All About Language

Неделя языка

Science, Theory, and Practice

наука, теория, практика

Elena Grigorenko
Yury Shtyrov
Peggy McCardle

the Extraordinary BRAIN series
THE DYSLEXIA FOUNDATION

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(Неделя языка: наука, теория, практика)

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Edited by: Elena L. Grigorenko, Peggy McCardle Ph.D., MPH, Yuri Shtyrov

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edited by

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Dr. Elliott, Principal of Collingwood College and Professor of Educational Psychology, Durham University, initially taught adolescents in mainstream and special schools prior to practicing as a local authority educational (school) psychologist. After holding an academic position at the University of Sunderland, he served as Dean of Education and Lifelong Learning, then

became a Chair at Durham University in 2004. A Chartered Psychologist and Fellow of the British Psychological Society, he is registered to engage in clinical practice by the Health Professions Council. Dr. Elliott is an Academician of the Academy of Social Sciences and an appointed member of the United Kingdom's 2014 Research Excellence Framework (REF) Education Panel and its immediate successor, the 2021 REF Education Panel. His research interests—stimulated and informed by his experiences as a school teacher, clinician, teacher trainer, and university lecturer—include reading disability/dyslexia, achievement motivation, behavior management, cognitive education, comparative education, and psychological assessment.

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Dr. Fisher is Director, Max Planck Institute for Psycholinguistics, Nijmegen, and a professor of language and genetics, Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, the Netherlands. He directs research at the Department of Language and Genetics at the Max Planck Institute for Psycholinguistics in Nijmegen that seeks to understand the functional links between genes, brains, and human cognitive traits. This program builds on prior work at Oxford University, where he developed genomic approaches for studying speech, language, and reading disorders. His research adopts a multidisciplinary viewpoint, integrating data from genomics, psychology, neuroscience, developmental biology, and evolutionary anthropology.

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Dr. Grainger, Senior Scientist at the Centre National de la Recherche Scientifique (CNRS) and Research Professor in cognitive psychology at Aix-Marseille University, Marseille, France, founded and directed (2000–2012) the cognitive psychology research department (LPC) at Aix-Marseille University. He received a prestigious midcareer award from the CNRS in 2011 and the Sir Frederic Bartlett lectureship from the Experimental Psychology Society (United Kingdom) in 2016, and he has served as President of the European Society for Cognitive Psychology. He has received two European Research Council advanced grants to pursue his research on reading. His research focuses on the basic mechanisms involved in the processing of orthographic information by skilled readers.

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Courtenay Norbury is Director of the Literacy, Language and Communication (LiLaC) Lab and a Fellow of the Royal College of Speech and Language

Therapists. She obtained her Ph.D. in experimental psychology at the University of Oxford, working with Professor Dorothy Bishop on the overlapping language profiles that characterize autism spectrum disorder and specific language impairment. Professor Norbury's current research focuses on language disorders in a range of neurodevelopmental conditions and how language interacts with other aspects of development. She is leading a population study of language development and disorder from school entry. She is also a founding member of the Raising Awareness of Developmental Language Disorder (RADLD) campaign (https://www.youtube.com/RADLD).

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Benjamin Powers is a practitioner, researcher, and advocate who works with students with dyslexia and attention-deficit/hyperactivity disorder (ADHD). Having completed his B.A. in Russian language, he holds an executive M.B.A. from Rochester Institute of Technology and a doctorate in business administration from Grenoble Ecole de Management, fusing his interests in dyslexia and entrepreneurship; his doctoral research focused on the self-esteem and self-efficacy perceptions of adolescents with dyslexia and ADHD to understand the affect those personal-level variables have on social-emotional well-being and career intentions. Additional interests include developing collaborative, community-based, and scalable implementation models across learning disability/ADHD, bilingual, bidialectal, and underserved communities. He is the headmaster of The Southport School, an affiliated research scientist at Haskins Laboratories, a research affiliate at Grenoble Ecole de Management, and the codirector of the Academic Centers of Excellence for The Dyslexia Foundation.

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Dr. Pugh is President and Director of Research, Haskins Laboratories, a Yale University and University of Connecticut affiliated interdisciplinary institute dedicated to the investigation of the biological bases of language, and he holds positions at the University of Connecticut, Yale University, and the Yale University School of Medicine. Dr. Pugh directs the Yale Reading Center; is a member of the Scientific Advisory Boards for the International Dyslexia Association and the Rodin Remediation Academy in Stockholm; and has served as a peer reviewer at the National Institutes of Health and as a panel member at the National Research Council of the National Academies. His research in cognitive neuroscience and psycholinguistics focuses on the neurobiology of typical and atypical language and reading development.

