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Social communication and quality of life in children using hearing aids

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A B S T R A C T

Objectives: This study compared the parent-reported structural language and social communication skills—measured with the Children's Communication Checklist-2 (CCC-2)—and health-related quality of life (HR-QOL)—measured with the Pediatric Quality of Life Inventory (PedsQL)—of children who use hearing aids (HAs) and their typical-hearing (TH) peers.

Design: The participants were 88 children (age range of 5; 6 to 13; 1 (years; months)) and their parents: 45 children with bilateral moderate to severe hearing loss using HAs who had no additional disabilities and 43 children with typical hearing. The groups were matched based on chronological age, gender, nonverbal IQ, and parental education level. The parents completed questionnaires related to their children's communication skills, including subdomains structural language and social communication, and HR-QOL.

Results: The HA group had significantly poorer overall communication skills than the TH group ($r = 0.49$). The children in the HA group scored significantly lower than the TH group on both structural language ($r = 0.37$) and social communication ($r = 0.41$). Half of the children in the HA group had overall communication scores that either indicated concern or required further investigation according to the instrument's manual. In terms of psychosocial functioning, which was measured as HR-QOL, the subdomain school functioning was the main driver of the difference between groups, with the HA group being at least twice as likely (OR = 2.52) as the TH group to have poor HR-QOL in the school domain. Better parent-reported social communication was associated with better parent-reported psychosocial functioning in the children using HAs—even when background variables were taken into account.

Conclusion: The results suggest that traditional assessments and interventions targeting structural aspects of language may overlook social communication difficulties in children with HAs, even those with no additional disabilities. As school functioning stood out as the most problematic domain for children with HAs, efforts to improve the well-being of these children should focus on this area.

1. Introduction

Connecting and interacting with others is crucial to our health and well-being. Studies indicate that perceived social isolation or loneliness affects not only our mental health but also our cognitive skills [1], physical health [2], and death rate [1]. Social communication as a tool for maintaining social bonds with others is thus vital. However, not all children develop social communication with ease. Children born with a hearing loss are at a disadvantage, as they miss out on auditory stimuli even from before birth [3,4]. Several studies indicate that children with hearing loss are more prone to experience problems with communication and language skills [5–8]. The communication difficulties experienced by children with hearing loss appear to be associated with more psychosocial problems or lower quality of life (QOL) compared to peers with typical hearing [9–13].

A problem in previous studies is that they have primarily examined the structural language of children with hearing loss through traditional measures, usually completed in a one-to-one setting with an adult. This is not how children communicate in everyday life. Standardized test-settings usually involve few speakers, minimal background noise, and adults who can rectify misunderstandings and adjust to the conversational level of the child. Thus, when children using hearing aids (HAs) are found to struggle with language in these controlled settings, it raises the question of how they cope in natural conversational settings in the playground, in school, and in other peer-group settings. To answer this, proxy-reports are required.

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Another limitation in previous research is a strong focus on children with severe to profound hearing loss, who are often candidates for cochlear implants (CIs). In addition, grouping children with all degrees of hearing loss, from mild to profound, results in studies with considerable heterogeneity, including differences in hearing devices used [6,8,14,15]. There are, however, potentially important differences in the services provided to children who use different hearing technologies. A recent Norwegian report found that almost two out of three parents of children using HAs reported that, during the initial years after HA fitting, they rarely or never received guidance on how to stimulate language development in their children. In contrast, only one in four parents of children wearing CIs reported a similar experience [16]. Less follow-up for children using HAs, compared to children using CIs, has been hypothesized to be a contributing factor for increased reported symptoms of psychosocial problems in children using HAs, compared to children using CIs [17]. Children with moderate to severe hearing loss, who are usually candidates for HAs, outnumber children with profound hearing loss [18]. Therefore, more research is needed focusing specifically on children who use HAs.

A third shortcoming in the previous literature is that most studies focus on English-speaking children, with the majority being studies from the United States (US). The present study, conducted in Norway, contributes diversity to the research literature in terms of native language, educational setting, and culture. For example, socio-economic differences may have a greater impact on access to healthcare, age at diagnosis, or device use in the US, compared to Norway, where all health costs are covered equally for all citizens through universal access to healthcare.

In sum, the present study has three important characteristics. First, the study examines a homogenous group of HA users with moderate to severe hearing loss, without additional disabilities, who are in a general education setting. Second, this study of Norwegian-speaking children contributes data from a less-studied language, educational settings, and culture to the existing research literature. Finally, this study is novel in that it measures social communication skills in school and everyday settings, rather than structural language skills addressed in most previous studies of children with hearing loss (e.g. via tests of vocabulary and grammar). Thus, this study contributes new knowledge about how children with hearing loss manage the complex communication skills needed for social interaction, not only in conversations with adults but also in peer interactions. Critically, this study examines the association between social communication skills and quality of life.

1.1. Language and social communication skills in children using HAs

Children with congenital hearing loss—even if mild—may start out with a delay in language development because of their limited auditory access. Several studies have found that children using HAs have poorer auditory and language skills compared to children with typical hearing (TH) across domains such as vocabulary [19–22], expressive and receptive language [15,19–21,23,24], receptive grammar [24], phonology [22], and speech perception in noise [25]. The presence of hearing loss requiring the use of HAs may thus be seen as a risk factor for language delay in children. In addition, has degree of hearing loss emerged in some studies as an important factor in language development, with some studies finding that milder hearing loss is associated with better language outcomes [15,21,23,26–28]. Other studies have found no relationship between the degree of hearing loss and language skills [19,24]. Socioeconomic status (SES) has also been found to affect language development. In many studies, higher family SES, often measured as parental education or income, has been found to be associated with better language outcomes in children with hearing loss [15,21,23,24,26], but there are exceptions [20]. However, most of these studies examined language skills in highly controlled one-to-one assessment situations, e.g., traditional vocabulary tests, and therefore lack a broader understanding of how children communicate in their daily lives.

