Journal of Communication Disorders 99 (2022) 106256

Contents lists available at ScienceDirect

Journal of Communication Disorders

journal homepage: www.elsevier.com/locate/jcomdis

Communication abilities in children with hearing loss – views of parents and daycare professionals

Krista Tuohimaa [a,b,*], Soile Loukusa [a,b], Heikki Löppönen [c,d], Taina Välimaa [a,b], Sari Kunnari [a,b]

[a] *Research Unit of Logopedics, University of Oulu, Finland*
[b] *Child Language Research Center, University of Oulu, Finland*
[c] *Institute of Clinical Medicine, Department of Otorhinolaryngology, University of Eastern Finland, Finland*
[d] *Department of Otorhinolaryngology - Head and Neck Surgery, Kuopio University Hospital, Finland*

A R T I C L E I N F O

Keywords:
Communication abilities
Hearing loss
Hearing aid
Cochlear implant
Parents
Daycare professionals

A B S T R A C T

Introduction: Today, children with hearing loss (HL) are diagnosed and fitted with hearing devices at an early age. However, HL may still influence their communicative development. Thus, we need up-to-date research on how children perform in their everyday environments, such as at home or daycare. This study provides an overview of the communication abilities of early-diagnosed children with HL reported by parents and daycare professionals. The first aim of the study is to compare the results of children with bilateral hearing aids (BiHAs) or bilateral cochlear implants (BiCIs) with those of children with normal hearing (NH) and with each other. The second aim of the study is to compare the views of the two respondents, parents and the daycare professionals. In addition, the effects of gender and nonverbal intelligence quotient (IQ) on the responses are explored.
Methods: The participants, aged 4;0–6;9, were 25 children with BiHAs, 29 children with BiCIs, and 64 children with NH. The Finnish version of the *Children's Communication Checklist-2 (CCC-2)* was used to assess the communication skills of the participants.
Results: Group and nonverbal IQ had a significant effect on the *General Communication Composite (GCC)* score. Both groups of children with HL had poorer GCC scores than the children with NH, apart from the respondent. The BiHA-group had significantly lower scores than the NH-group on *Speech, Syntax, Semantics,* and *Coherence* subscales. The BiCI-group had significantly lower scores than the NH-group across all subscales of the CCC-2. The parents rated the participants significantly higher than the daycare professionals in *Speech* and *Social Relations*. In contrast, the daycare professionals rated the participants higher than the parents in *Coherence, Inappropriate Initiation, Stereotyped Language,* and *Use of Context.* Furthermore, gender influenced *Coherence, Nonverbal Communication, Social Relations,* and *Interests*, for which the girls performed better than the boys. The nonverbal IQ had an effect on *Syntax, Semantics*, and *Use of Context*, for which higher nonverbal IQ was associated with better performance.

Abbreviations: HL, hearing loss; (Bi)HA, (bilateral) hearing aid; (Bi)CI, (bilateral) cochlear implant; NH, normal hearing; UNHS, universal hearing screening; CCC-2, Children's Communication Checklist-2; GCC, General Communication Composite; SIDC, Social Interaction Deviance Composite; ISCED, International Standard Classification of Education; PTA, pure tone average; IQ, intelligence quotinent; EOWPVT-4, Expressive One-Word Picture Vocabulary Test-4; NEPSY-II, The Neuropsychological Assessment II.

* Corresponding author at: Research Unit of Logopedics and Child Language Research Center, University of Oulu, P. O. Box 1000, 90014, Finland.
E-mail address: krista.tuohimaa@oulu.fi (K. Tuohimaa).

https://doi.org/10.1016/j.jcomdis.2022.106256
Received 14 October 2021; Received in revised form 12 August 2022; Accepted 18 August 2022
Available online 20 August 2022

Conclusions: On average the children with HL had poorer communication skills than the children with NH. Pragmatic difficulties were more common in the BiCI-group than in the BiHA-group. The respondents were not completely unanimous, which may be because of the different demands of different environments.

1. Introduction

Approximately 1–2/1000 of newborns are diagnosed with a hearing loss (HL) of some degree (Fortnum et al., 2001; Häkli et al., 2014; Russ et al., 2003). More than 95 % of children with HL are born into families where the parents are hearing (Mitchell & Karchmer, 2004). Hearing parents commonly use oral language to interact with their child with HL. In recent decades, early diagnosis with the help of universal hearing screening (UNHS) has led to better communicative outcomes for children with HL (Patel & Feldman, 2011). Typically, hearing aids (HAs) are fitted soon after the diagnosis has been confirmed, and children with sensorineural, severe-to-profound HL are considered candidates for cochlear implants (CIs; Anne et al., 2021). Many children with HL are enrolled in communicative interventions at an early age, and it has become common that children with HL study in modern mainstream settings (Antia et al., 2011). Nevertheless, HL may still affect communicative development in many ways in all aspects of communication (Guerzoni et al., 2015; Wie, et al., 2020). These communicative difficulties may have consequences for psychosocial wellbeing (Wong et al., 2017), behaviour (Theunissen et al., 2014), peer relationships (Zaidman-Zait & Most, 2020), and academic outcomes (Thagard et al., 2011). Additionally, the gaps between some children with HL and normal hearing (NH) seem to persist, particularly concerning pragmatic skills (Goberis, et al., 2012; Most et al., 2010). Continuing research on the communication abilities of children with HL is therefore needed to identify fields where these children need to be supported.

1.1. *Communication abilities of children with HL*

Previous research into communication abilities of children with HL has focused mostly on structural language skills (Crowe & Dammyer, 2021; Guerzoni et al., 2015). For example, gaining age-appropriate phonetic and phonological skills may be delayed due to HL (Baudonck et al., 2010; Välimaa et al., 2022). Challenges in syntax and semantic skills are also common (Tomblin et al., 2015; Wie et al., 2020). Moreover, language usually includes at least some ambiguity, and it gets its full meaning only when it is used in a social context (Kempson, 2012). Problems with cohesion are a common form of discourse impairment, in which pragmatic skills play an important role (Perkins, 2007, 131–138), and several studies have indicated that HL may pose a risk for discourse impairment (e.g., Most et al., 2010; Rinaldi et al., 2013). Some children with HL may also be less skilled than children with NH in sharing information that is relevant for the context of their narratives (Reuterskiöld et al., 2010). Moreover, Goberis et al. (2012) found out that children with HL may be at risk for problems in using relevant language for social contexts. In addition to verbal features, nonverbal means and prosody play a crucial role in pragmatic communication, for example, in conveying emotional information or interpreting irony (Perkins, 2007, 109; Wilson & Sperber, 2012). Previous research has shown that HL may influence the development of understanding sarcasm, which is a form of irony (Stiles & Nadler, 2013) as well as perceiving the emotional tone of speech (Most & Michaelis, 2012). Some children with HL may have difficulties in the prosody of their own speech as well (Peng et al., 2008). However, there is still a lack of comprehensive knowledge of the pragmatic development of children with HL.

In the previous literature, the communication skills of children with HAs have been compared with those of children with CIs. Many children with severe-to-profound HL who use CIs, seem to outperform HA users with mild-to-severe HL (Välimaa et al., 2022) or severe-to-profound HL (Yosinaga-Itano et al., 2010) in their linguistic skills. Nevertheless, there are some studies with opposing findings, in which children with moderate-to-severe HL using HAs have outperformed their peers with CIs (de Hoog et al., 2016). Pragmatic difficulties have been reported with both HA users (e.g., Stiles & Nadler, 2013) and CI users (e.g., Rinaldi et al., 2013). Thus far, very few studies have compared the pragmatic skills of children with HAs with those of children with CIs. Jones et al. (2015) and Most et al. (2010) found no difference in pragmatic skills between the participants with HAs (moderate-to-severe HL in Jones et al., 2015; moderate-to-profound HL in Most et al., 2010) and the participants with CIs. However, some studies have indicated that in contrast with phonetic information, HAs may be more efficient than CIs at conveying intonational information (Cullington & Zeng, 2011).

