This annotated bibliography was developed to provide research-based support for the communication and language development of individuals who are deaf or hard of hearing (DHH). It includes research about typical language development, language development for children who are DHH, bilingual language development, cochlear implant and hearing aid outcomes, auditory brain development, early intervention, outcomes of Listening and Spoken Language (LSL) intervention, psychosocial development, literacy, and parent choice/coaching.

This is by no means a comprehensive list, but a good place to start. To recommend additional resources, please reach out to info@agbell.org with your suggestions.

2018-2024 Annotated Bibliography, Research and Reference List
Compiled by Carol Flexer, Ph.D., CCC-A, LSLS Cert. AVT

This compilation of 70 research articles published between 2018 and 2024 is extremely informative. A number of overall trends reveal:

1. There are far too many children who use hearing aids and cochlear implants who are substantially behind hearing peers in language, literacy and executive functioning abilities. Study after study document their deficits.
2. However, the reasons for their delays are also clearly identified: late identification, limited wear-time from day one, poor language environment at home (or at least, lack of an enriched language environment at home), and lack of language evaluations and therapy (especially vocabulary expansion) after 4 years of age.
3. Most studies do not specify the type of Listening and Spoken Language (LSL) intervention (typically therapy is with unspecified speech-language pathologists), but when Auditory-Verbal Therapy (AVT) is specifically evaluated, outcomes tend to be consistent with hearing peers. Listening and Spoken Language intervention works!

Language and Speech Development

Arjmandi, M. K., Houston, D., & Dilley, L.C. (2022). Variability in quantity and quality of early linguistic experience in children with cochlear implants: Evidence from analysis of natural auditory environments. ***Ear and Hearing, 43*****(2), 685-698. https://doi.org/10.1097/AUD.0000000000001136**
[Language Development; Parent Coaching; LSL Outcomes]

The purpose of this study (Arjmandi et al 2022) was to analyze the quantity and quality of language input to early-implanted children (age of implantation< 23 mo) during the first year after implantation.

Day-long Language ENvironment Analysis (LENA) recordings, derived from home environments of 14 early-implanted children, were analyzed to estimate numbers of words per day, type-token ratio (TTR), and mean length of utterance in morphemes (MLU m) in adults' speech.

The results demonstrated that children with CIs varied substantially in the quantity and quality of language input experienced in their home environments. More importantly, individual children experienced highly variable amounts of high-quality, child-directed speech, which may drive variability in language outcomes across children with CIs. This substantial individual variability suggests that the quantity and quality of early linguistic input are potential sources of individual differences in outcomes of children with CIs and warrant further investigation to determine the effects of this variability on outcomes.

Brodie, K.D., Florentine, M.M., Taketa, E., Ho, M., & Chan, D. K. (2024). Differences in hearing devices and speech therapy utilization between children with permanent unilateral versus bilateral hearing loss. *Ear and Hearing, 45*(3), 563-571. https://doi.org/10.1097/AUD.0000000000001448
[Unilateral hearing loss; LSL; Use of Technology]

The purpose of this study (Brodie et al, 2024) was to describe differences in diagnosis and both auditory and speech/language intervention utilization between children with permanent unilateral hearing loss as compared with bilateral hearing loss.

A retrospective cohort study was performed of children evaluated in a multidisciplinary hearing loss clinic at a tertiary care pediatric hospital. Children aged 0 to 18 years with either permanent unilateral or bilateral hearing loss were included.

One hundred fourteen children with unilateral hearing loss and 268 children with bilateral hearing loss were studied for a total of 382 children.

There were no demographic differences between children with permanent unilateral versus bilateral hearing loss. Rates of newborn hearing screening and referred screening results were similar between those with unilateral and bilateral hearing loss.

Despite similar rates of referred newborn hearing screening, those with bilateral hearing loss were diagnosed at a younger age (mean 3.6 years, SD 3.8 years) as compared with those with unilateral hearing loss (mean 5.0 years, SD 4.2 years).

Children with unilateral hearing loss had similar severity of hearing loss in their poorer hearing ear as compared with children with bilateral hearing loss, yet they were significantly less likely to be fitted with hearing devices (53% versus 78%) or receive speech/language therapy (36% versus 54%) as compared with children with bilateral hearing loss. Multivariate analysis found that bilateral hearing loss and earlier age of hearing loss diagnosis were associated with hearing device use.

Early diagnosis and intervention for childhood hearing loss have a significant impact on a child's educational success and social relationships. Children with unilateral hearing loss were diagnosed at a

later age and were less likely to utilize hearing devices or speech/language therapy compared with those with bilateral hearing loss, despite having similar severity of hearing loss in the poorer hearing ear.

There is a strong body of evidence that children with unilateral hearing loss have improved hearing outcomes with hearing devices, which suggests there is room for improvement in identifying unilateral hearing loss and providing adequate services to optimize educational success.

However, speech therapy is generally implemented in response to language delays. Therefore, children with unilateral loss may have lower rates of language delays as compared with those with bilateral hearing loss, thereby explaining differences in speech therapy utilization.

Busch, T., Brinchmann, E.I., Braeken, J., & Wie, O.B. (2022). Receptive vocabulary of children with bilateral cochlear implants from 3 to 16 years of age. ***Ear and Hearing, 43*****(6), 1866-1880. https://doi.org/10.1097/AUD.0000000000001220**
[Language/Vocabulary Development; DHH; cochlear implants]

The purpose of this study (Busch et al, 2022) was to explore the receptive vocabulary abilities of children with cochlear implants matched to children with typical hearing, and to analyze associations between vocabulary skills and child-level characteristics.

A retrospective cross-sectional study with matched controls was conducted at the Norwegian national cochlear implant center at Oslo University Hospital. Eighty-eight children (mean age 8.7 years; range 3.2 to 15.9; 43 girls, 45 boys) who had received bilateral cochlear implants before 3 years of age were compared with two groups of children with typical hearing.

Cochlear implant users' receptive vocabulary was poorer than that of age-matched children with typical hearing. Further analysis revealed that, in addition to chronological age and hearing age, simultaneous versus sequential implantation, communication mode at school, and social integration were predictors of cochlear implant users' receptive vocabulary.

On average, the receptive vocabulary of children with cochlear implants was smaller than that of their typical hearing peers. The magnitude of the difference changed with age and was the largest for children in early primary school. The nonlinear effect of age might explain some of the ambiguity in previous research findings and could indicate that better intervention for language and vocabulary development is required around school entry. The results emphasize that continuous monitoring and support for vocabulary development are crucial to avoid far-reaching negative effects on the children's development and well-being.

Dettman, S., Choo, D., Au, A., Luu, A., & Dowell, R. (2021). Speech perception and language outcomes for infants receiving cochlear implants before or after 9 months of age: Use of category-based aggregation of data in an unselected pediatric cohort. ***Journal of Speech, Language, and Hearing Research, 64*****(3), 1023-1039. https://doi.org/10.1044/2020_JSLHR-20-00228**
[Cochlear implants; Language Development: DHH]

The purpose of this retrospective study (Dettman et al, 2021) was to amass large data sets to enable statistical comparisons of communication outcomes for infants receiving cochlear implants (CIs) before 9 months of age compared to groups who received their first CI between 9 months and 3.5 years of age.

Speech perception scores and experienced clinicians' observations were used to refine the Categories of Auditory Performance Index (CAPI), thus creating its revised version, namely, the CAPI-Revised (CAPI-R).

At 2 years of device experience, there was no significant difference in CAPI-R medians for children who received their first CI before 9 months compared to all other age-at-implant groups. At 5 years of age, however, a significantly better CAPI-R median was demonstrated by having a CI before 9 months of age.

Testing supported access to CIs before 18 months of age for speech perception, and access to CIs before 9 months of age for optimum language development.

Holt, R.F., Kronenberger, W.G., & Pisoni, D.B. (2022). Family environmental dynamics differentially influence spoken language development in children with and without hearing loss. ***Journal of Speech, Language and Hearing research, 65*****(1),361-377. https://doi.org/10.1044/2021_JSLHR-21-00220**
[Language Development: DHH]

The purpose of this study (Holt et al, 2022) was to evaluate whether families of children with sensorineural hearing loss (SNHL) are organized similarly to those of typically developing, typically hearing (TH) children and whether the dimensions of family dynamics and environment are related to spoken language development similarly in children with and without SNHL.

Primary caregivers of children with SNHL (n = 63) or TH (n = 65) completed the Family Environment Scale – Fourth Edition (FES-4) to assess multiple dimensions of family environment. Children's receptive vocabulary was assessed with the Peabody Picture Vocabulary Test – Fourth Edition, and their receptive language was assessed by an age-appropriate Sentence Comprehension subscale of the Comprehensive Assessment of Spoken Language – Second Edition.

Results revealed that three higher order components were derived from the FES-4 subscales for both families of children with SNHL and families with TH: Supportive, Controlling, and Conflicted. Differences were noted between the two groups. For the TH group, most family environment measures on the FES-4 were not associated with language outcomes. However, for children with SNHL, families who were more supportive, less controlling, and less conflicted had children with better language skills.

In conclusion, family environmental dynamics were much more strongly associated with language outcomes in children with SNHL than in their TH peers. Spoken language development is better in families that provide high levels of support for each other and, in particular, low levels of control, disorganization, and conflict, reflecting the fragile nature of the child's spoken language development.

Holzinger, D., Dall, M., Sanduvete-Chaves, S., Saldaña, D., Chacón-Moscoso, S., & Fellinger, J. (2020). The impact of family environment on language development of children with cochlear implants: A systematic review and meta-analysis. *Ear and Hearing, 41*(5),1077-1091. https://doi.org/10.1097/AUD.0000000000000852
[Language Development: DHH]

The purpose of this study (Holzinger et al, 2020) was to assess the influence of family environment on language development in children with cochlear implants, by conducting a systematic review of the literature and meta-analysis.

A total of 22 study populations reported in 27 publications were included.

The data support the hypothesis that parental linguistic input during the first years after cochlear implantation strongly predicts later child language outcomes. The effects of parental involvement in intervention and parental education were comparatively weaker and more heterogeneous.

These findings emphasize the need for early-intervention programs for children with cochlear implants to focus on providing support to parents for them to increase their children's exposure to high quality conversation.

Nyberg, S., Rudner, M., Thornberg, U.B., Koch, F-S., Barr, R., Heimann, M., & Sundqvist, A. (2020). The natural language environment of 9-month-old infants in Sweden and concurrent association with early language development. *Frontiers in Psychology, 11*, 01981. https://doi.org/10.3389/fpsyg.2020.01981
[Language Development: General]

The purpose of this study (Nyberg et al, 2020), was to describe the natural home language environment of 9-month-old infants in Sweden and its concurrent association with language development.

Eighty-eight families took part in the study. The home language environment was measured using the Language ENvironment Analysis (LENA) system, and language development was assessed using Swedish Early Communicative Development Inventory (SECDI), a parent questionnaire.

LENA measures showed dramatic variation between individuals but were comparable to and showed overlapping variance with previous studies conducted in English-speaking households. Nonetheless, there were significantly more infant vocalizations and conversational turns in the present study than in one previous study.

Adult word count correlated significantly and positively with infants' use of gestures and the subscale of that section Communicative gestures. These together with another four non-significant associations formed a consistent overall pattern that suggested a link between infants' language environment and language development.

Although the direction of causality cannot be determined from the current data, future studies should examine children longitudinally to assess the directionality or the bidirectionality of the associations.

Polka, L., Masapollo, M., & Menard, L. (2022). Setting the stage for speech production: Infants prefer listening to speech sounds with infant vocal resonances. ***Journal of Speech, Language and Hearing Research, 65*****(1), 109-120.** **https://doi.org/10.1044/2021_JSLHR-21-00412**
[Speech development: General]

This purpose of this study (Polka, Masapollo & Menard, 2022) was to investigate whether the vocal resonances (formants) of the infant vocal tract are sufficient to elicit a preference to attend to speech sounds (vowels) with infant vocal properties, rather than to adult vocal properties, and whether infant perceptual bias changes with age and emerging vocal production skills.

The researchers selectively manipulated the fundamental frequency (f_0) of vowels synthesized with formants specifying either an infant or adult vocal tract, and then tested the effects of those manipulations on the listening preferences of infants who were slightly older than those previously tested (at 6–8 months).

Unlike findings with younger infants (at 4–6 months), slightly older infants displayed a robust preference for vowels with infant formants over adult formants when f_0 was matched. The strength of this preference was also positively correlated with age among infants between 4 and 8 months.

Infants between 6 and 8 months of age displayed a robust and distinct preference for speech with resonances specifying a vocal tract that is similar in size and length to their own.

Rudge, A. M., Moog Brooks, B., & Grantham, H. (2022). Effects of early intervention frequency on expressive vocabulary growth rates of very young children who are deaf or hard of hearing: How much is enough? ***Journal of Speech, Language and Hearing Research, 65*****(5), 1978-1987.**
https://doi.org/10.1044/2022_JSLHR-21-00322
[Vocabulary and Language development: DHH]

The purposes of this study (Rudge et al, 2022) were to explore expressive vocabulary growth rates of children who are deaf or hard of hearing (DHH) during critical periods of brain development (birth to 3 years) as well as the factors that influence the trajectories of vocabulary growth in these early years of development. Of primary interest was the effect of intervention frequency on expressive vocabulary growth.