Although social communication is clearly dependent on speech and structural language skills [29], it encompasses a range of abilities that go beyond the core language domains of phonology, vocabulary, and grammar. Social communication includes pragmatic skills (using and comprehending language appropriate for the situational context), nonverbal skills (communicative facial expressions and gestures), and broader social skills, such as knowledge of appropriate ways to initiate a conversation [30], thus tapping into skills such as theory of mind and mentalization. Given children with HAs reported problems with structural language, one might suspect that social communication also might be an area of concern.

However, in contrast to other measures of language, less is known about whether children using HAs also struggle with social communication, e.g., the more context-dependent, nonverbal, and social aspects that are part of the overall concept of social communication. To our knowledge, no studies have examined social communication in children with HAs specifically. Studies of related topics such as overall communication and pragmatics in children with different degrees of hearing loss may still inform the question of how social communication might be affected in children using HAs. One study examined overall communication, which included also a measure of social communication, and found that children with HAs scored significantly below children with TH [24]. Reviews of pragmatic abilities in children with different degrees of hearing loss have shown that difficulties with or a delay in pragmatic abilities is common in children with different degrees of hearing loss [31,32]. Children with hearing loss seem to be less skilled at maintaining conversational topics, less often repair conversational breakdowns and use different strategies such as more frequent requests for clarification, repetitions, and confirmatory responses than peers [32].

In a structured clinical setting, problems with social communication might be more subtle and less easily detectable than structural language problems, and may thus be easier to overlook, especially as pragmatic language may not be part of the routine screening for children with hearing los [31,32]. But as the purpose of mastering social communication is to use it in interaction with others, problems with social communication may cause challenges in peer interactions, such as on the playground, in the classroom, or on the sports field. These situations are often especially difficult due to the presence of background noise, which makes initiating and maintaining interaction with other children more difficult for children with hearing loss and may also reduce their opportunities for social learning [33–35]. This self-reinforcing cycle may lead to problems with peer interaction and can ultimately compromise psychosocial functioning.

1.2. Psychosocial functioning in children using HAs and the impact of language

In children with hearing loss, psychosocial difficulties appear to be more frequent than in children with typical hearing [10,13]. Psychosocial difficulties involve both psychological and social aspects of functioning and may include mental health issues, behavioral problems, relationships with others, and self-regulation. Difficulties psychosocial functioning are related to health outcomes, well-being, and QOL [36]. Few studies have examined children with HAs specifically, and there is thus a need for more knowledge about their psychosocial functioning.

The present study investigated a specific aspect of psychosocial functioning through a measure of health-related quality of life (HR-QOL). HR-QOL is a multidimensional concept comprising the well-being of an individual across the physical, psychological, and social domains [37]. HR-QOL may be further defined as the well-being of an individual in areas or domains affected by a health condition or disability [38–40]. It is thus a useful way of measuring psychosocial functioning in children who have a disability affecting several areas of their life, such as hearing loss.

A number of factors may be related to psychosocial and behavioral difficulties in children using HAs, but difficulties with language and communication are frequently emphasized in the literature [9,10,17,41–44]. One probable explanation for the association between language and psychosocial problems is that language difficulties may affect the ability of a child to perceive the intentions of others, to express him/-herself, and to regulate their emotions and behavior [45]. Children with hearing loss may also miss out on social and emotional cues in language that are dependent on acoustic properties, such as prosody, pragmatics, and affective pitch [43].

Problems with pragmatic language abilities, which is the concept most closely related to social communication, appear to be associated with a range of difficulties with social interaction in children with different degrees of hearing loss such as being less popular and less accepted by peers [46], receiving less perceived support from peers [47] and experiencing problems with peer interaction [47]. Similar findings have been reported for other clinical groups who typically struggle with social communication, such as children with developmental language disorder (DLD). For example, poorer social communication was associated with less peer acceptance in children with DLD [48], and similarly, pragmatic language was the language measure most strongly associated with social outcomes in adolescents with DLD [49]. Pragmatic language difficulties have also been found to be associated with emotional and peer problems in adolescents with externalizing behavior problems in childhood [50].

In addition to language, gender has been found to be related to psychosocial difficulties, with several findings showing that boys tend to exhibit more psychosocial or behavioral difficulties than girls in studies of children with mild to severe hearing loss [9,43,51]. A difference in the prevalence of psychosocial problems with regard to gender is also found in children with typical hearing. Boys are more frequently diagnosed with early-onset disorders, such as attention deficit hyperactivity disorder (ADHD) or behavioral problems, while girls are more often diagnosed with emotional disorders with adolescent onset, such as depression or anxiety [52].

1.3. Purpose of the present study

The overall objective of the present study was to examine possible differences in parent-reported social communication and parent-reported HR-QOL in children using HAs compared to children with TH. We also examined differences in overall communication skills, as well as differences in the association between HR-QOL and structural language and social communication respectively. The two groups were matched on age, gender, nonverbal IQ, and parents' education. The participating children had no additional disabilities that could affect communication or HR-QOL and were educated in mainstream schools.

1.4. Research questions

1. Are there differences in how parents rate overall communication, structural language skills and social communication skills in children with HAs and children with TH?
2. Are there differences in parent-rated HR-QOL in children with HAs compared with children with TH?
3. For children with HAs, is there an association between HR-QOL and the two communication subscales when controlling for the background variables chronological age, degree of hearing loss, gender, and mother's educational level?

