6 VISUAL LANGUAGE & VISUAL LEARNING (VL2)
LEARNING FROM SCIENCE: RESEARCH BRIEF

THE IMPLICATIONS OF BIMODAL BILINGUAL APPROACHES FOR CHILDREN WITH COCHLEAR IMPLANTS

Photo credit: Clerc National Deaf Education Center

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KEY FINDINGS

- For deaf children with cochlear implants, a visual language such as American Sign Language (ASL) can provide advantages for the child's linguistic, communicative, cognitive, academic, literacy, and psychosocial development.
- Studies in neuroscience confirm that the brain has the ability to learn both visual and spoken languages. Furthermore, learning both a visual and a spoken language does not harm the development of either language.
- The development of early competence in a visual language can effectively facilitate a child's spoken language development.
- A bimodal bilingual language and communication approach – which addresses acquisition and use of both a visual and a spoken language – has the potential to foster early language through the child's vision while also stimulating the child's audition through a cochlear implant.
- Interaction with members of the Deaf community can be beneficial for the deaf child or adolescent's identity formation and social-emotional development.
- With systematic individualized planning, a rich spoken language environment can be provided within a bimodal bilingual setting.

The implications of bimodal bilingual approaches for children with cochlear implants

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Advantages of Visual Language for Children with Cochlear Implants

A review of the research in neuroscience demonstrates that the brain has the ability to acquire both a visual and spoken language without harm to the development of either language.[1,2,3] In addition, there is no evidence that visual language inhibits long-range spoken language outcomes.[4,5,6,7]

There is increasing evidence that early competence in a visual language can then be effectively used to support and facilitate a child's spoken language development.[5,9,10,11,12,13] In addition, there are numerous studies documenting the advantages of visual language for the linguistic, communicative, cognitive, academic, literacy, and psycho-social development of children and adolescents with cochlear implants.[9,13,14,15,16,17,18,19]

This research brief provides an overview of the key findings related to visual language and its advantages for young deaf learners with cochlear implants. Additionally, this brief discusses the implications of bimodal bilingual approaches for young deaf learners.

Bimodal bilingual approaches promote the development and use of both a natural signed language and a spoken language.[20,21,22,23,24] This approach is "additive," meaning that it builds upon a child's strength in one language while also addressing the development and use of a second language.[25]

In other words, prior to getting a cochlear implant a deaf child accesses language primarily through the visual modality. The bimodal bilingual approach facilitates the child's development and use of visual language while adding the development and use of a spoken language.[26,27,28,29,30,31,32,33,34,35]

Why is it important for parents and educators to learn more about visual language and its role in the language and communication development of deaf learners with cochlear implants?

One significant and important reason for parents and educators to learn more about visual language and its role in the language and communication development of deaf learners with cochlear implants is that studies indicate that many implanted deaf children do not develop the ability to use spoken language solely for learning and communication. Difficulties in developing spoken language are due to many interrelated factors specific to the child, the family, and the cochlear implant technology itself.


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As spoken language outcomes are unpredictable for all children who are deaf or hard of hearing, there is a risk of language delay if an accessible visual language is not used as early as possible.[24,36,37,38,39,52]

This risk also applies to children who do not have quality access to spoken language prior to implantation, who are just beginning to develop spoken language skills following implantation, or who for any number of reasons may not develop competence in spoken language following implantation.[17]

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Visual language also benefits those children who receive their implants after the typical language learning years. Research on the cortical development of children with cochlear implants indicates that the plasticity of the central auditory system begins to decline after 3.5 years of age, making it more difficult for them to acquire a spoken language. Evidence also shows that after 7 years of age, a deaf child’s auditory system begins to reorganize, and implantation after this time is no longer optimal for the development of spoken language.[40,41]

This reinforces the need for those children to have proficiency in visual language for access to communication and learning.

The Evidence for a Bimodal Bilingual Approach

A review of the evidence indicates that there are no clear disadvantages to the use of visual language and many added benefits to the use of a bimodal bilingual approach for children with cochlear implants.

Regarding the advantages of early visual language:

- There is a strong body of evidence documenting the linguistic advantages of early visual language for all deaf and hard of hearing children, including children with cochlear implants.[42]
- There is increasing evidence documenting that, regardless of the child's hearing status, early bilingual language exposure to both a visual and a spoken language can change the brain's neural circuitry in advantageous ways; these changes positively impact linguistic and other higher cognitive capacities.[43]
- There is evidence showing that the use of a visual language and interaction with native users of a visual language are beneficial for the identity and social-emotional development of children and adolescents using a cochlear implant.[44] Based on the evidence documenting the advantages of early visual language, a bimodal bilingual approach — which incorporates philosophies, beliefs, and practices to foster the development and use of both a visual and a spoken language —is strongly supported for children with cochlear implants.

A brief review of the history of bilingual practices in deaf education will help place bimodal bilingualism in context. During the 1980s, deaf education teachers and language specialists began developing bilingual practices for teaching deaf students. These bilingual practices addressed the needs of deaf learners, particularly in relation to language accessibility and cultural and identity development. These practices are referred to as the bilingual-bicultural ("Bi-Bi") approach.

> **"There is increasing evidence documenting that, regardless of the child's hearing status, early bilingual language exposure to both a visual and a spoken language can change the brain's neural circuitry in advantageous ways."**

In the Bi-Bi approach in the United States, development of a visual language — ASL — is promoted as a first language and used as the medium of instruction and communication; English is addressed primarily through reading and writing.[45,46,47,48]

More recently, bilingual educators have included the development of spoken English as appropriate for and consistent with a child's potential for oral/aural development.[46,49] Now that growing numbers of deaf children access spoken language through digital hearing aids and cochlear implants, many bilingual educational programs have incorporated additional strategies and opportunities for children to develop and use a spoken language.