The relationship between linguistic and pragmatic competence in children with HL has been discussed in the previous literature. It has been suggested that the pragmatic difficulties of children with HL may be secondary and a result of linguistic problems (e.g., Jones et al., 2015). For example, grammatical and lexical skills are known to be related to pragmatic skills, and this has also been noticed in children with HL (Rinaldi, et al., 2013). However, Most et al. (2010) concluded that pragmatic abilities may be lower in children with HL than in children with NH, even if the groups are matched according to their linguistic skills.

1.2. *Use of the children's communication checlist-2 (CCC-2) in the assessment of children with HL*

The CCC-2 questionnaire is a valid screening instrument for communication disorders with only little overlap of the typical population and populations with communication disorders (Bishop, 2015; Norbury et al., 2004). It gives a general insight into communicative abilities including both structural and pragmatic levels. Thus, with the CCC-2 it is possible to identify pragmatic deficits that are not necessarily easy to detect with other standard language measures. Importantly, it also gives a view of children's communicative ability in a real-word context in contrast to clinical test situations.

Even though the CCC-2 has been widely used with many different clinical populations (Bishop, 2015; Norbury et al., 2004), only some studies have previously used the CCC-2 to assess the communicative abilities of children with HL. However, Halliday et al. (2017) used the CCC-2 as part of their study on the linguistic development of children with mild-to-moderate HL (n = 46) between the ages of 8 and 16 years. Their study revealed that despite normal performance in their linguistic tests, the parents rated the children with HL lower than the peers with NH across all the subscales of the CCC-2. Moore et al. (2020) for their part used parental CCC-2 for one method to evaluate communication skills of children aged 6–11 years with minimal-to-mild HL (n = 333) and found that their performance did not differ from their peers with NH, despite difficulties in some aspects of cognitive skills and speech perception in noise.

Additionally, the CCC-2 has been used to evaluate the communication skills of children using CIs. A study by Löfqvist et al. (2020) indicated that the majority of 8–12-year-old children with a GJB2 mutation caused congenital HL (n=7) had a normal performance on the *General Communication Composite (GCC)* and the subscales of the parental CCC-2. In contrast, their peers with cytomegalovirus caused HL (n=10) had significantly poorer performance than children with a GJB2 mutation in the composite scores, initiatives, and use of context, possibly due to the later HL diagnosis age resulting from their progressive HL.

There are some studies with the CCC-2 that have included both children with HAs and children with CIs. Zaidman-Zait & Most (2020) used teacher reports of the *Speech* subscale and the pragmatic subscales in the CCC-2 to study the communication skills of adolescents with moderate-to-profound HL using HAs or CIs (n = 33; mean age = 14.83 years). They found a significant difference between the adolescents with HL and the adolescents with NH in all subscales studied. The children with HAs and/ or CIs were not compared. Theunissen et al. (2014) instead found that 8–16-year-old children with HAs (n = 75) or CIs (n = 57) were both at risk of

Table 1
Demographics of the Participants.

	BiHA	BiCI	NH
Total N = 118			
n	25	29	64
Gender			
Female	7	16	34
Male	18	13	30
Mean educational level of the parents [a]			
Mother	5.1	5.1	5.5
Father	4.6	5.3	4.8
Both	4.9	5.2	5.2
Age [b]			
M	5;3	5;3	5;3
SD	0;10	0;11	0;10
Range	4;0–6;7	4;0–6;9	4;0–6;8
Age [b] at hearing aid fitting			
M	0;8	0;6	-
SD	0;4	0;2	-
Range	0;4–1;8	0;3–1;2	-
Age [b] at implant activation			
M	-	1;1	-
SD	-	0;3	-
Range	-	0;10–1;10	-
Aided PTA [c]			
M	25.8	24.8	-
SD	5.1	4.6	-
Range	17.5–39.0	11.3–31.3	-
Unaided PTA [c, d]			
M	57.5	-	-
SD	16.2	-	-
Range	36–90	-	-
Preoperative unaided PTA [c]			
M	-	122.0 [e]	-
SD	-	14.7	-
Range	-	84–130	-
Speech recognition (%)			
M	97.0	97.1	-
SD	4.5	4.2	-
Range	84–100	88–100	-

Note. [a] International Standard Classification of Education (ISCED) levels: level 0 – Early childhood education, level 1 – Primary education, level 2 – Lower secondary education, level 3 – Upper secondary education, level 4 – Post-secondary non-tertiary education, level 5 – Short-cycle tertiary education, level 6 – Bachelor's or equivalent level, level 7 – Master's or equivalent level, level 8 – Doctoral or equivalent level, [b] years;months, [c] Pure Tone Average (0.5–4 kHz) dB HL, [d] Screening audiometry with a 20 dB HL threshold, included in the Finnish healthcare program, was performed for each participant in the NH group, [e] 130 dB/ no response for 19 children in the BiCI-group.

communicative problems, but the children with CIs outperformed the children with HAs with moderate-to-profound HL in the parental composite scores of the CCC-2.

1.3. Explanations for communicative difficulties of children with HL

Several explanations for the manifold consequences of HL on communicative development have been suggested. Some researchers emphasize the effects of sensory deprivation during early sensitive periods on the development of the auditory cortex (e.g., Sharma et al., 2009). Since auditory perception plays an important role in the perception of speech sounds and prosody (Most & Michaelis, 2012), difficulties in speech perception may negatively affect linguistic development (Kral et al., 2019). For example, more repetitions are required for word learning. Other researchers highlight the role of early experiences in the development of communication skills. Children build knowledge of language, context, the world, and the mental states of others with the aid of the linguistic output of the other people interacting with them (Meins et al., 2002).

The role of cognitive skills (e.g., attention, Theory of Mind, or nonverbal intelligence) in communication has been widely recognized as well (Perkins, 2007, 70–106). One explanation for the communicative difficulties of children with HL is that due to speech perception difficulties they are not able to direct their attention to things that are relevant for communication. For instance, children with HL may miss relevant nonverbal information if their attention is focused on speech reading (Cullington & Zeng, 2011). It has also been noticed that children with HL may have delayed development of Theory of Mind (ToM) abilities (Netten et al., 2017; Socher et al., 2019). In addition, difficulties in executive function and memory tasks (Wass et al., 2008) as well as discourse inferencing skills have been reported (Nicastri et al., 2014). Many other child-related and environmental factors as well (e.g., gender or parental education) are known to be associated with the communicative outcome of children with HL (Ching et al., 2013; Ching et al., 2018; Halliday et al., 2017; Välimaa et al., 2022). These various findings and explanations highlight the complex interaction between auditory perception, early experiences, socio-economic factors, linguistic skills, pragmatic skills, and cognition.

1.4. Study objective

The present study offers a comprehensive analysis of the CCC-2 performance of children with congenital HL with early identification and intervention. The first aim of the study is to compare the performance of children with HAs, CIs, and NH. Secondly, the reports from the parents are compared with the reports from the daycare professionals. By comparing the answers of the two respondents, it is possible to gain information from two different environments relevant to children's everyday life. Even though there are a few previous studies that have used parental CCC-2 reports to evaluate the communicative development of children with HL (Halliday et al., 2017; Löfqvist et al., 2020; Moore et al., 2020; Theunissen et al., 2020), CCC-2 reports from daycare and school professionals concerning children with HL (Zaidman-Zait & Most., 2020) are particularly rare. Moreover, many previous studies on the communication skills of children with HL have suffered from the heterogeneity of the participants. We aim to control variables such as age of diagnosis and amplification, age range and linguistic background of the participants in order to establish more homogenic groups of participants.

2. Methods

2.1. Participants

A total of 118 children participated in the study: 54 with HL and 64 with NH (see Table 1). The children with HL were divided into two subgroups: 25 children with mild-to-severe HL using bilateral hearing aids (BiHA-group) and 29 children with profound HL using bilateral cochlear implants (BiCI-group). The age range of the children was 4;0–6;9 (years;months). All the participants spoke Finnish as their native language. One of the children in the BiCI-group was bilingual. However, his mother spoke Finnish as her native language, and the child had attended a Finnish kindergarten for 18 months at the time he entered the study. All the participants attended mainstream daycare settings where oral Finnish was used. The children were unfamiliar with sign language, but some of the children with HL had used signing in addition to speech at some point of their communicative development. The educational level of the parents was classified into nine levels according to the International Standard Classification of Education (ISCED 2011; UNESCO, 2012). The mean educational levels of the parents were close to equal over all three groups. Children diagnosed with heart conditions, neurological disorders, or multiple disabilities (e.g., deafblindness) as well as children fitted with HAs or CIs after the age of 2, were excluded from the study. The children with NH had no linguistic or other developmental delays or disorders, or history of speech therapy. They had all passed the 20 dB hearing screening, which is included in the nation-wide Finnish healthcare program.