Hierarchical linear modeling was used to investigate trajectories of expressive vocabulary growth using multiple measures of longitudinal vocabulary scores. A total of 417 assessments across 105 participants were analyzed to determine the average rate of lexical growth in a young population of children who are

DHH receiving early intervention before age 3 years. Expected growth trajectories were constructed based on varying frequencies of intervention during critical periods of brain development.

Results indicated average growth rates of 5.21 new words expressed per week. Increased intervention hours prior to age 3 years was significantly associated with higher degrees of expressive vocabulary growth.

The findings of this study suggest that greater intervention hours received before age 3 years are associated with higher degrees of expressive vocabulary growth for children who are DHH.

Rufsvold, R., Wang, Y., Hartman, M. C., & Arora, S. B. (2018). The impact of language input on deaf and hard of hearing preschool children who use listening and spoken language. *American Annals of the Deaf 163*(1), 35-60. https://doi.org/10.1353/aad.2018.0010
[Language Development: DHH]

The purpose of this study (Rufsvold et al, 2018) was to investigate the influence of the quantity of adult language input on their deaf and hard-of-hearing preschool children and to explore the effects, if any, on the child's quantity of language, vocabulary development, and basic concept understanding.

Using audio recording and the Language ENvironment Analysis (LENA) software, the study involved 30 preschool children with hearing loss who used spoken language as their communication modality and 7 children with normal hearing. Their language and the language spoken to them in all waking-hours of a two-day period (16 hours per day) were recorded and analyzed quantitatively as adult word counts (AWC), child vocalizations (CVC), and conversational turns (CTC). These components were compared to the child's performance on the Boehm Test of Basic Concepts (BTBC-3) and the Peabody Picture Vocabulary Test (PPVT-4) to investigate if the quantity of language input had an effect on the child's usage of vocabulary and basic concepts.

Correlations were found between the amount of adult words, child vocalizations, and conversational turns across weekends and weekdays, but not on BTBC-3 or PPVT-4 scores. Interestingly, there were no significant differences between adult word counts and child vocalizations as a function of the child's hearing loss, indicating parents of deaf or hard-of-hearing children are using as many words with their children as parents of children with normal hearing.

Results from this study suggest the language used around children, whether or not the child has a hearing loss, impacts their language use and the amount of interactions they have in their environment.

This result is significant because it identifies the influence of the quantity of adult language input on the child's language development.

Smolen, E.R., Wang, Y., Hartman, M.C., & Lee, Y-S. (2021). Effects of parents' mealtime conversation techniques for preschool children with hearing loss who use listening and spoken language. ***Journal of Speech, Language and Hearing Research, 64*****(3), 979-992.** **https://doi.org/10.1044/2020_JSLHR-20-00420**
[Language Development: DHH]

The purpose of this study (Smolen et al, 2021) was to examine the conversation techniques used by parents of young children with hearing loss (HL) during dinnertime at home. Parents' usage rates of open- and closed-ended language elicitation, reformulation, imitation, directives, and explicit vocabulary instruction were examined in relation to children's receptive vocabulary and basic-concepts skills.

Twenty-minute dinnertime segments were extracted from naturalistic, daylong recordings of 37 preschoolers with HL who used listening and spoken language. The segments were hand-coded for parents' use of conversation techniques. Children's receptive vocabulary and basic concepts were assessed using standardized measures.

Parents' use of conversation techniques varied widely, with closed-ended elicitation and directives used most frequently during dinner. In addition, parents who used many techniques often introduced abstract conversation topics; electronic media was present in all conversations with few techniques.

Parents of preschoolers with HL may benefit from specific coaching to elicit language and introduce new vocabulary during home routines. These techniques may help develop their children's receptive language.

Trussell, J. W., Hasko, J., Kane, J., Amari, B., & Brusehaber, A. (2018). Interactive storybook reading instruction for preschoolers who are deaf and hard of hearing: A multiple probe across behaviors analysis. ***Language, Speech, and Hearing Services in Schools, 49*****, 922-937.**
https://doi.org/10.1044/2018_LSHSS-17-0085
[Language Development: DHH]

The purpose of this study (Trussell et al, 2018), was to modify interactive storybook reading (ISR) to include teaching word meanings along with the vocabulary picture label because vocabulary knowledge consistently predicts later reading achievement of children who are deaf and hard of hearing (DHH).

A multiple probe across behaviors single-case experimental design was implemented to determine the effects of ISR with word meaning instruction on picture labeling and word meaning knowledge of 6 preschoolers who are DHH and use spoken English. The student and teacher participants engaged in ISR for 15–20 min a day, 4 days a week for 3 weeks.

A functional relation was established between ISR and the increase in the preschoolers' word labeling and meaning knowledge. The preschoolers' word knowledge was generalized and was maintained over time.

ISR may be an effective vocabulary labeling and word meaning instructional strategy for young children who are DHH and use spoken English. Teachers and related service providers who work with this population may want to implement ISR with word meaning in 1-to-1 or small groups to individualize the target vocabulary and maximize the benefit.

Valimaa, T. T., Kunnari, S., Aarnisalo, A. A., Dietz, A., Hyvärinen, A., Laitakari, J., et al. (2022). Spoken language skills in children with bilateral hearing aids or bilateral cochlear implants at the age of three years. ***Ear and Hearing, 43*****(1), 220-233. https://doi.org/10.1097/AUD.0000000000001092**
[Language Development: DHH]

The purposes of this study (Valimaa et al, 2022) were (1) to examine spoken language skills of children with bilateral HAs and children with bilateral CIs;(2) to compare their language skills to the age-norms of peers with normal hearing (NH); and (3) to investigate factors associated with spoken language outcomes.

Spoken language results of 56 Finnish children with HL were obtained from a nationwide prospective multicenter study. Children with HL comprised two groups: children with mild-to-severe HL who used bilateral HAs (BiHA group, n= 28) and children with profound HL who used bilateral CIs (BiCI group, n= 28). Children's spoken language comprehension, expressive and receptive vocabulary, and phonological skills were compared with normative values of children NH at the age of three years.

At the age of 3 years, 50%–96% of children with HL performed 1 SD or more below the mean of the normative sample of age-peers with NH in spoken language skills, depending on the language domain. Receptive vocabulary and phonological skills were the most vulnerable language domains. In receptive vocabulary, 82% of the children in the BiHA group and 50% of the children in the BiCI group scored 1 SD or more below the normative mean. The BiHA group was 4.4 times more likely to have poorer receptive vocabulary than the BiCI group.

The present study joins others in showing that a substantial number of young children with HL still lag behind their peers with normal hearing, especially in receptive and expressive vocabulary and phonological skills, despite implementation of universal newborn hearing screening and bilateral HA fitting or bilateral implantation at an earlier age.

This study provides evidence that assessment of spoken language in all levels of language (i.e., phonology, vocabulary, morphology, and syntax) is important. This study also provides evidence that children with mild-to-severe HL using bilateral HAs may be more likely to have poorer spoken language skills than children with profound HL using bilateral CIs, especially if children with HAs do not receive similar opportunities for early intervention as children with bilateral CIs.

These findings corroborate those of several studies indicating that high maternal level of education is associated with better spoken language development, and clearly point out the need for healthcare

providers to offer all parents counseling and support regarding good-quality parental language input.

Wie, O. B., Torkildsen, J. V. K., Schauber, S., Busch, T., & Litovsky, R. (2020). Long-term language development in children with early simultaneous bilateral cochlear implants. ***Ear and Hearing, 41*****(5), 1294-1305. https://doi.org/10.1097/AUD.0000000000000851**
[Language Development: DHH; Cochlear implants]

The purpose of this longitudinal study (Wie et al, 2020) was to follow the language development of children who received the combination of early (5 to 18 months) and simultaneous bilateral cochlear implants (CIs) throughout the first 6 years after implantation, by examining the trajectories of their language development and identifying factors associated with their language outcomes.

Participants were 21 Norwegian children who received bilateral CIs between the ages of 5 and 18 months and 21 children with normal hearing (NH) who were matched to the children with CIs on age, sex, and maternal education. The language skills of these two groups were compared at 10 time points (3, 6, 9, 12, 18, 24, 36, 48, 60, and 72 months after implantation) using parent reports and standardized measures of general language skills, vocabulary, and grammar. In addition, assessments were made of the effects of age at CI activation, speech recognition abilities, and mothers' education on language outcomes 6 years after implantation.

During the first 4 years after implantation, the gap in general expressive and receptive language abilities between children with CIs and children with NH gradually closed. However, from 4 years after implantation until the end of the observation period, 6 years after implantation, expressive grammar skills of children with CIs were lower than those of children with NH. At the final assessment, the children with CIs had an average receptive vocabulary score around 1 SD below the normative mean. Regression analysis indicated that the children's language outcomes at 6 years after implantation were related to their speech recognition skills, age at CI activation, and maternal education.

In the first 4 years after implantation, the language performance of children with CIs became increasingly like that of their NH peers. However, between 4 and 6 years after implantation, there were indications of challenges with certain aspects of language, specifically receptive vocabulary and expressive grammar.

Because these challenges first appeared after the 4-year assessment, the findings underline the importance of long-term language intervention to increase the chances of a continued language development comparable to that of NH peers. They also indicate that there is a need for comprehensive longitudinal studies of the language development of children with CIs beyond 4 years after implantation.

Executive Function

Boerrigter, M. S., Vermeulen, A.M., Benard, M. R., van Dijk, H. J. E., Marres, H. A. M., Mylanus, E. A. M., & Langereis, M. C. (2023). Cochlear implants or hearing aids: Speech perception, language, and executive function outcomes. *Ear and Hearing, 44*(2), 411-422.
https://doi.org/10.1097/AUD.0000000000001300
[CI, LSL, Executive Function]

The purpose of the study (Boerrigter, 2023) was to determine whether children with severe hearing loss (HL) who use hearing aids (HAs) may experience added value in the perception of speech, language development, and executive function (EF) compared to children who are hard of hearing (HH) or children who are deaf and who use cochlear implants (CIs) and would benefit from CIs over HAs.

The results contribute to the ongoing debate concerning CI criteria.

The researchers addressed the following research question to achieve this aim: Do children who are HH or deaf with CIs perform better than children with severe HL with HAs with respect to auditory speech perception, and receptive vocabulary and/or EF?

Two groups of children with severe HL, profound HL or deafness, with CIs or HAs, were matched for gender, test age (range, 8 to 15 years), socioeconomic status, and nonverbal intelligence quotient. Forty-three children had CIs (pure-tone average at 2000 and 4000 Hz >85 dB HL), and 27 children had HAs (mean pure-tone average: 69 dB HL).

The researchers measured speech perception at the conversational level of (65 dB SPL) and the soft speech perception level at (45 dB SPL). Receptive vocabulary using the Peabody Picture Vocabulary Test-III-NL was established. The researchers tested EF using the Delis Kaplan Executive Function System battery and the Dutch Rey Auditory Verbal Learning Test.

Both groups of children, with CIs and Has, obtained ceiling scores for perception of speech on a conversational level. However, the HA group exhibited significantly lower perception on a soft speech level scores (68 %) than the CI group (87%).

No difference was present between the receptive vocabulary distributions of the CI and HA groups. In addition, no difference in EF between the CI and HA groups was found.

In both groups, a large proportion of children obtained below-average scores for planning (CI: 44%; HA: 33%) and for long-term verbal memory (CI: 44%; HA: 35%).

In the HA group, perception at a soft speech level was associated with receptive vocabulary and planning.

The results indicate that to obtain age-appropriate levels of receptive vocabulary and EF, the perception of soft speech is a necessary but not sufficient prerequisite.

McCreery, R. W., & Walker, E. A. (2022). Variation in auditory experience affects language and executive function skills in children who are hard of hearing. *Ear and Hearing, 43*(2), 347-360. https://doi.org/10.1097/AUD.0000000000001098
[Auditory experience; wear time (dosage); language development; executive function skills: DHH]

The purpose of this study (McCreery & Walker, 2022) was to examine the influences of auditory experience and language skills on the development of executive function in children who are hard of hearing (CHH).

The researchers collected measures of aided speech audibility, hearing aid use, executive function, and receptive vocabulary in 177 CHH and 86 children with typical hearing who were 5-to 10 years old and matched for socioeconomic status and nonverbal intelligence.

Auditory dosage was calculated by combining each child's average hours of hearing aid use with their audibility for speech to create a variable that quantifies individual differences in auditory access.

CHH had lower receptive vocabulary and deficits in executive function related to working memory and selective attention compared to peers with typical hearing.

CHH with greater auditory dosage had higher receptive vocabulary than CHH with lower auditory dosage. Better receptive vocabulary was associated with better scores on executive function measures related to working memory and attention. Auditory dosage was also directly associated with measures of verbal working memory.

CHH have deficits in language and some, but not all, areas of executive function related to working memory and attention. Auditory dosage was associated with language abilities and verbal working memory. Language was associated with individual differences in executive function skills related to attention and working memory.

These results provide support for systems theories regarding the development of executive function in CHH. Interventions that improve auditory access (getting auditory information to the child's brain via their hearing aids by wearing their hearing aids 10-12 hours per day) and language may be effective for improving executive function related to working memory and attention in CHH.