This type of bilingual approach, which may provide auditory access at certain times during the school day, can be referred to as a *bimodal bilingual approach*.

The Bimodal Bilingual Advantage for Children and Adolescents with Cochlear Implants

There are numerous benefits to a bimodal bilingual approach for children and adolescents with cochlear implants. In contrast to a monolingual/oral approach, this approach has the advantage of:

- Providing the proven benefits of bilingualism (i.e., communicative and cognitive flexibility, enhanced metalinguistic awareness and problem-solving skills, and greater cultural access and knowledge) to children with cochlear implants.[25,44]
- Providing an environment in which two languages are interdependent and learning one language facilitates the learning of the other language.[10,50]
- Promoting linguistic competence without compromising cognitive development, academic learning, and social-emotional growth.[51]
- Safeguarding language acquisition and learning through a deaf child's intact visual modality while stimulating, using, and evaluating spoken language. This safeguarding is especially important during the critical period of a child's linguistic development.[36,37,38,39,52]
- Expanding opportunities for early vocabulary expansion[38,53,54,55] and phonologic development in both languages[56,57] (which have been found to have a positive influence on the development of literacy skills).
- Providing language foundations in both visual and spoken languages so that the deaf learner has options for communication in social interactions in addition to options for access to learning in academic environments.[49,58]

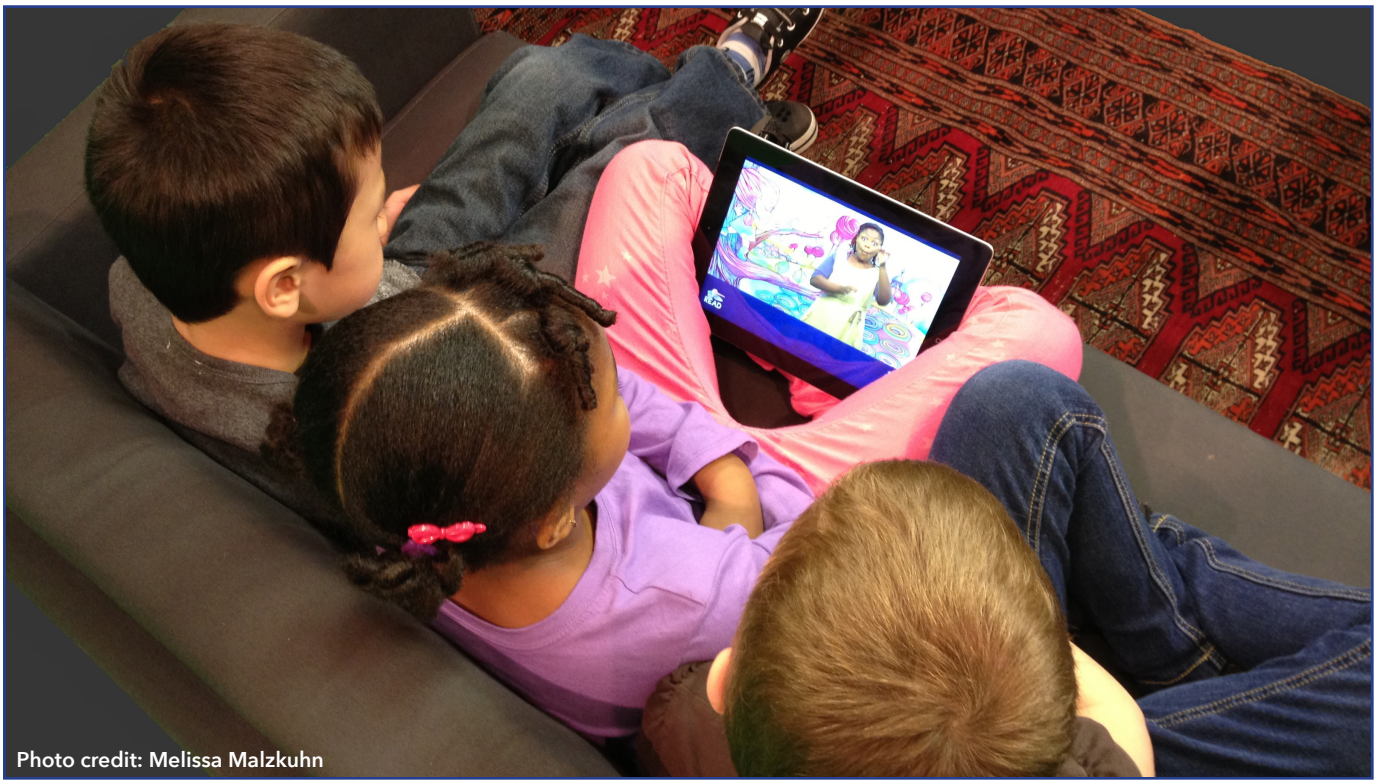
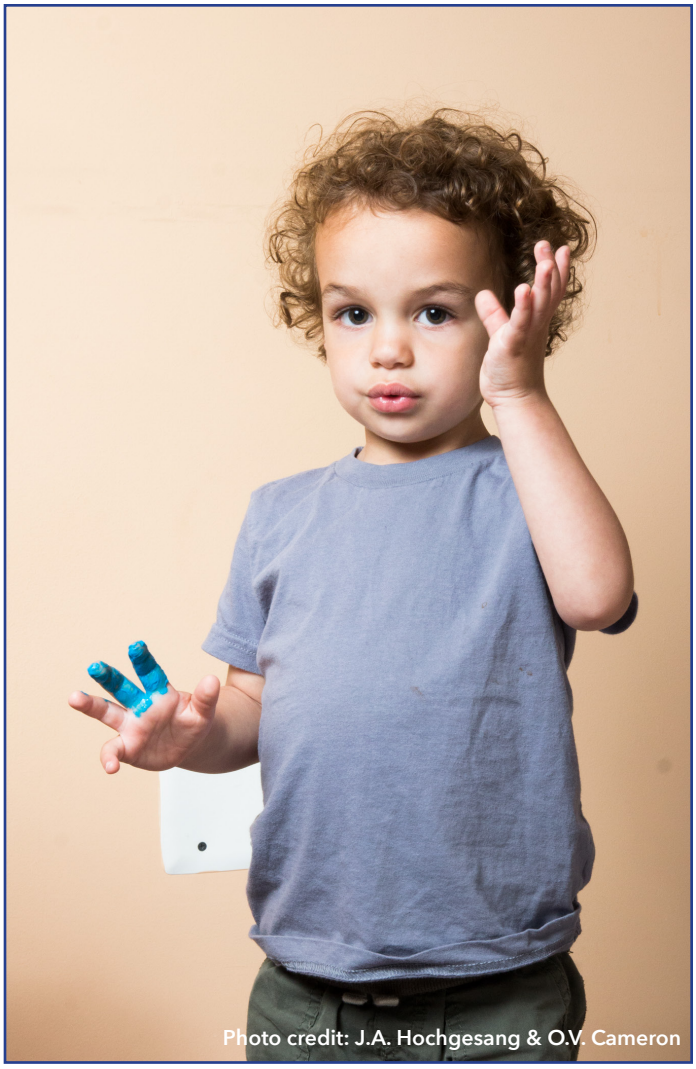


