The Exceptional Brain

Neuropsychology of Talent and Special Abilities

Edited by

Loraine K. Obler, Ph.D.
Graduate School and University Center of the City University of New York, and Boston University School of Medicine

Deborah Fein, Ph.D.
Boston University School of Medicine, and University of Connecticut

Foreword by Howard Gardner, Ph.D.

The Guilford Press
New York London

A Division of Guilford Publications, Inc.
72 Spring Street, New York, N.Y. 10012

Printed in the United States of America

Library of Congress Cataloging-in-Publication Data

The Exceptional Brain.

Includes bibliographies and index.
1. Intellect. 2. Ability—Physiological aspects.
3. Genius—Physiological aspects. 4. Neuropsychology.
I. Obler, Loraine K. II. Fein, Deborah.
[DNLM: 1. Aptitude. 2. Intelligence.
3. Neuropsychology. BF 431 E96]
QP398.E93 1988 153.9 86–27136
ISBN 0–89862–701-X

THE EXCEPTIONAL BRAIN

To those people and institutions who have encouraged my particular talents: Mimi and Edward Obler, Margaret S. Fearey, Brenda Steinberg, The Fieldston School, and the University of Michigan

LKO

To my inspiring parents, Pauline and Herbert Fein, teachers Edith Kaplan and Allan F. Mirsky, research partner and friend, Lynn Waterhouse, and to my loving husband and intellectual companion, Joseph Berger

DF

And to the memory of Norman Geschwind

LKO and DF

Contributors

Martin L. Albert, MD, PhD. Department of Neurology, Section of Behavioral Neuroscience, Boston University School of Medicine, Boston, Massachusetts; and Boston Veterans Administration Medical Center, Boston, Massachusetts.

Ann L. Aldershof, ScB. Boston University School of Medicine, Boston, Massachusetts.

Dorothy M. Aram, PhD. Department of Pediatrics, Case Western Reserve University, Rainbow Babies and Childrens Hospital, Cleveland, Ohio.

Camilla P. Benbow, PhD. Study of Mathematically Precocious Youth, Iowa State University, Ames, Iowa.

Lola Bogyo, PhD. North Shore Children's Hospital, Salem, Massachusetts.

Evan Brown, PhD. Department of Psychology, University of Nebraska, Omaha, Nebraska.

Neil Charness, PhD. Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada.

Jane Clifton, PhD. Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada.

Lee D. Cranberg, MD. Department of Neurology, Section of Behavioral Neuroscience, Boston University School of Medicine,

Boston, Massachusetts; and Boston Veterans Administration Medical Center, Boston, Massachusetts.

Susan Curtiss, PhD. Department of Linguistics, University of California at Los Angeles, Los Angeles, California.

Kenneth Deffenbacher, PhD. Department of Psychology, University of Nebraska, Omaha, Nebraska.

G. Robert DeLong, MD. Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts.

Chantal Desmarais, MA. School of Human Communication Disorders, McGill University, Montreal, Quebec, Canada.

Ronald Ellis, PhD. Boston University School of Medicine, Boston, Massachusetts.

K. Anders Ericsson, PhD. Department of Psychology, University of Colorado, Boulder, Colorado.

Irene A. Faivre, PhD. Department of Psychology, University of Colorado, Boulder, Colorado.

Deborah Fein, PhD. Laboratory of Neuropsychology, Boston University School of Medicine, Boston, Massachusetts; and Department of Psychology, University of Connecticut, Storrs, Connecticut.

Howard Gardner, PhD. Harvard University, Boston University School of Medicine, and Boston Veterans Administration Medical Center, Boston, Massachusetts.

Steven Greenberg, PhD. Harvard Medical School, Cambridge, Massachusetts.

Lyn R. Haber, PhD. Department of Psychology, University of Illinois at Chicago, Chicago, Illinois.

Ralph Norman Haber, PhD. Department of Psychology, University of Illinois at Chicago, Chicago, Illinois.

Jane M. Healy, PhD. Hathaway Brown School, Cleveland State University, Cleveland, Ohio.

Adele Holevas, PhD. League School of Boston, Newton, Massachusetts.

Tedd Judd, PhD. Department of Psychiatry and Behavioral Medicine, Pacific Medical Center, Seattle, Washington.

Edith Kaplan, PhD. Department of Neurology, and Division of Psychiatry, Boston University School of Medicine, Boston, Massachusetts.