Bilingual Language Development

Rozen-Blay, O., Novogrodsky, R., & Degani, T. (2022). Talking while signing: The influence of simultaneous communication on the spoken language of bimodal bilinguals. *Journal of Speech, Language and Hearing Research, 65*(2), 785-796. https://doi.org/10.1044/2021_JSLHR-21-00326
[Bilingual Language Development: DHH]

The purpose of this study (Rozen-Blay, et al, 2022) was to examine how speech while sign (simultaneous communication [SimCom]) affected the spoken language of bimodal bilingual teachers and how individual differences in sign-language vocabulary knowledge, SimCom teaching experience, and the ability to perform speech under dual-task conditions, explained the variability in SimCom performance.

Forty experienced teachers of deaf and hard of hearing students participated in a story narration task under different conditions. Speech rate, lexical richness, and syntactic complexity were measured and compared across speech-only versus SimCom conditions. Furthermore, participants' score on a sign-language vocabulary test, their self-reported SimCom teaching experience, and their performance in a dual-task condition were taken as predictors of SimCom narration performance.

The findings revealed slower speech rate, lower lexical richness, and lower syntactic complexity in the SimCom condition compared with the speech-only condition. Sign-language vocabulary score and SimCom teaching experience explained speech rate and lexical richness. Participant's ability to speak under a dual-task condition did not modulate performance.

The findings may suggest that the production of the less dominant (sign) language during SimCom entails inhibition of the dominant (spoken) language relative to the speech-only condition. At the same time, the findings are also compatible with the suggestion that SimCom serves as a unique complex communication unit that cannot be reduced to the combination of two languages.

Outcomes of LSL Intervention

Lim, S. R., Goldberg, D. M. & Flexer, C. (2019). Auditory-Verbal Graduates—25 Years Later: Outcome survey of the clinical effectiveness of the listening and spoken language approach for young children with hearing loss. *The Volta Review, 118*(18.2), 5-40. https://agbell.org/docs/volta-review/volume-118-no-01-02/
[Outcomes of LSL intervention]

The purpose of this study (Lim, Goldberg, & Flexer, 2019), was to replicate and provide an update of current graduates of auditory-verbal teaching from around the world, using an online consumer survey. The first study of outcomes of auditory-verbal graduates was published in the Journal of the American Academy of Audiology (JAAA) in 1993. A second study was published in 2001, also in JAAA. This is the

third study. The stated purpose of all three studies was to document the status of graduates of one early intervention option: Auditory-Verbal.

A total of 359 surveys were received from people in 16 countries, and 207 of the participants met the established eligibility criteria. All responses were voluntary and not all participants answered every question on the extensive survey.

The current results are incredibly like the original findings from the 1993 and 2001 studies. The continuity of results across 25 years is, in fact, one of the most important findings of this updated study. The common result of this auditory-verbal early detection and intervention methodology for all three studies was an exceptionally high degree of full mainstreaming with "typical" high school graduation milestones, and post-secondary education almost exclusively at "mainstream" colleges and universities.

One notable difference between the current study and previous studies concerns access to and use of CI technology. In the 1993 study, all the participants wore hearing aids; no one used CIs because the technology was not routinely considered for the pediatric population at that time. In the 2001 study, 16% of the participants had one or two CIs. In contrast, in the current study, 76% of the participants had one or two CIs, and the majority received their CIs in late childhood or as adults, following their early use of hearing aids.

About friendships, auditory-verbal graduates who participated in the current study have developed friendships not only with those who have typical hearing, but also with those who have hearing loss, highlighting the importance of social groups and connections with those who have hearing loss as part of the academic and community experience. An interesting finding in this study is the potential these participants have in learning multiple spoken languages.

In answer to a question on the survey, participants wrote that they would indeed choose auditory-verbal intervention if they "had to do it all over again."

Percy-Smith, L., Tenna Lindbjerg, T., Josvassen, J. L., Hølledig Mikkelsen, J., Nissen, L., Dieleman, E., Hallstrøm, M., & Cayé-Thomasen, P. (2018) Auditory verbal habilitation is associated with improved outcome for children with cochlear implants. *Cochlear Implants International, 19*(1), 38-45. https://doi.org/10.1080/14670100.2017.1389020
[LSL, AVT, Cochlear Implants]

The purpose of this study (Percy-Smith et al, 2018) was to investigate the impact of (re)habilitation strategy on speech-language outcomes for early, cochlear implanted children enrolled in different intervention programs post implant.

Data relate to a total of 130 children representing two pediatric cohorts consisting of 94 and 36 subjects, respectively. The two cohorts had different speech and language intervention following cochlear implantation, i.e. standard habilitation vs. auditory verbal (AV) intervention. Three tests of speech and

language were applied covering language areas of receptive and productive vocabulary and language understanding.

Children in AV intervention outperformed children in standard habilitation on all three tests of speech and language.

Compared to standard intervention, AV intervention is associated with improved outcome for children with CI. Based on this finding, the researchers recommend that all children with hearing impairment should be offered AV intervention, in which parents and professionals work in close partnership.

These results therefore add to the existing literature documenting the importance of parental involvement and engagement in the (re)habilitation process both prior and post CI.

Rosenzweig, E.A., Voss, J.M., de Melo, M.E., & Valenci, M.F.H. (2022). Family-centered intervention for deaf and hard of hearing multilingual learners. In *Deaf Education and Challenges for Bilingual/Multilingual Students*, Millicent Malinda Musyoka (Ed.), pp. 21 (Chapter 10). https://doi.org/10.4018/978-1-7998-8181-0.ch010
[LSL Intervention]

The purpose of this chapter (Rosenzweig et al, 2022) is to explore principles of family-centered listening and spoken language (LSL) intervention, research, and best practices for children who are d/Deaf or hard of hearing (DHH) using multiple spoken languages and their families.

Children with any degree/type of hearing loss who are in environments where multiple languages are spoken are referred to as deaf multilingual learners (DMLs). The language landscape for these children is varied. Some DMLs acquire a first language (L1) at home and are exposed to subsequent spoken languages in school or community settings; others are born into families where multiple languages are spoken from the beginning.

While the chapter focuses on a framework of family-centered intervention applied to language development for DMLs whose families have selected LSL outcomes, the principles discussed broadly apply to DMLs using varied language (s) or modality (ies). Through analysis of best practices for interventionists and case studies, readers will understand bi/multilingual spoken language development for children who are DHH.

Sarant, J., & Geers, A. (2020). The effect of communication mode on learning outcomes for children with severe–profound hearing loss: A review. In *The Oxford Handbook of Deaf Studies in Learning and Cognition*, M. Marschark & H. Knoors (Eds.), pp. 60-77. https://doi.org/10.1093/oxfordhb/9780190054045.013.20
[LSL Outcomes]

The purpose of this chapter (Sarant & Geers, 2020) is to review the evidence regarding learning outcomes for children using oral communication versus oral plus signed communication across a variety of outcomes, including language, reading, speech production, speech perception, and social and academic development. The cognitive/learning differences observed between children with normal hearing and hearing loss, and between children using different communication modes, are discussed, and conclusions are drawn to assist parents and clinicians with optimizing learning opportunities for children with hearing loss.

Overall, this review suggests that in terms of speech perception, speech production, vocabulary and spoken language (the areas in which there were the greatest numbers of studies), reported outcomes were significantly better for children using oral communication -- listening and spoken language. That is, spoken language development thrives in spoken language environments.

There is currently no evidence to suggest that students in TC programs outperform those using a strictly OC approach or that Bi-Bi programs are achieving the age-appropriate language and literacy levels that were predicted when these were first implemented.

The primary goal for all children should be the acquisition of a first language as early as possible, so they have the best chance of achieving their potential whatever the mode of communication used to attain this. In general, hearing parents can feel comfortable using their natural form of spoken communication, ideally while receiving expert guidance in stimulating auditory and speech development in their child with hearing loss.

Thomas, E.S., & Zwolan, T.A. (2019) Communication mode and speech and language outcomes of young cochlear implant recipients: A comparison of auditory-verbal, oral communication, and total communication. *Otology & Neurotology, 40*(10), e977-e983.
https://doi.org/10.1097/MAO.0000000000002405
[LSL, AVT, Positive Outcomes]

The purpose of this study (Thomas & Zwolan, 2019) was to evaluate the effect of communication mode on the spoken language outcomes of children who received a cochlear implant.

Retrospective analysis of postoperative speech and language and reading scores for children who received a cochlear implant and used three different modes of communication: auditory-verbal (AV) (n= 39), oral communication (OC) (n= 107), and total communication (TC) (n= 57).

All children received their cochlear implant before the age of 5 years, had no known cochlear anomaly or cognitive delay that would affect their outcome with the CI, and had established consistent use of their respective communication methodology.

Rehabilitation varied depending on the selected communication methodology. Data were collected during routine postoperative speech and language evaluations. Receptive and expressive language,

reading comprehension, and speech intelligibility scores obtained up to 7 years post-activation of a cochlear implant.

All groups showed improvements over time. Linear mixed model analyses indicated scores obtained by children in the AV group were significantly higher than mean scores obtained by children in the other groups on most test measures at most post-implant intervals.

Significantly greater numbers of children in the AV group obtained standard scores within normal limits than children in the OC and TC groups.

Findings support the use of the auditory-verbal communication approach to facilitate development of age-appropriate speech and language and literacy skills in profoundly deaf children.

Wischmann, S., Josvassen, J.L, Schiøth, C., & Percy-Smith, L. (2022). History re-written for children with hearing impairment. ***International Journal of Pediatric Otorhinolaryngology, 152*****(1), 110991. https://doi.org/10.1016/j.ijporl.2021.110991**
[LSL, AVT, Early Intervention]

The purpose of this study (Wischmann et al, 2022) was to investigate long-term development of language fundamentals of children with hearing loss at the school level and to analyze the relationship between several background variables.

The project design is prospective, longitudinal, and comparative. The study was conducted over a three-year period with annual testing of core language, expressive language, working memory and pragmatics. Language scores were compared to type of hearing technology, gender, additional disability, diagnosis of hearing loss, level of social well-being and start age of use of hearing technology. A total of 56 children participated (Children with HI N = 47; Children with normal hearing (NH) N = 9). Intervention included early start, full-time use of hearing technology, and 3 years of Auditory Verbal (AV) guidance at the school level.

Results showed that children with hearing loss scored within the norm on all language fundamentals and had high scores on parental assessments of the child's social well-being. Children with hearing loss and a diagnosed additional disability also showed positive progression in terms of their language development over the three years of the study.

The study found that this new generation of children with hearing loss have the potential of developing language fundamentals within the normal range and thriving in terms of social well-being. Opportunities exist for children to be fully included in their respective local hearing community, if qualitative technical and educational intervention is provided.

Wolfe, J. (2019). (WHITE PAPER). ***Mission: Probable: Age-Appropriate Listening and Spoken Language Abilities for Children with Hearing Loss.*** **Retrieved October 28, 2024, from https://www.hearingfirst.org/mission-probable**
[Outcomes of LSL, literature review to support outcomes]

The purpose of this paper (Wolfe, 2019) is to highlight several recent research studies that provide valuable evidence of the outstanding Listening and Spoken Language (LSL) outcomes possible for infants and children with hearing loss as well as detailing the various factors that influence those outcomes.

To summarize, age-appropriate LSL abilities should be the expectation for children with all degrees of hearing loss when: 1) The child is appropriately fitted with hearing technology during the first year of a child's life, 2) The child uses their hearing technology during all waking hours, which should be at least 10 hours a day, 3) The child's caregivers provide the child with a language-rich listening environment, and 4) The child's family is equipped with the resources and information needed to support the child in the goal of reaching his or her full potential in life.

Wolfe, J., Miller, S., Schafer, E. C., Rudge, A. M., Moog Brooks, B., Smith, J., Stowe, D., Birath, A. L., Wilson, P., Fales, E., & Elder, T. (2021). Intervention and outcomes of children in different types of listening and spoken language programs. ***The Journal of Early Detection and Intervention, 6*****(2), 9-27. https://doi.org/10.26077/7874-5589**
[LSL, Positive Outcomes]

The purpose of this study (Wolfe et al, 2021) was to explore the impact of the type and dosage of listening and spoken language (LSL) services on speech and language outcomes in children with cochlear implants or hearing aids in two LSL programs.

Identical demographic variables were collected across the two programs for use in the statistical analyses. Speech and language outcomes were examined at ages 3 and 5 using standardized test measures.

At age 3, significant differences in LSL outcomes existed between programs for children using cochlear implants but not for children using binaural hearing aids. However, at age five, outcomes were similar between the different LSL programs for children with hearing aids and cochlear implants.

Total hours of LSL services do not serve as a predictor of LSL outcomes at five years of age. However, early identification of hearing loss, early amplification, and early enrollment in a LSL program were highly influential factors affecting LSL outcomes at three and five years of age. Non-verbal IQ and maternal education levels also influence LSL outcomes.

Children with earlier access to hearing technology and LSL intervention may need fewer hours of LSL services to achieve age-appropriate LSL outcomes. Overall, both of these LSL programs supported age-appropriate speech and language outcomes by age 5.

Literacy Outcomes and Development

Antia, S.D., Lederberg, A.R., Easterbrooks, S., Schick, B., Branum-Martin, L., Connor, C.M., & Webb, M-Y. (2020). Language and reading progress of young deaf and hard-of-hearing children. ***Journal of Deaf Studies and Deaf Education*****, 25(3), 334–350. https://doi.org/10.1093/deafed/enz050**
[Language, Reading, LSL, ASL, Combined; DHH]

The purpose of this study (Antia et al, 2020) was to examine the language and reading progress of 336 young DHH children in kindergarten, first and second grades.

