

Clinical Management of Children With Cochlear Implants

Second Edition

Editor-in-Chief for Audiology
Brad A. Stach, PhD

Clinical Management of Children With Cochlear Implants

Second Edition

LAURIE S. EISENBERG, PhD





5521 Ruffin Road
San Diego, CA 92123

e-mail: info@pluralpublishing.com
Website: <http://www.pluralpublishing.com>

Copyright © 2017 by Plural Publishing, Inc.

Typeset in 10.5/13 Garamond book by Flanagan's Publishing Services, Inc.
Printed in the United States of America by McNaughton & Gunn, Inc.

All rights, including that of translation, reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, recording, or otherwise, including photocopying, recording, taping, Web distribution, or information storage and retrieval systems without the prior written consent of the publisher.

For permission to use material from this text, contact us by
Telephone: (866) 758-7251
Fax: (888) 758-7255
e-mail: permissions@pluralpublishing.com

Every attempt has been made to contact the copyright holders for material originally printed in another source. If any have been inadvertently overlooked, the publishers will gladly make the necessary arrangements at the first opportunity.

Library of Congress Cataloging-in-Publication Data

Names: Eisenberg, Laurie S., editor.
Title: Clinical management of children with cochlear implants / [edited by] Laurie S. Eisenberg.
Description: Second edition. | San Diego, CA : Plural Publishing, [2017] | Includes bibliographical references and index.
Identifiers: LCCN 2016011361 | ISBN 9781597567237 (alk. paper) | ISBN 159756723X (alk. paper)
Subjects: | MESH: Cochlear Implantation | Cochlear Implants | Deafness—therapy | Child | Infant
Classification: LCC RF305 | NLM WV 274 | DDC 617.8/82--dc23
LC record available at <http://lccn.loc.gov/2016011361>

Contents

<i>Preface</i>	<i>ix</i>
<i>Contributors</i>	<i>xi</i>
Section I. Clinical Management	1
1 Cochlear Implants in Children: Historical Perspectives and Personal Reflections <i>Laurie S. Eisenberg</i>	3
2 Clinical Management of Cochlear Implants in Children: An Overview <i>Margaret E. Winter and Kristina Celani Rousso</i>	21
3 Acoustic Amplification for Infants and Children: Selection, Fitting, and Management <i>Patricia A. Roush and Richard C. Seewald</i>	43
4 Cochlear Implants and Auditory Brainstem Implants for Children: Surgical Considerations <i>Ksenia A. Aaron, Elina Kari, Rick A. Friedman, and John K. Niparko</i>	69
5 Programming Cochlear Implants in Children <i>Jace Wolfe and Erin C. Schafer</i>	105
6 Bilateral Cochlear Implants in Children <i>Ruth Litovsky</i>	153
7 Electrically Evoked Auditory Potentials: Clinical Applications <i>Carolyn J. Brown, Rachel Anna Scheperle, Viral D. Tejani, Eun Kyung Jeon, Shruti Balvalli Deshpande, and Paul J. Abbas</i>	177
Section II. Assessment	205
8 Assessing Spoken Word Recognition in Children With Cochlear Implants <i>Karen Iler Kirk, René H. Gifford, and Kristin Uhler</i>	207
9 Issues and Challenges in the Development of Evidence-Based Pediatric Intervention Programs <i>Sigfrid D. Soli and Yun Zheng</i>	251

10	The Assessment Role of the Speech-Language Specialist on the Clinical Cochlear Implant Team <i>Dianne Hammes Ganguly, Sophie E. Ambrose, and Catherine Cronin Carotta</i>	273
11	Beyond Hearing: Use of Parent Questionnaires for Assessing Auditory Functioning in Hearing-Impaired Infants <i>Liat Kishon-Rabin and Osnat Segal</i>	373
12	Psychological Factors in Pediatric Cochlear Implantation: Practical Considerations <i>Carren J. Stika and John F. Knutson</i>	403
13	Neurocognitive Assessment of Children With Cochlear Implants <i>William G. Kronenberger and David B. Pisoni</i>	433
14	Vestibular Assessment <i>Sharon L. Cushing and Blake C. Papsin</i>	473
15	Outcomes in Cochlear Implantation: Assessment of Quality of Life Impact and Economic Evaluation of the Cochlear Implant <i>Yevgeniy R. Semenov, Frank R. Lin, Howard W. Francis, and John K. Niparko</i>	511
Section III. Rehabilitation and Education		537
16	Listening and Spoken Language at the John Tracy Clinic: Dwelling in Possibilities through Hope, Guidance, and Encouragement <i>Jane Freutel, Mary D. McGinnis, and Jill A. Mubs</i>	539
17	Literacy and Educational Considerations for Children Who are Deaf and Hard of Hearing <i>Debra Kay Schrader and Vicki L. Reynolds</i>	587
18	Habilitation Considerations for Families Who are Linguistically Diverse <i>W. Michael Douglas</i>	651
19	Empowering Families of Children With Cochlear Implants: Implications for Early Intervention and Language Development <i>Jean L. Desjardin</i>	665