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Dr. Rice, Fred & Virginia Merrill Distinguished Professor of Advanced Studies, University of Kansas, directs the cross-disciplinary Child Language Doctoral Program and the Merrill Advanced Studies Center. Her research focuses on children with and without language impairments, twins as well as single-born. She has directed longitudinal studies since the late 1980s, encompassing an age span of 2 years into adulthood, including children's siblings and parents, and bridging disciplines (speech-language pathology, linguistics, psychology, pediatrics, genetics, public health, and education) and international boundaries (including work with colleagues in Australia, Norway, Scotland, South Korea, and the Czech Republic). A researcher with the National Institutes of Health–wide Pediatric HIV/AIDS Cohort Study, she has been continuously supported by NIH. She is a Fellow of the American Speech-Language-Hearing Association (ASHA), the American Association for the Advancement of Science, the American Psychological Association, and the American Association for Psychological Science, and she is a member of the Education Board of the American Health Council. Her interests include the linguistic bases of reading and possible shared inherited traits.

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Dr. Saffran, Vilas Distinguished Achievement Professor, Department of Psychology, University of Wisconsin, directs the Infant Learning Lab at the Waisman Center, University of Wisconsin, Madison. Her research there, which has garnered numerous national awards, is focused on how infants learn about language and other complex aspects of their environment. She

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The Dyslexia Foundation and the Extraordinary Brain Series

In the late 1980s, The Dyslexia Foundation (TDF) was founded by William H. "Will" Baker in collaboration with notable researchers in dyslexia. The concept began in the late 70s, then came to fruition in 1982, when, through the generosity of the Underwood and Baker families, the first Dyslexia Research Laboratory under the direction of Drs. Albert Galaburda and Norman Geschwind at Beth Israel Hospital, Harvard Medical School, Boston, Massachusetts, was established to investigate the neural underpinnings of dyslexia. In 1987, top researchers from cognition, neuroscience, and education were convened in a scientific symposium in Florence, Italy, where ideas were presented and discussed, with sufficient time to disagree, identify research challenges, and brainstorm solutions—and the concept of a dyslexia symposium series was born. In the fall of 1989, Baker established the National Dyslexia Research Foundation (later renamed TDF), to focus specifically on research. In 1990, the new foundation sponsored a second symposium in Barcelona, Spain. With it, the symposium series was designated as the Extraordinary Brain Series (EBS)!

The EBS symposia began as think tanks of researchers who were encouraged to discuss, disagree, and explore new possibilities. Many have called these symposia the best research meetings they have ever attended because of the depth of discussion and exchange of ideas afforded by a 5-day think tank. Each symposium resulted in a volume to share the research presented and the ideas that grew out of the deliberations. Educators from independent schools for students with learning differences, interested in hearing the latest research and witnessing these cutting-edge discussions, began to attend and contribute as TDF sponsors to the meetings. Hearing their cry for bringing current research to their classrooms, in a then-novel outreach activity, TDF instituted 1-day annual educational meetings held on the campus of Harvard Medical School, where educators and allied health practitioners could hear about current research directly from researchers. In 2007, at the 10th EBS symposium in Brazil, educators were asking so many questions and were so eager to share their research needs with the researchers present that these educators were given a forum during the meeting, and the research-to-practice efforts of TDF moved to a new, higher level. Since that time, educators and practitioners are heard and participate in each EBS symposium, and the interactions among them and researchers have been rich and rewarding. Although it had been part of the TDF philosophy to include not only senior, established researchers but also promising early-stage researchers as participants in the symposia,

this has also accelerated. At the 11th symposium in Taiwan, in 2010, Taiwanese researchers invited their graduate students and postdoctoral fellows to display posters of their work during the meeting. Since that time, those invited to present or moderate sessions at EBS symposia are also invited to bring junior colleagues, postdoctoral fellows, and graduate students and have them present posters—displaying the posters and giving a very brief explanation of their work during one special session at the symposium.

Over the three decades of the Foundation's and EBS's existence, major strides have been made in not only dyslexia and reading research (many researchers have commented that their best new ideas and great new collaborations have grown out of their participation in EBS symposia), but these meetings have also provided a safe venue for exchanging and developing research-to-practice ideas, mentoring many new and emerging researchers, and providing content for the continuing and expanding 1-day research-to-practice meetings for educators and practitioners, which are live-streamed in real time and archived for later viewing.