Based on the previous research literature, we hypothesized that the parents of children using HAs would report more problems related to overall communication, structural language, social communication, and psychosocial functioning when compared with the parents of children with TH. Furthermore, we expected that there would be a significant association between social communication skills and HR-QOL in children using HAs, even when controlling for background variables.

2. Methods

This study was a part of a larger national cross-sectional research project, *Speech Perception, Language, and QOL in People Who Received CI as Children in Norway*. The study was approved by the Regional Committees for Medical and Health Research Ethics in Norway and the Data Protection Official at Oslo University Hospital. Originally, the larger study only included children with CIs, but it was later extended to include children using HAs and children with developmental language disorders as well as a control group of 90 children with typical hearing. For the purposes of the present study, a subsample of children with TH was selected (through propensity matching) to match the group of children with HAs, resulting in a total sample of 88 children: 45 children using HAs and 43 children with TH (see Table 1 for participant characteristics).

The average educational attainment of the mothers in both the HA group (73% have some higher education) and the TH group (77% have some higher education) was higher than the average for Norwegian women in the age group 25–49 years old (58% have some higher education). The same difference was seen in the fathers, where 64% of fathers in the HA group and 93% fathers in the TH group held some higher education, compared to 39% in Norwegian men between 25 and 49 years old in Norway [53].

Table 1
Participant characteristics.

	HA group (n = 45, 21 male (47%)			TH matched group (n = 43, 20 male (47%)		
	Mean	**Range**	**SD**	**Mean**	**Range**	**SD**
Age at assessment (in months)	105.5	66.5–152.9	24.7	111.4	68.1–158.8	29.3
Nonverbal IQ	98.9	75.0–135.0	15.8	97.1	85.0–115.0	8.5
Degree of hearing loss						
Moderate* (41–60 dB HL)	37 (82.2%)					
Severe (61–80 dB HL)	8 (17.8%)					
Profound (>80 dB HL)	0 (0%)					
Missing	0 (0%)					
Age at diagnosis (acc. Parent reports)	**Mean**	**Range**	**SD**			
	8.7	0–81.0	17.9			
At birth	32 (71.1%)					
First 12 months	4 (8.9%)					
After 12 months	9 (29.0%)					
Hearing aid use						
4–8 h a day	2 (4.4%)					
All day, but with breaks	4 (8.9%)					
All waking hours	39 (86.7%)					
Mothers education						
No higher education	12 (33.3%)			10 (23.3%)		
Some higher education	33 (73.3%)			33 (76.7%)		
Fathers education						
No higher education	15 (33.3%)			3 (7.0%)		
Some higher education	29 (64.4%)			40 (93.0%)		

Note. All ages in months, nonverbal IQ in standard scores, percentages in parenthesis, hearing loss categorized as the PTA-4 in the better ear. Higher education in Norway equals at least one completed year of college or university education. * One child had a PTA of 37 dB, but was included in the final sample, as WHO refers to a HL > 30 dB as disabling. The remaining children had an average PTA above 41 dB.

2.1. Inclusion criteria, recruitment and procedure

The inclusion criteria for both groups were as follows: 1) Norwegian as the first language of the child and a Scandinavian language as the first language of at least one parent; 2) a nonverbal IQ score of 75 or above, indicating the absence of intellectual disability (we chose 75 instead of the diagnostic criteria of below 70 [54] in order to include a margin of measurement error); and 3) no diagnosed additional disabilities or conditions suspected to affect HR-QOL or language development (besides hearing loss in the HA group). We chose to exclude children with additional disabilities because a cognitive delay can have a negative effect on both language development and quality of life. Exclusion was based on assessment of nonverbal IQ, information from parents and medical records. The children in the HA group all had congenital or early-acquired bilateral moderate (HL dB 41–60) to severe hearing loss (HL dB 61–80). There was one exception, one of the children had a PTA of 37 dB, but was included as WHO refers to a HL > 30 dB as disabling in children, requiring amplification [55]. Furthermore, had all children in the group with HAs bilateral HAs with the exception of one child with a unilateral HA. Prior to the assessments, all children in the TH group passed an otoacoustic emission screening, indicating typical hearing.

Participants were recruited from all parts of Norway. The children in the HA group were recruited through the hospital at which they received follow-up for their HAs. The project staff contacted the local ear, nose, and throat (ENT) departments to request that a letter of invitation be sent to all children in their register matching the inclusion criteria. The children and parents who agreed to participate in the study returned a signed consent form to the project staff, and a project employee contacted the family to set up a meeting at the local hospital. The children in the TH group were recruited through the research assistants' networks, which included different schools in Oslo as well as a school in a rural part of southeast Norway. According to family preferences, the children were tested in a quiet room at their school or home.

2.2. Materials

2.2.1. Communication skills; structural language and social communication

Overall communication skills were assessed using the Norwegian adaptation of the Children's Communication Checklist-2 (CCC-2) [30]. The checklist was originally developed to identify children with developmental language disorder and differentiate them from children with pragmatic difficulties [30]. The checklist is based on proxy reporting, which is useful when measuring communication use. Parents answer questions based on their observations of their child interacting with other people, including other children, in various situations over time; thus, the questionnaire provides information about social communicative behavior that is difficult to capture with the use of traditional language tests [56].