Children were divided into groups based on their auditory access and classroom communication: a spoken-only group (n=101), a sign-only group (n=131), and a bimodal group (n=104). Trained assessors tested children's language, reading, and spoken and fingerspelled phonological awareness in the fall and spring of the school year.

Overall, children in this study showed delays in language and reading compared to norms established for hearing children. For language, vocabulary standard scores were higher than for English syntax; English syntax was the weakest area for all children in this study.

Although delayed in language, children in this study made expected gains based on hearing norms from kindergarten to second grade. Reading scores declined from kindergarten to second grade. Spoken-only and bimodal children had similar word reading and reading comprehension abilities and higher scores than sign-only children. Spoken-only children had better spoken phonological awareness and nonword reading skills than the other two groups.

The positive news is that the DHH children in the study sample made progress in vocabulary learning and were acquiring the syntax of either English (spoken-only and bimodal children) or ASL (sign-only and bimodal children). Thus, despite delays, children were acquiring language to which they had access in their environment.

They were also developing phonological processing skills either auditorily or visually. However, for all groups in this study, delays in reading comprehension increased in higher grades.

Future research might clarify how and why classroom instruction influences these outcomes. Given DHH children's delays in vocabulary and English morpho-syntax, it might be necessary for teachers to engage in explicit direct instruction and for researchers and practitioners to collaborate on developing and evaluating instructional practices in these areas.

The challenge, as always, will be to develop evidence-based instructional strategies that will lead to improvement in literacy for all children while taking advantage of their opportunities for visual and

auditory access to language.

Farquharson, K., Oleson, J., McCreery, R.W., & Walker, E. (2022). Auditory experience, speech sound production growth and early literacy in children who are hard of hearing. ***American Journal of Speech Language Pathology, 31*****(5), 2092-2107. https://doi.org/10.1044/2022_AJSLP-21-00400**
[Speech and Literacy Development: DHH; Hearing Aids]

The purpose of this study (Farquharson et al, 2022) was to longitudinally examine relationships between auditory experience, speech sound production abilities, and literacy (i.e., nonword reading and spelling in second grade) in children who are hard of hearing (CHH).

Participants included 166 CHH. All participants used hearing aids (HAs). Auditory experience is a weighted measure of the number of hours of daily HA use and the amount of audibility with and without their HAs. Children's speech sound production was tested 2–3 times between the ages of 3 and 9 years. At age 5 years and again in second grade, children were tested on a battery of language and literacy measures.

Auditory experience was significantly correlated with speech sound production abilities, but age at HA fitting was not.

The results support the importance of auditory experience and speech sound production for later literacy abilities. Specifically, the researchers found that speech sound production abilities and print knowledge at age 5 years are related to second grade spelling outcomes.

Hearing Technology

Cochlear Implants

Arndt, S., Findeis, L., Wesarg, T., Aschendorff, A., Speck, I., Ketterer, M. C., & Rauch, A. K. (2024). Long-term outcome of cochlear implantation in children with congenital, perilingual and postlingual single-sided deafness. ***Ear and Hearing, 45*****(2), 316-328. https://doi.org/10.1097/AUD.0000000000001426**
[Cochlear-Implants; Single-sided deafness; age of implantation]

The purpose of this study (Arndt et al, 2024), was to investigate the long-term outcomes of children with single-sided deafness (SSD) after cochlear implant (CI) surgery, during and after rehabilitation, and compared the results of children with congenital, perilingual, and postlingual SSD.

Thirty-six children with SSD treated with CI participated in the study: 20 had congenital, seven perilingual (defined:> 0 to 4 years), and nine had postlingual deafness (defined as> 4 years of age).

After a mean follow-up time of 4.75 years, 32 of the 36 children used their CI on a regular basis. The remaining four children were nonusers. These children had congenital SSD and were older than three years at the time of CI surgery.

This study showed that cochlear implantation is a successful treatment for children with congenital/perilingual or postlingual SSD. Results largely differed with respect to the onset and duration of deafness. Better outcomes were achieved by children with postlingual SSD and with a short duration of deafness. The data also confirmed that children with congenital SSD should be implanted with a CI within three years of age.

Buss, E., Richter, M.E., Sweeney, V.N., Davis, A.G., Dillon, M.T., & Park, L.R. (2024). Effect of age and unaided acoustic hearing on pediatric cochlear implant users' ability to distinguish yes/no statements and questions. *Journal of Speech, Language, and Hearing Research, 67*(6)*,* 1932-1944*.*
https://doi.org/10.1044/2024_JSLHR-23-00631
[Cochlear Implants, LSL]

The purpose of this study (Buss et al, 2024) was to evaluate the ability to discriminate yes/no questions from statements in three groups of children: bilateral cochlear implant (CI) users, nontraditional CI users with aidable hearing preoperatively in the ear to be implanted, and controls with normal hearing. Half of the nontraditional CI users had sufficient postoperative acoustic hearing in the implanted ear to use electric–acoustic stimulation, and half used a CI alone.

Participants heard recorded sentences that were produced either as yes/no questions or as statements by three male and three female talkers. Three raters scored each participant response as either a question or a statement. Bilateral CI users (*n* = 40, 4–12 years old) and normal-hearing controls (*n* = 10, 4–12 years old) were tested binaurally in the free field. Nontraditional CI recipients (*n* = 22, 6–17 years old) were tested with direct audio input to the study ear.

Participants in this group had measurable 125-Hz thresholds in their better ear. For nontraditional CI recipients, better performance was predicted by lower 125-Hz acoustic thresholds in the test ear, and there was no association with participant age. Performance approached that of the normal-hearing controls for some participants in each group.

Results suggest that a 125-Hz acoustic hearing supports discrimination of yes/no questions and statements in pediatric CI users. Bilateral CI users with little or no acoustic hearing at 125 Hz develop the ability to perform this task, but that ability emerges later than for children with better acoustic hearing.

These results underscore the importance of preserving acoustic hearing for pediatric CI users when possible.

Cejas, I., Barker, D.H., Petruzzello, E., Sarangoulis, C.M., & Quittner, A.L. (2024). Costs of severe to profound hearing loss & cost savings of cochlear implants. *Laryngoscope, 134*(10), 4358-4365.
https://doi.org/10.1002/lary.31497

[CI; Costs; Age of Implantation]

The purpose of this study (Cejas et. al, 2024) was to comprehensively estimate the lifetime costs and societal burden associated with severe-profound hearing loss (SPHL) in the United States by leveraging multiple national data sources and simulating patient life histories. The researchers conducted a careful evaluation of costs arising from reduced work productivity, special education resources, and medical expenses.

Results reveal an immense economic burden posed by SPHL. The lifetime cost for individuals with early-onset SPHL was estimated at $489,274, with 48% attributed to lost productivity, 29% to educational costs, and 24% to medical expenses.

These costs were significantly reduced when individuals received cochlear implants, thanks to lower educational costs and smaller income gaps, despite higher medical costs associated with the procedure.

At the societal level, the annual cost of SPHL in the United States was estimated at a staggering $37.09 billion. This figure highlights the substantial economic impact of hearing loss, often overlooked as a low-incidence condition.

A compelling finding of the study is the potential for cost savings that accrue through early identification and cochlear implantation. The researchers found a lifetime cost savings of $215,393 for children identified and implanted early compared to those who were not implanted. This difference was primarily driven by higher earnings and substantial savings in educational costs.

Cejas, I., Barker, D.H., Petruzzello, E., Sarangoulis, C.M., & Quittner, A.L. (2023). Cochlear implantation and educational and quality-of-life outcomes in adolescence. ***JAMA Otolaryngology-Head & Neck Surgery, 149*****(8), 708-715. https://doi.org/10.1001/jamaoto.2023.1327**
[CI; early implantation; LSL outcomes]

The purpose of this study (Cejas et al, 2024) was to estimate the costs of severe to profound hearing loss, including costs and cost-savings associated with cochlear implantation.

Data were obtained from the National Health Interview Survey, the National Health and Nutrition Examination Survey and national Medicare rates. The authors used continuous time state transition models with individual patient simulations to estimate the costs of severe to profound hearing loss (SPHL) across the lifespan.

Results revealed that the estimated lifetime cost of an individual born with SPHL is $489,274 [377,518; 616,519]. Costs are lower for those who received a cochlear implant before 18 months of age $390,931

[311,976; 471,475], compared to those who are not implanted $608,167 [442,544; 791,719]. For individuals with a later onset of hearing loss (60 years old) lifetime costs were $154,536 [7,093; 302,936]. The annual societal costs for the US population were estimated to be $37 [8; 187] billion.

In conclusion, SPHL is a costly condition, with the primary driver being lost productivity. Medical costs were higher for cochlear implantation, however, the higher income earnings offset the higher medical costs. Overall, early implantation substantially reduced lifetime costs.

Access to hearing health care and technology is critical given the documented benefits for language, education, and quality of life. Government and insurance policies should be modified to allow for equal access and coverage for hearing technology, which will ultimately reduce lifetime and societal costs.

Culbertson, S.R., Dillon, M.T., Richter, M.E., Brown, K. D., Anderson, M. R., Hancock, S. L., & Park, L. R. (2022). Younger age at cochlear implant activation results in improved auditory skill development for children with congenital deafness. ***Journal of Speech, Language, and Hearing Research, 65*****(9), 3539-3547. https://doi.org/10.1044/2022_JSLHR-22-00039**
[Cochlear implants, age at implantation; Auditory Skill Development: DHH]

The purpose of this study (Culbertson et al, 2022) was to investigate the influence of age at cochlear implant (CI) activation on auditory skill acquisition in young children. A secondary aim was to describe the auditory skills of children implanted prior to 9 months of age as compared to children with older ages of activation.

Functional Listening Index (FLI) scores obtained during routine clinical visits were reviewed for 78 pediatric CI recipients with congenital bilateral profound hearing loss who were activated before 2 years of age.

There was a significant interaction between age at activation and chronological age at the time of evaluation, indicating that children with earlier access to sound achieved a greater number of auditory skills than those with later CI activations when measured at the same chronological age. Children activated before the age of 9 months approximated scores expected of children with typical hearing, whereas children activated between 9 and 24 months of age did not.

Younger age at CI activation is associated with increased auditory skills over time. Children who undergo cochlear implantation and CI activation before 9 months achieve more auditory skills by 4 years of age than children who are activated at later ages. These data suggest that reducing the approved age at cochlear implantation for children with congenital bilateral profound SNHL may support optimal auditory skill acquisition.

Davidson, L.S., Geers, AE., Uchanski, R.M., & Firszt, J.B. (2019). Effects of early acoustic hearing on speech perception and language for pediatric cochlear implant recipients. ***Journal of Speech, Language, and Hearing Research, 62*****(9), 3620-3637. https://doi.org/10.1044/2019_jslhr-h-18-0255**
[Cochlear Implants, LSL, Age of Implant, Hearing Aids]

The purpose of this study (Davidson et al, 2019) was to identify an optimal level and duration of acoustic experience (hearing aid experience) that facilitates language development for pediatric cochlear implant (CI) recipients.

A total of 117 pediatric CI recipients (ages 5–9 years) were given speech perception and standardized tests of receptive vocabulary and language.

A continuum of residual hearing levels and the length of HA use were represented by calculating the unaided PTA of the ear with the longest duration of HA use for each child. Analyses indicated that suprasegmental perception contributes unique variance to receptive language scores and that both segmental and suprasegmental skills each contribute independently to receptive vocabulary scores.

For children with the most profound losses, early bilateral CIs provide the greatest opportunity for developing good spoken language skills. For those children with moderate-to-severe losses, however, a prescribed period of bimodal use may be more advantageous for developing good spoken language skills.

Hoff, S., Ryan, M., Thomas, D., Tournis, E., Kenny, H., Hajduk, J., & Young, N.M. (2019). Safety and effectiveness of cochlear implantation of young children, including those with complicating conditions. *Otology and Neurotology*, *40*, 454-463. https://doi.org/10.1097/MAO.0000000000002156
[Cochlear Implant Outcomes]

The purpose of this study (Hoff et al, 2019) was to determine the safety and effectiveness of cochlear implantation of children under the age of 37 months, including below age 12 months.

This study was a retrospective review of 219 children implanted before the age 37 months; 39 children were implanted below age 12 months of age. Outcome measures investigated were surgical and anesthesia complications, measurable open-set speech discrimination, and primary communication mode (s).

Results showed that few surgical complications occurred, with no difference by age group. No major anesthetic morbidity occurred, with no critical events requiring intervention in the younger group.

Children implanted under 12 months developed open-set earlier (3.3 years vs 4.3 years $p \leq 0.001$) and were more likely to develop oral-only communication (88.2% vs 48.8%, $p \leq 0.001$). A significant decline in rate of oral-only communication was present if implanted over 24 months, especially when comparing children with and without additional conditions associated with language delay (8.3% and 35%, respectively).

Implantation of children under 37 months of age can be done safely, including those below age 12 months. Implantation below 12 months is positively associated with earlier open-set ability and oral-

only communication. Children implanted after age 24 months were much less likely to use oral communication exclusively, especially those with complex medical history or additional conditions associated with language delay.