Section IV. Special Populations	717
20 Working With Children from Lower SES Families: Understanding Health Disparities <i>Rachel Umans and Dana L. Suskind</i>	719
21 Cochlear Implantation in Children With Additional Disabilities <i>Karen C. Johnson, Susan Wiley, and Jareen Meinzen-Derr</i>	737
22 Clinical Management of Children With Auditory Neuropathy Spectrum Disorder <i>Holly F.B. Teagle, Patricia A. Roush, Lisa R. Park, Shuman He, Carlton J. Zdanski, and Craig A. Buchman</i>	791
23 New Frontiers in Auditory Prostheses: Auditory Brainstem Implants in Prelingually Deaf Children <i>Laurel M. Fisher, Amy S. Martinez, Jamie L. Glater, and Robert V. Shannon</i>	821
<i>Index</i>	847

Preface to the Second Edition

My career as an audiologist began in 1976 at the House Ear Institute in Los Angeles during the time when the single-channel cochlear implant was being developed by William F. House, DDS, MD. For 10 years I participated in the first cochlear implant clinical trials conducted on adults and children with profound hearing loss. I also had the opportunity to work with the first group of adult recipients of the auditory brainstem implant. During those early trials there were no resources to guide our team. My colleagues and I had to learn by experience and to develop our own materials and assessment tools. The primary objective for publishing the First Edition of *Clinical Management of Children with Cochlear Implants* in 2009 was to compile a series of chapters from experts in the field to guide students and clinicians. The Second Edition highlights the many ways in which the field is evolving with respect to patient demographics, expanding indications, technology, rehabilitation, and education. Although the clinical concepts and assessment tools described in the First Edition remain relevant today, new topics covered in the Second Edition offer fresh insights into this ever changing field.

The chapters in this book are as diverse as the disciplines that represent the specialty area of pediatric cochlear implantation. The authors come from a variety of professional backgrounds, including neurotology, otolaryngology, pediatric otolaryngology, developmental behavioral pedi-

rics, audiology, speech-language pathology, electrophysiology, auditory neuroscience, clinical and pediatric psychology, cognitive science, experimental methodology, epidemiology, and education.

Several chapters provide guidance for managing a pediatric implant program, encompassing candidacy, assessment, surgery, device programming, and post-implant follow-up. Other chapters address specialized areas of assessment such as electrophysiology, vestibular functioning, speech recognition, speech and language, neurocognitive and psychological functioning, and quality of life. The second edition also updates chapters oriented to the child, family, and intervention with emphasis on education, parental contributions, families of low socioeconomic status, and second language learners. Hearing aids, bilateral implants, and auditory brainstem implants are covered in individual chapters. Finally, special cases typically encountered in clinical practice are highlighted, such as those with auditory neuropathy, multiple disabilities, and/or developmental delays.

Preparation of the second edition follows my 2013 move from the House Ear Institute to the Keck School of Medicine (KSOM) of the University of Southern California (USC) along with a number of my research colleagues and pediatric clinical specialists. In particular, I wish to thank John K. Niparko, MD and the USC Tina and Rick Caruso Department of Otolaryngology–Head and Neck Surgery at KSOM for support of this book. I am most grateful to Kalie

Koscielak from Plural Publishing and to Amy Martinez and Jacqueline Jimenez from the USC Tina and Rick Caruso Department of Otolaryngology–Head and Neck Surgery for their tireless support in the preparation of the second edition.

Laurie S. Eisenberg

Contributors

Ksenia A. Aaron, MD

Resident

Tina and Rick Caruso Department of
Otolaryngology–Head and Neck Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 4

Paul J. Abbas, PhD

Professor

Department of Communication Sciences
and Disorders
Department of Otolaryngology
University of Iowa
Iowa City, Iowa
Chapter 7

Sophie E. Ambrose, PhD, CCC-SLP

Director

Communication Development Laboratory
Center for Childhood Deafness
Boys Town National Research Hospital
Omaha, Nebraska
Chapter 10

Carolyn J. Brown, PhD

Professor

Department of Communication Sciences
and Disorders
Department of Otolaryngology–Head and
Neck Surgery
University of Iowa
Iowa City, Iowa
Chapter 7

Craig A. Buchman, MD

Lindburg Professor and Head

Department of Otolaryngology–Head and
Neck Surgery
Washington University School of Medicine
St. Louis, Missouri
Chapter 22

Catherine Cronin Carotta, EdD, CCC-SLP

Associate Director

Center for Childhood Deafness
Boys Town National Research Hospital
Omaha, Nebraska
Chapter 10

Sharon L. Cushing, MD

Assistant Professor

Department of Otolaryngology–Head and
Neck Surgery
Hospital for Sick Children
University of Toronto
Toronto, Canada
Chapter 14

Shruti Balvalli Deshpande, PhD, CCC-A

Assistant Professor

Department of Communication Sciences
and Disorders
St. John's University
Queens, New York
Chapter 7

Jean L. DesJardin, PhD

Associate Professor

Education Department
Early Childhood Education Teacher
Certification Program
Moravian College
Bethlehem, Pennsylvania
Chapter 19

W. Michael Douglas, MA, CCC-SLP, LSCS,
Cert. AVT

Principal
Mama Lere Hearing School
Vanderbilt University
Department of Hearing and Speech
Sciences
Nashville, Tennessee
Chapter 18

Laurie S. Eisenberg, PhD

Professor of Research Otolaryngology
Caruso Family Center for Childhood
Communication
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck
Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 1

Laurel M. Fisher, PhD

Associate Professor
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck
Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 23