The questionnaire has been translated and standardized for use on Norwegian children and has previously been found to be sufficiently valid and reliable [57]. In this study sample, the overall Cronbach's alpha was .95, while it was .90 for the TH group and .95 for the HA group. The questionnaire consists of 70 questions covering the 10 following subdomains: (A) speech, (B) syntax, (C) semantics, (D) coherence, (E) inappropriate initiation, (F) stereotypic language, (G) use of context, (H) non-verbal communication, (I) social relations, and (J) interests (see Table 2 for description of subdomains). The test provides a total score of overall communication and scaled scores for each of the subdomains. Raw scores are transformed to scaled scores through age-adjusted norms for each subdomain. The general communication composite (GCC) is then calculated by summing the scaled scores that make up the 10 subdomains [30]. The manual indicates that GCC scores below 55 (equivalent to the 10th percentile) indicate language impairment with difficulties in communication in a broad sense. Three or more subscales at the 10th percentile or two or more subscales at the 5th percentile indicate communication difficulties that should be investigated further [30,56,58].

The questionnaire also allows for grouping the subdomains into two main areas: structural language (subdomains A–D) and social communication (subdomains E–J). In the present study, we used the tool to examine these two areas separately but made two changes to the original measure. A structural language index was measured by combining the syntax, semantics, and coherence subdomains (B–D) but excluding the speech subdomain. The speech subdomain was omitted because recent confirmatory factor analyses have found that articulation represents a different dimension of language that is relatively independent of vocabulary and sentence use (B–D) [59]. The social communication index was constructed by combining the subdomains of inappropriate initiation, stereotypic language, use of context, non-verbal communication, and social relations (E–I) but excluding the interests (J) subdomain. The interests subdomain was omitted because it reflects an aspect of social communication that more specifically measures symptoms of autism spectrum disorder and is thus less applicable to the present sample of children who have no additional disabilities. These two new

Table 2
Scores on CCC-2 in the HA group and the TH group.

	HA (n = 45)				TH (n = 43)						
CCC-2 Subscales	Mean	SD	Median	IQR	Mean	SD	Median	IQR	Alpha	*p*	*r*
A. Speech (articulation)	6.6	3.6	6.0	8	10.2	2.1	11.0	0	.773		
B. Syntax (sentence structure and grammar)	8.4	3.5	11.0	5	10.0	2.3	11.0	3	.751		
C. Semantics (vocabulary and use of words)	7.2	3.9	6.0	7	10.1	2.9	10.0	5	.837		
D. Coherence (providing the right amount of information to the conversational partner)	7.6	3.5	7.0	5	10.2	3.0	11.0	6	.717		
E. Inappropriate initiation (talking too much or in the wrong situations)	8.8	3.0	9.0	5	10.9	2.5	11.0	4	.804		
F. Stereotyped language (gives excessive information or use words phrases s/he does not master)	8.3	3.2	8.0	6	10.4	2.3	11.0	3	.740		
G. Use of context (takes things literally, problems understanding humor, right use of politeness)	6.6	3.1	6.0	5	9.5	3.0	9.0	4	.838		
H. Non-verbal communication (use and recognition of facial expressions, gestures and eye contact)	8.3	2.9	9.0	4	10.4	2.9	12.0	4	.757		
I. Social relations (social competence and interaction)	8.3	3.6	8.0	7	10.0	3.2	12.0	6	.733		
J. Interests (favorite topic, unusual interest)	8.3	3.0	8.0	4	9.6	2.9	9.0	6	.550		
Structural language index	7.7	3.2	7.7	5	10.1	2.3	10.3	4	.855	<.001	.37
Social communication	8.1	2.7	8.0	4	10.2	2.1	10.6	3	.886	<.001	.41
Overall communication (GCC, total score)	61.8	20.8	61.0	30	81.6	13.7	83.0	21	.953	<.001	.49

Note. Scores on the CCC-2 in the HA group and the matched TH group. SD = standard deviation, IQR = interquartile range, r = effect size. Indexes A to J in scaled scores (mean 10, SD 3), a GCC (general communication composite) score of 83 equals the mean or 51st percentile, while a GCC score of 61 equals the 15th percentile. The alpha gives the observed reliability, across groups, estimated by Cronbach's Alpha. Group comparison with Mann Whitney *U* test.

indexes—structural language and social communication—were designed to examine if problems persisted across both areas of communication.

2.2.2. HR-QOL

In this study, psychosocial functioning and QOL was assessed using the proxy version of the PedsQL™ 4.0 Generic Core Scale [60], which measures HR-QOL. The questionnaire consists of 23 questions organized into four domains: physical health (eight questions), emotional functioning (five questions), social functioning (five questions), and school functioning (five questions). This assessment also provides a total score (the sum of all 23 questions). The questionnaire is available in Norwegian, but no national norms have been issued for its application, and it has only been validated for use in adolescents (13–15 years old) [61]. In this study, we therefore compensated for this lack of validation by collecting data from a reference group of typical-hearing children in the same age range.

The questions were answered on a five-point Likert scale: (0) never a problem [1], almost never a problem [2], sometimes a problem [3], often a problem, and [4] almost always a problem. The items are reversed upon scoring and summed up on a 0–100 scale, with a higher score indicating a better HR-QOL and a lower score indicating a poorer HR-QOL [60]. The combined Cronbach's alpha for both groups for the full scale was .91, while, for the TH group, it was .85, and, for the HA group, it was .92.

2.2.3. Nonverbal abilities

Raven's Colored Progressive Matrices test was administered to children under 8; 11 [62], and Raven's Standard Progressive Matrices Plus test was administered to children 9; 0 or older [63]. Raven's Matrices provide a measure of general nonverbal intelligence, or fluid intelligence, and were used as an inclusion criterion in this study to ensure that the children had a nonverbal IQ score of 75 or above, consistent with the absence of intellectual disability. The test is considered to be language- and culture-independent. It is standardized, has available norms for the age group investigated in the present study, and has previously been found to be valid and reliable [63].