HL was diagnosed in one of the five university hospitals of Finland through a combination of neonatal hearing screening with otoacoustic emissions, and either auditory brainstem responses or auditory steady-state responses. The aetiology of the HL was verified as genetic for 10 children in the BiHA-group and for 15 children in the BiCI-group, but the cause of the HL was unknown for the rest of the participants with HL. After diagnosis, the children with HL were fitted with bilateral HAs. After at least a three-month hearing aid trial period, the children with severe-to-profound HL received bilateral CIs. All the children with CIs were implanted bilaterally before the age of two. The speech perception of the children with HL was assessed as a word recognition score (word recognition in silence [percentage]; BiHA-group, $n = 15$; BiCI-group, $n = 19$).

Psychometric tests were carried out to ensure normal nonverbal intelligence (Leiter-3; Roid et al., 2013) and describe language comprehension and verbal and nonverbal short-term memory (NEPSY-II; Korkman et al., 2008 and Leiter-3; Roid et al., 2013), as well as expressive vocabulary skills (EOWPVT-4; Martin & Brownell, 2010). All participants had normal nonverbal intelligence (see Table 2). The mean scores on the linguistic measures were lower in the groups of children with HL than in the NH-group.

2.2. Materials

The Finnish version of the CCC-2 (Bishop, 2015) was used to measure the views of parents and daycare professionals concerning the communication abilities of the participants. There are 10 subscales and a total of 70 items in the CCC-2 questionnaire. In each subscale, there are seven items, five of which represent weaknesses, and two of which represent strengths. The first four subscales (A. Speech, B. Syntax, C. Semantics, D. Coherence) are designed to measure structural language. The following four subscales (E. Inappropriate Initiation, F. Stereotyped Language, G. Use of Context, H. Nonverbal Communication) measure pragmatic aspects of communication. The last two subscales (I. Social Relations, and J. Interests) assess atypical behaviours that are often observed in children with autism spectrum disorder.

Two composite scores can be derived from the subscales of the CCC-2: the General Communication Composite (GCC) and the Social Interaction Deviance Composite (SIDC). The GCC is the sum of the scaled scores of subscales A-H. It is used to identify children with clinically relevant communication problems. The Social Interaction Deviance Composite (SIDC) is the difference of the sums of subscales E, H, I, and J, and subscales A-D. The SIDC is used in identifying children with a communicative and social profile characteristic of autism spectrum disorder. It is usually interpreted only if the child scores in the lowest 10^{th} percentile on the GCC (56 points or below in the Finnish data). A low GCC score with a negative SIDC score may indicate the possibility of autism spectrum disorder. SIDC scores below -15 may indicate the possibility of autism spectrum disorder, even if the GCC score is within the normal limits. In the Finnish version of the CCC-2 (Bishop, 2015), parental reports were used in the validation.

2.3. Procedure

This cross-sectional study is part of a larger nationwide prospective multicenter follow-up study conducted in all five university hospitals in Finland (Helsinki, Kuopio, Oulu, Tampere, and Turku). The Research Ethics Committee of the Northern-Savonia Hospital District has approved the study as ethically acceptable and has given a favorable statement regarding the research plan. The study is registered in the registry for Randomized Control Trials and Clinical Trials (ClinicalTrials.gov ID: NCT00960102). The children with HL were recruited by the responsible members of the clinical research teams at each university hospital as identified in the ethical documents, i.e., either a medical doctor or a speech and language therapist. Thus, in the data concerning children with HL there are children from all over Finland. The children with NH were recruited by the corresponding author from kindergartens in the City of Oulu in Finland, and municipalities surrounding Oulu. After receiving oral and written information regarding the study, the parent signed a consent letter.

Each participant was met for the purposes of this study at a university hospital, home, and/ or kindergarten on two to three occasions within two weeks. The psychometric tests were performed and the questionnaires with oral and written information were given

Table 2
Performance in the Psychometric Tests.

	BiHA	BiCI	NH
Nonverbal IQ [a]			
M	102.9	103.0	106.0
SD	7.0	5.9	7.6
Range	89–117	91–113	88–127
Nonverbal memory [b]			
M	13.4	12.5	15.0
SD	4.0	5.3	4.4
Range	3–19	3–22	3–23
EOWPVT-4 [c]			
M	65.5	71.8	76.8
SD	17.7	20.4	15.8
Range	31–111	28–106	41–114
Sentence Repetition [d]			
M	16.2	16.2	20.0
SD	4.7	5.7	4.0
Range	7–25	5–24	11–28
Comprehension of Instructions [d]			
M	16.5	18.7	20.4
SD	5.5	5.2	4.3
Range	2–26	7–27	12–29
Narrative Memory [d]			
M	7.8	13.2	14.5
SD	6.4	9.8	8.4
Range	1–27	0–33	3–37

Note. [a] measured with the Leiter-3, [b] measured with the Forward Memory subtest in the Leiter-3, [c] the Finnish version of the Expressive One-Word Picture Vocabulary Test-4 (EOWPVT-4), [d] subtest of the Neuropsychological Assessment II (NEPSY-II) to the respondents during the meetings. Background information on socio-economic factors and health was gathered using a study-specific questionnaire directly from the parents. Details on hearing loss, hearing devices, speech perception and health were also gathered from the clinical records at each university hospital accordingly to the ethical documents. The Finnish version of the CCC-2-questionnaire (Bishop, 2015) with a return envelope was given to the parents and the daycare professionals of the participants. The respondents were instructed to mail the questionnaires no later than after two weeks.

2.4. Analyses

After careful preliminary analyses, including tests of normality with histograms and the Kolmogorov-Smirnov test, the linear mixed model was used to analyze the effects of the group and respondent on the GCC scores and the subscales of the CCC-2. Since the groups differed in terms of gender and nonverbal IQ, these variables were included in the linear mixed model to control their effects on the results. For the analyses of the SIDC scores, statistical methods were not used, because the interpretation should be made with respect to the GCC scores. Moreover, the focus of this study was not on recognizing the communicative and social features that are typical in autism spectrum disorder. Therefore, the relationship between the two composite scores was evaluated individually, and only deviating findings are reported. The Bonferroni adjustment for multiple comparisons was used in the post hoc analyses of the effect of group on the GCC and subscales. To test the internal consistency of the responses, the Cronbach Alpha (acceptable above 0.65; DeVellis, 2003, 95–96) was calculated for the GCC and the subscales of the CCC-2.

3. Results

Of the responses from the parents, 80.9 % of the respondents were mothers, 9.6 % were fathers, and in 9.6 % of the cases, the parents responded together. Of the daycare professionals' responses, 85.0 % of the respondents were kindergarten teachers, 8.8 % were kindergarten nurses, 4.4 % were family daycare providers, and 1.8 % were special kindergarten teachers. Distributions of the respondents over the three groups of participants are presented in Table 3. It can be seen from the table that responses from fathers and cases where the parents worked together to fill the questionnaire were the most common among the BiCI-group. Of the daycare professionals' responses there were special kindergarten teachers only in the responses for the children in the BiCI-group.