This volume celebrates the 16th symposium in the Extraordinary Brain Series. The volumes make the thoughts of scholars across various disciplines accessible to all researchers and practitioners as they tackle various aspects of the behavior, neurobiology, and genetics of dyslexia and of learning to read and write. Following is a listing of TDF symposia and the related volumes to date:

I. June 1987, Florence, Italy. Symposium Director: Albert M. Galaburda.
Galaburda, A. M. (Ed.). (1989). *From reading to neurons.* Cambridge, MA: Bradford Books/MIT Press.

II. June 1990, Barcelona, Spain. Symposium Director: Albert M. Galaburda.
Galaburda, A. M. (Ed.). (1993). *Dyslexia and development: Neurobiological aspects of extra-ordinary brains.* Cambridge, MA: Bradford Books/Harvard University Press.

III. June 1992, Santa Fe, NM. Symposium Director: Paula Tallal.
Chase, C., Rosen, G., & Sherman, G. F. (Eds.). (1996). *Developmental dyslexia: Neural, cognitive, and genetic mechanisms.* Mahwah, NJ: Lawrence Erlbaum Associates.

IV. June 1994, Kauai, Hawaii. Symposium Director: Benita Blachman.
Blachman, B. R. (Ed.). (1997). *Foundations of reading acquisition and dyslexia: Implications for early intervention.* Mahwah, NJ: Lawrence Erlbaum Associates.

V. June 1998, Kona, Hawaii. Symposium Director: Drake Duane.
Duane, D. (Ed.). (1999). *Reading and attention disorders: Neurobiological correlates.* Baltimore, MD: York Press.

VI. June 2000, Crete, Greece. Symposium Director: Maryanne Wolf.
Wolf, M. (Ed.). (2001). *Time, fluency, and dyslexia.* Baltimore, MD: York Press.

VII. June 2002, Kona, Hawaii. Symposium Director: Barbara Foorman.
Foorman, B. (Ed.). (2003). *Preventing and remediating reading difficulties: Bringing science to scale.* Baltimore, MD: York Press.

VIII. October 2002, Johannesburg, South Africa. Symposium Director: Frank Wood.
Multilingualism and dyslexia. No publication.

IX. June 2004, Como, Italy. Symposium Director: Glenn Rosen.
Rosen, G. (Ed.). (2006). *The dyslexic brain: New pathways in neuroscience discovery.* Mahwah, NJ: Lawrence Erlbaum Associates.

X. June 2007, Campos do Jordão, Brazil. Symposium Directors: Ken Pugh and Peggy McCardle.
Pugh, K., & McCardle, P. (Eds.). (2009). *How children learn to read: Current issues and new directions in the integration of cognition, neurobiology and genetics of reading and dyslexia research and practice.* New York, NY: Psychology Press, Taylor & Francis Group.

XI. January 2010, Taipei, Taiwan. Symposium Directors: Peggy McCardle, Ovid Tseng, Jun Ren Lee, and Brett Miller.
McCardle, P., Miller, B., Lee, J. R., & Tseng, O. J. L. (Eds.). (2011). *Dyslexia across languages: Orthography and the brain-gene-behavior link.* Baltimore, MD: Paul H. Brookes Publishing Co.

XII. June 2010, Cong, Ireland. Symposium Directors: April Benasich and Holly Fitch.
Benasich, A. A., & R. H. Fitch (Eds.). (2012). *Developmental dyslexia: Early precursors, neurobehavioral markers, and biological substrates.* Baltimore, MD: Paul H. Brookes Publishing Co.

XIII. June 2012, Tallinn, Estonia. Symposium Directors: Brett Miller and Laurie Cutting.
Miller, B., Cutting, L. E., & McCardle, P. (Eds.). (2013). *Unraveling reading comprehension: Behavioral, neurobiological, and genetic components.* Baltimore, MD: Paul H. Brookes Publishing Co.

XIV. June 2014, Horta, Faial Island, The Azores. Symposium Directors: Carol Connor and Peggy McCardle.

Connor, C. M., & McCardle, P. (Eds.). (2015). *Advances in reading intervention: Research to practice to research.* Baltimore, MD: Paul H. Brookes Publishing Co.