Howard W. Francis, MD, MBA

Professor and Vice Director
Department of Otolaryngology-Head and
Neck Surgery
Johns Hopkins University
Baltimore, Maryland
Chapter 15

Jane Freutel, EdD, LSLC Cert. AVT

Associate Director
DHH Graduate Program
Mount Saint Mary's University
John Tracy Clinic

Los Angeles, California
Chapter 16

Rick A. Friedman, MD, PhD

Director and Professor
Division of Otolaryngology, Neurotology and
Skull Based Surgery
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 4

Dianne Hammes Ganguly, MA, CCC-SLP

Adjunct Associate Professor of Clinical
Otolaryngology
Caruso Family Center for Childhood
Communication
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck
Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 10

René H. Gifford, PhD

Associate Professor
Director, Cochlear Implant Program
Department of Hearing and Speech
Sciences
Vanderbilt Bill Wilkerson Center
Vanderbilt University
Nashville, Tennessee
Chapter 8

Jamie Glater, AuD

Assistant Professor
Clinical Otolaryngology
Caruso Family Center for Childhood
Communication
University of Southern California
Los Angeles, California
Chapter 23

Shuman He, MD, PhD

Director of Human Auditory
Electrophysiology Laboratory
Center for Hearing Research
Boys Town National Research Hospital
Omaha, Nebraska
Chapter 22

Eun Kyung Jeon, AuD

Research Assistant
University of Iowa
Iowa City, Iowa
Chapter 7

Karen C. Johnson, PhD

Associate Professor of Clinical
Otolaryngology
USC Caruso Family Center for Childhood
Communication
Department of Otolaryngology–Head and
Neck Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapter 21

Elina Kari, MD

Assistant Professor
Otology, Neurotology and Skull Base
Surgery
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck
Surgery
University of Southern California
Keck School of Medicine
Los Angeles, California
Chapter 4

Karen Iler Kirk, PhD, CCC-SLP

ASHA Fellow
Shahid and Ann Carlson Khan Professor
Head Department of Speech and Hearing
Science
University of Illinois at Urbana
Champaign

Champaign, Illinois
Chapter 8

Liat Kishon-Rabin, PhD

Professor
Communication Disorders Department
Speech and Hearing Science
Sackler Faculty of Medicine
Tel-Aviv University
Tel Aviv, Israel
Chapter 11

John F. Knutson, PhD

Professor Emeritus
Department of Psychological and Brain
Sciences
The University of Iowa
Iowa City, Iowa
Chapter 12

William G. Kronenberger, PhD

Professor and Director
Section of Psychology
Department of Psychiatry
Indiana University School of Medicine
Indianapolis, Indiana
Chapter 13

Frank R. Lin, MD, PhD

Associate Professor
Department of Otolaryngology–Head and
Neck Surgery
Johns Hopkins School of Medicine
Baltimore, Maryland
Chapter 15

Ruth Litovsky, PhD

Professor of Communication Sciences and
Disorders, and Surgery
Division of Otolaryngology
Director
Binaural Hearing and Speech Lab,
Waisman Center
University of Wisconsin-Madison
Madison, Wisconsin
Chapter 6

Amy Martinez, MA, CCC-A

Assistant Professor
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck
Surgery
Keck School of Medicine
University of Southern California
Caruso Family Center for Childhood
Communication
Los Angeles, California
Chapter 23

**Mary D. McGinnis, Cand PhD, LSL
Cert. AVT**

Director
DHH Graduate Program
Mount Saint Mary's University
John Tracy Clinic
Los Angeles, California
Chapter 16

Jareen Meitzen-Derr, PhD, MPH

Associate Professor of Pediatrics
Division of Biostatistics and Epidemiology
Cincinnati Children's Hospital Medical
Center
Cincinnati, Ohio
Chapter 21

Jill A. Muhs, MEd, MEd

Vice President of Programs
John Tracy Clinic
Los Angeles, California
Chapter 16

John K. Niparko, MD

Tiber Alpert Chair
Division of Otology, Neurotology, and
Skull Base Surgery
Tina and Rick Caruso Department of
Otolaryngology–Head and Neck Surgery
Keck School of Medicine
University of Southern California
Los Angeles, California
Chapters 4 and 15

**Blake C. Papsin, MD, MSc, FRCSC,
FACS, FAAP**

Otolaryngologist-in-Chief
Cochlear Chair in Auditory Department
The Hospital for Sick Children
Professor of Otolaryngology
The Faculty of Medicine
The University of Toronto
Toronto, Ontario
Chapter 14

Lisa R. Park, AuD, CCC-A

Audiologist
Clinic Manager
The Children's Cochlear Implant Center
at UNC
Durham, North Carolina
Chapter 22

David B. Pisoni, PhD

Distinguished Professor of Psychology
and Cognitive Science
Department of Psychological and Brain
Sciences
Indiana University, Bloomington
Bloomington, Indiana
Chapter 13

Vicki L. Reynolds, MEd

Literary Consultant
Region 10 Education Service Center
Allen, Texas
Chapter 17

Patricia A. Roush, AuD

Associate Professor
Department of Otolaryngology–Head and
Neck Surgery
University of North Carolina at Chapel
Hill
Director of Pediatric Audiology
University of North Carolina Hospitals
Chapel Hill, North Carolina
Chapters 3 and 22