2.2.4. Background information

In addition to the HR-QOL questionnaire, all parents completed a background questionnaire that was developed specifically for the present study to capture SES (measured as the educational level of the parents), age of diagnosis, gender, age at testing, follow-up, and use of HAs (as reported by the parents). Different versions of the questionnaire were administered to the two groups of parents (HA and TH). The parents also signed a consent form that allowed us to collect a copy of their child's latest available audiogram from which we calculated four frequency PTA (500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz). In the analyses, PTA was treated as a continuous variable.

2.3. Statistical analysis

The analyses performed in this study were carried out in three different steps. In the first step, the data was pre-processed, and an appropriate group of TH children was selected to strengthen the between-group comparisons. This reduced the total number of TH children from 90 children to a comparison group consisting of 43 children with TH, who were matched with the HA group based on chronological age, gender, nonverbal IQ, and education levels of the mother and the father. This matched group of children with TH was used for all further analyses and comparisons. In the second step, a number of between-group analyses were conducted based on step 1 outcomes. In the third step, the analyses focused on describing the patterns within the HA group. The three steps are explained in detail below.

2.3.1. First step: accounting for between-group differences in contextual variables

Children using HAs usually differ on contextual variables when compared with TH children. To limit the possibility of between-group comparisons producing results that reflect the contextual differences experienced by the children in our study instead of reflecting the outcomes related to their hearing loss, we used a procedure based on propensity-score matching (see, e.g., Austin, 2011 for an example of application). Propensity-score matching was originally introduced to strengthen causal inferences in quasi-experimental settings, i.e., when researchers want to make causal inferences regarding the effects of an intervention on certain outcomes. Propensity-score matching has become especially important when randomized controlled trials are not feasible (e.g., effectiveness of Alcoholics Anonymous, effects of school size on student achievement; Austin, 2011). However, propensity-score matching has also become increasingly popular in situations in which strengthening causal inferences is not the main goal. Rather, this technique can be understood as a way of adjusting for multiple mediators simultaneously, that is, when contextual factors may affect the outcomes in a given research setting [64]. Likewise, in the specific context of our study, the research questions do not focus on estimating the causal effect of an intervention but rather on understanding the ratings given by parents regarding the communication skills and HR-QOL of their children. Evidently, these ratings may be mediated by contextual influences. For that reason, we used propensity scores to select children with TH (and their parents) for the comparison group. This offered a straightforward approach to balancing the two groups in terms of important background variables, specifically chronological age, gender, nonverbal IQ, and the education levels of the mother and father, respectively.

Propensity-score matching is typically conducted as a two-step procedure. The first step involves fitting a logistic regression model that uses group membership as a dependent variable and contextual factors as the predictor. For any individual in the sample, this step provides a particular score signifying the propensity of being treated given the background variables. In the second step, the propensity scores are used to match the individuals in both groups accordingly. In our analyses, we applied the rationale delineated by Curran et al. [65] and used a maximum difference of 0.10 to select children with hearing loss and their typical-hearing counterparts for the matched groups.

2.3.2. Second step: examining between-group differences (research questions 1 and 2)

For the first research question, we examined differences in the parent-rated overall communication, structural language skills and social communication abilities of the children with HAs compared with the children with TH. We performed a Mann–Whitney *U* test to examine the differences in the CCC-2 scores between the groups. The structural language index and social communication index were examined separately. These indexes were calculated by summing up the scaled scores of the subdomains included in the separate indexes and dividing by the number of subdomains. A descriptive analysis was also performed to determine how many children in each group had CCC-2 scores that suggested language difficulties or a need for further testing to rule out difficulties.

For the second research question, we conducted a logistic regression analysis to examine differences in the parent-rated HR-QOL between the children with HAs and the children with TH. A major advantage of logistic regression is that the estimated effects can be converted into odds ratios, thus allowing for an intuitive interpretation of effect sizes.

2.3.3. Third step: examining within-group associations (research question 3)

For the third research question, Pearson correlations were examined to assess intercorrelation between the index's structural language and social communication in each group. A linear regression model was then fitted to assess possible differences in how much of the variation in social

communication was explained by the structural language index in each group. Finally, a multiple regression analysis for the HA group only was conducted to examine the possible associations between the proxy-reported social communication and structural language indexes respectively and the HR-QOL reports, controlling for background variables, including age at testing, gender, mother's education, and PTA (entered in the regression as a continuous variable).

3. Results

The full sample consisted of 135 children: 45 children with HAs and 90 with TH. Propensity scores were used to select a control group consisting of 43 children with TH with background variables matched to the 45 children with HAs (see Table 1). Two children in the HA group had missing entries on one or more of the background variables, leaving 43 children for analysis in each group. The mean differences between the propensity scores of the children in the two groups was 0.02, ranging from a maximum set distance of 0.10 to a minimum of 0.002. These results suggest that the matching procedure delivered sufficiently comparable scores.

All children using HAs in the study had moderate to severe hearing loss, which is defined by the World Health Organization (WHO) as an average air-conduction PTA of 40 dB in the better ear for adults and 31 dB in the better ear for children [66]—with the exception of one child who had mild hearing loss and used bilateral hearing aids.