Photo credit: Melissa Malzkuhn

- Providing an environment that allows the learner to interact with members of the Deaf community. Interaction with those who are native users of a visual language and who share common experiences, beliefs, and values[59] is beneficial to the identity formation and social-emotional development of a deaf child or adolescent.[15,18,19,51,60,61,62,63,64,65,66,92]
- Facilitating linguistic competence in both a visual and a spoken language provides expanded opportunities for direct and accessible communication between a child and his or her family members. This has been shown to increase a child's perception of self as well as overall quality of life.[67]
- Providing accessible language and communication so that the child has options when, for example, he or she has limited spoken language skills or is unable to use the cochlear implant or hearing aid, is in a challenging listening environment (as is the case when a device malfunctions), or is interacting with deaf peers without a cochlear implant.[5,17]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Implications for Family and Professional Education

While many hearing families embrace some form of sign use for their children with cochlear implants, sign language is typically viewed as a bridge to or support for spoken language. Few families and professionals are aware of the implications and advantages of full access to a visual language.[4,15,68,69,70,71,72,73,74,75,76,77,78,79,80,81]

Evidence suggests that with appropriate education, hearing families are open to learning about the benefits of a visual language and the value of interaction with a Deaf community and culture.[15,16,17,66,80,82,83]

There is an increasing population of culturally Deaf families who choose cochlear implants for their children. Many of these families state that the objective for their child is to be linguistically fluent in ASL and written English in addition to being competent in spoken English. Their aim is for their child to develop social and academic proficiency in both visual and spoken languages and for him or her to have the opportunity to participate in both the Deaf and the hearing communities.[83,84,85,93]

Within the Deaf community, there is increasing acceptance of the use of cochlear implant technology as a tool, one of several in the range of possibilities for children who are deaf. Some members of the Deaf community continue to cite concern about cochlear implants in general and specifically pediatric implantation.[61,92]

In order to foster increased awareness of bilingualism and support for a bimodal bilingual approach, family and professional education should include:

- Providing research documenting the advantages of visual language for the overall development of children with cochlear implants.
- Research from linguistics and neuroscience demonstrating that bilingualism does not cause language delay or confusion.[86]
- Research discussion of the equence of typical bimodal bilingual development. Given a fully accessible language environment, there are similar developmental milestones for ASL and spoken English.[94]
- Concrete strategies about how this approach can effectively be designed to facilitate development of spoken language.[4,14,69,83,87]
- Discussion of the equence of typical bimodal bilingual development. Given a fully accessible language environment, there are similar developmental milestones for ASL and spoken English.[94]
- Discussion of the equence of typical bimodal bilingual development. Given a fully accessible language environment, there are similar developmental milestones for ASL and spoken English.[94]
- Discussion of the value in promoting a child's use of both a visual language and a spoken language from the start rather than adding a visual language only when the spoken language fails to develop.[17,24]

Bimodal Bilingual Planning and Implementation

Each child's path to becoming bilingual is unique; therefore, systematic individualized planning and monitoring of the development and use of each language is central to implementing a bimodal bilingual approach.[88]

With individualized planning, use of a visual and a spoken language can be tailored to reflect the varied characteristics of children prior to implantation and following implantation. This planning process can be applied to children with varied demographic characteristics, including those with additional disabilities, those obtaining implants in the early language development stages, and those obtaining implants beyond the early language development years and during adolescence.[49,58]

Planning and implementation include the development of an individualized profile and assessment of the child, which then are used to guide learning activities and how and when each language is used in the classroom and at home as well as to provide recommendations for support services.[49,58,88]

When designing a bimodal bilingual approach to address the development and use of a spoken and a visual language, it is important that the child's environment include evidence-based strategies and techniques integral to each language.

For spoken language, this includes an environment that promotes consistent use of the cochlear implant device, availability of rich spoken language models, consistent valuation and use of spoken language, and the presence of professionals and families knowledgeable with strategies and techniques to facilitate spoken language development and use.[13,35,70,74,78,89,90] Similarly, for visual language it is crucial to provide an environment that includes rich visual language models and professionals and families knowledgeable in the strategies and techniques to facilitate development and use of visual language.[44,49,88]

Issues in Cochlear Implant Research

While researching and writing this brief, a number of issues emerged for the writers when they reviewed the literature related to the use of visual language for children with cochlear implants. Early language acquisition and cochlear implantation research is generally clinical in nature, related predominantly to the development of speech perception and speech production skills. This research often does not reflect all aspects of language development.[91]

Additionally, when discussed in the literature, "sign" is rarely defined, and the quantity and quality of sign use is typically not discussed. When sign-inclusive approaches were studied, it was generally in Total Communication settings. Researchers in these settings were often investigating the use of sign as a support to spoken language.