Kristina Celani Rousso, AuD

Assistant Professor
 Clinical Otolaryngology
 Caruso Family Center for Childhood
 Communication
 Tina and Rick Caruso Department of
 Otolaryngology–Head and Neck
 Surgery
 University of Southern California
 Los Angeles, California
Chapter 2

Erin C. Schafer, PhD

Associate Professor
 Department of Audiology and Speech-
 Language Pathology
 University of North Texas
 Denton, Texas
Chapter 5

**Rachel Anna Scheperle, AuD, PhD,
CCC-A**

Postdoctoral Fellow
 Hearing Science
 University of Iowa
 Iowa City, Iowa
Chapter 7

**Debra Kay Schrader, BS, LSLC Cert.
AVT**

Educational Specialist
 Assistant Professor
 Clinical Otolaryngology
 Keck School of Medicine
 Caruso Family Center for Childhood
 Communication
 University of Southern California
 Los Angeles, California
Chapter 17

Richard C. Seewald, PhD

Distinguished University Professor
 Emeritus
 The National Centre for Audiology
 University of Western Ontario

London, Ontario, Canada
Chapter 3

Osnat Segal, PhD

Department of Communication Disorders
 Speech and Hearing Sciences
 Sackler Faculty of Medicine
 Tel-Aviv University
 Tel Aviv, Israel
Chapter 11

Yevgeniy R. Semenov, MD, MA

Research Fellow
 Johns Hopkins University
 School of Medicine
 Baltimore, Maryland
Chapter 15

Robert V. Shannon, PhD

Professor of Research
 Tina and Rick Caruso Department of
 Otolaryngology–Head and Neck
 Surgery
 Keck School of Medicine
 University of Southern California
 Los Angeles, California
Chapter 23

Sigfrid D. Soli, PhD

Clinical Professor of Otolaryngology
 (Adj.)
 Keck School of Medicine
 University of Southern California
 Senior Clinical Research Scientist
 House Clinic
 Los Angeles, California
Chapter 9

Carren J. Stika, PhD

Adjunct Faculty
 School of Speech, Language and Hearing
 Sciences
 San Diego State University
 San Diego, California
Chapter 12

Dana L. Suskind, MD

Professor, Director
Pediatric Cochlear Implant Program
Otolaryngology–Head and Neck Surgery
and Pediatrics
University of Chicago Hospital
Chicago, Illinois
Chapter 20

Holly F.B. Teagle, AuD

Associate Professor
The Children’s Cochlear Implant Center at
UNC
University of North Carolina
Chapel Hill, North Carolina
Chapter 22

Viral D. Tejani, AuD

Clinical/Research Audiologist
Cochlear Implant Program
Department of Otolaryngology–Head and
Neck Surgery
University of Iowa Hospitals and Clinics
Iowa City, Iowa
Chapter 7

Kristin Uhler, PhD, CCC-A

Assistant Professor
University of Colorado-Denver, School of
Medicine
Denver, Colorado
Chapter 8

Rachel Umans, BA

Chicago, Illinois
Chapter 20

Susan Wiley, MD

Professor
University of Cincinnati
Cincinnati Children’s Hospital Medical
Center

Division of Developmental and Behavioral
Pediatrics
Cincinnati, Ohio
Chapter 21

Margaret E. Winter, MS, CCC-A

Board Certified in Audiology
Associate Professor
Clinical Otolaryngology
University of Southern California
Caruso Family Center for Childhood
Communication
Los Angeles, California
Chapter 2

Jace Wolfe, PhD

Director of Audiology and Research
Hearts for Hearing
Oklahoma City, Oklahoma
Chapter 5

Carlton J. Zdanski, MD, FAAP, FACS

Chief
Division of Pediatric Otolaryngology
Associate Professor
Department of Otolaryngology–HNS
Surgical Director
The North Carolina Children’s Airway
Center
University of North Carolina
Chapel Hill, North Carolina
Chapter 22

Yun Zheng, MD, PhD, MSc, Aud(C)

President, Chinese Academy of
Audiological Rehabilitation (CAAR)
Professor/Director, Hearing Center
Department of Otolaryngology–Head and
Neck Surgery
West China Hospital of Sichuan University
Chengdu, Sichuan, China
Chapter 9

increases and becomes more sophisticated, de-contextualization increases. Academic learning incorporates more frequent usage of decontextualized talk. Recent studies highlight the importance of incorporating and teaching academic language in preschool programs (Bunch, 2013; Cummins, 2014; Gebhard, Chen, & Britton, 2014).

To develop proficiency, acquire content knowledge, and develop skills identified within the CCSS, a learner must demonstrate proficiency using academic talk and competency using decontextualized talk. Academic talk has been defined by van Kleeck (2014) as the broader pattern of language use incorporated into teaching and learning contexts. Academic talk is transferred from adults to children in turn, allowing children to develop and display academic knowledge. There is a growing body of research on the development of broad based formal register that incorporates the use of academic talk in school aged children. For children who are DHH there is compelling evidence of the need to incorporate the use of academic talk within the home environment and preschool learning contexts. Academic talk is embedded within the school curriculum, most often not taught explicitly. Comprehension and effective use of academic talk is essential to literacy skill attainment and overall school success. The CCSS contain embedded expectations for proficiency with the use of formal register and academic talk.

