Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix. CDaCI (Childhood Development after Cochlear Implantation) Investigators

House Ear Institute, Los Angeles, California: Laurie S. Eisenberg, PhD, CCC-A (principal investigator [PI]); Karen Johnson, PhD, CCC-A (coordinator); Traci Critton, PhD (data collection); Jean DesJardin, PhD (data collection); Melinda Gillinger (data collection); William Luxford, MD (surgeon); Amy Martinez, MA, CCC-A (data collection); Louise Mebane, PhD (data collection); Jennifer Regnery, MS (data collection); Leslie Visser-Dumont, MA, CCC-A (data collection). Johns Hopkins University, Listening Center, Baltimore, Maryland: John K. Niparko, MD (PI); Steve Bowditch, MS, CCC-A (data collection); Jill Chinnici, MA, CCC-A (data collection); James Clark, MB (data analyst); Howard Francis, MD (surgeon); Jennifer Mertes, AuD, CCC-A (coordinator); Rick Ostrander, EDD (data collection); Jennifer Yeagle, MEd, CCC-A (data collection); Jiovani Visaya, MD (data analyst); Josef Coresh MD, PhD (data analyst). Johns Hopkins University, The River School, Washington, DC: Nancy Mellon (administration); Mary O'Leary Kane, MA, CCC-SLP (coordinator); Sarah Wainscott (data collection); Jennifer Wallace, MS, CCC-SLP (data collection). University of Miami, Miami, Florida: Annelle Hodges, PhD (PI); Thomas Balkany, MD (surgeon); Alina Lopez, MA, CCC-SLP/A (coordinator); Leslie Goodwin, MSN, CCRC (data collection); Stacy Payne, MA, CCC-A (data collection). University of Michigan, Ann Arbor: Teresa Zwolan, PhD (PI); Amy Donaldson, MA, CCC-A (coordinator); H. Alexander Arts, MD (surgeon); Brandi Butler, MA, CCC-A (data collection); Hussam El-Kashlam, MD (surgeon); Krista Heavner, MS, CCC-SLP (data collection); Mary Beth O'Sullivan, MS, CCC-A (data collection); Steve Telian, MD (surgeon); Ellen Thomas, MA, CCC-SLP (data collection); Anita Vereb, MS, CCC-A (former coordinator). University of North Carolina, Carolina Children's Communicative Disorders Program, Chapel Hill: Carolyn J. Brown, MS (PI); Holly F. B. Teagle, AuD (coordinator); Craig A. Buchman, MD (surgeon); Carlton Zdanski, MD (surgeon); Hannah Eskridge, MSP (data collection); Harold C. Pillsbury, MD (surgeon). University of Texas at Dallas, Callier Advanced Hearing Research Center, Dallas: Emily A. Tobey, PhD, CCC-SLP (PI); Betty Loy, AuD, CCC-A (coordinator); Paul Bauer, MD (surgeon); Angela Boyd, BA (data collection); Laura Cantu, BS (data collection); Carol Cokely, PhD, CCC-A (data collection); Sarah Florence, MS, CCC-A (data collection); Janee Gisclair, MS, CCC-A (data collection); Laura Levitan, BA (data collection); Joy Penrad (data collection); Shannon Raby, MA, CCC-SLP (data collection); Jamie Rasmus, BS (data collection); Peter Roland, MD (surgeon); Heather MacFadyen, MS, CCC-SLP (data collection); Donise Pearson, MS, CCC-SLP (data collection); Deborah M. Rekart, PhD (former coordinator); Lauren Sacar, BA (data collection); Melissa Sweeney, MS, CCC-SLP (data collection); Linsey Wagner, BA (data collection); Nicole Weissner, BA (data collection); Berkley Williams, MA, CCC-SLP (data collection).

eAppendix. CDaCI (Childhood Development after Cochlear Implantation) Investigators (continued)

Resource Centers: Data Coordinating Center, Johns Hopkins University, Welch Center for Prevention, Epidemiology, and Clinical Research, Baltimore: Nancy E. Fink, MPH (PI); Patricia Bayton (data assembly); Daniel Habtemarian (data assembly); Neil R. Powe, MD, MPH, MBA (senior epidemiologist); Thelma Vilche (data assembly); Nae-Yuh Wang, PhD (co-PI, biostatistician, data assembly and analysis). Psychometrics Center, University of Miami, Department of Psychology, Coral Gables, Florida: Alexandra L. Quittner, PhD (PI); David Barker (data analysis); Pam Leibach (data analysis); Ivette Cruz (data analysis). *Study Oversight Committees: Executive Committee:* John K. Niparko, MD (chair); Laurie S. Eisenberg, PhD; Nancy E. Fink, MPH; Alexandra L. Quittner, PhD; Donna Thal, PhD; Emily A. Tobey, PhD, Nae-Yuh Wang, PhD. *External Advisors:* Noel Cohen, MD; Julia Evans, PhD; Ann Geers, PhD; Karen Iler Kirk, PhD, Anil Lalwani, MD.