Incerti, P.V., Ching, T.Y.C., Hou, S., Van Buynder, P.V., Flynn, C., & Cowan, R. (2018). Programming characteristics of cochlear implants in children: Effects of etiology and age at implantation. ***International Journal of Audiology, 57*****(Suppl. 2): S27-S40.**
https://doi.org/10.1080/14992027.2017.1370139
[Cochlear implants; critical periods; cause of hearing loss]

The purpose of this study (Incerti et al, 2018) was to investigate the effects of etiology and age at implantation on changes in threshold (T) levels, comfortable (C) levels and dynamic range (DR) for cochlear implants (CIs) in children over the first five years of life.

Information was collected at 6 months post-activation of CIs, and at 3 and 5 years of age for 161 children participating in the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study in Australia.

Results revealed that children with neural and structural cochlear lesions had higher T-levels and C-levels as compared to those without these conditions. Parameter settings varied from manufacturer's defaults more often in children with neural and structural cochlear lesions.

Investigation of the effect of age at implantation for children without neural and structural cochlear lesions showed that those implanted at ≤12 months of age had higher T-levels and narrower DR at 6 months post-activation, as compared to the later-implanted group. For both early- and later-implanted groups, the C-levels at 6 months post-activation were lower than those at age 3 and 5 years. There were no significant differences in T-levels, C-levels, or DR between age 3 and 5 years.

Etiology and age at implantation had significant effects on T-levels and C-levels.

Kral, A., Dorman, M.F., & Wilson, B.S. (2019). OVERVIEW ARTICLE. Neuronal development of hearing and language: Cochlear implants and critical periods. ***Annual Review of Neuroscience, 42,*** **47-65.**
https://doi.org/10.1146/annurev-neuro-080317-061513
[Cochlear implants and critical periods]

The purpose of this overview article (Kral, Dorman, & Wilson, 2019) is to report on new insights, provided by CIs, into (*a*) minimal representations at the periphery for speech reception, (*b*) brain mechanisms for decoding speech presented in quiet and in acoustically adverse conditions, (*c*) the developmental neuroscience of language and hearing, and (*d*) the mechanisms and time courses of intramodal and cross-modal plasticity.

The results of current studies have underscored the interconnectedness of brain functions and the

importance of top-down processes in perception and learning. The findings are described in this review with emphasis on the developing brain and the acquisition of hearing and spoken language and sensitive periods of development.

Park, L.R., Gagnon, E.B., Thompson, E., & Brown, K.D. (2019). Age at full-time use predicts language outcomes better than age of surgery in children who use cochlear implants. ***American Journal of Audiology, 28*****(4), 986-992. https://doi.org/10.1044/2019_AJA-19-0073**
[CI; Wear Time; Language: DHH]

The purposes of this study (Park et al, 2019) were to (a) determine a metric for describing full-time use (FTU), (b) establish whether age at FTU in children with cochlear implants (CIs) predicts language at 3 years of age better than age at surgery, and (c) describe the extent of FTU and length of time it took to establish FTU in this population.

This retrospective analysis examined receptive and expressive language outcomes at 3 years of age for 40 children with CIs. Multiple linear regression analyses were run with age at surgery and age at FTU as predictor variables. FTU definitions included 8 hours of device use and 80% of average waking hours for a typically developing child.

Although 8 hours of daily wear is typically considered FTU in the literature, the 80% hearing hours percentage metric accounts for more variability in outcomes.

For both receptive and expressive language, age at FTU was found to be a better predictor of outcomes than age at surgery. It took an average of 17 months for children in this cohort to establish FTU, and only 52.5% reached this milestone by the time they were 3 years old.

Children with normal hearing can access spoken language whenever they are awake, and the amount of time young children are awake increases with age. A metric that incorporates the percentage of time that children with CIs have access to sound as compared to their same-aged peers with normal hearing accounts for more variability in outcomes than using an arbitrary number of hours.

Although early FTU is not possible without surgery occurring at a young age, device placement does not guarantee use and does not predict language outcomes as well as age at FTU.

Wasmann, J-W., Huinck, W.J., & Lanting, C.P. (2024). Remote cochlear implant assessments: Validity and stability in self-administration smartphone-based testing. ***Ear and Hearing, 45*****(1), 239-249. https://doi.org/10.1097/AUD.0000000000001422**
[Cochlear-Implants; remote testing conditions and validity in adults]

The purpose of this study (Wasmann et al, 2024) was to evaluate the stability of remote testing in cochlear implant care by testing the influence of time-of-day, listener fatigue, and motivation on the

outcomes of the aided threshold test (ATT) and digit triplets test (DTT) in cochlear implant (CI) recipients using self-tests at-home on a smartphone or tablet.

A single-center repeated measures cohort study design (n= 50 adult CI recipients) was used. The ATT and DTT were tested at-home ten times, with nine of these sessions planned within a period of eight days. Outcomes were modeled as a function of time-of-day, momentary motivation, listeners' task-related fatigue, and chronotype (ie, someone's preference for morning or evening due to the sleep-wake cycle) using linear mixed models. Additional factors included aided monosyllabic word recognition in quiet, daily-life fatigue, age, and CI experience.

Out of 500 planned measurements, 407 ATTs and 476 DTTs were completed. The ATT determined thresholds and impedances were stable across sessions.

This study is one of the first to report on the validity and stability of remote assessments in CI recipients and reveals relevant factors.

CI recipients can be self-tested at any waking hour to monitor performance via smartphone or tablet. Motivation, task-related fatigue, and chronotype did not affect the outcomes of ATT or DTT in the studied cohort. Word recognition in quiet is a good predictor for deciding whether the DTT should be included in an individual's remote test battery.

At-home testing is reliable for cochlear implant recipients (adults in this study) and offers an opportunity to provide care in a virtual hearing clinic setting.

Hearing Aids

Brigham, N., Thompson, E.C., Picou, E.M. Davis, H., & Tharpe, A.M. (2024). Pediatric hearing aid daily wear time is significantly impacted by clinician–family language discordance. ***American Journal of Audiology, 33*****(2), 321-329. https://doi.org/10.1044/2023_AJA-23-00043**
[Hearing Aid; Wear time; Family counseling]

The purpose of this study (Brigham et al, 2024) was to evaluate the potential contribution of limited English proficiency on daily hearing aid wear time for children with hearing loss.

A retrospective chart review was completed to evaluate hearing aid wear time based on data logging information available at the time of a follow-up visit following an initial hearing aid fitting. Children included in the study had permanent bilateral hearing loss and were less than 60 months of age at the time of their first follow-up visit. Wear time was compared between children who attended an interpreter-mediated appointment and those who did not have an interpreter present. The presence of an interpreter at the appointment was the study indicator that the family had limited English proficiency.

Children from families with limited English proficiency exhibited significantly shorter daily wear time (*M* = 1.3 hours) than their peers whose families were English-proficient speakers, thus, having a shared language with their audiologists (*M* = 5.2 hours).

Results of this study suggest that family–clinician language discordance might put children at greater risk of shorter hearing aid wear time than children whose caregivers share a common language with their child's audiologist. There can be many linguistic, cultural, and educational factors that contribute to hearing aid wear time in children whose families have limited English proficiency as well as different approaches to improving that wear time. Efforts should ensure that hearing and hearing aid–related information is accessible to all families, especially those with clinician–family language discordance. Such efforts can include, among others, training that improves clinicians' cultural and linguistic responsiveness to the diverse families they serve.

Stewart, H., Cash, E.K., Pinkl, J., Nakeva von Mentzer, C., Lin, L., Hunter, L. L., Moore, D. R., & the CCHMC Division of Audiology. (2022). Adaptive hearing aid benefit in children with mild/moderate hearing loss: A registered double-blind, randomized clinical trial. *Ear and Hearing, 43*(5), 1402-1415. https://doi.org/10.1097/AUD.0000000000001230
[Hearing aids; wear time]

The purpose of this study (Stewart et al, 2022) was to compare acclimatization to two hearing aid fitting algorithms by experienced pediatric hearing aid users with mild to moderate hearing loss. The researchers hypothesized that extended use (up to 13 months) of an adaptive algorithm with integrated directionality and noise reduction, OpenSound Navigator (OSN), would result in improved performance on auditory, cognitive, academic, and caregiver-or self-report measures compared with a control, omnidirectional algorithm (OMNI).

Forty children aged 6 to 13 years with mild to moderate/severe symmetric sensorineural hearing loss completed this study. They were all experienced hearing aid users and were recruited through the Cincinnati Children's Hospital Medical Center Division of Audiology. The children were divided into 20 pairs based on similarity of age (within 1 year) and hearing loss (level and configuration). Individuals from each pair were randomly assigned to either an OSN (experimental) or OMNI (control) fitting algorithm group. Each child completed an audiology evaluation, hearing aid fitting using physically identical Oticon OPN hearing aids, follow-up audiological appointment, and 2 research visits up to 13 months apart.

Use of the experimental (OSN) algorithm neither enhanced nor reduced performance on auditory, cognitive, academic or caregiver report measures compared with the control (OMNI) algorithm. However, prolonged hearing aid use led to benefits in hearing, academic skills, attention, and caregiver evaluation.

Wiseman, K.B., McCreery, R.W., & Walker, E. (2023). Hearing thresholds, speech recognition, and audibility indicators for modifying intervention in children with hearing aids. *Ear and Hearing, 44*(4), 787-802. https://doi.org/10.1097/AUD.0000000000001328
[Hearing aids; Language DHH]

The purpose of this study (Wiseman et al, 2023) was to determine if traditional audiologic measures (e.g., pure-tone average, speech recognition) and audibility-based measures predict risk for spoken language delay in children who are hard of hearing (CHH) who use hearing aids (HAs).

Audibility-based measures included the Speech Intelligibility Index (SII), HA use, and auditory dosage, a measure of auditory access that weighs each child's unaided and aided audibility by the average hours of HA use per day. The authors also sought to estimate values of these measures at which CHH would be at greater risk for delayed outcomes compared with a group of children with typical hearing (CTH) matched for age and socioeconomic status, potentially signaling a need to make changes to a child's hearing technology or intervention plan.

The authors compared spoken language outcomes of 182 CHH and 78 CTH and evaluated relationships between language and audiologic measures (e.g., aided SII) in CHH using generalized additive models.

Results support using aided SII, aided speech recognition in noise measures, and auditory dosage as tools to facilitate clinical decision-making, such as deciding whether changes to a child's intervention, hearing technology, or referral for cochlear implant evaluation are warranted.

Yuan, D., Tournis E., Ryan, M.E., Lai, C.M., Geng, X., Young, N.M., & Wong, P.C. (2024). Early-stage use of hearing aids preserves auditory cortical structure in children with sensorineural hearing loss. *Cerebral Cortex, 34*(4), bhae145. https://doi.org/10.1093/cercor/bhae145
[Hearing Aids; Auditory Brain Development; Early HA Use]

The purpose of this study (Yuan et al, 2024) was to examine the influence of hearing aid use and residual hearing on the auditory cortex of children with severe to profound congenital sensorineural hearing loss; little is known about how early auditory experiences impact the brain structure of children with bilateral sensorineural hearing loss.

The cortical preservation in 103 young pediatric cochlear implant candidates (55 females and 48 males) was evaluated by comparing their multivoxel pattern similarity of auditory cortical structure with that of 78 age-matched children with typical hearing.

The results demonstrated that early-stage hearing aid use preserved the auditory cortex of children with bilateral congenital sensorineural hearing loss. Children with less residual hearing experienced a more pronounced advantage from hearing aid use. However, this beneficial effect gradually diminished after 17 months of hearing aid use.

These findings support timely fitting of hearing aids in conjunction with early implantation to take advantage of neural preservation to maximize auditory and spoken language development.

Early Intervention

Ching, T.Y., Dillon, H., Leigh, G., & Cupples, L. (2018). Learning from the longitudinal outcomes of children with hearing impairment (LOCHI) study: Summary of 5-year findings and implications. ***International Journal of Audiology, 57*****(2), S105-S111.**
https://doi.org/10.1080/14992027.2017.1385865
[Early Intervention Outcomes]

The purpose of this article (Ching et al, 2018) was to summarize findings of the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study, and to discuss implications of the findings for research and clinical practice.

This is a population-based study on outcomes of children with hearing loss. Evaluations were conducted at five years of age. Participants were 470 children born with hearing loss between 2002 and 2007 in New South Wales, Victoria and Queensland in Australia, and who first received amplification or cochlear implantation by three years of age.

The earlier hearing aids or cochlear implants were fitted, the better the speech, language and functional performance outcomes. Better speech perception was also associated with better language and higher cognitive abilities. Better psychosocial development was associated with better language and functional performance. Higher maternal education level was also associated with better outcomes.

The LOCHI study has shown that early fitting of hearing devices is key to achieving better speech, language and functional performance outcomes for children with hearing loss. The findings are discussed in relation to changes in clinical practice and directions for future research.

Findlen, U.M., Gerth, H., Zemba, A., Schuller, N., Guerra, G., Vaughan, C., Brimmer, M., & Benedict, J. (2024). Examining barriers to early hearing diagnosis. ***American Journal of Audiology, 33*****(2), 369-378.**
https://doi.org/10.1044/2024_AJA-23-00174
[Barriers to EHDI services]

The purpose of this study (Findlen et al, 2024) was to evaluate diagnostic timing of infants at risk for congenital hearing loss in consideration of known barriers.