Yvan Lebrun, PhD. Neurolinguistics Department, Free University of Brussels, School of Medicine, Brussels, Belgium.

Dorothy Lucci, PhD. Laboratory of Neuropsychology, Boston University School of Medicine, Boston, Massachusetts.

Lyle MacDonald, MA. Algoma District Mental Retardation Service, Sault Ste. Marie, Ontario, Canada.

Steven Matthysse, MD. Mailman Research Center, McLean Hospital, Belmont, Massachusetts.

Loriana Novoa, MA. Department of Curriculum and Instruction, College of Education, Florida International University, Miami, Florida.

Loraine K. Obler, PhD. Program in Speech and Hearing Sciences, Graduate School and University Center of the City University of New York, New York, New York; and Aphasia Research Center of the Boston University School of Medicine, Boston, Massachusetts.

Marlene Oscar-Berman, PhD. Psychology Service, Boston Veterans Administration Medical Center, Boston, Massachusetts; and Department of Neurology and Division of Psychiatry, Boston University School of Medicine, Boston, Massachusetts.

Bernard Rimland, PhD. Institute for Child Behavior Research, San Diego, California.

Elizabeth Rosenblatt, EdM. Harvard Project Zero, Harvard University, Cambridge, Massachusetts.

Eta I. Schneiderman, PhD. Department of Linguistics, University of Ottawa, Ottawa, Ontario, Canada.

Avraham Schweiger, PhD. Psychology Department, University of California at Los Angeles, Los Angeles, California.

Steven Smith, PhD. Private practice, Wenatchee, Washington.

Henri Szliwowski, MD. Neurology Unit, University Hospital, Brussels, Belgium.

Claudie Van Endert, MD. Free University of Brussels, School of Medicine, Brussels, Belgium.

Lynn Waterhouse, PhD. Child Behavior Study, Trenton State College, Trenton, New Jersey.

Ellen Winner, PhD. Psychology Department, Boston College, Chestnut Hill, Massachusetts; and Harvard Project Zero, Harvard University, Cambridge, Massachusetts.

Jeremy M. Wolfe, PhD. Department of Psychology, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Foreword

The topic of this fascinating collection of papers would have raised few eyebrows during the 19th century. During its initial stirrings in the days of phrenology, and during its early history at the time of Paul Broca's epoch-making discoveries, the field of brain–behavior relations comfortably embraced the major issues being examined here. That is, the range of human abilities, talents, and proclivities was considered a suitable subject for study, and the belief that these capacities had specific neural representations was quite widely held.

Why, then, would this topic have seemed so suspect just a few decades ago? Why have we had to wait until this moment for a comprehensive collection of papers on the neuropsychology of talent? In the history of science, events (or, for that matter, nonevents) rarely have a single cause. Any review of the past century of neurological and psychological studies would disclose at least the following factors that contributed to the delay in focusing on the neuropsychological approach: the widespread (and sometimes ideologically based) lack of interest in neural representation entailed in the behaviorist revolution; the precipitous decline of interest in localization following the First World War and the concomitant ascendance of holistic and gestalt positions; the psychometric tyranny that placed "general intelligence" on a pedestal and dictated one way of measuring it; the restriction of psychological studies to populations of normal subjects (unreflectively particularized as Norwegian rats or college sophomores), with individual differences and developmental progressions essentially ignored; and the well-intentioned but naive belief that all minds were (or could be trained to be) essentially alike.

An introductory essay is scarcely the appropriate place for a critique of these items of faith to which so many of our predecessors adhered, often with surprising and ill-supported tenacity. What must be stressed, however, is that each of these perspectives has been gradually undermined by the cognitive and neurobiological revolutions. Cognitive science has sanctioned the study of the full range, and the highest reaches, of human cognitive capacities; there has been a willingness to examine covert thoughts and internal representations as well as observable behaviors; a multifaceted view of the human intellect has increasingly been endorsed, and it is considered appropriate to examine a variety of factors using a range of research methods. Analogously, within the neurobiological disciplines there is universal recognition that the nervous system is highly differentiated, with specific capacities exhibiting their own characteristic structural and functional organizations; that there are regular and perhaps systematic differences in the morphology of brain organization in different populations and subpopulations; and that the

nervous system undergoes a characteristic development that is influenced by extrinsic as well as intrinsic factors.