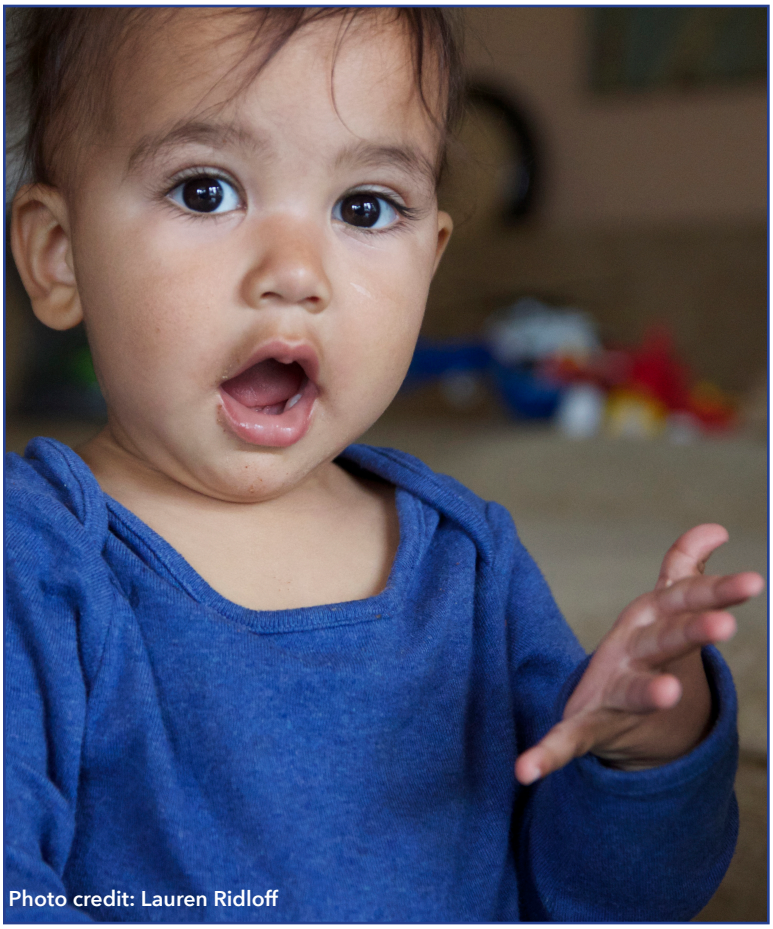
The writers of this brief found no longitudinal studies that looked at the development and the use of both a full visual language and a spoken language. Furthermore, the writers found that many researchers did not consider the complexities of language modality and how modality interacts with a multitude of factors impacting spoken language outcomes and implant outcomes in a variety of other domains, such as psychosocial development, literacy, and academic achievement.[53,90]

There was also only limited attention paid to cochlear implant user perspectives on how modality use (visual as opposed to auditory) related to quality of life.[10]

Further Research

Research is needed that looks beyond spoken language outcomes as a measure of a child's success with a cochlear implant and explores:

- The impact of early visual language acquisition and learning on the linguistic, cognitive, social- emotional, and academic development of early implanted children.
- The impact of visual language use on the linguistic, cognitive, social-emotional, and academic development of late-implanted children and adolescents.
- The longitudinal outcomes comparing orally educated implanted children and those educated using an ASL/English bimodal bilingual approach.
- Effective practices to facilitate development of both a visual and a spoken language for implanted children within a bimodal bilingual program.
- Family and child/adolescent perspectives on the use of the cochlear implant, bimodal bilingual development, and quality of life.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Translating VL2 Research

The National Science Foundation Science of Learning Center on Visual Language and Visual Learning (VL2) publishes research briefs as a resource for parents, educators, and others who work with deaf and hard of hearing children. These briefs review important research findings, summarize relevant scholarship, and present informed suggestions for parents, educators, and professionals.

The information provided in this brief is intended to explain the advantages of bimodal bilingual approaches for young deaf children with cochlear implants or hearing aids.

This research brief is co-sponsored by the Laurent Clerc National Deaf Education Center and the VL2 Center.

For more information on visual language and cochlear implants, see the Clerc Center Cochlear Implant Education Center webpage: www.gallaudet.edu/Clerc_Center/Information_and_Resources/ Cochlear_Implant_Education_Center.html.

VL2 Resources for Your Family and Your Classroom

Scientific discoveries from the National Science Foundation Science of Learning Center on Visual Language and Visual Learning (VL2) at Gallaudet University have provided foundational knowledge that has been used to create important evidence-based translational resources.

Key discoveries that contribute to VL2's translation of science span multiple VL2 laboratories and include the discovery that early exposure to a visual language provides visual processing and higher cognitive processing advantages; early bilingual ASL and English exposure provides powerful dual language benefits; and visual sign phonology plays an important facilitative role in the young deaf child's early acquisition of reading English in the same way that sound phonology has a facilitative role in young hearing children's accessing of meaning from English print.

VL2 has created translational, educational, and ethical resources for educators, practitioners, policymakers, parents, researchers, and the greater public. For more information, see:

- vl2.gallaudet.edu
- www.vl2storybookapps.com
- www.vl2parentspackage.org

VL2 Center Mission Statement

The Center's primary mission is to improve learning through an understanding of the behavioral and brain mechanisms of learning primarily through vision and visual processes, with our scientific questions being motivated and informed by an exciting balance of advances and questions in science and advances and questions in learning and social environments. Our mission is to create a science of learning using a two-way discovery model in which practitioners and scientists exchange ideas freely and mutually identify core questions in educational and social practice that would be fundamentally advanced with knowledge from the behavioral and brain sciences. The mission involves the advancement of two overarching complementary groups.