A retrospective chart review was completed for infants referred for diagnostic audiologic testing at a tertiary urban-setting Children's Hospital from 2018 to 2021, and 1,488 infants were included in the analysis. Various factors were recorded from electronic medical records including those specific to social determinants of health (SDOH). Time to diagnosis was derived and compared across five factors of interest that have previously been shown to impact diagnostic timeline, including (a) insurance type, (b)

race/ethnicity, (c) presence of middle ear dysfunction at first auditory brainstem response (ABR), (d) proximity to diagnostic center, and (e) diagnostic timing before and during/after the COVID-19 pandemic.

Across the study time period, 77% of infants referred for diagnostic testing had confirmed diagnosis by the EHDI benchmark of 3 months. Analysis of time to diagnosis across factors of interest revealed no clinically significant differences for insurance type, race/ethnicity, proximity to diagnostic center, or timing in reference to the COVID-19 pandemic.

The presence of middle ear dysfunction on first ABR was found to significantly protract final diagnostic timing.

Although some known barriers for EHDI can be universal, other factors may have a differential impact on an infant's timeline to diagnosis based on their specific location, which can interact differently with additional known barriers. Understanding local challenges will serve to better guide programs in implementing facilitators that will address their specific needs for improved outcomes.

Mahal, R., Bluher, A., Kallogjeri, D., Seeser, J., Piccirillo, J., & Buchman, C. A. (2024). Longitudinal analysis of early hearing detection and intervention program performance. ***Ear and Hearing, 45*****(1), 62-71. https://doi.org/10.1097/AUD.0000000000001402**
[EHDI Programs]

Early hearing detection and intervention (EHDI) is a newborn hearing screening system created to detect infants with hearing loss (HL) and intervene to reduce language and communication impairment. Early hearing detection (EHD) consists of three sequential stages: identification, screening, and diagnostic testing.

The purpose of this longitudinal study (Mahal, Bluher, et al, 2024) was to review each stage of EHD in each state and propose a framework to improve utilization of EHD data.

A retrospective public database review was conducted, accessing publicly available data from the Centers for Disease Control and Prevention. Summary descriptive statistics were utilized to generate a descriptive study of EHDI programs in each US state from 2007 to 2016.

Data over 10 years from 50 states as well as Washington, DC were included in this analysis, creating up to 510 data points per analysis.

Hundred percent (85 to 105) (median [min to max]) of newborns were identified by and entered EHDI programs. Ninety-eight percent (51 to 100) of identified infants completed screening. Of the infants who screened positive for HL, the proportion that received diagnostic testing was 55% (1 to 100). The overall proportion of infants who failed to complete EHD was 3% (1 to 51).

Of the infants who fail to complete EHD 70% (0 to 100) are from missed screenings, 24% (0 to 95) are from missed diagnostic testing, and 0%(0 to 93) are from missed identification. Although there are more infants missed at screening, it was estimated, with limitations, that there is an order of magnitude more infants with HL among those who did not complete diagnostic testing compared with those who did not complete screening.

Analysis demonstrates high completion rates at both identification and screening stages, whereas the diagnostic testing stage demonstrates low and highly variable completion rates.

The low completion rates at diagnostic testing create a bottleneck in the EHD process and the large variability impedes the comparison of HL outcomes across states. Analysis also demonstrates that among all stages of EHD, whereas the largest number of infants are missed at screening, the largest number of children with HL are likely missed at diagnostic testing.

Therefore, a focus by individual EHDI programs on addressing causes of low diagnostic testing completion rates would yield the greatest increase in the identification of children with HL.

Woodruff-Gautherin, T.A., & Cienkowski, K. (2023). Modeling lost to intervention in early hearing detection and intervention: A modified eDelphi study. *American Journal of Audiology, 32*(3), 543-559. https://doi.org/10.1044/2023_AJA-22-00046
[Early intervention access; parent choice; parent coaching]

The purpose of this study (Woodruff-Gautherin & Cienkowski, 2023) was to develop a functional model of the drivers behind why families may decline early intervention services following the identification of a child as D/deaf or hard of hearing.

This model was developed using a modified eDelphi method. Invited experts (*N* = 155) were provided proposed models of why families may decline early intervention services in accordance with current literature.

Agreement was reached on five main barriers to early intervention access for children who have been identified as D/deaf or hard of hearing: (family experience, family culture, perceived vulnerability, perceived benefits, and perceived barriers). Each of these main barriers has associated examples of how they may manifest across different early intervention programs and situations.

This is the first theoretical model of why loss to intervention happens within early hearing detection and intervention. Having a model provides the opportunity for future work to implement novel approaches to support families during the early intervention enrollment process.

Yoshinaga-Itano, C., Mason, C.A., Wiggin, M., Grosse, S.D., & Centers for Disease Control and Prevention. (2021). Reading proficiency trends following newborn hearing screening implementation. Pediatrics, *148*(4). https://doi.org/10.1542/peds.2020-048702

[Newborn Hearing Screening; Literacy; Population Disparities: DHH]

The purpose of this study (Yoshinaga-Itano et al, 2021) was to investigate trends in population-level school-aged reading scores among students with hearing loss in an urban Colorado school district after implementation of universal newborn hearing screening (UNHS) and Early Hearing Detection and Intervention.

The final sample included 1422 assessments conducted during the 2000–2001 through 2013–2014 school years for 321 children with hearing loss in grades 3 through 10. Longitudinal hierarchical linear modeling analyses were used to examine reading proficiency (controlling for birth year, grade in school, free and reduced lunch status, additional disability services, and English not spoken in the home). The Colorado Student Assessment Program was administered to students in third through 10th grades throughout the state. The test years chosen included children born before and after implementation of UNHS.

After implementation of UNHS, significant longitudinal reading proficiency improvements were observed by birth year and grade overall and for all subgroups. However, gains in reading proficiency were substantially less for children eligible for free and reduced lunch and those with moderate-severe to profound hearing loss. With each succeeding birth cohort and grade, increased numbers of children participated in testing because of improved language skills, with higher proportions identified as proficient or advanced readers

Notable improvements in reading proficiency after Early Hearing Detection and Intervention implementation were demonstrated, as all groups of children with hearing loss became more likely to achieve proficient and advanced reading levels. On the other hand, some disparities increased, with greater improvements in reading proficiency for children in economically advantaged families.

Auditory Brain Development

Feng, G., Ingvalson, E.M., Grieco-Calub, T.M., Roberts, M.Y., Ryan, M.E., Birmingham, P., Burrowes, D., Young, N.M., & Wong, P.C. (2018). Neural preservation underlies speech improvement from auditory deprivation in young cochlear implant recipients. ***Proceedings of the National Academy of Sciences, 115*****(5), E1022-31. https://doi.org/10.1073/pnas.1717603115**
[Auditory Brain; cochlear implant; LSL; early intervention]

The purpose of this study (Feng et al, 2018) was to investigate the neurobiological basis of the variable and difficult to predict outcomes of children who received a cochlear implant. To understand the neurobiological basis of this outcome variability, the researchers used presurgical neural morphological data obtained from MRIs of individual pediatric cochlear implant (CI) candidates implanted younger than 3.5 years to predict variability of their speech-perception improvement after surgery.

The researchers first compared neuroanatomical density and spatial pattern similarity of CI candidates to that of age-matched children with normal hearing, which allowed the detailing of neuroanatomical networks that were either affected or unaffected by auditory deprivation. This information enabled the building of machine-learning models to predict the individual children's speech development following CI.

Results showed that regions of the brain that were unaffected by auditory deprivation, in particular the auditory association and cognitive brain regions, produced the most precise prediction results.

These findings suggest that brain areas unaffected by auditory deprivation are critical to developing closer to typical speech outcomes. Moreover, the findings suggest that determination of the type of neural reorganization caused by auditory deprivation before implantation is valuable for predicting post-CI language outcomes for young children.

Sharma, A., Martin, K., Roland, P., Bauer, P., Sweeney, M.H., Gilley, P., & Dorman, M. (2005). P1 latency as a biomarker for central auditory development in children with hearing impairment. ***Journal of the American Academy of Audiology, 16*****(08), 564-573. https://doi.org/10.3766/jaaa.16.8.5**
[Auditory Brain development; measurement]

The purpose of this study (Sharma et al, 2005) was to examine the clinical feasibility of using the latency of the P1 CAEP as an objective tool to evaluate whether acoustic amplification for children who are hearing impaired has provided sufficient stimulation for normal development of central auditory pathways.

The researchers used the latency of the P1 cortical auditory-evoked potential (CAEP) as a biomarker for the development of central auditory pathways in three children who received intervention through hearing aids and/or cochlear implants.

The results suggest that the P1 latency can indeed provide clinicians with an objective tool to evaluate whether acoustic amplification for hearing-impaired children has provided sufficient stimulation for normal development of central auditory pathways. If clinicians have such a marker, then they can more confidently decide about whether to provide a child with a cochlear implant following an appropriate hearing-aid trial.

Using the same marker, clinicians will also be able to monitor the maturation of central auditory pathways once electrical stimulation is initiated.

This article is foundational because it explains the biological basis of amplification and central auditory maturation.

Shiell, M. M., Champoux, F., & Zatorre, R. J. (2015). Reorganization of auditory cortex in early-deaf people: functional connectivity and relationship to hearing aid use. ***Journal of Cognitive Neuroscience, 27*****(1), 150-163. https://doi.org/10.1162/jocn_a_00683**
[Hearing aids; auditory brain; auditory deprivation]

The purpose of this article (Shiell, Champoux & Zatorre, 2015) was to investigate cross-modal reorganization after auditory sensory deprivation as a model for understanding brain plasticity.

Using fMRI, the researchers identified visual motion-related activity in 17 early-deaf and 17 hearing adults. They found that, in the deaf, the posterior superior temporal gyrus (STG) was responsive to visual motion. The researchers compared functional connectivity of this reorganized cortex between groups to identify differences in functional networks associated with reorganization. In the deaf more than the hearing, the STG displayed increased functional connectivity with a region in the calcarine fissure.

The researchers also explored the role of hearing aid use, a factor that may contribute to variability in cross-modal reorganization. They found that both the cross-modal activity in STG and the functional connectivity between STG and calcarine cortex correlated with duration of hearing aid use, supporting the hypothesis that residual hearing affects cross-modal reorganization.

The researchers conclude that early auditory deprivation alters not only the organization of auditory regions but also the interactions between auditory and primary visual cortex, and that auditory input, as indexed by hearing aid use, may inhibit cross-modal reorganization in early-deaf people.

This foundational article shows that those with longer duration of hearing aid use have near-normal responses comparable to those with typical hearing.

Wolfe, J. (2020). ***Entrain the Brain: Optimize listening and spoken language outcomes for children with hearing loss*****. (WHITE PAPER). Retrieved October 28, 2024, from https://www.hearingfirst.org/m/resources/7153**
[Auditory Brain, Outcomes of LSL, literature review to support auditory brain development and outcomes]

The purpose of this paper (Wolfe, 2020) is to highlight the vital relationship between auditory brain development and the listening and spoken language outcomes of children with hearing loss.

The author guides us through groundbreaking studies that explore the neuroscience behind Listening and Spoken Language (LSL). Drawing on landmark brain imaging studies and the work of leading researchers in the field, Dr. Wolfe explains the relationship between auditory brain development and Listening and Spoken Language outcomes.

That is, listening and spoken language outcomes are intimately associated with auditory brain development. To optimize auditory brain development, children must have access to a robust, language-rich listening environment that is replete with intelligible speech.

The spoken word serves as the fertilizer that optimizes synaptogenesis as well the growth and development of the auditory circuits and neural networks that underlie the neural entrainment necessary for successful communication through listening and spoken language. When children with hearing loss are provided with a language-rich listening environment, age-appropriate LSL outcomes are not just possible, they are probable.

Yuan, D., Ng, I.H-Y., Feng, G., Chang, W. T., Tong, M. C. F., Young, N. M., & Wong, P. C. M. (2023). The extent of hearing input affects the plasticity of the auditory cortex in children with hearing loss: A preliminary study. ***American Journal of Audiology, 32*****(2), 379-390. https://doi.org/10.1044/2023_AJA-22-00172**
[Auditory Brain development; Early Hearing aid use: DHH]

The purpose of this study (Yuan, et al, 2023) was to investigate to what extent residual hearing and use of hearing aids [HAs]) affect the auditory cortex in children with hearing loss.

Twenty-one children with bilateral congenital sensorineural hearing loss who were candidates for cochlear implantation were recruited.

Voxel-based morphometry analysis was conducted to assess the gray matter (GM) volume in the auditory cortex. Children's residual hearing was measured by pure-tone audiometry at different frequencies. Multiple linear regression models were conducted to examine the effects of residual hearing and the use of HAs on GM volume in the auditory cortex with the control of age and gender.

Children with more residual hearing at high frequencies had larger GM volume ratio (corrected by total intracranial volume) in the left Heschl's gyrus. Compared with children with less residual hearing, children who had more residual hearing benefited more from longer use of HAs in terms of a larger GM ratio.

Preliminary findings highlight the impact of residual hearing on the neuroanatomy of the auditory cortex in children with hearing loss.

These results call for more auditory input via HAs for children with more residual hearing to preserve their auditory cortex before cochlear implantation.

For children with less residual hearing who might receive limited benefit from HAs, an early cochlear implant would be necessary.