Descriptive statistics on the GCC scores and the scores of the subscales in the CCC-2 are presented in Table 4. Altogether, 42.6 % of children with HL in the parental reports and 40.7 % in the professionals' reports had a GCC-performance below the 10th percentile. The SIDC scores of the participants were used to check whether the participants had communicative and social features that were typical to autism spectrum disorder, and these scores were interpreted with respect to the GCC scores. In the parental ratings, there were three children in the BiCI-group with a deviant SIDC score. One of them had a GCC score below the 10th percentile, and the SIDC value was below zero (SIDC = -7). Two of them had GCC scores above the 10th percentile, but the SIDC value was -15 or lower (SIDC = -16, -19). In addition, three children in the NH-group had a deviant SIDC score in the parental ratings. Two of them had GCC scores blow the 10th percentile, and the SIDC value was below zero (SIDC = -6, -8). One of them had a normal GCC score, but the SIDC value was -15. In the professionals' ratings, two of the children in the BiHA-group had a deviant SIDC score. Their GCC scores were above the 10th percentile, but the SIDC score was -15 or less (SIDC = -21, -17). Additionally, three children in the NH-group had a deviant SIDC score in the professional's ratings. One of them had a GCC score below the 10th percentile, and the SIDC value was below zero (SIDC = -2). Two of them had GCC scores above the 10th percentile, but a SIDC score below -15 (SIDC = -18, -16). However, none of the participants had a diagnosis of autism spectrum disorder.

3.1. GCC scores

The distributions of the GCC scores are illustrated in Fig. 1. In the parent ratings, 36.0 % of the children in the BiHA-group, 48.3 % of the children in the BiCI-group, and 7.8 % of the children in the NH-group scored in the lowest 10th percentile according to the Finnish normative sample. The corresponding percentages in the daycare professionals' ratings were 32.0 %, 48.3 %, and 5.6 %, respectively.

The analyses with the linear mixed model revealed significant main effects for group, and nonverbal IQ on the GCC scores (see Table 5). Post hoc comparisons with the Bonferroni test indicated that the mean GCC scores of the BiHA-group and the BiCI-group were

Table 3
Distributions of the Respondents (%).

	BiHA	BiCI	NH
Parents			
Mother	91.7	64.3	84.1
Father	4.2	14.3	9.5
Together	4.2	21.4	6.3
Daycare professionals			
Kindergarten teachers	87.0	78.6	87.1
Kindergarten nurses	4.3	7.1	11.3
Family daycare providers	8.4	7.1	1.6
Special kindergarten teachers	0.0	7.1	0.0

Table 4
Scaled Scores of the Subscales and the General Communication Composites (GCC) in the CCC-2.

	Parents			Professionals		
	BiHA	BiCI	NH	BiHA	BiCI	NH
A.						
M	6.4	5.0	9.4	4.0	4.9	8.5
SD	4.7	4.4	4.4	4.9	5.1	5.0
Range	0–13	0–13	0–14	0–13	0–14	0–14
B.						
M	7.4	6.3	10.6	7.4	5.4	10.6
SD	4.4	5.2	3.4	5.3	5.3	3.7
Range	0–13	0–14	0-–14	0–14	0–13	0–14
C.						
M	8.3	7.1	10.5	7.6	7.9	10.6
SD	3.3	3.6	3.3	4.5	3.9	3.8
Range	2–15	0–15	3–18	0–15	0–15	4–18
D.						
M	8.2	6.2	10.3	8.4	7.8	10.8
SD	4.0	3.5	3.5	4.1	4.5	3.0
Range	2–15	0–13	2–15	3–14	0–15	3–15
E.						
M	10.0	7.9	10.4	11.4	8.6	11.6
SD	2.7	2.7	3.0	3.0	2.8	2.8
Range	5–15	3–15	4–16	6–16	5–16	6–17
F.						
M	8.5	7.2	10.4	10.3	9.1	11.2
SD	3.5	2.8	2.9	4.5	93.6	2.9
Range	–14	1–13	5–14	5–14	2–14	6–14
H.						
M	9.2	8.7	10.6	8.4	8.6	10.0
SD	2.9	3.0	3.0	3.4	3.1	3.3
Range	4–14	4–14	1–14	4–14	4–14	2–14
I.						
M	8.8	8.5	9.1	7.9	5.8	8.0
SD	2.7	3.3	3.1	3.2	2.4	3.0
Range	4–14	2–14	3–14	4–14	2–14	3–14
J.						
M	11.0	9.3	10.7	10.5	10.0	11.4
SD	2.8	2.8	2.6	2.8	2.4	2.7
Range	6–15	5–15	5–16	7–16	7–15	6–16
GCC						
M	66.8	55.6	82.9	68.9	61.5	85.0
SD	23.3	21.9	17.4	23.5	24.6	16.4
Range	20–107	20–106	46–112	26–100	23–102	45–111

Note. A. = Speech, B. = Syntax, C. = Semantics, D.= Coherence, E. = Inappropriate Initiation, F. = Stereotyped Language, G.= Use of Context, H. = Nonverbal Communication, I.= Social Relations, J. = Interests

significantly lower than in the NH group ($p = .003$ and $p < .001$, respectively), but there was no statistical difference between the BiHA-group and the BiCI-group on the GCC scores. Additionally, the effects for respondent and gender were not significant.

3.2. CCC-2 profiles

To gain detailed information on different aspects of communication, the performance in the 10 subscales of the CCC-2 (Table 4, Fig. 2) was explored. Many significant differences between the variables were detected (Table 5). Analyses with the linear mixed model showed a significant main effect for group across all the subscales of the CCC-2. The post hoc tests revealed that the BiHA-group had significantly lower scores than the NH-group in *Speech* ($p = .002$)*, Syntax* ($p = .002$), *Semantics* ($p = .006$), and *Coherence* ($p = .033$). In contrast, the BiCI-group had significantly lower scores than the NH-group in all the subscales of the CCC-2 (*Speech:* $p < .001$; *Syntax:* $p < .001$; *Semantics:* $p < .001$; *Coherence:* $p < .001$; *Inappropriate Initiation:* $p < .001$; *Stereotyped Language:* $p < .001$; *Use of Context:* $p < .001$; *Nonverbal Communication:* $p = .031$; *Social Relations:* $p = .031$; *Interests:* $p = .045$). Additionally, the BiCI-group had significantly poorer performance than the BiHA-group in *Inappropriate Initiation* ($p < .001$), and *Social Relations* ($p = .033$).

In addition to group, there was a significant main effect for respondent on *Speech, Coherence, Inappropriate Initiation, Stereotyped Language, Use of Context,* and *Social Relations*. Interestingly, the parents gave better scores on average than the professionals on *Speech* and *Social Relations* across the groups, whereas the professionals rated participants higher than parents on *Coherence, Inappropriate Initiation, Stereotyped Language,* and *Use of Context* (see Table 4). The main effect for gender was significant or very close to significant for *Coherence, Inappropriate Initiation, Nonverbal Communication, Social Relations,* and *Interests*. The girls performed better than the boys on average in these subscales, regardless of the group. Moreover, the main effect for nonverbal IQ was significant for *Syntax, Semantics,* and *Use of Context* indicating that higher nonverbal IQ was associated with higher scores in these subscales.

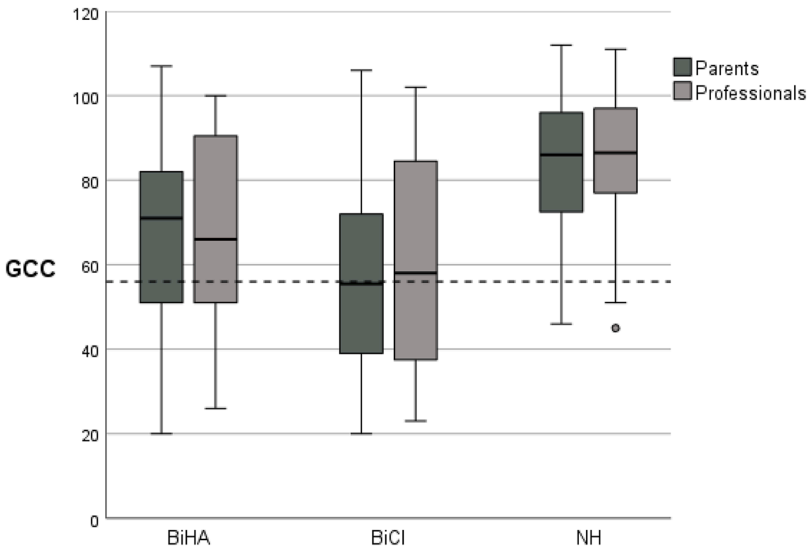

Fig. 1. *Distributions of the General Communication Composite Scores (GCC) Note.* The dashed line represents the limit of the 10th percentile in the Finnish normative data.