Clerc Center Mission Statement

The Clerc Center, a federally funded national deaf education center, ensures that the diverse population of deaf and hard of hearing students (birth through age 21) in the nation are educated and empowered and have the linguistic competence to maximize their potential as productive and contributing members of society. This is accomplished through early access to and acquisition of language, excellence in teaching, family involvement, research, identification and implementation of best practices, collaboration, and information sharing among schools and programs across the nation.

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References

1. Kovelman, I., Shalinsky, M. H., White, K. S., Schmitt, S. N., Berens, M. S., Paymer, N., et al. (2009). Dual language use in sign-speech bimodal bilinguals: fNIRS brain-imaging evidence. *Brain & Language, 109*, 112-123. doi: 10.1016/j.bandl.2008.09.008

2. Petitto, L. A., Katerelos, M., Levy, B. G., Gauna, K., Tetreault, K., & Ferraro, V. (2001). Bilingual signed and spoken language acquisition from birth: Implications for the mechanisms underlying early bilingual language acquisition. *Journal of Child Language, 28*, 453-496.

3. Petitto, L. A., & Kovelman, I. (2003). The bilingual paradox: How signing-speaking bilingual children help us resolve bilingual issues and teach us about the brain mechanisms underlying all language acquisition. *Learning Languages, 8*(3), 5-18.

4. Archbold, S., Sach, T., O'Neill, C., Lutman, M., & Gregory, S. (2008). Outcomes from cochlear implantation for child and family: Parental perspectives. Deafness and Education International, 10(3), 120-142. doi:10.1002/dei.243

5. Giezen, M. R. (2011). *Speech and sign perception in deaf children with cochlear implants* (Doctoral dissertation). Retrieved from UvA-DARE. (374190)

6. Marschark, M., & Hauser, P. C. (2012). *How deaf children learn: What parents and teachers need to know.* New York: Oxford University Press, Inc.

7. Marschark, M., Schick, B., & Spencer, P. E. (2006). Understanding sign language development of deaf children. In B. Schick, M. Marschark, & P. E. Spencer (Eds.), *Advances in the sign language development of deaf children* (pp. 3-19). New York: Oxford University Press.

8. Spencer, P. E. (2009, April). *Research to practice.* Presented at Cochlear Implants and Sign Language: Building Foundations for Effective Educational Practices. Washington, DC: Laurent Clerc National Deaf Education Center, Gallaudet University.

9. Jimenez, M. S., Pino, M. J., & Herruzo, J. (2009). A comparative study of speech development between deaf children with cochlear implants who have been educated with spoken or spoken + sign language. *International Journal of Pediatric Otorhinolaryngology, 73*(1), 109-114. doi:10.1016/j.ijporl.2008.10.007

10. Preisler, G., Tvingstedt, A. L., & Ahlström, M. (2005). Interviews with deaf children about their experiences using cochlear implants. *American Annals of the Deaf, 150*(3), 260-267.

11. Seal, B. C., Nussbaum, D. B., Belzner, K. A., Scott, S., & Waddy-Smith, B. (2011). Consonant and sign phoneme acquisition in signing children following cochlear implantation. *Cochlear Implants International, 12*(1), 34-43.

12. Tait, M., Lutman, M. E., & Robinson, K. (2000). Preimplant measures of preverbal communicative behavior as predictors of cochlear implant outcomes in children. *Ear & Hearing, 21*(1), 18-24.

13. Yoshinaga-Itano, C. (2006). Early identification, communication modality, and the development of speech and spoken language skills: Patterns and considerations. In P. E. Spencer & M. Marschark (Eds.), *Advances in the spoken language development of deaf and hard-of-hearing children* (pp. 298-327). New York: Oxford University Press.

14. Bat-Chava, Y., & Deignan, E. (2001). Peer relationship of children with cochlear implants. *Journal of Deaf Studies and Deaf Education, 6*(3), 186-199. doi: 10.1093/deafed/6.3.186

15. Christiansen, J. B., & Leigh, I. W. (2004). Children with cochlear implants: Changing parent and deaf community perspectives. *Archives of Otolaryngology- Head and Neck Surgery, 130*(5), 673-677.

16. Hyde, M., & Punch, R. (2011). The modes of communication used by children with cochlear implants and the role of sign in their lives. *American Annals of the Deaf, 155*(5), 535-549.

17. Kermit, P. (2010). Choosing for the child with cochlear implants: A note of precaution. *Medicine, Health Care, and Philosophy, 13*(2), 157. doi: 10.1007/s11019-010-9232-9

18. Most, T., Wiesel, A., & Blitzer, T. (2007). Identity and attitudes towards cochlear implants among deaf and hard of hearing adolescents. *Deafness Education International, 9*(2), 68-82. doi:10.1002/ dei.207

19. Preisler, G., Tvingstedt, A. L., & Ahlström, M. (2002). A psychosocial follow-up study of deaf preschool children using cochlear implants. *Child: Care, Health & Development, 28*(5), 403-418. doi: 10.1046/j.1365-2214.2002.00291.x

20. Berent, G. P. (2004). Sign language-spoken language bilingualism: Code mixing and mode mixing by ASL-English bilinguals. In W. C. Ritchie & T. K. Bhatia (Eds.), *The handbook of bilingualism* (pp. 312-335). Malden, MA: Blackwell.