XV. June 2016, Saint Croix, U.S. Virgin Islands. Symposium Directors: Albert Galaburda, Fumiko Hoeft, and Nadine Gaab.

Galaburda, A. M., Gaab, N., Hoeft, F., & McCardle, P. (Eds.). (2018). *Dyslexia and neuroscience: The Geschwind-Galaburda Hypothesis 30 years later.* Baltimore, MD: Paul H. Brookes Publishing Co.

XVI. May 2018. St. Petersburg, Russia. Symposium Directors: Elena Grigorenko & Yury Shtyrov.

Grigorenko, E. L., Shtyrov, Y., & McCardle, P. (Eds.). (2020). *All about language: Science, theory, and practice.* Baltimore, MD: Paul H. Brookes Publishing Co.

Preface

This volume is one of two, both based on Extraordinary Brain Series (EBS) Symposia, and thus both resulting in EBS edited volumes. Although it was unprecedented to hold two such symposia within months of one another, it turned out to be a wonderful convergence of ideas and information on the underpinnings of reading and dyslexia. The first symposium (and eponymous volume, coedited by Elena Grigorenko, Yury Shtyrov, and Peggy McCardle), *All About Language: Science, Theory, and Practice* (Paul H. Brookes Publishing Co., 2020), focuses on the evolution and development of language in all its forms—spoken and written—and how typical and atypical language underlie and relate to reading and reading difficulties. The meeting was held in Russia and addressed some of the issues of diagnosis; access to special education services in Russia, the United States, the United Kingdom, and other countries; and education policy. The second volume, *Dyslexia: Revisiting Etiology, Diagnosis, Treatment, and Policy* (Paul H. Brookes Publishing Co., in press), coedited by Julie Washington, Don Compton, and Peggy McCardle, similarly examines how reading develops, what happens when it does not develop typically, and how best to identify and treat those cases, as well as how local and national policies and legislation can help or hinder those trying to do so. This symposium was held in South Africa and looked beyond the United States, with presenters (and thus authors) from other countries or whose work involves international collaborations. The two meetings had seemingly different foci, but both were asking similar questions about how best to understand, treat, and implement proven interventions for those who struggle with reading. Each symposium brought together a group of scholars and clinicians in a think-tank setting to take stock of what is known and what needs to be known. These two groups were largely nonoverlapping, but their timely (almost) co-occurrence allows us to gain access to both sets of information in a very useful complementarity via these two volumes.

The complementarity of these two volumes should enhance our thinking as a field as we move to gain a fuller, more complete understanding of the total picture of reading difficulties, the reading process, the language skills that underlie it, and the individual differences that add to the complexity of this task. EBS symposia (and volumes) bring together scientists from different disciplines and areas of research and generally seek to integratively address the neurobiology, genetics, and behavior of reading and reading disabilities, thinking about how skills are learned, why they might

not be, and what influences are in play across development and how they change the course of development (be it typical or atypical) as well as how those influences change our interventions (i.e., what we do about teaching individuals to read). It is increasingly clear that the context—the environment, physical, social, linguistic, cultural, and economic—affects learning. The environment includes language exposure—in the home, community, and school—whereas school instruction requires knowledge that teachers often do not have upon entering the profession. Thus, ensuring that researchers share their reliable findings with educators and other clinicians, and that they seek to answer the questions most pressing for those educators and clinicians, is also an essential goal of every EBS symposium. The volumes contain chapters addressing these issues (with nontechnical summaries to begin each), and the volumes' integrative section commentaries seek to pull together across chapters the common threads of each thematic section. The final chapter in each volume offers suggestions for the way forward.

Acknowledgments

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We also must acknowledge the authors, who traveled to St. Petersburg, Russia, to present their own work and thoughts and engage in deep discussions with symposium participants, and who then wrote and revised chapters for this volume, often meeting stringent deadlines. Some of the coauthors and authors of the integrative commentaries were not in attendance at the meeting but contributed very meaningfully to the volume, and we thank them for their willingness to participate in this work. In addition, we acknowledge the practitioners (teachers, educators, administrators, and clinicians), researchers, graduate students, and postdoctoral fellows who also traveled and not only listened attentively and thought deeply but also discussed, questioned, and commented, helping to inform this volume.

We and TDF offer heartfelt thanks to the following individuals, schools, and businesses that generously supported EBS XVI: Wilson Language Training, Jemicy School, AIM Academy, The Howard School, The Schenck School, The Southport School, Westmark School, Athena Academy, Brehm Preparatory School, Carroll School, Curry Ingram Academy, Marburn Academy, The New Community School, The Summit School, and five individuals and two foundations that wish to remain anonymous.