3.3. Internal consistency of the responses

The Cronbach's Alpha scores for the GCC and the subscales of the CCC-2 were calculated to test the internal consistency of the responses (Table 6). In this study, the alpha levels were high for GCC, *Speech, Syntax, Semantics, Coherence, Use of Context*, and *Inappropriate Initiation*. However, low alpha levels were detected for *Stereotyped Language, Nonverbal Communication, Social Relations,* and *Interests* for both parental and professional responses.

Table 5
Effects of Group, Respondent, Gender, and IQ as Analysed With the Linear Mixed Model.

	Group		Respondent		Gender		IQ	
	F(df)	*p*	*F(df)*	*p*	*F(df)*	*p*	*F(df)*	*p*
A.	**11.88 (2, 119)**	**< 0.001**	**5.38 (1, 115)**	**0.022**	0.33 (1, 118)	0.565	0.49 (1, 118)	0.483
B.	**18.03 (2, 118)**	**< 0.001**	0.22 (1, 116)	0.644	0.17 (1, 116)	0.681	**6.66 (1, 117)**	**0.011**
C.	**9.87 (2, 119)**	**< 0.001**	0.05 (1, 116)	0.830	0.05 (1, 117)	0.816	**13.96 (1, 117)**	**< 0.001**
D.	**13.08 (2, 118)**	**< 0.001**	**3.99 (1, 116)**	**0.048**	**4.03 (1, 117)**	**0.047**	3.45 (1, 118)	0.066
E.	**15.21 (2, 119)**	**< 0.001**	**9.69 (1, 118)**	**0.002**	3.76 (1, 118)	0.055	0.54 (1, 118)	0.466
F.	**13.17 (2, 118)**	**< 0.001**	**13.65 (1, 117)**	**< 0.001**	0.02 (1, 117)	0.895	2.47 (1, 117)	0.119
G.	**8.59 (2, 118)**	**< 0.001**	**16.23 (1, 116)**	**< 0.001**	3.2 (1, 117)	0.076	**6.86 (1, 117)**	**0.010**
H.	**4.03 (2, 118)**	**0.020**	1.65 (1, 116)	0.202	**5.03 (1, 116)**	**0.027**	2.62 (1, 117)	0.108
I.	**4.33 (2, 117)**	**0.015**	**20.18 (1, 116)**	**< 0.001**	**12.93 (1, 115)**	**< 0.001**	1.62 (1, 116)	0.205
J.	**3.40 (2, 114)**	**0.037**	1.88 (1, 111)	0.174	**3.91 (1, 113)**	**0.051**	0.93 (1, 113)	0.337
GCC	**20.88 (2, 119)**	**< 0.001**	3.10 (1, 116)	0.081	2.21 (1, 118)	0.140	**6.98 (1, 118)**	**0.009**

Note. A. = Speech, B. = Syntax, C. = Semantics, D.= Coherence, E. = Inappropriate Initiation, F. = Stereotyped Language, G.= Use of Context, H. = Nonverbal Communication, I.= Social Relations, J. = Interests; Significant effects are marked with bold font.

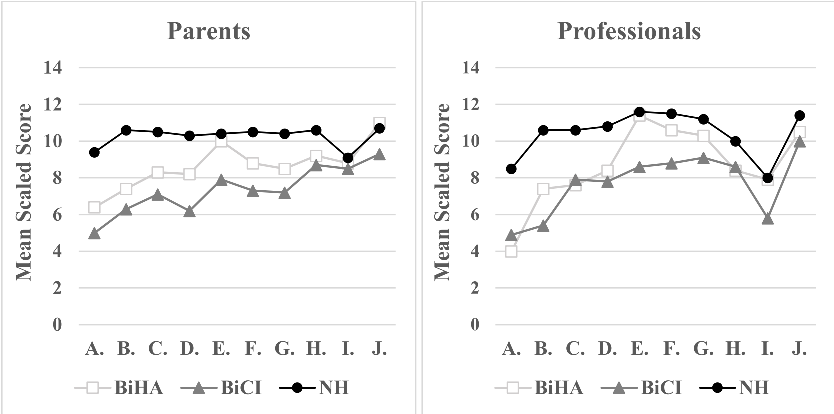

Fig. 2. *Between-Group Comparisons Across the Subscales of the CCC-2 Rated by the Parents (Left) And the Daycare Professionals (Right) Note.* A. = Speech, B. = Syntax, C. = Semantics, D.= Coherence, E. = Inappropriate Initiation, F. = Stereotyped Language, G.= Use of Context, H. = Nonverbal Communication, I.= Social Relations, J. = Interests.

4. Discussion

4.1. Differences between the groups

The first aim of the study was to investigate how the communicative skills of the children with an early diagnosis of HL using either BiHAs or BiCIs compared with children with NH, and with each other. The results indicated that approximately two thirds of the children in the BiHA-group and half the children in the BiCI-group had a normal performance in the CCC-2 according to the parents and daycare professionals. However, the results highlighted that despite an early age of diagnosis and early HA fitting (and bilateral implantation), children with HL were clearly at risk of communicative problems that were evident in both home and daycare settings (42.6 % of the parental reports and 40.7 % of the professionals' reports concerning all the children with HL). In addition, our results revealed that these communicative difficulties were not necessarily restricted to the linguistic domain. Particularly, many children with BiCIs had wide-scale communicative difficulties that covered both structural and pragmatic domains. Our results are in line with previous studies indicating that children with HL are at risk of delayed linguistic development (e.g., Baudonck et al., 2010; Wie, et al., 2020) as well as delayed pragmatic development (e.g., Most et al., 2010; Rinaldi et al., 2013), despite an early diagnosis.

There were a few children in each group who had a SIDC-score that may indicate a risk of autism spectrum disorder. Nevertheless, none of them had been diagnosed with autism spectrum disorder despite all participating in the nationwide Finnish health care program with regular follow-up visits. In addition, all the children with HL had regular follow-up visits in one of the university hospitals in Finland. Neither the parents nor the daycare professionals working with these children had expressed any concerns related to autistic-type behaviour. Moreover, Norbury et al. (2004) concluded in their validation study of the CCC-2 that there are no clear boundaries between different communicative impairments, and a deviant SIDC-score may also indicate some other condition than autism that has consequences on pragmatic and social abilities.

Some previous studies have indica that children with CIs outperform their peers with HAs on linguistic skills (e.g., Välimaa et al., 2022; Yosinaga-Itano et al., 2010). Additionally, in at least some of the behavioural linguistic measures made as a part of the background measures of our study, the children with CIs indeed seem to outperform their peers with HAs. Interestingly, the reports from the parents and the daycare professionals did not confirm these findings. The pragmatic skills of children with HL remain a sparsely studied domain, but some previous studies (e.g., Stiles & Nadler, 2013; Rinaldi et al., 2013) have revealed pragmatic level communicative

Table 6
Cronbach's Alpha Results for the Subscales and the GCC Scores.

	Cronbach's Alpha Parents	Professionals
A. Speech	0.84	0.79
B. Syntax	0.87	0.82
C. Semantics	0.78	0.75
D. Coherence	0.77	0.77
E. Inappropriate Initiation	0.74	0.67
F. Stereotyped Language	0.58	0.40
G. Use of Context	0.73	0.75
H. Nonverbal Communication	0.45	0.52
I. Social Relations	0.49	0.49
J. Interests	0.53	0.39
GCC	0.95	0.94

difficulties in children with HL using HAs or CIs. In some previous studies (Jones et al., 2015; Most et al., 2010), no significant differences in pragmatic skills between children with HAs and CIs were found. Yet, there is some evidence of the outperformance of children with CIs compared with their peers with HAs from the previous studies with the CCC-2 (Theunissen et al., 2014). Moreover, Halliday et al. (2017) concluded that despite normal performance in the linguistic tests, the parents of the children with mild-to-moderate HL rated them lower than peers with NH across all the subscales of the CCC-2. Instead, the reports of our study suggest that the possible communicative difficulties of children with HAs are often centered around linguistic skills, but the communicative difficulties of children with CIs are more often wide-scale. The children with CIs in our study performed particularly weakly in *Inappropriate Initiation* and *Social Relations* compared with their peers with HAs or normal hearing. Goberis et al. (2012) as well noticed previously in their study that children with HL may have delays in developing several pragmatic skills, including the relevant use of language. However, they had children with mild-to-profound HL in their study, and they did not have separate groups for children with HAs and CIs. The teachers in the study by Zaidman-Zait & Most (2020) reported problems with pragmatic language and social relations in children with HL. These findings are consistent with our results concerning the pragmatic skills and social relations of the children with CIs.