21. Bishop, M. (2006). *Bimodal bilingualism in hearing, native users of American Sign Language* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Database. (UMI No. 3337513)

22. Emmorey, K., Bornstein, H. B., & Thompson, R. (2005). *Bimodal bilingualism: Code-blending between spoken English and American Sign Language.* In J. Cohen, K. T. McAlister, K. Rolstad, & J. MacSwan (Eds.), ISB4: Proceedings of the 4th International Symposium on Bilingualism (pp. 663-673). Somerville, MA: Cascadilla Press.

23. Emmorey, K., & McCullough, S. (2009). The bimodal bilingual brain: Effects of sign language experience. *Brain and Language, 109*, 124-132. doi: 10.1016/j.bandl/2008.03.005

24. Humphries, T., Kushalnagar, P., Mathur, G., Napoki, D. J., Padden, C., Rathmann, C., et al. (2012). Language acquisition for deaf children: Reducing the harms of zero tolerance to the use of alternative approaches. *Harm Reduction Journal, 9*(16). doi:10.1186/1477-7517-9-16

25. Baker, C. (2006). *Foundations of bilingual education and bilingualism* (4th ed.). Clevedon, England: Multilingual Matters.

26. Belzner, K. A., & Seal, B. C. (2009). Children with cochlear implants: A review of demographics and communication outcomes. *American Annals of the Deaf, 154*(3), 311-333.

27. Fagan, M. K., Pisoni, D. B., Horn, D. L., & Dillon, C. M. (2007). Neuropsychological correlates of vocabulary, reading, and working memory in deaf children with cochlear implants. *Journal of Deaf Studies and Deaf Education, 12*(4), 461-471. doi: 10.1093/deafed/enm023

28. Hawker, K., Ramirez-Inscoe, J., Bishop, D. V., Twomey, T., O'Donoghue, G. M., & Moore, D. R. (2008). Disproportionate language impairment in children using cochlear implants. *Ear & Hearing, 29*(3), 467-471.

29. Inscoe, J. R., Odell, A., Archbold, S., & Nikolopoulos, T. (2009). Expressive spoken language development in deaf children with cochlear implants who are beginning formal education. *Deafness and Education International, 11*(1), 39-55. doi:10.1002/dei.252

30. Nicholas, J. G., & Geers, A. E. (2007). Will they catch up? The role of age at cochlear implantation in the spoken language development of children with severe to profound hearing loss. *Journal of Speech, Language, and Hearing Research, 50*(4), 1048-1062. doi:10.1044/1092-4388(2007/073)

31. Pisoni, D. B., Conway, C. M., Kronenberger, W. G., Horn, D. L., Karpicke, J., & Hennings, S. C. (2008). Efficacy and effectiveness of cochlear implants in deaf children. In M. Marschark & P. C. Hauser (Eds.), *Deaf cognition: Foundations and outcomes* (pp. 52-101). New York: Oxford University Press.

32. Robbins, A. M., Koch, D. B., Osberger, M. J., Zimmerman-Phillips, S., & Kishon-Rabin, L. (2004). Effect of age at cochlear implantation on auditory skill development in infants and toddlers. *Archives of Otolaryngology—Head Neck Surgery, 130*, 570-574.

33. Sarant, J. Z., Holt, C. M., Dowell, R. C., Rickards, F. W., & Blamey, P. J. (2009). Spoken language development in oral preschool children with permanent childhood deafness. *Journal of Deaf Studies and Deaf Education, 14*(2), 205-217. doi: 10.1093/deafed/enn034

34. Spencer, P. E. (2004). Individual differences in language performance after cochlear implantation at one to three years of age: Child, family, and linguistic factors. *Journal of Deaf Studies and Deaf Education, 9*(4), 395-412. doi:10.1093/deafed/ enh033

35. Wie, O. B., Falkenberg, E. S., Tvete, O., & Tomblin, B. (2007). Children with a cochlear implant: Characteristics and determinants of speech recognition, speech-recognition growth rate, and speech production. *International Journal of Audiology, 46*(5), 232-243. doi: 10.1080/14992020601182891

36. Mayberry, R. I. (1993). First-language acquisition after childhood differs from second-language acquisition: The case of American Sign Language. *Journal of Speech, Language, and Hearing Research, 36*(6), 1258-1270.

37. Mayberry, R. I., & Eichen, E. B. (1991). The long- lasting advantage of learning sign language in childhood: Another look at the critical period for language acquisition. *Journal of Memory and Language, 30*(4), 486-512. doi: 10.1016/0749-596X(91)90018-F

38. Mayberry, R. I., Lock, E., & Kazmi, H. (2002). Linguistic ability and early language exposure. *Nature, 417*(6884), 38. doi:10.1038/417038a

39. Schick, B., de Villiers, J., de Villiers, P., & Hoffmeister, R. (2007). Language and theory of mind: A study of deaf children. *Child Development, 78*(2), 376-396.

40. Sharma, A., & Dorman, M. F. (2006). Central auditory development in children with cochlear implants: Clinical implications. *Advances in Otorhinolaryngology, 64*, 66-88.

41. Sharma, A., Dorman, M. F., & Kral, A. (2005). The influence of a sensitive period on central auditory development in children with unilateral and bilateral cochlear implants. *Hearing Research, 203*, 134-143.

42. Visual Language and Visual Learning Science of Learning Center. (2011, January). *Advantages of early visual language* (Research Brief No. 2). Washington, DC: Sharon Baker.

43. Petitto, L. A. (2009). New discoveries from the bilingual brain and mind across the lifespan: Implications for education. *International Journal of Mind, Brain and Education, 3*(4), 185-197.

44. Swanwick, R., & Tsverik, I. (2007). The role of sign language for deaf children with cochlear implants: Good practice in sign bilingual settings. *Deafness and Education International, 9*(4), 214-231. doi: 10.1002/dei.226

45. Nover, S. (1995). Politics and language: American Sign Language and English in deaf education. In C. Lucas (Ed.), *Sociolinguistics in deaf communities* (pp. 109-163). Washington, DC: Gallaudet University Press.