Parent Choice

Cooper, E., & Werfel, K. (2024). High general health literacy does not ensure hearing loss health literacy in mothers of children who are deaf and hard of hearing. ***American Journal of Speech Language Pathology, 33*****(1), 468-475. https://doi.org/10.1044/2023_AJSLP-23-00110**
[Parent Choice]

The purpose of this study (Cooper & Werfel, 2024) was to characterize general health literacy and hearing loss health literacy for mothers of children who are deaf and hard of hearing (DHH). Participants were 25 mothers of 2- and 3-year-old children who had a diagnosis of permanent, bilateral hearing loss for at least 1 year. Measurers of general health literacy and hearing loss health literacy were collected.

Results indicated that mothers had high general health literacy but had lower hearing loss health literacy skills than expected.

Even though mothers had high education and experience of at least 1 year of having a child with hearing loss, performance on hearing loss health literacy measures was low. Caregiver understanding of hearing loss terminology and concepts is essential for decision making regarding their child's hearing loss health care.

Jones, M.K., & Roberts, M.Y. (2024). Speech, sign, or both? Factors influencing caregivers' communication method decision making for deaf/hard of hearing children. ***Journal of Speech, Language and Hearing Research, 67*****(1),187-195. https://doi.org/10.1044/2023_JSLHR-23-00386**
[Parent Choice]

The purpose of this investigation (Jones & Roberts, 2024) was to characterize the advice that caregivers receive and value as well as to identify factors that influence caregivers' decision making.

The current study had 105 caregiver–child dyads, including children between 12 and 18 months of age with bilateral, congenital hearing loss. All children were exposed to spoken language, and 63.81% of children were also exposed to sign language. Caregivers completed the "Making Decisions About Sign, Speech, and Multilingualism Survey".

Caregivers most frequently received advice to use both speech and sign, and they highly valued advice from speech-language pathologists.

When considering the use of speech, the factors that caregivers most frequently rated as *very important* were "My child's future academic success" (96.19%), "My child's future literary success" (95.24%), and "My child's future access to higher education" (95.19%).

When considering the use of sign, the factors that caregivers most frequently rated as *very important* were “My child's ability to form friendships and future relationships” (82.52%), “My child's future literary success” (81.37%), and “My child's future academic success” (81.37%).

Results of the current study suggest that throughout the decision-making process, caregivers' highest priority is understanding how their decisions will influence their child's future access to opportunities and relationships.

Nailand, L., Munro, N., & Purcell. A. (2023). What are parents’ experiences with their child’s hearing aid use in the first 5 years? *Ear and Hearing, 44*(4), 816-828.
https://doi.org/10.1097/AUD.0000000000001332
[Parent choice; parent coaching; hearing aid use]

The purpose of this study (Nailand, Munro, & Purcell, 2023) was to explore parents’ firsthand experiences with their child’s hearing aid use in the first 5 years. If parents choose a listening and spoken language approach for their child where the development of age-appropriate spoken language is the parents’ goal, then the early fitting and frequent use of hearing aids is crucial.

The study utilized a prospective qualitative design to explore parents’ firsthand experiences with their child’s hearing aid use. Purposive sampling was used to recruit 12 parents who participated in semi-structured interviews. Parents’ responses were analyzed using thematic analysis.

Three overarching themes were conceptualized, namely:(a) towards hearing aids-journey into the wilderness;(b) adjusting to hearing aids-it’s the journey, not the destination; and (c) support for my child’s hearing aid use-it’s not where you are going, it’s who you have beside you. Each theme was further divided into categories and subcategories.

This study identified that parents have much to contribute to service providers’ understanding regarding the aspects that shape consistent hearing aid use in young children.

Parents shared many insights such as the emotionally daunting nature of the first few months post hearing loss confirmation, the influence of family support, and the importance of building connections and understanding about hearing loss and hearing aid use within their social networks.

Based on family insights, the authors provided recommendations for clinical best practice that drew upon key principles of family centered care. They consisted of practical suggestions including strategic support to overcome less optimal hearing aid use and ways to facilitate parent support within their familial and communal networks.

Sapp, C., McCreery, R., Holte, L., Oleson, J., & Walker, E. (2023). Descriptions of hearing loss severity differentially influence parental concern about the impact of childhood hearing loss. *Ear and Hearing, 44*(2), 287-299. https://doi.org/10.1097/AUD.0000000000001280
[Parent counseling; hearing loss information]

The purpose of this study (Sapp et al, 2023) was to measure how parent concern about childhood hearing loss varies under different description conditions: classification-based, audibility-based, and simulation-based descriptions.

Study participants (n=143) were randomly allocated to complete an online survey about expected child difficulties with listening situations with hearing loss. Participants were parents of children with typical hearing in the 0–12-month age range. Participants were exposed to one type of description (classification-based, audibility-based, or simulation-based) and one level of hearing loss (slight, mild, and moderate or their audibility and simulation equivalents), producing nine total groups. Participants rated the level of expected difficulty their child would experience performing age-appropriate listening tasks with the given hearing loss. They also selected what they perceived as the most appropriate intervention from a list of increasingly intense options.

Findings revealed that audibility-based descriptions (i.e., the Speech Intelligibility Index -- SII) elicited significantly higher levels of parent concerns about hearing loss than classification-based strategies, but that simulation-based descriptions elicited the highest levels of concern. Those assigned to simulation-based and audibility-based groups also judged relatively more intense intervention options as appropriate compared to those assigned to classification-based groups.

This study offers more information about how descriptive factors impact levels of parent concern about hearing loss after diagnosis. Parental concern has potentially cascading effects on later intervention actions such as fitting hearing technology.

Parent Coaching

deJong, T., van der Schroeff, M., & Vroegop, J. (2021). Child-and-environment-related factors influencing daily cochlear implant use: A datalog study. *Ear and Hearing, 42*(1), 122-129. https://doi.org/10.1097/AUD.0000000000000911
[Cochlear Implants, Wear-time, LSL, parent coaching]

The purpose of this study (deJong et al, 2021) was to investigate the degree to which new child-related and environment-related characteristics were associated with consistent cochlear implant (CI) use.

The design of this study was retrospective. Data were reviewed for 81 children (51% females, mean age 6.4 years with a range of 1.3 to 17.7 years) who received a CI between 2012 and 2019. Developmental

status, quantified burden of comorbidity, hearing experience, and hearing environment were investigated for correlation with consistency in daily CI use. The CIs datalog was used to objectively record the wearing times.

On average, the CI was worn 8.6 hours per day and 59% of the children wore it more than 8 hours daily. The latter children's hearing performance was significantly higher than that of the others. Consistency in CI use was significantly dependent on nonverbal IQ and parental communication mode. These together accounted for 47% of the variation in daily CI use.

The findings indicate that children with lower nonverbal IQ scores and low exposure to oral communication by their parents are at risk of inconsistent CI use.

Deniz, B., Kara, H.C., & Cogen, T. (2024). Reduced tolerance for risky play in primary caregivers of children with hearing loss. ***American Journal of Audiology, 33*****(2), 492-502.**
https://doi.org/10.1044/2024_AJA-23-00238
[LSL; Play; Family Coaching/Guidance]

The purpose of this study (Deniz, Kara, & Cogen, 2024) was to investigate the attitudes of parents or caregivers with children with HL toward risky play. It is known that taking appropriate risks during play is crucial for the development of a child's creativity, problem-solving abilities, resilience, self-confidence, and skills in evaluating risky situations. However, communication problems resulting from hearing loss (HL) can affect a child's ability to hear danger and warning signals during play, potentially leading to injury.

The study included 170 caregivers of children with normal hearing (NH; *n* = 103) and cochlear implant and/or hearing aids users (*n* = 67) aged 3–13 years. The primary caregiver completed the Tolerance for Risk in Play Scale (TRIPS), and the caregivers of children with HL also completed the Auditory Behavior in Everyday Life (ABEL) questionnaire.

The study found that caregivers of children with HL have less tolerance for risky play.

However, caregivers of children with better auditory skills were more tolerant of risky play.

Therefore, it is suggested that caregivers of children using appropriate hearing devices should be informed that they do not need to be overly restrictive during play, and these children should be encouraged to engage in risky play.

Munoz, K., Guillen, D., Munoz, C., & Twohig, M.P. (2023). Pediatric hearing aid management: Experiences and perspectives of Spanish-speaking parents. ***American Journal of Audiology, 32*****(4), 812-822. https://doi.org/10.1044/2023_AJA-23-00070**
[Hearing aids; wear-time; parent coaching; data-logging, tele-audiology]

The purpose of this study (Munoz et al, 2023) was twofold: (a) to explore hearing aid management experiences of Spanish-speaking parents who have young children using hearing aids and (b) to explore parents' access to the Internet and their perceptions about remote audiology services.

The study used a mixed methods design. Data were collected through a phone interview. Eleven mothers of children aged 14–60 months participated. Most of the children (9/11) had a bilateral hearing loss, and two had an additional disability.

Three themes emerged for hearing aid management experiences: audiology services, routines, and emotional challenges/supports.

Parents had variable levels of confidence in their skills ranging from no confidence to complete confidence, with the greatest variability for three items: (a) using the listening tube to make sure that the sound quality of the hearing aid is good, (b) removing moisture from the earmold tubing, and (c) troubleshooting problems when your child's hearing aids are not working. All participants reported having consistent Internet access and had positive perceptions about the possibility of remote audiology services.

This study provided insights into hearing aid management experiences and perceptions of Spanish-speaking parents. Parents described variability for audiology services, routines for hearing aid use and care, and access to other parents of children with hearing loss. Spanish-speaking parents present additional elements in the hearing care process that need to be incorporated in planning.

Remote services may be an opportunity to enhance access to support that could improve effectiveness of hearing aid management.

Munoz, K., Markle, K., San Miguel, G.G., & Twohig, M.P. (2023). Increasing pediatric hearing aid use: Considerations for clinical practice. ***American Journal of Audiology, 32*****(3), 665-670. https://doi.org/10.1044/2023_AJA-23-00036**
[Hearing aids; wear-time; parent coaching; data-logging; tele-audiology]

The purpose of this study (Munoz et al, 2023) was to explore the effectiveness of hearing aid data logging (DL) awareness and coaching sessions on increasing hours of hearing aid use. Qualitative data were also collected on challenges participants experienced managing hearing aid use.

A single-subject design was used that included three conditions, during a 6-week period, in the same order for each participant. Condition A was baseline, Condition B was DL monitoring alone, and Condition C was remote coaching calls plus DL monitoring.

Hours of hearing aid use increased for each child from baseline to the end of the study, ranging from 1.19 to 4.4 hr. Mothers reported that the coaching calls were beneficial and helped them identify and problem-solve issues.

Parents were able to increase hours of hearing aid use with DL awareness and coaching support.

Tele-audiology offers an opportunity to provide parents with more frequent support that can be individualized based on their situation, challenges, and family needs.

Noll, D., DiFabio, D., Moodie, S., Graham, I. D., Potter, B., Grandpierre, V., & Fitzpatrick, E. M. (2021). Coaching caregivers of children who are deaf or hard of hearing: A scoping review. ***Journal of Deaf Studies and Deaf Education, 26*****(4), 1-16. https://doi.org/10.1093/deafed/enab018**
[LSL; Caregiver coaching to improve language outcomes]

The purpose of this scoping review article (Noll, et al, 2021) was to gain a better understanding of the current state of the listening and spoken language (LSL) literature regarding caregiver coaching definitions, practices, recommendations, and impact.

A systematic review of 7 databases, the gray literature, and consultation with 7 expert LSL practitioners yielded 506 records for full-text review, 22 of which were ultimately included in the review.

The findings of this review highlight the lack of a consistent, widely recognized model of coaching being utilized in LSL practice. Instead, there is a continuum of practices that fall within caregiver coaching in LSL services and the definitions are varied.

Common elements include coaching to equip and empower caregivers to increase and improve language interactions with their children, ultimately resulting in self-efficacy and generalization of LSL intervention strategies into their daily routines.

Recommendations for caregiver coaching drawn from this scoping review of the literature indicate that LSL coaching should be individualized, context-driven, collaborative, and strengths-based.

The proposed model includes a synthesis of caregiver coaching steps, coaching recommendations, and the role of caregiver participation and reflection in coaching in LSL practice, and represents commonalities identified across most of the literature.

Scherer, K., Christianson, E., Wang, X., White, R., & Durnnell, J. (2023). Pilot cap acoustic transparency for pediatric amplification devices. *American Journal of Audiology, 32*(2), 432-439. https://doi.org/10.1044/2023_AJA-22-00171
[Amplification devices; parent coaching]

The purpose of this study (Scherer et al, 2023) was to measure the acoustic transparency when a hearing aid functions under a pilot cap accessory.

A hearing aid accessory, called a pilot cap, is often recommended to families to help mitigate the issues around device retention. Although pilot caps are commonly suggested to families, there is sparse data available about how acoustically transparent they are when used with a hearing aid.

The Verifit 2 Hearing Aid Analyzer and the Speech Intelligibility Index (SII) were used to measure acoustic transparency related to access of aided speech. Measurements involved four hearing aids that are commonly fit on pediatric patients and four different commercially available pilot caps. SII data were collected at two intensity levels for four simulated sensorineural hearing losses (SNHLs). Response differences between acoustic measurements with a hearing aid plus a pilot cap compared with the hearing aid alone (control) were collected.