eTable. Measures: Domain Probed, Age Administered, Respondent, Construct(s) Measured and Interpretation

Domain/Use	Test	Age	Respondent	Construct(s) Measured	Interpretation
Cognition/screening	Bayley Scales of Infant Development[1]	<2 y	Child	Physical and mental development	Exclusion from study if >2 SDs from age-normed scores established in typical childhood populations
	Leiter Brief Form[2]	>2 y	Child	Nonverbal cognitive abilities	
Language/1° outcome	Reynell Developmental Language Scales[3,4]	1-6 y 11 mo	Child	Comprehension and expressive skills of spoken language	Score relative to age-normed scores established in typical childhood populations; range, 0-67: 0-3 represents no selective recognition of objects in the environment; >60 represents comprehension and expressive language similar to normal-hearing 4- to 5-year-olds
Speech Recognition Index[5,6]/2° outcome	Infant-toddler meaningful auditory Integration scale (IT-MAIS)[7]	1-3 y	Parent	Parent perception of everyday communication behaviors	Hierarchical battery of tests of speech recognition The SRI generates scores between 0-600 based on: IT-MAIS/MAIS: 0-100 ESP: 101-200 PSI: 201-300 MLNT/LNT: 301-400 PBK: 401-500 HINT-C: 501-600
	Meaningful auditory integration scale (MAIS)[8]	>4 y	Parent	Parent perception of everyday communication behaviors	
	Early speech perception (low verbal)[9]	>2 y	Child	Word perception using toys	
	Early speech perception (standard)[9]	3-7 y	Child	Word perception requiring a picture-pointing response	
	Pediatric Speech Intelligibility (PSI-Format II) (standard)[10]	3-7 y	Child	Word/sentence stimuli requiring a picture-pointing response	

eTable. Measures: Domain Probed, Age Administered, Respondent, Construct(s) Measured and Interpretation (continued)

Domain/Use	Test	Age	Respondent	Construct(s) Measured	Interpretation
	Multisyllabic/lexical Neighborhood Test (MLNT)[11]	>3 y	Child	Word recognition ability requiring verbal response	
	Lexical Neighborhood Test (LNT)[11]	>4 y	Child	Word recognition ability requiring verbal response	
	Phonetically balanced word list (PBK)[12]	>5 y	Child	Word recognition ability requiring verbal response	
	Hearing in Noise Test (HINT-C)[13]	>5 y	Child	Word and sentence recognition requiring verbal response	
Video analysis of child/provider interaction/2° outcome	Parent-child interactions videotaped and coded[14]: - Free play, Puzzles, Art gallery, Symbolic play - Noun learning	Toy sets selected for age of child	Parent-Child interaction	Respect for child autonomy, positive regard, cognitive stimulation, shared visual attention, bi-directional interaction	Mean scaled scores of 2 observers rating parental sensitivity, time in joint attention, and communicative competence