Suffice it to say, then, that the zeitgeist is extremely friendly to the appearance now of a volume that surveys a wide sweep of talents—from eidetic imagery to chess—in a broad range of populations—from autistic children to skilled scientists—and does so from a variety of disciplinary perspectives and theoretical allegiances. Thanks to the work described in this book, and to other research being carried on in the same tradition, we will soon have excellent descriptions of a variety of human talents, preliminary accounts of the computational processes that underlie these talents, and promising taxonomies of the neural substrates and systems that undergird these individually striking behaviors. Moreover, by fully proposing a research agenda, this book should prove invaluable to researchers and clinicians, who will henceforth be on the lookout for evidence supporting—or refuting—the accounts offered here. Happily, this volume is comprehensive and compelling; it touches on the principal lines of study undertaken in this new area, and it leaves the reader with an excellent sense of what has been accomplished and what remains to be done.

Because the remainder of this volume will allow readers to survey what has been done, I would like to comment on the task that lies ahead. I believe that the focus on talents and special abilities marks but the beginning of a larger scientific agenda—a story of complexity and importance which ultimately needs to be told. Human capacities do not, in most cases, exist and unfold in a vacuum. Rather, they evolve within a particular cultural setting to serve certain individual and collective needs, and whether and how they come to be expressed is as much a social and cultural phenomenon as it is an issue of individual neuroanatomy and expression. To be sure, there are people in whom special talents exist in splendid or terrifying isolation. Much can be learned from studying these exceptional individuals. But for the most part, talents exist in people who have definite goals and purposes, who have been molded to exercise their abilities in one way or another, and whose ultimate performances are accepted or rejected, channeled or thwarted, by the social groups in whose company they live.

Because unusual talents and abilities unfold in such a context, we need to view them from at least five different perspectives. First, there is the *neurobiological substrate* of unusual abilities, and second, there are the *cognitive or informational processes* by which these abilities are expressed. These perspectives, deriving from the cognitive and neurobiological sciences, are well reflected in these pages.

The third perspective focuses on the *personality characteristics and personal dynamics* that enable certain individuals to persevere in developing their talents, while others are diverted from, or self-consciously choose to abandon, their endeavors. These aspects of purpose, will, and mission, which determine whether the potential talent can even be detected by others, are the concern of psychologists of personality and motivation.

Fourth, we must take into account the content of the *domain of knowledge* (Feldman, 1980). Not even the most gifted individuals can excel in chess if the game does not exist; individuals cannot create polyphonic music if they live in a monophonic society; nor can talented persons practice physics if they are reared in a preliterate or prescientific culture. Such epistemological issues must be addressed not only by philosophers or experts in a particular domain (linguists or

musicologists) but by anyone who studies the expression of talent within a given cultural setting.

Finally, there is the *social context or field* in which abilities are fostered, tolerated, or thwarted (Robinson & Csikszentmihalyi, 1986). Individuals may be extremely talented and highly motivated, and they may have access to an appropriate domain of knowledge or performance; but unless they effect the proper affiliations within their culture, advance through appropriate networks, and become identified as members of their guild or profession, their only options are to create their own fields of expertise or to remain obscure. These are the concerns of sociologists or historians, but neuroscientists ignore them at their peril.

In touching upon such concerns as the domain of knowledge and the field of expression, I am going beyond the stated scope of this book. Indeed, I am addressing the differences between gifted *potential* and the *expression of a talent* in ways valued by the culture. In my view, however, this is an important step. Talented individuals may be of theoretical interest in the abstract, but unless they become of some consequence within the society, they are likely to be ignored. No doubt countless special abilities are possessed across the population—perhaps each of us has dozens of unique talents—and yet they would not be noticed, let alone singled out for study, unless on some account they matter. Just why certain talents have mattered in the past, and how they may matter even more in the future, is part of the story that any examination of this subject must encompass. And why some individual talents are expressed chiefly for one's personal amusement, whereas others become mobilized by society for constructive or destructive ends, is a question that none of us can afford to ignore—in our stances as scientists as well as in our roles as citizens. We need to understand the relationships—and the differences—among the isolated idiot savant, the gifted technician, and the radically creative genius.