We are also grateful to the many junior colleagues from St. Petersburg State University who organized and supported the symposium and shared the beauty of the city with the participants. Special thanks to Irina Golovanova, Ekaterina Nikolaeva, Irina Ovchinnikova, Ekaterina Perikova, Olga Titova, and Marina Zhukova.

Finally, thanks go to the flexible, helpful, and very capable editorial staff at Paul H. Brookes Publishing Co., especially Astrid Pohl Zuckerman, Tess Hoffman, MaryBeth Winkler, and Nicole Schmidl, who were willing to take on not just one but two EBS volumes at the same time! Thank you for your diligence, excellent help, and patience on this and the EBS XVII book. We loved working with you!

Coeditors,
Elena Grigorenko, Yury Shtyrov, and Peggy McCardle

CHAPTER 1

All About Language

Science, Theory, and Practice
An Overview and Introduction to the Volume

(Неделя языка: наука, теория, практика)

Elena L. Grigorenko, Yury Shtyrov, and Peggy McCardle

This volume is the collaborative outgrowth of Extraordinary Brain Symposium XVI, which was held in St. Petersburg, Russia, from May 28 to June 1, 2018.[1] The meeting (and thus the volume) included various language-related topics with targeted speakers in language evolution, genetic and environmental etiology, typical development, language disorders, bi- and multilingualism, and various types of literacy, as well as very rich and spirited discussion of these. There were also sessions addressing key language, learning, and learning disability research, practice, and policy issues, which were open to the public and geared toward teachers, parents, and other advocates. In addition to a scientific exchange of ideas among leading scientists, the symposium included a round table of practitioners—participating educators from independent schools, representatives of the Russian educational authorities, and social entrepreneurs and charitable organizations interested in special education. We have sought to include aspects of all of these activities within this volume, and to enhance the accessibility of the information in all sections, each chapter includes a summary of its contents in less technical language, allowing readers to preview chapters prior to delving into them.

Language, in the forms we know it (including 7,472 known spoken languages as well as written, digital, and other varieties), is a hallmark of our species and a backbone of human society. It changes as humans change, both ontogenetically and phylogenetically, and, although most individuals master it, they vary in their language capacity. Human language represents a complex, hierarchically organized symbolic system employed to communicate—that is, to receive and transmit information. These (spoken, written, digital, gestural, and other) systems of symbols are complex, yet they are learnable, although at different developmental periods and at different speeds. It is assumed that the acquisition of spoken language unfolds first, followed by written, then followed by digital language, with the latter two

The symposium was supported primarily by two laboratories led by Elena Grigorenko and Yury Shtyrov, both established at the St. Petersburg University, Russia, within the framework of so-called "Mega-grant projects" aimed at giving a major boost to Russian sciences (http://www.p220.ru/en/) and by philanthropic organizations, including The Dyslexia Foundation (United States), the Association for Children and Parents with Dyslexia (Russian Federation), and the Way Out Foundation (Russian Federation).

requiring explicit instruction, whereas spoken language requires only (or primarily) reliable input and imitable human models. These different types of communicative ability and literacy emerge as a child develops into an adult. Although language/literacy acquisition usually unfolds seamlessly when bracketed within a typical developmental trajectory, assuming exposure to normative social and educational environments (i.e., family, school, and digital technology), numerous children demonstrate impairments in acquiring different forms of language, either within one or across two or three of its modes.

The chapters in this volume sample the current state of knowledge regarding the evolution and manifestation of human language. There is a large body of research literature that allows students of language to appreciate both its ontogenetic and phylogenetic development and the multiple sources of individual differences in its (a)typical acquisition. This acquisition begins in utero and continuously extends into the infinity of human life because there is no known age threshold for when language learning, in any or all of its forms, is destined to stop, although there is a great deal of information on the differential parameters of language learning at different stages of the life span. The rate of language learning in all its forms is different during different developmental periods; the earliest acquisition stages are characterized by a growth spurt, followed by a gradual increase in sophistication and expansion of literacy. In general, it is assumed that language learning encompasses increasingly complex linguistic representations, sophisticated communication skills, erudite reasoning, and deepened conceptual knowledge. From the very beginning, however defined, language acquisition follows the powerful laws of exposure and practice in which more leads to enhancements and less leads to stagnation or even attrition.