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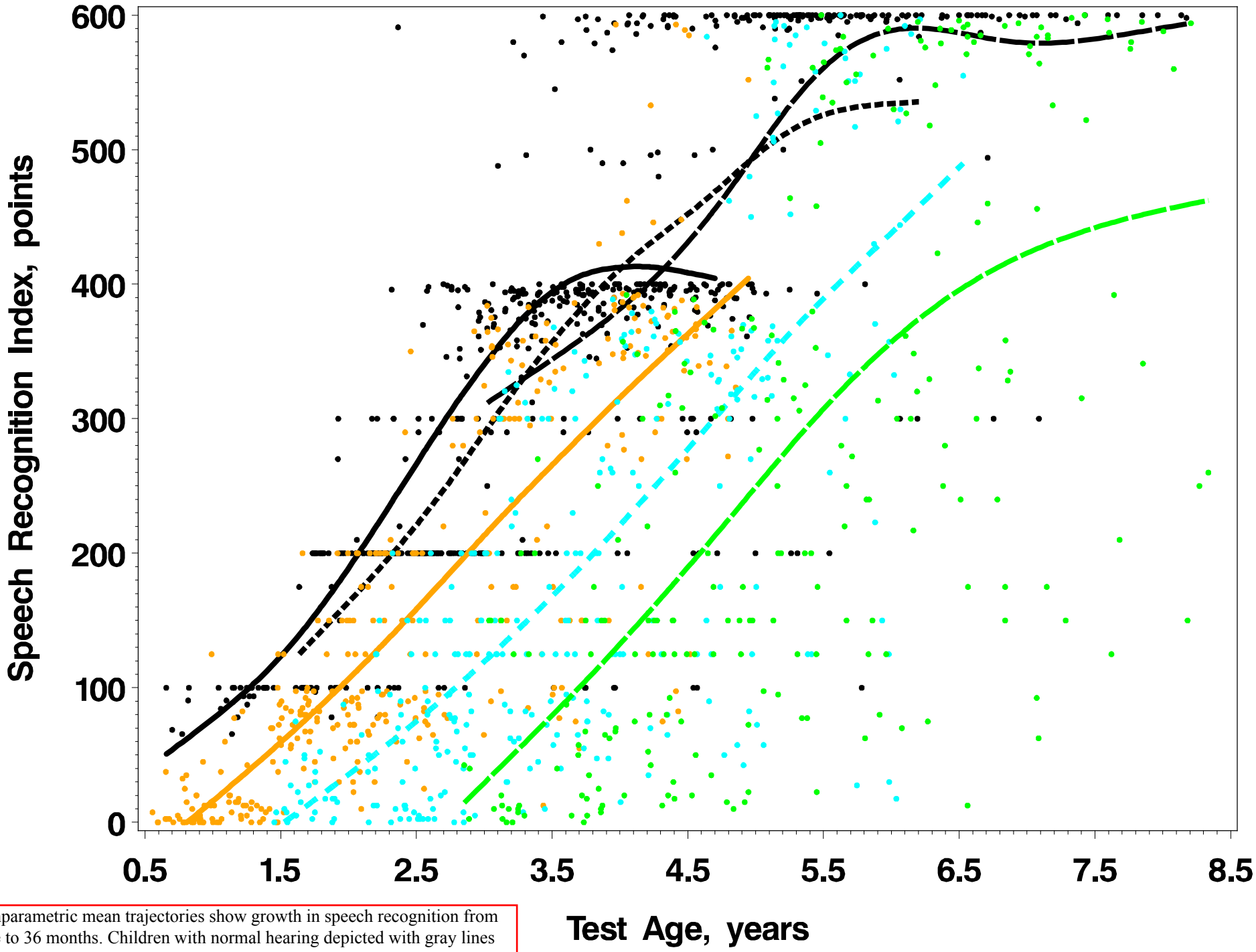
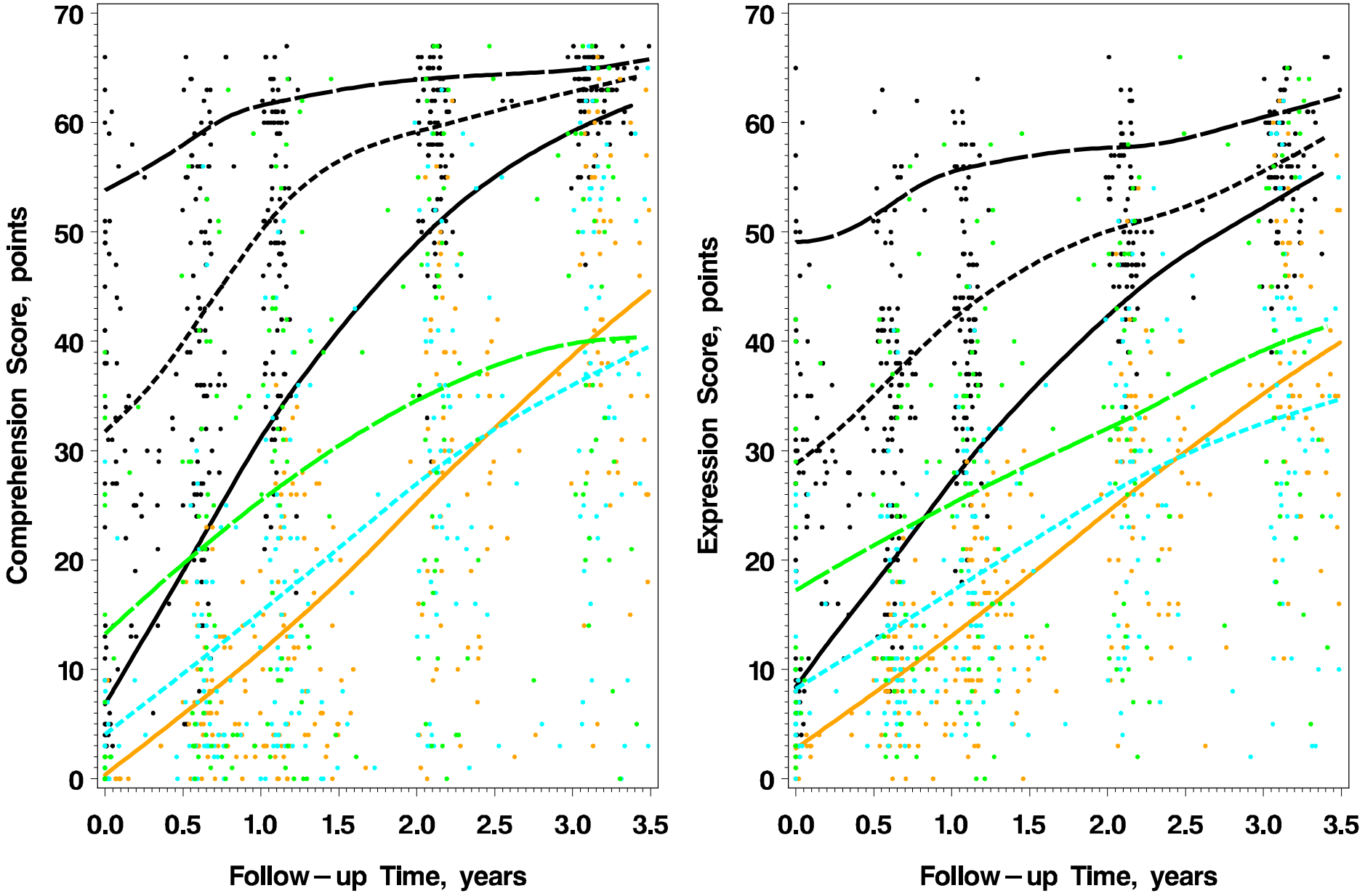
eFigure 1. Nonparametric mean trajectories within the SRI of measures of speech recognition.