Obviously, no one scientist can address all of these concerns, but it is important not to lose sight of the ensemble. My own bias, like that of many of the authors collected here, is to begin with the biological bases of talent. Toward that end, in the spring of 1984, I and several of my colleagues at the Social Science Research Council organized what may have been the first conference on the biological bases of giftedness. During the conference, we discussed issues even more purely biological than those treated here: the roles of the most basic levels of anlaysis, including individual neurons and the connections among nerve cells; aspects of neural development; various genetic and epigenetic models of the expression of a talent; and animal models of talent (see Gardner & Dudai, 1985, for a summary of the results of this conference). Following the conference, its organizers agreed that the most relevant contributions to a neurobiological account of human talents had been made by the noted neurologist Norman Geschwind, who was to die suddenly just a few months after the meeting.

I am sure I will not be alone among readers of this book in missing the words of Norman Geschwind. More so than any other single researcher, he called attention to the issues discussed here and devised some of the most fruitful ways of thinking about the neuropsychological and the neuroanatomical aspects of unusual human capacities. Perhaps not coincidentally, he himself epitomized the individual of unusual talents who was able to direct them toward the advancement of knowledge and that sharpening of issues that may lead to improvements in the human condition. Ideally, he should have written this introduction; indeed, he

should have written this book. We should keep in mind his example as we ponder the ideas in this volume and try to build upon them in our future work.

Howard Gardner, Ph.D.
Harvard University
Boston University School of Medicine
Boston Veterans Administration Medical Center

References

Csikszentmihaly, M., & Robinson, R. (1986). Culture, time, and the development of talent. In R. Sternberg (Ed.), *Conceptions of giftedness*. New York: Cambridge University Press.

Feldman, D. H. (1980). *Beyond universals in cognitive development*. Norwood, NJ: Ablex.

Gardner, H., & Dudai, Y. (1985). Biology and giftedness. *ITEMS* (Social Science Research Council) *39*, 1–6.

Preface

The idea for this book began when LKO attended the 1982 NATO Conference on Dyslexia in Maratea, Italy. She was struck by the case of a hyperlexic autistic young man with musical abilities reported by Dorothy Aram; the case appeared to provide an opportunity to invert the standard neuropsychological paradigm and focus on special talents rather than specific disabilities. R. Malatesha Joshi and Harry Whitaker are to be thanked for organizing that conference under a warm October sun by an exquisite coast, and at the relaxed pace of a ten-day conference which permitted the idea behind the book to capture the imagination.

Deborah Fein then agreed to co-work on the project; her commitment to understanding the neuropsychological underpinnings of autism had generated in her a prior interest in *idiots savants*. We decided to attempt to collect in one volume current thinking and research on the neuropsychology of talent, sharing both the intellectual burden and the excitement with our authors. We are most grateful to them for the high caliber of work and enthusiasm they put into their contributions.

The ground for our seed of an idea had already been prepared for us at the Boston Veterans Administration Medical Center, a truly remarkable center for study of neuropsychology. In his regular case presentations at the Aphasia Research Center Aphasia and Neurobehavior Grand Rounds, Norman Geschwind shared the important neuroimmunoendocrinological theory he was developing. On the 14th floor in Psychology Research, as well as at Harvard, Howard Gardner was elaborating his theory of multiple intelligences which was to influence our thinking for this book. And on 7-D, Edith Kaplan trained DF, and served as a model for both of us in the keen observation of ability and disability. All three of them gave this project support in its developmental stages.

We are deeply grateful to LKO's research partner, Martin Albert and to DF's research partner Lynn Waterhouse for their general encouragement and for fruitful discussions in the course of the project, as well as their agreeing to set their minds to address the difficult questions we posed for them in their chapters.

Boston more generally has served as a stimulating environment for us. Phyllis Fisher's help was invaluable in preparing our prospectus for the book. LKO received much valuable inspiration from the Feminist Research Methodology Group and DF much from her lab chief, Marlene Oscar-Berman.

Grants that have funded our research projects on language and autism in the course of work on this book (VA Project 001 to Albert and Obler; NIMH 28605 to Waterhouse and Fein; NIMH 40162 to Fein and Waterhouse; NINCDS 20489 to Fein as part of the CNS-INS Task Force on Nosology of Higher Cerebral Function Disorders in Children, R. David, P.I.) have enabled us to undertake it, as have

our affiliations with Boston University School of Medicine and the Boston Veterans Administration Medical Center, and now the City University of New York Graduate School (LKO) and the University of Connecticut (DF).