Although language has always been at the center of humanity's scientific thought, the last two decades of research have been marked by major advances in understanding how children acquire the formal properties of the ambient languages to which they are exposed, with researchers investigating evolutionary, biological, sociocultural, cognitive, affective, and all other relevant mechanisms that underlie different forms of literacy acquisition. Still, numerous essential questions remain unanswered regarding the extent to which the different types of language unfold and the universality and specificity of the mechanisms within and across these different domains, within and across different developmental periods, and within and across different cultures and societies.

All these questions were the focal point of an interdisciplinary group of scholars attempting to integrate the diversity of research findings into coherent theories that, on the one hand, inspire and shape future research and, on the other hand, are of vital interest to practitioners, including speech-language pathologists, pediatricians, and educators faced with the tasks of evaluating the language learning trajectories and deficits in particular individuals and devising clinical and educational interventions that may

facilitate the acquisition of literacy in all its forms. Given the theoretical and practical importance of this field of research, opportunities for scholars and practitioners to exchange knowledge and collectively enhance research opportunities are of immense significance. This volume, like the symposium that it draws from, is conceived to provide one such opportunity. The volume is structured in six sections. Each of the first five sections ends with integrative commentary by a known scholar in that topical area, whereas the sixth section (Chapter 16) integrates the research findings presented throughout the volume. Section I sets the stage for our broadly conceived discussion of all aspects of language by addressing the biological underpinnings of language phylogeny and ontogeny. Burenkova and Fisher address language development from a genetic perspective, and Pugh addresses it from a neuroscience one, both chapters citing recent breakthroughs and future directions. These are contextualized by Zevin's integrative commentary in his discussion of *emergentism,* which he defines as "a synthesis between the impulse to delineate and describe distinct language functions, and the impulse to engage with the messiness of their biological substrate."

Sections II–IV address typical and atypical development in oral and written language (i.e., speaking, listening, and reading). The section on typical development (Section II) includes information on how infants learn and build a body of words (Saffran), what eye tracking can tell us about reading development (Akhutina and colleagues), and how children process orthographic units (Grainger). An integrative commentary by Hogan cross-references this section's chapters by focusing the discussion on three key themes—the power of statistical learning, the utilization of innovative methodologies (e.g., eye tracking, computational modeling, infant behavioral learning paradigms), and general and specific characteristics of language acquisition in different languages. She concludes the commentary by stressing the importance of early assessment of language development "to determine individual variation to inform quality, evidence-based spoken and written language instruction."

In Section III, Rice addresses atypical language development via a large longitudinal twin study, offering thoughts on possible causal pathways to specific language impairment, whereas Norbury discusses stability and change over time in the manifestation of Developmental Language Disorders. In addition, Eigsti and Castelluccio examine what can be learned about neural plasticity from the study of language in children with autism spectrum disorder. Common themes of these chapters are addressed in Snowling's integrative commentary. She takes the discourse in these chapters to a higher level, pointing out the importance of remediating language difficulties and the development of robust and long-term interventions "that prevent an intergenerational downward spiral from language difficulty to social disadvantage and poor mental health."

Section IV focuses on reading difficulties, with chapters addressing the role and importance of executive function in both reading development and

disorders (Cirino and colleagues) and how students with reading difficulties respond to intervention (Cirino and colleagues as well as Morris). There is also a discussion of what research has shown us regarding the identification of reading disabilities in children learning English as a second language (Francis and colleagues) and the relationships of reading to oral language during development (Cutting and colleagues). Wagner's commentary on these chapters and related recent work integrates these various themes, highlighting both the amazing progress the science of reading has achieved and the amount of work that still needs to be done to ensure fair opportunities for all emergent readers in all languages and of all backgrounds.

Section V addresses real-world applications of the research presented in the previous sections. Abbeduto and colleagues highlight how technology can be used to make interventions more accessible, emphasizing a community-based approach. Elliott describes what we know about identification, assessment, and treatment and how the presently acquired knowledge and experience (that varies across cultures and countries) can benefit those nations and communities seeking to provide or enhance the provision of special education and evidence-based instruction. In their commentary, Mele-McCarthy and Powers address how policy guides practice and stress the importance of research guiding policy, focusing on how districts, states, and nations can move toward education equity for all students.

In our own final chapter, we bring together our own thoughts, the thoughts of the chapter authors, and the thoughts of those who were present in the St. Petersburg discussions in May 2018 on the directions that research should take if we are to be able to integrate what we know of typical and atypical development in all aspects of language—both oral and written, as they clearly are intimately related. We comment on the current landscape of the science of human language and its various modes and acknowledge that although much more detailed and refined than ever before, our understanding of the ontogeny and phylogeny of human language is still far from complete.