46. Nover, S. M., Christensen, K. M., & Cheng, L. L. (1998). Development of ASL and English competence for learners who are deaf. *Topics in Language Disorders, 18*(4), 61-72.

47. Reynolds, D. O., & Titus, A. M. (1991). Bilingual/ bicultural education: Constructing a model for change. In S. Polowe-Aldersley, P. Schragle, V. Armour, & J. Polowe (Eds.), *Proceedings of the New Orleans 1991 CAID/CEASD Convention* (pp. 127-133). Silver Spring, MD: The Convention.

48. Vernon, M., & Daigle, B. (1994). Bilingual and bicultural education. *Deaf American Monograph, 44*, 121-126.

49. Garate, M. (2011). Educating children with cochlear implants in an ASL/English bilingual classroom. In R. Paludneviciene & I. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp. 206-228). Washington, DC: Gallaudet University Press.

50. Cummins, J. (2006, October). *The relationship between American Sign Language proficiency and English academic development: A review of the research.* Paper presented at the conference of Challenges, Opportunities, and Choices in Educating Minority Group Students, Norway. Retrieved from http://www.gallaudet.edu/ documents/cummins_asl-eng.pdf

51. Grosjean, F. (2008). *Studying bilinguals.* Oxford, UK: Oxford University Press.

52. Mayberry, R. I. (2007). When timing is everything: Age of first-language acquisition effects on second-language learning. *Applied Psycholinguistics, 28*(3), 537-549. doi:10.1017/S0142716407070294

53. Connor, C. M., Hieber, S., Arts, H. A., & Zwolan, T. A. (2000). Speech, vocabulary, and the education of children using cochlear implants: Oral or total communication? *Journal of Speech, Language, and Hearing Research, 43*(5), 1185-1204.

54. Connor, C. M., & Zwolan, T. A. (2004). Examining multiple sources of influence on the reading comprehension skills of children who use cochlear implants. *Journal of Speech, Language, and Hearing Research 47*, 509-526.

55. Vermeulen, A., van Bon, W., Schreuder, R., Knoors, H., & Snik, A. (2007). Reading comprehension of deaf children with cochlear implants. *Journal of Deaf Studies and Deaf Education 12*(3), 283-302. doi:10.1093/deafed/ enm017

56. Goldin-Meadow, S., & Mayberry, R. I. (2001). How do profoundly deaf children learn to read? *Learning Disabilities Research & Practice, 16*(4), 222-229.

57. Petitto, L. A. (2000). On the biological foundations of human language. In K. Emmorey &

H. Lane (Eds.), *The signs of language revisited: An anthology in honor of Ursual Bellugi and Edward Klima* (pp. 447-471). Mahwah, NJ: Lawrence Erlbaum.

58. Nussbaum, D. B., & Scott, S. M. (2011). The Cochlear Implant Education Center: Perspectives on effective educational practices. In R. Paludneviciene & I. W. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp.175-205). Washington, DC: Gallaudet University Press.

59. Ladd, P. (2003). *Understanding deaf culture: In search of deafhood.* Tonawanda, NY: Multilingual Matters.

60. Archbold, S., & Wheeler, A. (2010). Cochlear implants: Family and young people's perspectives. In M. Marschark & P. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education* (Vol. 2, pp. 226-240). New York: Oxford University Press.

61. Paludneviciene, R., & Harris, R. L. (2011). Impact of cochlear implants on the deaf community. In R. Paludneviciene & I. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp. 3-19). Washington, DC: Gallaudet University Press.

62. Leigh, I. W., & Maxwell-McCaw, D. (2011). Cochlear implants: Implications for deaf identities. In R. Paludneviciene & I. W. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp. 95-110). Washington, DC: Gallaudet University Press.

63. Swanwick, R., & Gregory, S. (2007). *Sign bilingual education: Policy and practice.* Coleford, UK: Douglas McLean Publishing.

64. Keating, E., & Mirus, G. (2003). Examining interactions across language modalities: Deaf children and hearing peers at school. *Anthropology and Education Quarterly, 34*(2), 115-135.

65. Wald, R. L., & Knutson, J. F. (2000). Deaf culture identity of adolescents with and without cochlear implants. *The Annals of Otology, Rhinology and Laryngology, 109*(12), 87-89.

66. Wheeler, A., Archbold, S., Gregory, S., & Skipp, A. (2007). Cochlear implants: The young people's perspective. *Journal of Deaf Studies and Deaf Education, 12*(3), 303-316. doi:10.1093/deafed/enm018

67. Kushalnagar, P., Topolski, T. D., Schick, B., Edwards, T. C., Skalicky, A. M., & Patrick, D. L. (2011). Mode of communication, perceived level of understanding and perceived quality of life in youth who are deaf or hard of hearing. *Journal of Deaf Studies and Deaf Education, 16*(4), 512-523. doi:10.1093/deafed/enr015

68. Archbold, S., & O'Donoghue. (2009). Education and childhood deafness: Changing choices and new challenges. In J. K. Niparko (Ed.), *Cochlear implants: Principles & practice* (pp. 313- 345). Baltimore: Lippincott, Williams & Wilkins.

69. Archbold, S., Sach, T., O'Neill, C., Lutman, M., & Gregory, S. (2006). Deciding to have a cochlear implant and subsequent after-care: Parental perspectives. *Deafness and Education International, 8*(4), 190-206. doi: 10.1002/dei.20

70. Geers, A. E. (2006). Spoken language in children with cochlear implants. In P. E. Spencer & M. Marschark (Eds.), *Advances in the spoken language development of deaf and hard-of- hearing children* (pp. 244-270). New York: Oxford University Press.

71. Moeller, P. M. (2006). Use of sign with children who have cochlear implants: A diverse set of approaches. *Loud and Clear, 2*, 1 & 6-10.