According to the parent reports, most children in the HA group used their HAs during all waking hours. The parents of four of these 45 children reported that they used sign language or total communication in addition to spoken language in some situations. The remaining children with HA used spoken language only (76%) or spoken language with occasional signs to support speech content (15%). Among the sample of 45 children in the HA group, 58% (n = 26) of the parents reported that their children received special education services, whereas 38% (n = 17) reported that their children did not receive special education. Two parents did not respond to this question. Among the children who received special education services, 65% (n = 17) received one to 5 h a week, whereas the others received more than 5 h a week (n = 8).

3.1. Research question 1: Are there differences in how parents rate overall communication, structural language skills and social communication skills in children with HAs and children with TH?

The median scores of the HA group were lower than those of the TH group for all indexes (see Table 2). A comparison of the median total scores (GCC) of the two groups showed a significant difference of a moderate size, with a higher median score in the TH group (median = 83.0, n = 43) than in the HA group (median = 61.0, n = 45, U = 419.0, p < .001, r = 0.49). The children in the HA group scored significantly lower on the structural language index (median = 7.7, n = 45, U = 557.0, p < .001, r = 0.37) than the TH children (median = 10.3, n = 43). Similarly, the median score for the social communication index was higher in the TH group (median = 10.6, n = 43) compared to the HA group (median = 8.00, n = 45, U = 508.0, p < .001, r = 0.41). The median score of the HA group for both the structural language index and the social communication index was 2.6 scale points below the TH group median, which means that the HA group scored nearly one SD below the TH group and in the lower normal range in terms of scaled scores.

A GCC index score below 55 suggests language impairments and difficulties with social communication. The rates of proxy-reported social communication problems in the two groups were 16 out of 45 children (36%) in the HA group and 1 out of 43 (2%) in the TH group.

Five children in the HA group had three or more subscales at the 10th percentile or two or more subscales at the 5th percentile. These results suggest that, in addition to the 16 HA children who had scores consistent with language impairment, another seven children had a CCC-2 profile indicating a need for further testing. Overall, the parent reports suggested that half of the children in the HA group had overall communication scores that either caused concern or required further investigation.

The one child in the TH group who was proxy-reported to display communication problems also scored below the 6th percentile in the subdomains I (social relations) and J (interests). Another six TH children had three or more subscales at the 10th percentile or two or more subscales at the 5th percentile or below. Overall, this suggests that roughly 16% of the total TH sample either had problems with communication or had difficulties that would suggest the need for further testing.

3.2. Research question 2: are there differences in parent-rated HR-QOL in children with HAs compared with children with TH?

A descriptive comparison shows lower mean scores in the HA group compared to the matched TH group (see Table 3). A series of logistic regression models were used to assess the differences between the two groups in two steps (results shown in Table 4). First, a model using group membership as the dependent variable was fitted, and the total score for the HR-QOL measure was fitted with PedsQL as the only predictor. The results indicated that a lower HR-QOL score was related to twice the likelihood of being in the HA group (odds ratio [OR] = 2.25; p = .002). Second, a model was also fitted using group membership as the dependent variable. In this model, the following four subdomains were entered as predictors of group membership: physical health, emotional functioning, social functioning, and school functioning. School functioning had the strongest association (OR = 2.23, p = .066), whereas the others contributed only marginally, with estimates ranging between $OR_{\text{emotional functioning}} = .97$ and $OR_{\text{social functioning}} = 1.13$. All subdomains were significantly intercorrelated (ranging from rho = .51 to .87). When school functioning was entered as the sole predictor variable for group membership, we found an OR of 2.52 (p = .001), meaning that lower school functioning scores were twice as likely in the HA group. In summary, the analyses indicated general differences in proxy-reported HR-QOL between the two groups. Further exploration of the contributions of the specific subdimensions suggested that the main driver of this difference was the subscale school functioning.

3.3. Research question 3: For children with HAs, is there an association between HR-QOL and the two communication subscales when controlling for the background variables chronological age, degree of hearing loss, gender, and mother's educational level?

There was a substantial intercorrelation between the structural language index and the social communication index, r = .754, p < .001, this is not surprising as the two indexes are part of the same questionnaire and measure the same overarching concept: communication. However, there were differences in the intercorrelation in the two groups with a lower intercorrelation between the structural language index and the social communication index in the TH group r = .521, p < .001, compared to r = .806, p < .001 in the HA group. When entered in a linear regression model, structural language explained more of the

Table 3
Scores on the HR-QOL measure, PedsQL in the HA and NH group.

	HA		NH		
	Mean	SD	Mean	SD	Alpha
Total score	81.1	13.6	89.3	8.1	.912
Physical health	88.3	13.1	93.4	8.8	.776
Emotional functioning	72.9	18.6	81.2	14.0	.826
Social functioning	83.0	15.2	92.3	11.0	.792
School functioning	75.2	17.7	88.0	12.4	.776
Psychosocial health	77.2	15.3	87.2	10.2	.901

Note. Mean score for the HA group and the matched NH group. SD = standard deviation. Scale from 0 to 100, with a higher score indicating better HR-QOL.

Table 4
Logistic regression models predicting group affiliation from the HR-QOL score.

	Model 1			Model 2			Model 3		
PedsQL domains	OR	CI	p	OR	CI	p	OR	CI	p
(Intercept)	0.98	0.62–1.54	.917	.096	0.60–1.53	.874	0.97	0.60–1.53	.881
Total score	2.25	1.39–3.90	.002						
Physical health				1.09	0.60–2.03	.778			
Emotional functioning				0.97	0.53–1.77	.932			
Social functioning				1.13	0.48–2.67	.782			
School functioning				2.23	0.97–5.45	.066	2.52	1.53–4.48	.001
Observations	86			86			86		

Note. Table displaying results of logistic regression in odds ratio (OR), confidence intervals (CI).

observed variance in social communication in the HA group β = .666, std. Error = .075, p < .001, r^2 = .649, compared to the TH group β = .482, std. Error = .123, p < .001, r^2 = .271.