A total of 80 SII measurements were made. For each hearing aid, there was no significant difference between the SII measurements collected for the hearing aid alone and the hearing aid plus a pilot cap. Additionally, there was no significant difference between the different pilot caps used with each hearing aid tested.

Pilot cap use with the four types of hearing aids in this study results in no significant differences in acoustic transparency compared with the control condition.

The data in this study support the use of pilot caps for hearing device retention in children with hearing loss.

Wiseman, K.B., Warner-Czyz, A.D., Kwon, S., Fiorentino, K., & Sweeney, M. (2021). Relationships between daily device use and early communication outcomes in young children with cochlear implants. *Ear and Hearing, 42*(4), 1042-1053. https://doi.org/10.1097/AUD.0000000000000999
[Wear-time, cochlear implants, parent coaching, LSL outcomes]

The purpose of this retrospective study (Wiseman, et al, 2021) was to investigate the relationship between daily CI use and communication performance (auditory skills, speech recognition, expressive and receptive language) in young children, with the hypothesis that greater daily device use coincides with better communication outcomes. That is, poor daily device use may result in underdeveloped perceptual and language skills in children and adolescents using CIs.

The authors conducted a clinical chart review of patients with CIs younger than 5 years old who used at least 1 CI speech processor with datalogging technology. Participants (n= 65) had a mean chronologic age of 3.5 years, mean implantation age of 1.9 years, and mean device experience of 1.6 years. Approximately one quarter of participants had additional disabilities. Daily device use (ie, datalogging information), child characteristics (eg, age at CI), and assessments of communication skills (ie, parent questionnaires, speech recognition tests, standardized language assessments) were obtained from each child's records.

Young children with CIs used their device, on average, 6.7 hr/d, with 63% below full-time use (< 8 hr/d).

Children without additional disabilities who wore their CI more hours per day had significantly better auditory, speech recognition, and language skills. A significant correlation also emerged between daily device use and early auditory skills in young CI users with additional disabilities, though relationships were more complicated for this subsample.

Longer daily device use significantly correlated with younger age at CI and longer device experience. Differences in device use occurred in regards to absence versus presence of additional disabilities, bilateral versus unilateral device configuration, sign versus spoken language, and private versus government-assisted insurance.

The strong relationship between daily device use and early communication suggests clinicians and parents should focus on increasing the number of hours per day young children wear their CIs to enhance auditory and language outcomes. However, intervention strategies must consider barriers to consistent device use and goals of the family to efficiently and effectively support families of young children with CIs who struggle with inconsistent device use.

Social Adjustment

Ching, T.Y.D., Cupples, L., Leigh, G., Hou, S., & Wong, A. (2021). Predicting quality of life and behavior and emotion from functional auditory and pragmatic language abilities in 9-year-old deaf and hard-of-hearing children. ***Journal of Clinical Medicine, 10*****(22), 5357. https://doi.org/10.3390/jcm10225357**
[Pragmatic Language; DHH]

The purpose of this study (Ching et al, 2021) was to investigate the influence of functional auditory performance and use of language and speech in real-world environments on children's behavior and emotion, and on their health-related quality of life. This relationship was explored in DHH children at 9 years of age. Data from 144 participants of the Longitudinal Outcomes of Children with Hearing Impairment study were analyzed. Parent reports were obtained on quality of life, behavior and emotion, pragmatic language skills, and auditory functional performance of children in real life.

Results revealed on average, outcomes on measures of behavior and emotion in nine-year-old DHH children were within one SD of the normative data, suggesting that the current generation of DHH children do not show significantly more emotional and behavioral problems, as measured by the SDQ, than their hearing peers do. However, about 7–9% of children demonstrated clinically significant difficulties in peer problems and hyperactivity, and about 6% were found to be at risk of poor psychosocial health; relative to the 2.3% expected in the normal population.

Age at intervention was significantly correlated with pragmatic language and expressive and receptive language scores. Earlier intervention was associated with better functional language and communication development, which in turn was related to better psychosocial outcomes.

The present study found that structural language scores and speech intelligibility measures were not significant predictors of SDQ score in the current study. On average, children that used CIs had better total difficulties and emotion scores on the SDQ than did those using HAs despite the latter having lesser hearing loss.

The present study lends support to the need for early intervention programs to focus on the encouragement of speech and language development and highlights the unmet need for intervention that is targeted on development of functional hearing abilities and pragmatic language skills to support psychosocial health and well-being.

Audiological care professionals play a critical role in identifying the diverse listening needs of DHH children in their home and school environments and in providing appropriate levels of technology to meet those needs. These findings also emphasize the importance of collaborative approaches among medical, hearing healthcare, audiology, allied health, and educational professionals to identify those at risk so that timely referral and intervention can be implemented for improving psychosocial health and well-being in DHH children.

Professional Development

de Melo, M. E., Soman, U., Voss, J., Hinojosa Valencia, M. F., Noll, D., Clark, F., Guignard, G. H., & Löfkvist, U. (2022). Listening and spoken language specialist auditory–verbal certification: Self-perceived benefits and barriers to inform change. ***Perspectives of the ASHA Special Interest Groups, 7,*** **1828–1852. https://doi.org/10.1044/2022_PERSP-22-00060**
[LSL Certification]

The purpose of this study (de Melo et al, 2022) was to explore the path to Listening and Spoken Language Specialist (LSLS) certification from the professional's viewpoint and to address motivation, self-perceived gains, challenges, and barriers to certification in an international cohort with the purpose of guiding future change within the existing certification system.

Members of the AG Bell Academy for Listening and Spoken Language (AG Bell Academy) Global Matters Committee created an online survey disseminated by the AG Bell Academy in English and Spanish for professionals who were certified LSLSs, mentees currently pursuing the certification, and professionals interested in the certification. Participants (*N* = 295) were from different parts of the world.

The findings indicated that certified LSL Specialists perceived significant growth in their knowledge and skills because of the certification process. Personal motivation was a key factor in pursuing certification. A common barrier among all participants was limited resources, such as time, funds, and access to a mentor who speaks the same language. Because there is a need for more LSL professionals worldwide, it's important to raise awareness of the significant gains LSLS certification can bring to families and professionals.

Other

Mitchell, R.E., & Karchmer, M.A. (2004). Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies 4*(2), 138-163. https://doi.org/10.1353/sls.2004.0005
[Primary Demographics; DHH]

The purpose of this article (Mitchell & Karchmer, 2004) was to investigate the basis for the frequently reported statement that ten percent of deaf people are born to families with one or more deaf parents. This analysis provides a current estimate for the distribution of parental hearing status among deaf and hard of hearing students in United States using data from the Annual Survey of Deaf and Hard of Hearing Children and Youth (1999-2000). This is the first national estimate that fully utilizes the distinction between children having deaf parents and hard of hearing parents, as well as hearing parents.

The authors propose that the key demographic to report, other than that the *overwhelming majority* of deaf and hard of hearing students have hearing parents, is whether the child has one or two deaf parents. The annual survey findings indicate that *less than five percent* of deaf and hard of hearing students receiving special education (in 1999-2000) are known to have at least one deaf parent, which is less than half of the presumed ten percent.

Qi, L., Tan, F., Zhang, L., Lu, L., Wang, H., Li, W., Liu, W…Chai, R. (2024). Clinical practice guidelines for gene therapy to treat hereditary hearing loss: A position paper. *Interdisciplinary Medicine, 2*(2). https://doi.org/10.1002/INMD.20240008
[Gene Therapy: DHH]

The purpose of this document (Qi et al, 2024) is to guide the standardization of gene therapy for hearing loss. Hereditary deafness is a common neurosensory disorder, and 148 non-syndromic deafness genes have been identified to date.

These guidelines were jointly developed and drafted by experienced audiologists, virologists and biologists who are vigorously involved in inner ear gene therapy research in the Hearing, Speech and Communication Subsociety of Biophysical Society of China, Audiology Development Foundation of China and Audiology Subsociety of Jiangsu Medical Association.

These guidelines cover preclinical research and clinical practice of gene therapy for hereditary deafness, including indications, key points of pre-clinical research, patient selection criteria, pre-clinical preparation, drug efficacy, drug safety evaluation criteria, ethical review, etc.

It is hoped that these guidelines will promote the standardization of clinical practice related to gene therapy for hereditary deafness in China and around the world.

Rohren, L., Shanley, R., Smith, M., Yue, M., Huang, T., Nelson, P., Hernandez-Alvarado, N., Schleiss, M. R., & Gravel, K. E. (2024). Congenital cytomegalovirus-associated sensorineural hearing loss in children: Identification following universal newborn hearing screening, effect of antiviral treatment, and long-term outcomes. ***Ear and Hearing, 45(1),*****198-206.**
https://doi.org/10.1097/AUD.0000000000001411
[CMV; Universal Newborn Hearing Screening]

Congenital cytomegalovirus (cCMV) is the most common cause of nongenetic sensorineural hearing loss (SNHL) in children.

The purpose of this study (Rohren et al, 2024) was to examine the longitudinal hearing outcomes of children with cCMV in relation to their newborn hearing screening findings, and their use of antiviral therapy.

The study was based on a retrospective chart review using a database of pediatric patients (N= 445) seen at the University of Minnesota Lions clinic. Chart review identified infants with cCMV, and records were reviewed for information about universal newborn hearing screen (UNHS) results, the clinical course of SNHL, and the use of antiviral therapy.

A total of 44 children were identified with cCMV. In this group, 33 (75%) had SNHL of varying degree and age at onset. Notably, 17 (39%) children passed UNHS bilaterally. Of those children, 6 (35%) ultimately acquired bilateral or unilateral SNHL, detected at a mean age of 20 months (median age, 12 months). Five out of 10 children (50%) that did not pass UNHS in one ear acquired late-onset hearing loss in the contralateral ear, identified at a mean age of 24 months (median age, 4 months). Eleven (25%) children passed UNHS bilaterally and continued to demonstrate normal hearing in both ears at their most recent follow-up visit at a mean age of 19 months (SD, 18 months).

Of the 33 children with cCMV and SNHL, 18 (55%) received antiviral medication (ganciclovir and/or valganciclovir). While, on average, both treated and untreated ears experienced a progression of

hearing loss over time, the group that received antiviral treatment experienced less overall hearing change compared with the untreated group.

Among children with cCMV included in this study who passed UNHS in both ears, 35% demonstrated delayed-onset SNHL. Notably, of those children who referred unilaterally, 50% later demonstrated SNHL in the contralateral ear.

These findings have implications for audiological monitoring, and potentially antiviral therapy, of children with cCMV.

As implementation of universal cCMV screening moves forward, a key aspect of follow-up will be appropriate long-term audiologic monitoring.

Silva, J.d.M., Silva, B.C., Lopes, N.B.F., Jacob, R.T.d.S. & Moret, A.L.M. (2023). Effectiveness of computerized auditory training on speech perception in children with hearing loss: A systematic review. ***American Journal of Audiology, 32*****(4), 990-1004. https://doi.org/10.1044/2023_AJA-23-00078**
[Auditory development; use of computer auditory training models]

The purpose of this study (Silva et al, 2023) was to investigate the effectiveness of using computerized auditory training in the auditory perception of speech in children who use electronic devices through a systematic review of the literature.

This systematic review was based on the elaboration of the following guiding question: In hearing-impaired children who use electronic devices, how effective is the use of computerized auditory training in the auditory perception of speech?

Nine hundred and eighteen records were identified, with additional two studies in the citation search, totaling 920 studies. After excluding the 184 duplicate references, the titles and abstracts were screened (*n* = 736), with 20 studies selected and considered for full reading. Six of the 20 studies were included in the systematic review of the literature.

Positive and beneficial results regarding computerized auditory training are evidenced, which describe and discuss the proof of the effectiveness of the positive effects on the auditory perception of speech in children using hearing aids and cochlear implants with regard to auditory detection skills, discrimination, recognition, and auditory memory.

The positive results are inspiring for the continuity and expansion of studies that further investigate the use of computerized auditory training with contemporary technologies and have an impact on the improvement of access to specialized intervention.

Wiener-Vacher, S. R., Campi, M., Caldani, S., & Thai-Van, H. (2024). Vestibular impairment and postural development in children with bilateral profound hearing loss. *JAMA Network Open, 7*(5), e2412846. https://doi.org/10.1001/jamanetworkopen.2024.12846
[Cochlear Implants; LSL; bilateral profound hearing loss and vestibular dysfunction]

The purpose of this study (Wiener-Vacher et al, 2024) was to investigate the prevalence of vestibular impairment in children with bilateral profound hearing loss (HL) and to identify its association with developmental delays.

The study included 592 children with bilateral profound HL. The researchers found that 44% of the children had vestibular impairment, and a delay in achieving developmental milestones was significantly associated with the severity of vestibular impairment.

The findings indicated that children with genetic syndromic hearing loss and CMV infections were more likely to suffer from severe vestibular impairments, impacting their posturomotor development.

The researchers analyzed the association between vestibular impairment and the delay in achieving four critical developmental milestones: head holding, sitting, standing with support, and independent walking. The results showed that children with partial or complete vestibular dysfunction experienced significant delays in reaching these milestones compared to children with normal vestibular function. Therefore, professionals should implement early and appropriate interventions, ultimately improving developmental outcomes for these children.

This study provides strong evidence that vestibular impairment is a common and significant issue in children with bilateral profound hearing loss. The findings emphasize the need to prioritize vestibular function assessments, before and after cochlear implantation.