The nonparametric mean trajectories show growth in speech recognition from baseline to 36 months. Children with normal hearing depicted with gray lines and mean scores in black; Children undergoing CI: Implant age <18 months in orange, 18-36 months in cyan, and >36 months in green.

eFigure 2. Nonparametric fit of RDLS raw scores of comprehension and expression over 3-year follow-up by age at baseline.

Hearing children in black (categorized by age at enrollment: < 18 months in solid line, 18-36 months in short dash, >36-60 months in long dash). Children undergoing CI at age <18 months in orange, 18-36 months in cyan, and >36 months in green). Children undergoing CI at <18 months demonstrated higher rates of oral language acquisition (12.5 points/year in comprehension [P<0.0001]; 10.2 points/y in expressive language; [P<0.0001]). Children undergoing CI >36 months achieved higher a language level at baseline (14.9 points in comprehension with [P<0.0001]; 17.8 points in expressive language with [P<0.0001] but a slower growth rate (8.9 points/year in comprehension [P<0.0001] and 7.1 points/year in expressive language [P<0.0001]).



eFigure 3. Nonparametric fit of RDLS raw scores of comprehension and expression in children undergoing CI stratified by implant age and baseline RDLS scores. Children undergoing CI at >36 months sub-stratified by history of hearing deficit.

Normal hearing children are stratified by baseline ages and designated by black lines: solid represents hearing children < 18 months; short dashed 18-36 months; long-dashed >36 months. Children undergoing CI: Implant age <18 months in red; 18-36 months in orange dash. Children undergoing CI at >36 months of age are further stratified to demonstrate language associations with 2 clinical factors: the history of hearing deficit experienced (SNHL prior to, and after amplification) and RDLS scores at baseline. Children undergoing CI >36 months with 2 years or less of hearing deficit and baseline RDLS raw scores > 10 in light green; CI >36 months with greater than 2 years of hearing deficit and baseline RDLS raw scores >10 in dark green. Children undergoing CI >36 months with 2 years or less of hearing deficit and baseline RDLS raw score of <10 in light blue; Children undergoing CI >36 months with greater than 2 year of hearing deficit and baseline RDLS raw score <10 in dark blue.