The remaining analyses were conducted for the HA group only (n = 45). To assess the association between psychosocial functioning and the two communication indexes, we fitted two separate multiple regression models. For the first model, HR-QOL was the outcome variable, and structural language and the background variables age at testing, gender, mother's education, and PTA were entered simultaneously in the model. As shown in Table 5, structural language was the only significant predictor in the regression model (std **β** = 0.459; p = .003), indicating a significant association between the structural language index and HR-QOL—after controlling for background variables. In the second model, HR-QOL was the outcome variable, and social communication and the background variables age at testing, gender, mother's education, and PTA were entered simultaneously in the model. As shown in Table 5, social communication was the only significant predictor in the regression model (std **β** = 0.607; p < .001). Finally, a third model was fitted, with HR-QOL as the outcome variable, including both structural language and social communication, in addition to the background variables. Social communication was the only significant predictor in the third regression model (std **β** = 0.631; p < .010), see Table 5. The third model did not explain more of the variation in the HR-QOL score, than the second model, see Table 5.

4. Discussion

The purpose of this study was to examine the association between communication skills and HR-QOL in a group of children with moderate to severe hearing loss who used HAs. More specifically, the aim was to especially focus on social communication and its relation to HR-QOL. The children in the HA group had typical development other than their hearing loss, and none of the children in either group had known difficulties affecting their communication or HR-QOL. The children with HA were all in general educational settings alongside their peers with typical hearing.

4.1. Social communication skills: Comparing the results with peers who have typical hearing

As hypothesized, the results of this study showed that children using HAs had lower parent-rated overall communication skills when compared with their TH peers. The mean reported scores on overall communication for the TH group correspond approximately to the 50th percentile, whereas the mean reported overall communication level in the HA group corresponded to the 15th percentile [30]. In other words, the HA group was reported to have an average overall communication score approximately one SD below that of the TH group, at the lower end of the normal range. Several studies have reported lower levels of communication and auditory or language skills in children with mild to severe hearing loss using HAs [8,15,19–25]. Previous studies have also reported language abilities that are one SD or more below the normative means in children using HAs [15,20,23,26,28], although the children in these studies were, on average, younger than those in the present study and measured language, in contrast to communication as in the present study. A novel finding in the present study is that overall communication skills, which are based on parent reports of everyday functioning rather than test scores, were lower in the children with HAs than in their TH peers. This suggests that communication problems are not restricted to tests carried out in highly structured assessment settings with test items constructed to maximize individual differences but also extend to everyday functioning in a variety of different communicative situations.

A separate examination of the two subdomains of social communication—structural language and social communication—revealed that the children in the HA group scored lower on both when compared with their peers with TH. The effect size suggests that children using HAs have difficulties that are of a similar magnitude in these two areas; structural language and social communication. Structural language and

Table 5
Results from the multiple regression analyses of variables predicting a higher or lower Total score on the PedsQL (HR-QOL) in the HA group.

	Model 1			Model 2			Model 3		
	β	SE B_1	Sdt. Beta	**β**	SE B_1	Sdt. Beta	**β**	SE B_1	Sdt. Beta
Age (at testing)	-.012	.076	-.022	.003	.068	.005	.005	.069	.008
PTA-4 (mean both ears)	-.149	.195	-.108	-.125	.174	-.091	-.128	.178	-.093
Gender									
Female (ref)									
Male	−2.50	3.83	-.093	-.424	3.51	-.016	-.435	3.56	-.016
CCC 2 Structural language	1.97	.629	.459**				-.129	.912	-.030
CCC 2 Social communication				3.09	.674	.607***	3.21	1.09	.631**
Mothers' education									
No higher education (ref)									
Some higher education	−5.84	4.18	-.194	−5.24	3.77	-.174	−5.24	3.82	-.174
	R^2 = .299			R^2 = .432			R^2 = .432		

Note. N = 45. P < .001***, p < .010**, p < .05*. First model examines the association between HR-QOL, Structural language and background variables. Model 2 examine the association between HR-QOL, Social communication and background variables. Model 3 examine the association between HR-QOL and both structural language and social communication, in addition to the background variables.

social communication were substantially intercorrelated, but when examining associations between structural language and social communication in the two groups separately, the intercorrelation was stronger in the HA group compared to the TH group. This indicates that for children in the HA group, structural language and social communication might be more dependent upon each other and thus more overlapping than in children with TH. Interventions targeting structural aspects of language are thus especially important in children with hearing loss, although structural language improvements may not necessarily translate into gains in social communication. Much social and emotional learning happens through interaction with peers or through incidental learning, situations that may be less accessible to children with hearing loss—unless facilitated [35]. Therefore, our finding that both structural language and social communication areas were affected is important to consider in planning interventions. Future studies and interventions should focus more on the social aspects of communication in addition to structural language skills, such as vocabulary and grammar.