The partly conflicting findings between the results from the previous studies and our study may have several explanations. First, the groups of participants may have been heterogeneous across the studies. For example, diagnostic procedures and intervention protocols may vary across countries and they have also changed over time (Patel & Feldman, 2011). In addition, there is variation between the studies in the linguistic and socio-economic factors as well as in hearing statuses of the participants.

The exact quality and quantity of communicative intervention was not known in many of the previous studies nor in our study. However, it is typical in Finland that children with profound HL using CIs may get a greater amount of speech therapy and it may start earlier than for children with mild-to-severe HL using HAs (Välimaa et al., 2022). Thus, the respondents for the BiCI-group of our study may have worked more often with a speech therapist and may have been more educated on communicative abilities, hence, better at noticing communicative difficulties than the respondents for the BiHA-group. In addition, since the respondents of the CCC-2 need to be familiar with the children they evaluate, the respondents cannot be blinded. Thus, the respondents in our study knew whether the child they evaluated had or had not a HL. Moreover, the fact that the BiCI-group may have received more speech therapy, may have influenced the opinions of the respondents. That is, the children of the BiCI-group with more speech therapy may have seemed more impaired in their communication abilities than the children of the BiHA-group with less speech therapy. The varying results between the studies on the communication abilities of children with HL may thus have methodological explanations. Results from questionnaires may sometimes differ from results from behavioural measurements. One may question whether the children in the BiCI-group indeed had wider-scale communicative difficulties than the children in the BiHA-group or if the difficulties of the children in the BiHA-group were at least partly imperceptible in their everyday environments for some reason. Thus, further research is needed in the future.

4.2. Differences between the respondents

The second aim of our study was to compare the ratings of the parents and the daycare professionals with each other. The results showed that the parents and the professionals were not completely unanimous in their opinions. Our results and the results of Norbury et al. (2004) indicated that teachers tended to give higher GCC scores than parents overall, although there was some variation between the clinical groups in the study by Norbury et al. (2004). However, in our study, the parents rated the children higher than the professionals on *Speech* and *Social Relations.*

It is not entirely uncommon to find low parent-professional agreement. This may also be because the social aspects of communication are particularly dependent on the communicative context (Bishop & Baird, 2001). Children may behave differently in different settings, and the settings may have different demands. For example, daycare settings may have different demands from the home environment for social interaction or hearing in noise. On the other hand, some linguistic or behavioural aspects may be easier to observe at home in one-on-one situations between a parent and a child than at daycare. Additionally, parents usually spend more time with their children than professionals (Bishop, 2015). However, professionals working with groups of children may have a better perception than parents on the range of typical development. Regardless, parents and professionals always have somewhat different perspective on children. Additionally, each parent and professional has a subjective perspective on a specific child. Therefore, the results of our study may not equally represent the views of both parents and each daycare professional working with the particular participant. For example, a majority of the parental responses came from mothers, which may have biased the parental responses (see. e.g., Hintermair & Sarimski, 2019; Ingber & Most, 2012).

4.3. Explanations for communicative difficulties of children with HL

Previous research has suggested that communicative problems of children with HL are likely to arise from sensory deprivation and its effects on the development of auditory cortex (e.g., Sharma et al., 2009), and from the effect of the HL on the amount and quality of early experiences of communicative situations (e.g., Meins et al., 2002). Additionally, it has been suggested that HL influences many aspects of cognitive development (e.g., attention, ToM, nonverbal intelligence) which may on their half have consequences on communicative development. Many other factors such as gender or parental education may be associated with the communicative development of children with HL (Ching et al., 2013; Ching et al., 2018; Halliday et al., 2017; Välimaa et al., 2022).

The focus of our study was not on studying the contributory factors behind the communicative difficulties some children with HL face. However, gender and nonverbal IQ were included in the statistical model to control for their effects on the results. The analyses revealed that gender and nonverbal intelligence might affect some aspects of communicative development. According to the respondents, gender had an effect mainly on social-pragmatic aspects of communication. Nonverbal IQ instead had an influence on syntactic and semantic skills as well as use of context.

Some previous research (e.g., Jones et al., 2015; Rinaldi, et al., 2013) as well as our study indicate that pragmatic difficulties often occur together with linguistic deficits in children with HL. However, Most et al. (2010) concluded that pragmatic abilities of children with HL may be weak despite relatively good performance in linguistic measures. Additionally, our results concerning the BiCI-group as well as the results from Zaidman-Zait and Most (2020), and from Halliday et al. (2017) indicate that the pragmatic difficulties of the children with HL are not necessarily restricted to the verbal domain. According to Cullington and Zeng (2011), possible delay in the development of nonverbal communication abilities in children with HL may be due to their inability to direct attention to the nonverbal features that are relevant for communication if they struggle with speech perception, and their attention is focused on speech reading. Other explanations as well for the delayed pragmatic development of some children with HL have been suggested. Several studies have shown that children with HL are at risk of delayed ToM development (e.g., Jones et al., 2015), which is known to influence pragmatic development. However, many other factors, such as auditory or socioeconomic factors or differences in exposure to spoken language or intervention may have influenced our results concerning the communicative development of children with HL.

4.4. Limitations and future research

Our results revealed that almost half the children with HL had communicative difficulties, indicated with the CCC-2 questionnaire by both parents and daycare professionals, and the BiCI-group had more wide-scale communicative problems on average than the BiHA-group, including the pragmatic domain in addition to the linguistic domain. However, it would have been better if the sample size of our study had been larger, so further studies are needed to confirm our findings. Additionally, the groups differed from each other on their hearing age, i.e., the time with robust auditory input. Thus, there were differences between the groups in their exposure to spoken language. In the future, we need a comprehensive analysis of the associations between different contributing factors and communication skills of children. As suggested in some previous studies, pragmatic deficits of some children with HL may be secondary and due to linguistic difficulties (e.g., Jones et al., 2015). However, there are currently very few studies where the connection between linguistic and pragmatic skills have been explored in children with HL. Revealing contributing factors to the communicative development of children with HL would be crucial in the future to develop better intervention methods to support the development of children with HL.

In addition, results from questionnaires always represent a subjective view of the respondents. Moreover, the internal consistency of the responses in our study was high for the linguistic scales, but only partly so for the pragmatic scales, and it was low for both of the scales developed for assessing atypical behaviour related to autism spectrum disorder. However, the Cronbach's Alpha is known to be sensitive to the number of items and sample size, and it is not rare to have low alpha values if the number of items in one scale is lower than ten (DeVellis, 2003, 94–96). Yet the measures of internal consistency indicated that some respondents may have had difficulties in answering some of the questions related to pragmatic skills and those related to atypical behaviour associated with autism spectrum disorder. This highlights the importance of studying the topic of our research further with other assessment methods as well to verify our findings. According to our results, it seems that the performance of the children is dependent on the communicative environment. Additionally, many other factors may have contributed the differences between the respondents. As we did not analyze associations between the reports and behavioural tests, we cannot say, which responses were more associated with behavioural tests. Particularly, the pragmatic development of children with HL remains a very little understood area of research. In the future, it will therefore be important to study this area additionally with behavioural tests to gain better insight into the communication abilities of children with HAs or CIs.

