAA–intelligence, reasoning, general cognitive functioning relationship (X axis), with the overall relationship being inverse ($R^2 = .20$). | 289 |
| 15.1 | Examples of a quantified ^1H MRS spectrum and a quantified ^3P MRS spectrum. | 299 |
| 16.1 | A graphical depiction of the Deep Boltzmann Machine (DMN) developed by Wang et al. (2018) to predict psychiatric case status. | 336 |
| 19.1 | Schematic drawing of brain areas associated with intelligence based on lesion mapping studies. | 385 |
| 23.1 | Conceptual schematic showing differences between GLM activation-based approaches and pattern-oriented MVPA, where the same number of voxels activate (shown as dark voxels) for two concepts but the spatial pattern of the activated voxels differs. | 450 |

Tables

4.1	Details of large-scale datasets and research consortia with concurrent measures of neuroimaging and intelligence (and/or related) scores, and, in some cases, genetic data.	<i>page 72</i>
6.1	Summary of cognitive neuroscience theories of human intelligence.	103
7.1	An overview of longitudinal studies of brain structure, function, and intelligence.	127
13.1	Definitions and descriptions of graph theory metrics.	266
14.1	Studies of NAA.	288
21.1	Vertical levels of analysis for the study of human intelligence.	418
21.2	Horizontal levels of analysis for the study of human intelligence.	424
22.1	Reverse and forward causal questions pertaining to intelligence.	438

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Preface

This book introduces one of the greatest and most exciting scientific challenges of our time – explicating the neurobiological foundations of human intelligence. Written for students and for professionals in related fields, *The Cambridge Handbook of Intelligence and Cognitive Neuroscience* surveys research emerging from the rapidly developing neuroscience literature on human intelligence. Our emphasis is on theoretical innovation and recent advances in the measurement, modeling, and characterization of the neurobiology, especially from brain imaging studies.

Scientific research on human intelligence is evolving from limitations of psychometric testing approaches to advanced neuroscience methods. Each chapter, written by experts, explains these developments in clear language. Together the chapters show how scientists are uncovering the rich constellation of brain elements and connections that give rise to the remarkable depth and complexity of human reasoning and personal expression. If you doubt that intelligence can be defined or measured sufficiently for scientific study, you are in for a surprise. Each chapter presents thought-provoking findings and conceptions to whet the appetite of students and researchers.

Part I is an introduction to fundamental issues in the characterization and measurement of general intelligence (Coyle, Chapter 1), reviewing emerging methods from network neuroscience (Hilger and Sporns, Chapter 2), presenting a comparative analysis of structural and functional MRI methods (Martínez and Colom, Chapter 3), and surveying multidisciplinary research consortia and large-scale data repositories for the study of general intelligence (Khundrakpam, Poline, and Evans, Chapter 4).

Part II reviews cognitive neuroscience theories of general intelligence, evaluating the weight of the neuroscience evidence (Euler and McKinney, Chapter 5), presenting an emerging approach from network neuroscience (Barbey, Chapter 6), and reviewing neuroscience research that investigates general intelligence within a developmental (Kievit and Simpson-Kent, Chapter 7) and lifespan framework (Hennessee and Park, Chapter 8), and that applies a social, cognitive, and affective neuroscience perspective (Ahrends, Vuust, and Kringelbach, Chapter 9). Due to a production issue, Chapter 23 (Vargas and Just) was omitted from Part II, where it was intended to appear. This chapter now appears as the final chapter.

Part III provides a systematic review of contemporary neuroimaging methods for studying intelligence, including structural and diffusion-weighted MRI techniques (Genç and Fraenz, Chapter 10; Drakulich and Karama, Chapter 11), functional MRI methods (Basten and Fiebach, Chapter 12; Cohen and D’Esposito, Chapter 13), and spectroscopic imaging of metabolic markers of intelligence (Jung and Chohan, Chapter 14; Raz and Stanley, Chapter 15).

Part IV reviews predictive modeling approaches to the study of human intelligence, presenting research that enables the prediction of cognitive ability differences from brain imaging and genetics data (Anderson and Holmes, Chapter 16; Willoughby and Lee, Chapter 17).

Finally, Part V addresses the need to translate findings from this burgeoning literature into potential action/policy, presenting research on cognitive enhancement (Posner and Rothbart, Chapter 18), clinical translation (Cohen-Zimmerman, Salvi, and Grafman, Chapter 19), and education and public policy (Asbury and Fields, Chapter 20; Sternberg, Chapter 21; Wai and Bailey, Chapter 22).

Research on cognitive neuroscience offers the profound possibility of enhancing intelligence, perhaps in combination with molecular biology, by manipulating genes and brain systems. Imagine what this might mean for education, life success, and for addressing fundamental social problems. You may even decide to pursue a career dedicated to these prospects. That would be an extra reward for us.