There is significant value in increasing the use of academic talk in inclusive preschool programs, specialized educational programs, and during listening and spoken language intervention and speech and language therapy sessions for preschool children who are DHH. Waiting for DHH children to naturally acquire the use of academic talk will place them substantially behind their peers. Children who are typi-

cally developing and whose parents possess higher levels of education often demonstrate greater proficiency with formal register and academic language by the time they are school age. Our early intervention efforts must focus on the development of formal register and academic language in children who are DHH as well. Timely introduction of the use of academic talk positively supports early school achievement levels which are directly related to reading comprehension skills. Geers, Tobey, Moog, and Brenner (2008) identified that 72% of the variance in reading outcomes in 181 students deafened by 3 years of age and implanted prior to 5.5 years of age was accounted for by child and family variables and speech and language use in the home. Further investigation of family variables and the quantity and quality of academic talk during the preschool years in children who are DHH is needed. Speech-language pathologists, early interventionists, listening and spoken language specialists, and parents who support children's early educational experiences must take advantage of every opportunity to use explicit teaching and academic talk during the preschool learning years.

Developing Language and Early Literacy Abilities

Throughout the preschool years, a child's vocabulary increases at a rapid rate. Children typically use approximately 300 words by age 3 years; 1,500 words by age 4, and 2,500 words by age 5. This number rapidly increases between the ages of 5 and 7 years to approximately 12,000 to 13,000 words. (Gard, Gilman, & Gorman, 1980; Templin, 1967). Children should be acquiring between two and three words per day by the first grade year which equals an addi-

tional 800 words per year. Children who lag behind in vocabulary skills in the first grade have difficulty closing the word gap (Biemiller, 1999; Luckner & Cooke, 2010).

A child's understanding of vocabulary is a significant predictor of early reading success (Kim, Apel, & Al Otaiba, 2013). Children who are able to acquire rich extensive vocabularies are able to understand more of what they read; the "Matthew Effect" occurs. That is, those who know more words learn more words and as result become better readers (Stanovich, 2000). When children comprehend with ease as a result of knowing more words, they tend to read more. The more the children read and are read to during the preschool and early elementary years, the more competent children become in determining the meaning of unknown words.

Studies on vocabulary acquisition indicate that implantation in children younger than 2 years of age using CIs may achieve receptive vocabulary abilities equivalent to their typically developing peers (Connor, Craig, Radenbush, Heavner, & Zwolan, 2006; Fagan, 2015; Svirsky, Teoh, & Neuberger, 2004). The ability to overhear conversations and acquire linguistic information through incidental listening is crucial to building a strong understanding of vocabulary and a substantial lexicon. The contribution of incidental listening may be greater for children with CIs than in children who are DHH but who do not use CIs; however, even with a CI some children may not have sufficient hearing to adequately access language and other environmental information that supports incidental learning (Convertino, Borgna, Marschark, & Durkin, 2014).

As children progress through the grades, their ability to learn new words and increase their understanding of vocabulary is dependent upon their ability to add morphemes to the root word. Sixteen suffixes account for

87% of suffixed words. The suffixes *-s/-es*, *-ed*, and *-ing* account for 65% of word suffixes; the suffixes *-ly*, *-er/-or*, *-ion/-tion*, *-able/-ible*, *-al*, *-y*, *-ness*, *-ity*, *-ment* account for 22% of word suffixes (Stahl & Nagy, 2006; White, Stowell, & Yanagihara, 1989). A child's ability to use appropriate verb inflections and word endings correlates with a child's early reading and writing progress. A child who demonstrates the use of inflectional endings in spoken language should be able to incorporate the use of these cues in error correction strategies when learning to read. Conversely, the child with poor abilities to use inflectional endings may produce more reading errors and experience a greater degree of difficulty making self corrections. The acquisition of bound inflectional ending rules is a process that cannot be left to memorization. These rules continue to be acquired during the early schooling years, mandating the consistent need for auditory access, classroom acoustical enhancements, and the use of sound field and personal FM systems to ensure access to spoken language in children who are DHH listening with CIs and ABIs. In children who are typically developing, grammatical knowledge becomes a better predictor of reading comprehension than vocabulary skills by the second grade (Berninger, Abbott, Nagy, & Carlisle, 2010).

The level of reasoning required to support meeting the CCSS necessitates the use of inferential analysis abilities. Inferential uses of language require the child to think beyond literal meaning. Language use must support the development of a hypothesis and the abilities to predict, to generalize, to summarize, to evaluate, to analyze, and to create. For this reason, the authors suggest that interventionists, including speech-language pathologists, incorporate the use of the think-aloud strategies. By verbally stating their thoughts (i.e., using "think-aloud")

adults model what they are thinking, for example:

I am going to look at the picture on the front cover of the book. The picture might give me information about where the story is happening. Maybe the story will happen in the forest. I will need to read the story to find out.

Think-alouds support error free learning.⁵ It is also essential that service providers, care takers, and family members provide necessary wait time that allows young children who are DHH to process language rather than immediately scaffolding responses to support a child's comprehension.