We are appreciative of the contributions made by Suzanne Ruscitti on the index, and by Margaret Humes-Bartlo and Ann Aldershof in helping proofread the manuscript.

And as always, we are grateful to our life partners Margaret Fearey and Joseph Berger for the intellectual stimulation and support they bring to our lives.

Loraine K. Obler
Deborah Fein

Contents

I. Introduction

1. *Neuropsychological Study of Talent: A Developing Field* 3

Deborah Fein and Loraine K. Obler

A Definition of Terms, 3 | Historical Context of the Discussion of Talent, 4 | The Current Questions, 6 | Overview of the Book, 13 | Future Research, 14

II. Surveying Specific Areas of Talent

2. *Calculating Prodigies* 19

Steven B. Smith

Types of Calculators, 19 | Nature of the Ability, 21 | Genesis, 24 | Exaggerated Motor Activity, 27 | Childhood Illness and Injury, 29 | Spatial Inabilities, 31 | Environment, 33 | Heredity, 34 | Gender, 35 | Intelligence, 36 | Cerebral Dominance, 37 | Compulsive Practice, 39 | Birth Order, 39 | Supernumerary Digits, 40 | Handedness, 40 | Second-Language Ability, 40 | Mathematical Ability, 41 | Further Research, 43 | Conclusions, 43

3. *Neuropsychological Perspectives on Mathematical Talent* 48

Camilla Persson Benbow

Definitions of Mathematical Talent, 48 | Development of Mathematical Talent, 51 | Abilities Correlating with Mathematical Talent, 53 | Neuropsychological Parameters of Mathematical Talent, 55 | Brain Structures or Processes and Mathematical Talent, 60 | Biological Bases to Mathematical Talent, 61 | Summary, 62

4. *Hyperlexia: A Review of Extraordinary Word Recognition* 70

Dorothy M. Aram and Jane M. Healy

The Data: Studies Reviewed, 70 | Definition of Hyperlexia, 74 | Nonreading Characteristics of Hyperlexic Children, 77 | Reading, 89 | Explanatory Theories, 95 | Directions for Future Research, 99

5. *A Neuropsychological Substrate for Talent in Second-Language Acquisition* 103

Eta I. Schneiderman and Chantal Desmarais

A Definition of Talent, 103 | Assessment of Nativelike Abilities, 105 | A Theory of Language Acquisition, 106 | A Neuropsychological Perspective on the Child Acquirer, 108 | Talent and Flexibility in Second-Language Acquisition, 109 | Alternative Explanations for Talent, 113 | Input, Speed, and Talent, 114 | Correlates of Talent in Neurological Organization, 114 | Cognitive Consequences of Flexibility, 116 | Flexibility and Bilingualism in Children, 117 | Affective Factors and Flexibility, 118 | Suggestions for Further Research, 119

6. *The Varieties of Musical Talent* 127

Tedd Judd

Overview of Musical Talent, 127 | Relationships Between Music and Other Skills, 134 | Relationships Among Musical Skills, 146 | Future Directions, 148 | Conclusions, 151

7. *The Chess Mind* 156

Lee D. Cranberg and Martin L. Albert

The Chess Players, 157 | Intelligence in Chess Players, 159 | Proficiency at Chess, 161 | The Neurology of Chess, 167 | Conclusion, 185

8. *Superior Memory Performance and Mnemonic Encoding* 191

Evan Brown and Kenneth Deffenbacher

Mnemonic Techniques, 192 | Binet's Studies of Superior Memory, 192 | Studies by Muller and Hegge, 194 | Other Earlier Studies, 198 | More Recent Studies of Superior Memory, 200 | Discussion and Conclusions, 206

9. *Superior Memory: Perspective from the Neuropsychology of Memory Disorders* 212

Marlene Oscar-Berman

Studies of Anterograde Amnesias and Neurological Patients, 212 | A Mechanism for Memory Storage, 214

10. *The Characteristics of Eidetic Imagery* 218

Ralph Norman Haber and Lyn R. Haber

What Is Eidetic Imagery?, 222 | Measurement Procedures and Identification of Eidetic Subjects, 223 | Validating a Reported Image as Eidetic, 225 | The Characteristics of Eidetic Images, 229 | Eidetic Imagery and Age, 233 | Definition of Eidetic Imagery, 236