5. Conclusions

According to the respondents, the BiHA- and BiCI-groups had poorer communication skills on average than the NH-group, despite early diagnoses and modern hearing technology. The communicative difficulties reported in approximately one third of the BiHA-group, mostly centered around structural language skills. Instead, approximately half of the children in the BiCI-group had communication difficulties, and their difficulties often included the pragmatic domain as well. However, the respondents were not completely unanimous, which may be an indication that different environments have different demands. Thus, questionnaires directed to parents and daycare professionals may give clinicians important information from different everyday environments of children.

Our findings lead us to suggest that in addition to linguistic skills, the pragmatic skills of children with HL should be evaluated regularly, and information should be gathered with a combination of behavioural tests and reports from natural environments such as home and daycare/ school to find more specific practical solutions to support children with HL. Finally, further studies are needed to gain a better understanding of the communicative development of children with HL and factors contributing to it.

Author contributions

Krista Tuohimaa: Conceptualization, Data collection, Analyses, Funding acquisition, Visualization, Writing – original draft, Writing – review and editing, **Soile Loukusa:** Methodology, Supervision, Writing – review & editing **Heikki Löppönen:** Project administration, Funding acquisition, Resources, Writing – review & editing, **Taina Välimaa:** Supervision, Project administration, Funding acquisition, Resources, Data collection, Writing – review & editing, **Sari Kunnari:** Supervision, Project administration, Funding acquisition, Resources, Writing – review & editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Acknowledgements

We are very grateful to the clinical research team members of Helsinki, Kuopio, Oulu, Tampere, and Turku University Hospitals who were responsible for the recruitment of the participants, as well as to the parents, daycare professionals, and children who participated in this study. We wish to express our gratitude to Dr Hannu Vähänikkilä from the Faculty of Medicine, University of Oulu and Dr Päivi Laukkanen-Nevala from the Finnish Institute for Health and Welfare (THL) for their statistical counselling. This study was funded by the Finnish Brain Foundation, the Päivikki and Sakari Sohlberg Foundation, the Finnish Cultural Foundation, the Academy of Finland, the Eudaimonia Institute at the University of Oulu, and the Institute of Clinical Medicine, Department of Otorhinolaryngology in the University of Eastern Finland.

References

Anne, S., Brown, K. D., Goldberg, D. M., Adunka, O. F., Kenna, M., Chien, W., Teagle, H., Zwolan, T. A., Sydlowski, S. A., Roush, P., & Buchman, C. A. (2021). Pediatric bilateral sensorineural hearing loss: minimum test battery and referral criteria for cochlear implant candidacy evaluation. *Otolaryngology–Head and Neck Surgery*, 1–5. https://doi.org/10.1177/01945998211027352

Antia, S. D., Jones, P., Luckner, J., Kreimeyer, K. H., & Reed, S. (2011). Social outcomes of students who are deaf and hard of hearing in general education classrooms. *Exceptional Children, 77*(4), 489–504. https://doi.org/10.1177/001440291107700407

Baudonck, N., Dhooge, I., D'haeseleer, E., & Van Lierde, K (2010). A comparison of the consonant production between Dutch children using cochlear implants and children using hearing aids. *International Journal of Pediatric Otorhinolaryngology, 74*(4), 416–421. https://doi.org/10.1016/j.ijporl.2010.01.017

Bishop, D. V. M., & Baird, G. (2001). Parent and teacher report of pragmatic aspects of communication: use of the children's communication checklist in a clinical setting. *Developmental Medicine and Child Neurology, 43*(12), 809–818. https://doi.org/10.1017/s0012162201001475

Bishop, D.V.M. (2015). *The children's communication checklist version 2 (CCC-2), [Lasten Kommunikointitaitojen Kysely, toinen painos]* (Yliherva, A., Loukusa, S., & Väisänen, R, Trans.) Hogrefe Psykologien Kustannus Oy. (Original work published in 2003.).

Ching, T. Y. C., 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), 105–111. https://doi.org/10.1080/14992027.2017.1385865

Ching, T. Y. C., Dillon, H., Marnane, V., Hou, S., Day, J., Seeto, M., Crowe, K., Thomson, J., van Buynder, P., Zhang, V., Wong, A., Burns, L., Flynn, C., Cupples, L., Cowan, R. S., Leigh, G., Sjahalam-King, J., & Yeh, A. (2013). Outcomes of early- and late-identified children at 3 years of age: Findings from a prospective population-based study. *Ear and Hearing, 34*(5), 535–552. https://doi.org/10.1097/AUD.0b013e3182857718

Crowe, K., & Dammeyer, J. (2021). Sensory loss. In L. Cummings (Ed.), *Handbook pragmatic language disorders: Complex and underserved populations* (pp. 215–246). Springer. https://doi.org/10.1007/978-3-030-74985-9_9.

Cullington, H. E., & Zeng, F. G. (2011). Comparison of bimodal and bilateral cochlear implant users on speech recognition with competing talker, music perception, affective prosody discrimination, and talker identification. *Ear and Hearing, 32*(1), 16–30. https://doi.org/10.1097/AUD.0b013e3181edfbd2

De Hoog, B. E., Langereis, M. C., van Weedenburg, M., Knoors, H. E. T., & Verhoeven, L. (2016). Linguistic profiles of children with CI as compared with children with hearing or specific language impairment. *International Journal of Language and Communication Disorders, 51*(5), 518–530. https://doi.org/10.1111/1460-6984.12228

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2nd ed.). Sage Publications.

Fortnum, H. M., Summerfield, A. Q., Marshall, D. H., Davis, A. C., & Bamford, J. M. (2001). Prevalence of permanent childhood hearing impairment in the United Kingdom and implications for universal neonatal hearing screening: Questionnaire based ascertainment study. *BMJ, 323*, 536–540. https://doi.org/10.1136/bmj.323.7312.536

Goberis, D., Beams, D., Dalpes, M., Albrosch, A., Baca, R., & Yoshinaga-Itano, C. (2012). The missing link in language development of deaf and hard of hearing children: Pragmatic language development. *Seminars in Speech and Language, 33*(4), 297–309. https://doi.org/10.1055/s-0032-1326916

Guerzoni, L., Murri, A., Fabrizi, E., Nicastri, M., Mancini, P., & Cuda, D. (2015). Social conversational skills development in early implanted children. *The Laryngoscope, 126*(9), 2098–2105. https://doi.org/10.1002/lary.25809

Häkli, S., Luotonen, M., Bloigu, R., Majamaa, K., & Sorri, M. (2014). Childhood hearing impairment in Northen Finland, etiology and additional disabilities. *International Journal of Pediatric Otorhinolaryngology, 78*(11), 1852–1856. https://doi.org/10.1016/j.ijporl.2014.08.007

Halliday, L. F., Tuomainen, O., & Rosen, S. (2017). Language development and impairment in children with mild to moderate sensorineural hearing loss. *Journal of Speech, Language, and Hearing Research, 60*(6), 1551–1567. https://doi.org/10.1044/2016_JSLHR-L-16-0297

Hintermair, M., & Sarimski, K. (2019). Fathers of deaf and hard-of-hearing infants and toddlers – experiences, needs, and challenges. *Journal of Deaf Studies and Deaf Education, 24*(2), 84–94. https://doi.org/10.1093/deafed/eny040

Ingber, S., & Most, T. (2012). Fathers' involvement in preschool programs for children with and without hearing loss. *American Annals of the Deaf, 157*(3), 276–288.

Jones, A. C., Gutierrez, R., & Ludlow, A. K. (2015). Confronting the language barrier: Theory of Mind in deaf children. *Journal of Communication Disorders, 56*, 47–58. https://doi.org/10.1016/j.jcomdis.2015.06.005

Kempson. (2012). The syntax/pragmatics interface. In K. Allan, & K. M. Jaszczolt (Eds.), *The Cambridge handbook of pragmatics* (pp. 529–548). Cambridge University Press.

Korkman, M., Kirk, U., & Kemp, S. (2008). *NEPSY-II. Lasten neuropsykologinen tutkimus [A developmental neuropsychological assessment]*. Psykologien Kustannus Oy.