Young children learning to read must acquire a metalinguistic understanding of language and conventions associated with printed texts such as comprehending what a word is, what a sound is, or what a letter is, and knowing the rules of directionality, including the use of left to right sweep and that we read from the top of the page to the bottom of the page. Print referencing techniques incorporated into shared reading experiences support greater gains in alphabetic knowledge, print concept knowledge, and early name writing skills (Justice, Kaderavek, Fan, Sofka, & Hunt, 2009). In addition to acquiring concepts of print and word knowledge, a child needs to develop an ability to produce most of the sounds of speech when attempting to read in order to link these skills to clusters of letters. The articulation of a word is linked to the sequence of sounds in a word (Zaporozhets, Zinchenk, & Elkonin, 1971). It has

been found that good articulation skills are associated with early progress in writing (Robinson, 2005). When articulation delays are evident at an early age in children who are DHH, strong consideration should be given to providing individualized instruction and intervention by knowledgeable service providers, including a certified and licensed speech-language pathologist.

As children develop increased proficiency in spoken language use and incorporate a greater degree of academic talk, typically developing children begin telling their own stories. Storytelling is a crucial step in learning to read and write. Children begin narrating their own stories; they soon develop the understanding that print can be turned into speech. A child develops the understanding that speech or the story's message can be recorded in writing. The picture accompanying the text serves as a guide to the written message. Children gain more experience with storytelling and come to the realization that some components of language begin recurring more frequently. As this understanding develops, a child comes to the realization that words often appear in a given order. Memory aids in the overall understanding of this process.

A child with a good memory for language may rely heavily on recalling what someone else has said. From the child's perspective, he is using his strengths. From an educational perspective, this comes with considerable risks if it interferes with the development of supporting visual strategies crucially bound to the reading and writing processes. It is vital during this early reading stage that young children develop the ability to search, to check, to formulate,

⁵Error free learning is an instructional design based on the work of B. F. Skinner that has been correlated with improved outcomes in individuals with impairments in memory. Individuals with sufficient memory function can recall their mistakes and learn from them. Those with reduced memory function may have difficulty recalling what supported learning most effectively. Error free repetition may be required to solidly link information (Thorne, 2006).

to recheck, and to self-correct in order to confirm accurate responses. A linguistically capable child will make errors in reading; however, these errors may be both grammatical and meaningful. Knowledge of language guides the child's responses and self-corrections.

Recent models for viewing the relationship between phonological awareness, spoken language, and reading development incorporate the role of working memory, executive function, and fluency in children who are typically developing (DeThorne, Petrill, Schatschneider, & Cutting, 2010). Children who are DHH may require explicit instruction in language development, phonological awareness training, and instructional support in attending to the development of executive function, Theory of Mind, and fluency during their primary years (Geers, Pisoni, & Brenner, 2013). Knowledgeable parents may contribute to the development of these skills in their children with the guidance of a literacy coach or highly qualified service provider. In this way parents have the opportunity to play a vital role in developing their child's language and literacy skills.

The functions and forms of literacy are equally important when developing reading and writing abilities. Young children learn the functions and forms of reading and writing concurrently through shared literacy experiences, such as writing a list before going to the grocery store. Families are essential to literacy development. Researchers have found repeatedly that the home literacy environment of toddlers and preschoolers has measurable effects on later literacy skills (Weinberger, 1996). Adult contributions provided during the

preschool language learning years through increased quality of talk and conversation with a child also play a significant role in top down phonological decoding and encoding necessary for the development of reading and writing skills (DeThorne et al., 2010). We believe that the quality of talk during conversational exchanges will support greater language and literacy outcomes in children who are DHH as well. Therefore, school placements for preschool children who are DHH and the provision of services under Part B of IDEA (2004) must be carefully considered. In addition to careful analysis of school placement, curricular methodologies selected that support early reading and writing processes in children who are DHH must be carefully analyzed, continuously evaluated, and reviewed for instructional fidelity by transdisciplinary team members. The authors believe that including balanced literacy instruction⁶ by providing children who are DHH with quality literature, explicit instruction in phonics, grammar skills, reading and comprehension, and writing instruction during the preschool and school aged years could provide significant educational benefit. While this evidence-based practice (balanced literacy) has been incorporated in general education classroom settings for decades, there is a need for investigation and research regarding the efficacy for use with children who are DHH using implantable technologies.

Preparing for Reading Instruction

Children with hearing loss bring to the task of reading language experiences that are

⁶Balanced literacy instruction is an evidenced based instructional approach that incorporates the use of whole language and phonics, balances teacher talk with child talk, and incorporates dialogic reading, read aloud, interactive read aloud, shared reading, guided reading, shared writing, interactive writing and guided writing.

both similar to and different from those of hearing children (Hanson, 1987). The National Reading Panel (2000) identifies five key components of reading instruction: phonological awareness/phonemic awareness, phonics, fluency, vocabulary instruction, and text comprehension. Lack of attention to teaching early foundational reading skills, such as phonemic awareness and phonics, may contribute to the reading difficulties experienced by students who are DHH and may contribute to the fourth-grade ceiling consistently documented for more than 90 years (Wang, Trezek, Luckner, & Paul, 2008).

Learning to read and write requires children to utilize four primary processing systems: an orthographic processor, a phonological processor, a meaning processor, and a context processor.