72. Chute, P., & Nevins, M. E. (2006). *School professionals working with children with cochlear implants.* San Diego, CA: Plural Publishing, Inc.

73. Berg, A. L., Ip, S. C., Hurst, M., & Herb, A. (2007). Cochlear implants in young children: Informed consent as a process and current practices. *American Journal of Audiology, 16*(1), 13-28. doi: 10.1044/1059-0889(2007/003)

74. Geers, A. E., Spehar, B., & Sedey, A. (2002). Use of speech by children from Total Communication programs who wear cochlear implants. *American Journal of Speech-Language Pathology, 11*(1), 50-58. doi:10.1044/1058-0360(2002/006)

75. Hammes, D. M., Novak, M. A., Rotz, L. A., Willis, M., Edmondson, D. M., & Thomas, J. F. (2002). Early identification and cochlear implantation: *Critical factors for spoken language development. The Annals of Otology, Rhinology and Laryngology, 111*, 74-78.

76. Huttunen, K., & Välimaa, T. (2010). Parents' views on changes in their child's communication and linguistic and socioemotional development after cochlear implantation. *Journal of Deaf Studies and Deaf Education, 15*(4), 383. doi:10.1093/deafed/ enq029

77. Spencer, L. J., & Tomblin, J. B. (2006). Speech production and spoken language development of children using "Total Communication." In P. E. Spencer & M. Marschark (Eds.), *Advances in the spoken language development of deaf and hard of hearing children* (pp.166-192). New York: Oxford University Press.

78. Spencer, L. J., & Bass-Ringdahl, S. (2004). An evolution of communication modalities: Very young cochlear implant users who transitioned from sign to speech during the first years of use. *International Congress Series, 1273*, 352-355.

79. Watson, L. M., Archbold, S. M., & Nikolopoulos, T. P. (2006). Children's communication mode five years after cochlear implantation: Changes over time according to age at implant. *Cochlear Implants International, 7*(2), 77-91. doi:10.1002/cii. 301

80. Watson, L. M., Hardie, T., Archbold, S. M., & Wheeler, A. (2008). Parents' views on changing communication after cochlear implantation. *Journal of Deaf Studies and Deaf Education, 13*(1), 104-116. doi:10.1093/deafed/enm036

81. Wheeler, A., Archbold, S. M., Hardie, T., & Watson, L. M. (2009). Children with cochlear implants: The communication journey. *Cochlear Implants International, 10*(1), 41-62.

82. Hyde, M., & Power, D. (2006). Some ethical dimensions of cochlear implantation for deaf children and their families. *Journal of Deaf Studies and Deaf Education, 11*(1), 102-111. doi:10.1093/deafed/enj009

83. Hyde, M., Punch, R., & Komesaroff, L. (2010). Coming to a decision about cochlear implantation: Parents making choices for their deaf children. *Journal of Deaf Studies and Deaf Education, 15*(2), 162-178. doi:10.1093/deafed/enq004

84. Mitchiner, J. C., & Sass-Lehrer, M. (2011). My child can have more choices: Reflections of deaf mothers on cochlear implants for their children. In R. Paludneviciene & I. W. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp. 71-94). Washington, DC: Gallaudet University Press.

85. Mitchiner, J. (2012, May). *Deaf families with children who have cochlear implants: Beliefs & perspectives on bilingualism in American Sign Language & English.* Poster session presented at the 1st International Congress on Family-Centered Early Intervention for Children Who are Deaf and Hard of Hearing, Bad Ischl, Austria.

86. Petitto, L. A., & Holowka, S. (2002). Evaluating attributions of delay and confusion in young bilinguals: Special insights from infants acquiring a signed and spoken language. *Sign Language Studies, 3*(1), 4-33. doi: 10.1353/sls.2002.0025

87. Mayer, C., & Leigh, G. (2010). The changing context for sign bilingual education program: Issues in language and the development of literacy. *International Journal of Bilingual Education and Bilingualism,13*(2), 175-186.

88. Nussbaum, D. B., Scott, S., & Simms, L. E. (2012). The "why" and "how" of an ASL/English bimodal bilingual program. *Odyssey, 13*, 14-19.

89. Geers, A. E. (2002). Factors affecting the development of speech, language, and literacy in children with early cochlear implantation. *Language, Speech, and Hearing Services in Schools, 33*(3), 172-183. doi: 10.1044/0161-1461(2002/015)

90. Marschark, M., Rhoten, C., & Fabich, M. (2007). Effects of cochlear implants on children's reading and academic achievement. *Journal of Deaf Studies and Deaf Education, 12*(3), 269-282. doi: 10.1093/deafed/enm013

91. Beadle, E. A. R., McKinley, D. J., Nikolopoulos, T. P., Brough, J., O'Donoghue, G. M., & Archbold, S. M. (2005). Long-term functional outcomes and academic-occupational status in implanted children after 10-14 years of cochlear implant use. *Otology & Neurotology, 26*(6), 1152-1160.

92. Christiansen, J. B., & Leigh, I. W. (2011). Cochlear implants and deaf community perceptions. In R. Paludneviciene & I. W. Leigh (Eds.), *Cochlear implants: Evolving perspectives* (pp. 39-55). Washington, DC: Gallaudet University Press.

93. Nussbaum, D. B., & Mitchiner, J. (2012, May). *Cochlear implants: Where do visual language & deaf culture fit in?.* Poster session presented at the 12th International Conference on Cochlear Implants and Other Implantable Auditory Technologies, Baltimore, MD.

94. Andrews, J., Logan, R., Phelan, J. (2008, January). Milestones of language development for speech, hearing & ASL. *ADVANCE for Speech-Language Pathologists and Audiologists, 18*(2), 16. Retrieved January 15, 2010, from www.advanceweb.com

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