Kral, A., Dorman, M. F., & Wilson, B. S. (2019). Neuronal development of hearing and language: Cochlear implants and critical periods. *Annual Review of Neuroscience, 42*(1), 47–65. https://doi.org/10.1146/annurev-neuro-080317-061513

Löfqvist, U., Anmyr, L., Henricson, C., & Karltorp, E. (2020). Executive functions, pragmatic skills, and mental Health in children with congenital cytomegalovirus (CMV) infection with cochlear implants: A pilot study. *Frontiers in Psychology, 10*, 1–16. https://doi.org/10.3389/fpsyg.2019.02808

Martin, N., & Brownell, R. (2010). *Expressive One-Word Picture Vocabulary Test* (4th ed.). Academic Therapy Publications.

Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind-mindedness and attachment security as predictors of theory of mind understanding. *Child Development, 73*(6), 1715–1726. https://doi.org/10.1111/1467-8624.00501

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

Moore, D. R., Zobay, O., & Ferguson, M. A. (2020). Minimal and mild hearing loss in children: Association with auditory perception, cognition, and communication problems. *Ear and Hearing, 41*(4), 720–732. https://doi.org/10.1097/AUD.0000000000000802

Most, T., & Michaelis, H. (2012). Auditory, visual, and auditory–visual perceptions of emotions by young children with hearing loss versus children with normal hearing. *Journal of Speech, Language, and Hearing Research, 55*(4), 1148–1162. https://doi.org/10.1044/1092-4388(2011/11-0060

Most, T., Shina-August, E., & Meilijson, S. (2010). Pragmatic abilities of children with hearing loss using cochlear implants or hearing aids compared to hearing children. *Journal of Deaf Studies and Deaf Education, 15*(4), 422–437. https://doi.org/10.1093/deafed/enq032

Netten, A. P., Rieffe, C., Soede, W., Dirks, E., Korver, A. M. H., Konings, S., Briaire, J. J., Oudesluys-Murphy, A. M., Dekker, F., W., Frijns, J. H. M., & DECIBEL Collaborative study group. (2017). Can you hear what I think? Theory of mind in young children with moderate hearing loss. *Ear and Hearing, 38*(5), 588–597. https://doi.org/10.1097/AUD.0000000000000427

Nicastri, M., Filipo, R., Ruoppolo, G., Viccaro, M., Dincer, H., Guerzoni, L., Cuda, D., Bosco, E., Prosperini, L., & Mancini, P. (2014). Inferences and metaphoric comprehension in unilaterally implanted children with adequate formal oral language performance. *International Journal of Pediatric Otorhinolaryngology, 78*(5), 821–827. https://doi.org/10.1016/j.ijporl.2014.02.022

Norbury, C. F., Nash, M., Baird, G., & Bishop, D. V. M. (2004). Using a parental checklist to identify diagnostic groups in children with communication impairment: A validation of the Children's Communication Checklist–2. *International Journal of Language and Communication Disorders, 39*(3), 345–364. https://doi.org/10.1080/13682820410001654883

Patel, H., & Feldman, M. (2011). Universal newborn hearing screening. *Paediatrics & Child Health, 16*(5), 301–305, 10.1093%2Fpch%2F16.5.301.

Peng, S.-C., Tomblin, J. B., & Turner, C. W. (2008). Production and perception of speech intonation in pediatric cochlear implant recipients and individuals with normal hearing. *Ear and Hearing, 29*(3), 336–351. https://doi.org/10.1097/AUD.0b013e318168d94d

Perkins, M. (2007). *Pragmatic impairment*. Cambridge University Press.

Reuterskiöld, C., Ibertsson, T., & Sahlén, B. (2010). Venturing beyond the sentence level: Narrative skills in children with hearing loss. *The Volta Review, 110*(3), 389–406. https://doi.org/10.17955/tvr.110.3.638

Rinaldi, P., Baruffaldi, F., Burdo, S., & Caselli, M. C. (2013). Linguistic and pragmatic skills in toddlers with cochlear implant. *International Journal of Language and Communication Disorders, 48*(6), 715–725. https://doi.org/10.1111/1460-6984.12046

Roid, G., Miller, L., Pomplun, M., & Koch, C. (2013). *Leiter International Performance Scale* (3rd Ed). Stoelting.

Russ, S. A., Poulakis, Z., Barker, M., Wake, M., Rickards, F., Sounders, K., & Oberklaid, F. (2003). Epidemiology of congenital hearing loss in Victoria, Australia. *International Journal of Audiology, 42*(7), 385–390. https://doi.org/10.3109/14992020309080047

Sharma, A., Nash, A. A., & Dorman, M. (2009). Cortical development, plasticity, and re-organization in children with cochlear implants. *Journal of Communication Disorders, 42*(4), 272–279, 10.1016%2Fj.jcomdis.2009.03.003.

Socher, M., Lyxell, B., Ellis, R., Gärskog, M., Hedström, I., & Wass, M. (2019). Pragmatic language skills: A comparison of children with cochlear implants and children without hearing loss. *Frontiers in Psychology, 10*, 1–10. https://doi.org/10.3389/fpsyg.2019.02243

Stiles, D. J., & Nadler, L. J. (2013). Sarcasm recognition in children with hearing loss: The role of context and intonation. *Journal of Educational Audiology, 19*, 3–11.

Thagard, E. K., Hilsmier, S. A., & Easter-Brooks, S. R. (2011). Pragmatic language in deaf and hard of hearing students. Correlation with success in general education. *American Annals of The Deaf, 155*(5), 526–534. https://doi.org/10.1353/aad.2011.0008

Theunissen, S. C. P. M., Rieffe, C., Kouwenberg, M., De Raeve, L., J, I., Soede, W., Briaire, J. J., & Frjns, J. H. M (2014). Behavioral problems in school-aged hearing-impaired children: The influence of sociodemographic, linguistic, and medical factors. *European Child & Adolescence Psychiatry, 23*, 187–196. https://doi.org/10.1007/s00787-013-0444-4

Tomblin, J. B., Harrison, M., Ambrose, S. E., Walker, E. A., Oleson, J. J., & Moeller, M. P. (2015). Language outcomes in young children with mild to severe hearing loss. *Ear and Hearing, 36*, 76S–91S. https://doi.org/10.1097/AUD.0000000000000219

UNESCO. (2012). *International standard classification of education ISCED 2011*. UNESCO Institute for Statistics.

Välimaa, T., Kunnari, S., Aarnisalo, A. A., Dietz, A., Hyvärinen, A., Laitakari, J., Mykkänen, S., Rimmanen, S., Salonen, J., Sivonen, J., Tennilä, T., Tsupari, T., Vikman, S., Virokannas, N., Laukkanen-Nevala, P., Tolonen, A.-K., Tuohimaa, K., & Löppönen, H. (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

Wass, M., Ibertsson, T., Lyxell, B., Sahlén, B., Hällgren, M., Larsby, B., & Mäki-Torkko, E. (2008). Cognitive and linguistic skills in Swedish children with cochlear implants—measures of accuracy and latency as indicators of development. *Scandinavian Journal of Psychology, 49*(6), 559–576. https://doi.org/10.1111/j.1467-9450.2008.00680.x

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

Wilson, D., & Sperber, D. (2012). Explaining irony. In D. Wilson, & D. Sperber (Eds.), *Meaning and relevance* (pp. 123–145). Cambridge.

Wong, C., L., Ching, T. Y. C., Cupples, L., Button, L., Leigh, G., Marnane, V., Whitfield, J., Gunnourie, M., & Martin, L (2017). Psychosocial development in 5-year-old children with hearing loss using hearing aids or cochlear implants. *Trends in Hearing, 21*, 1–19. https://doi.org/10.1177/2331216517710373

Yoshinaga-Itano, C., Baca, R. L., & Sedey, A. L. (2010). Describing the trajectory of language development in the presence of severe-to-profound hearing loss: A closer look at children with cochlear implants versus hearing aids. *Otology & Neurotology, 31*(8), 1268–1274. https://doi.org/10.1097/MAO.0b013e3181f1ce07

Zaidman-Zait, A., & Most, T. (2020). Pragmatics and peer relationships among deaf, hard of hearing, and hearing adolescents. *Pediatrics, 146*(3), 298–303. https://doi.org/10.1542/peds.2020-0242J