Children acquire the reading and writing processes during their preschool and early elementary years, increasing their competence with the use of the four primary reading processing systems, over time throughout the elementary years. Development of phonological awareness—the overall awareness of the sound of words—is deeply rooted in early conversational experiences that foster reading development and phonological awareness through interaction. Children develop this awareness through play with the sounds of spoken language incorporated in early rhyming activities, and also during early writing activities when they begin to explore the relationship of writing one's speech in print by identifying what is heard through recorded printed letters (Anderson & Briggs, 2011). A child's phonological and phonemic awareness is supported through early access to spoken language by full-time use of prescribed amplification. Children with CIs and ABIs may benefit from explicit intervention in

the development of phonological awareness skills applying research based instructional practices (Schuele & Boudreau, 2008). Avoiding prolonged use of electronic media that may distract the listener from attending to oral features of language is recommended. Clinicians must guide parents in allowing the young newly implanted listener to develop an internal schema necessary for organizing sound and its ultimate relationship to print. The contribution of phonological awareness to word learning and language learning in young CI users has been linked to building effective reading processors (Mayer & Trezek, 2014). Refer to Figure 17-1.

The four processing systems work jointly to assist with decoding and comprehension of printed text. The orthographic processor refers to the ability to use orthographic knowledge to read and spell words. This knowledge is critically bound to reading fluency and the spelling of words. Children rely on using their visual system to form, store, and recall words. Young readers learn to look at letters and words on a page and use their knowledge of sound/symbol relations to decode, or sound-out, the word. Eventually the child stores the memory of the word in the brain and retrieves the information at a later time. Words memorized in their entirety are defined as sight words. Children rely on orthographic processing to remember words and recall them later when reading and writing. Orthographic processing and phonological processing develop as parallel processing systems. Eventually children who are typically developing are able to store a significant number of words and no longer rely on sounding out the words. The meaning processing system involves incorporating the use of semantic relationships underlying meaning of words. Vocabulary knowledge plays a primary role

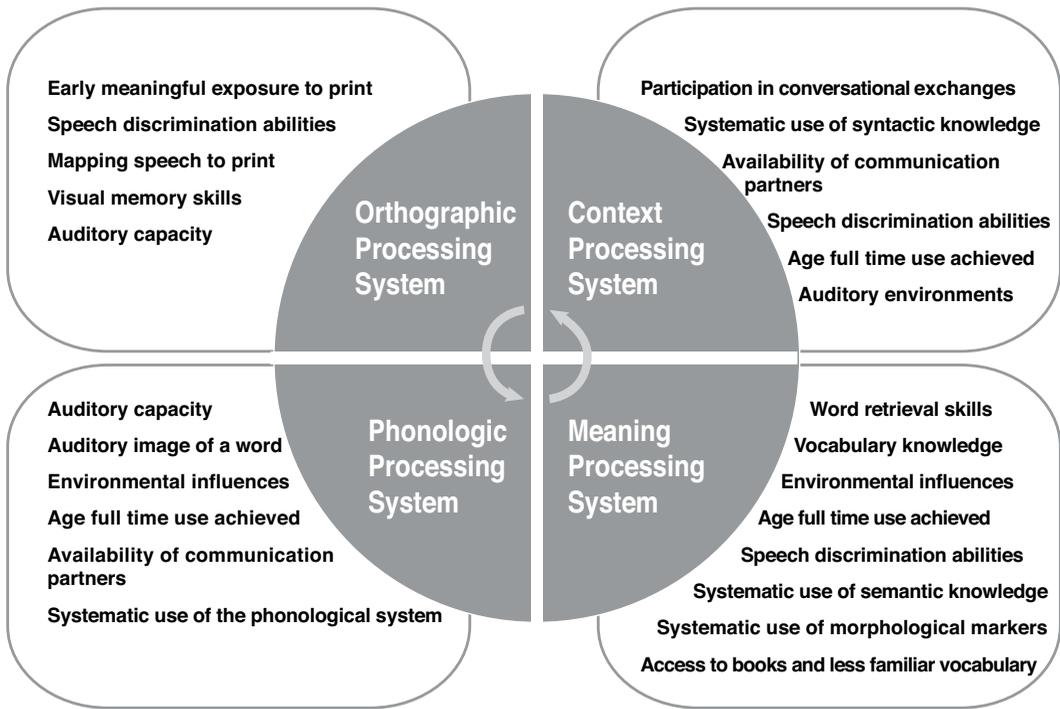


Figure 17-1. Relationships between listening and spoken language development to the use of the four processing systems.

in the application of the meaning processing system when reading. Young children begin to systematically apply their knowledge of word meanings to interpret text that they are decoding. The final processing system, the context processing system, involves the order and arrangement of words bound to printed text, (e.g., the use of syntax to support decoding and comprehending printed text). As children develop coordination and proficiency using all four processing systems, they reduce the amount of effort required to read. Reading becomes automatic; when automaticity is achieved, cognitive efforts decrease. This frees cognitive resources that can be allocated to support higher levels of achievement through increased comprehension and engagement

with the text. If one of the processing systems is weak, reading outcomes may be constricted.

The use of each of the processing systems may be highly effective or ineffective in an individual implanted child. Given the complexity of the acquisition of the reading and writing processes, education and intervention practices must not further contribute to reading difficulties of children who are DHH by allowing them to continue to use ineffective processes for literacy learning. Success in school historically has been highly correlated with reading and writing abilities (Taylor & Pearson, 2002). Traditional viewpoints toward slow progress in young readers often suggest that a child needs more time to develop phonological

awareness skills. These viewpoints may be incorrect; slow progress may be the result of developing ineffective processing systems. Allowing a child to continue operating on a haphazard system with no means for efficiently monitoring or checking his accuracy may perpetuate poor progress (Clay, 1991). Service providers during the preschool and primary years must possess the necessary expertise to implement and monitor the overall development of the reading and writing processes to avoid allowing children to continue to use ineffective processes, thus delaying reading and writing skill development (Katz & Fallon, 2015). Similarly, the authors believe that children who are DHH and continue to use ineffective processes as young readers are at great educational risk for reaching the well documented fourth grade reading ceiling levels. Children can be prompted and guided by mainstream preschool teachers, teachers of the deaf and hard of hearing, listening and spoken language specialists, and their parents to the acquisition of these early reading processes.

It is essential that young children who are DHH using spoken language develop listening and speaking skills that parallel reading and writing processes. Sharing books with infants provides visual stimuli and auditory pleasure. Long before a child understands what a book is, learning is taking place. The child who looks at books as early as 2 years of age will scan pictures for meaningful messages (Clay, 1979). An unfamiliar book will take the brain longer to scan pictures; comprehending and labeling images will require additional processing time. Young children need time to analyze two dimensional spaces.

By increasing early experiences with picture books, children who are DHH gain experience scanning visual information while developing necessary visual control. Young children whose musculature is not

well developed (e.g., children who do not have good control of hand-eye movements) may encounter later difficulties in acquiring necessary directionality when learning to read if early literacy experiences are infrequent. When a child develops inappropriate scanning abilities at an early age, the eyes do not support what the head and body are trying to achieve when responding to pictures and to text. The relationship of eye movements to more advanced reading is essential when developing left to right, top to bottom directionality, discriminating and identifying individual letters, and identifying clusters of letters. The inflexible use of directionality is often difficult for typically developing 5-year-old children; we must not underestimate the importance of attending to and providing appropriate intervention which monitors the development of these processes in young CI and ABI users.

The years before a child enters school are prime years for nurturing reading behaviors that will carry them into becoming readers. Talking about books allows parents the opportunity to encourage an interest in books, expand vocabulary, and spend quality time with their children, thus building fundamental literacy abilities (Davidse, de Jong, Bus, Huijbregts, & Swaab, 2011; Taylor & Pearson, 2002). In addition to the importance of talking to and with the child as discussed earlier in the chapter, the value of reading aloud to children of all ages has been studied for years as well (Mol & Bus, 2011). Reading aloud has been determined to be the most important factor in raising a child to be a reader (Trelease, 2001). Bus and van Ijzendoorn (1988) and Wasik (2004) emphasized the importance of reading to children prior to their sixth birthday; this exposure corresponded to higher outcomes in the areas of language growth, emergent literacy, and reading achievement. Their research supported the concept that read-

ing development starts before the preverbal stage of linguistic development. Early shared book reading through read-alouds also offers an opportunity to support the acquisition of decontextualized language and vocabulary (Justice, Pence, & Beckman, 2005).

Children listening with CIs and ABIs will need more linguistic input, more opportunities to acquire and use decontextualized language, increased exposure to different genres, and a greater number of background experiences than their peers who are typically developing. Schirmer (2000) suggests reading aloud to a child who is DHH before the child can understand every word and every concept. Parents and service providers are encouraged to consider the level of difficulty of story books selected for early read aloud experiences. Considerations should be given to the overall complexity of the language and story structure, the quantity and type of inference found within the text, and abstract concepts introduced, the length of the book, and the child's experiential familiarity (Schwarz et al., 2015).

When children begin to read, they incorporate simultaneous use of visual, auditory, and tactile kinesthetic senses (Clay, 1979). Support for integration of these senses begins at birth. Familiarity with early books triggers a brain response. Research indicates that between the ages of 3 and 9 years the young child fully comprehends that the two sides of the body are different from one another (McManus, et al., 1988). Sensory postural awareness develops during this period of time. Dominant hand awareness likewise is developing. Children double their frequency of eye movements between ages 4 to 6 years relative to the age of 3 years

(Clay, 1991). The child who has had a greater number of early literacy experiences incorporating the use of all sensory systems most likely will demonstrate a greater degree of readiness for formal literacy instruction.

Formal Literacy Instructional Practices

Balanced literacy, based on the research of Marie Clay, Irene Fountas, Gay Su Pinnell and others, is a comprehensive model of language acquisition that incorporates fundamentals of listening, speaking, reading, writing, and word study into daily instruction (Clay, 1991; Fountas & Pinnell, 2006; Pinnell & Fountas, 2007). It is also a curricular methodology which includes the use of modeled, shared, guided, and independent practice when teaching effective reading and writing skills. Balanced literacy instruction offers equal time for teacher talk and child talk during teacher-directed and child-directed learning activities (determined through the ongoing administration of formal and informal assessments) supporting multiple opportunities for engagement, expression, and inquiry. The authors believe that children who are DHH using listening and spoken language may benefit from a balanced literacy approach rooted in highly individualized instruction that moves learners from high dependency on teacher support to learner independence. This model of literacy instruction is frequently incorporated in the Reader's and Writer's Workshop model⁷ of instruction in general education classrooms.

⁷A result of a mandate to improve instructional practices in the New York City Public Schools, the Columbia Teacher's College Reading and Writing Project, was pedagogical work (e.g., Reader's and Writer's Workshop) that supported daily instruction in reading as well as writing. The workshop approach to teaching literacy, rooted in the work of Lucy Calkins, provides explicit instruction in comprehending text (Calkins & Bellino, 1997).