Given that children with hearing loss comprise a heterogeneous group with regard to language outcomes, another way of examining the results is to consider the percentage of children achieving communication scores within the normal range. In the present study, based on the total CCC-2 scores, 36% of the children in the HA group had communication difficulties compared with only 2% in the TH group. If we also include the children who scored within the normal range on the overall measure but below the 10th percentile on three subscales, the percentages of children with difficulties increase in both groups, while the group difference remains. When including the children with low scores on three subtests, half of the children in the HA group—compared to 12% in the TH group—had parent-reported scores reflecting difficulties with communication or suggesting the need for further language testing. Our findings are similar to those of Cuppels et al. [15], who reported that approximately half of the children using HAs had language scores within the normative range. This contrasts with the findings of Fitzpatrick et al. [21], in which 65%–86% of the four-to five-year-old children using HAs had scores within the normative range, depending on the speech-language measure. In that study, all the children were enrolled in a rehabilitation program focusing on oral language development, which may have provided the children and their parents with better tools to support their language development than those typically provided to children using HAs. A previous report from Norway, which was based on the same sample as in the present study, found that 64% of the parents stated that they had never or almost never received guidance on how to stimulate language development in their children in the first years following HA fitting. Only five parents (11%) stated that they received monthly follow-ups [16]. This proportion is concerningly low for a group of children in which the majority was diagnosed with hearing loss at birth and half were reported to currently have communication difficulties. The very limited follow-up received by the parents of these children may be partly attributed to the fact that the participants had no additional disabilities. Clinicians and teachers working with these children may not have received sufficient information about the effects hearing loss may have on language and communication development even in the absence of other difficulties.

As the CCC-2 is based on parent reporting, the high percentage of children with hearing loss who struggle with overall communication may also partly indicate that these parents are more observant of the communicative behavior of their children than the parents of children with TH. For example, parents of children with HAs may be more likely to notice when their children do not fully master different aspects of communication when compared with other parents. It is also possible that parents of children with HAs worry more about the communication skills of their children and thus report more problems, especially as so many of them reportedly received poor support during the first years after diagnosis. However, the majority (58%) of the children in the HA group in our study were receiving special education services (including speech-language services), although most of the children (60%) only received additional help for one to 5 h a week. The percentage of children in the HA group receiving special education services corresponded well to the percentage of children using HAs reported to struggle with communication on the CCC-2. Although more than half of the children received special needs education, this does not indicate that these children have major learning disabilities. The Norwegian educational system promotes inclusive education, and almost half of special education services are provided within the regular classroom setting alongside peers with typical development [67].

We know from previous studies that early identification and amplification of hearing loss in children are associated with better language skills [8,15,19,27], and the recommendation from the Joint Committee on Infant Hearing (JCIH) accentuates the importance of early screening, diagnosis, and follow-up in the first six months of life [68–70]. Although most children in our study were diagnosed with hearing loss at birth—as reported by their parents—we do not know at what age the children were actually fitted with HAs or whether they received follow-up in-line with JCIH recommendations. However, most parents reported that they did not receive guidance on how to stimulate language development in their children after diagnosis. One can speculate that this lack of support at an early age may have contributed to the high percentage of children struggling with communication at the time of testing in our study.

There is an overrepresentation of parents with higher educational attainment, often used as an indication of SES, in the present study, in both the HA group and the TH group compared to the average in Norwegian men and women in the included age groups. Is well-established that higher SES is associated with better language outcomes in children with hearing loss [15,21,23,24,26]. In children with typical hearing, SES has been found to be related to the amount and complexity of the language the child is exposed to [71,72], quality of parent-child interactions, and opportunities to learn language e.g. number of books available in the home [73]. The percentage of mothers with who hold some higher education is similar in the HA and TH group, although higher than in the average Norwegian population. Thus, when the children in the HA group in the present study struggle with communication, including structural language and social communication, these difficulties may be even more pronounced in children who come from less advantageous backgrounds.

4.2. Health-related quality of life: Comparing the results with those of peers with TH and examining the association with social communication

As hypothesized, the parents in the HA group reported lower levels of psychosocial functioning, measured as HR-QOL, in their children compared with the parents of the children with TH. The children in the HA group were twice as likely to have a low HR-QOL score, with the school functioning domain explaining most of the observed differences between the two groups. Physical health, emotional functioning and social functioning were seemingly less affected. The main finding of a lower parent-reported HR-QOL is in line with previous findings of lower levels of HR-QOL in children with mild to profound hearing loss using HAs [74,75], or in related areas, such as the psychosocial aspects of functioning in children with hearing loss [9,10,17], although the main difference between the groups in the present study seems to be related to how the well-being of the children in school. A positive aspect of this finding is that with regards to the remaining aspects of HR-QOL, the children in the HA group were reported to function similarly to their peers with TH. Our findings are similar to those reported in the study by Nimensivu et al. [75], which found that although the total score of the HR-QOL instrument was significantly lower in the HA group, the difference was small. Rather, specific areas seemed to be more affected in the HA group, such as communication, hearing (for both children and adolescents), and the school dimension (for adolescents).

The finding that better structural language or social communication was related to better HR-QOL ratings by parents in the HA group was

also in line with our hypothesis. On closer examination, after controlling for background variables, social communication explained more of the variation in parent-reported HR-QOL than did structural language. When the two subscales were entered in the same multiple regression model, social communication was the only significant predictor, with structural language not adding significantly to the model. However, given the high correlation between the two subscales, we interpret this association with caution and cannot firmly conclude that social communication is a more important contributor to HR-QOL than structural language.

Previous studies of children with hearing loss have shown how that they struggle with pragmatic skills such as maintaining conversational topics, less often repair conversational breakdowns and use different strategies such as more frequent requests for clarification, repetitions, and confirmatory responses than peers [32]. Pragmatic difficulties has reported to also affect the children's social interaction negatively [46, 47], an association that also has been shown in children and adolescents with DLD [48–50]. A key difference between children with hearing loss and children with DLD, is that problems with pragmatic language in children with DLD are attributable to an underlying etiology, while the problems in children with different degrees of hearing loss may at least partly stem from insufficient access or exposure.

As previously discussed, half of the children in our sample were reported by their parents to struggle in some areas of communication, and many parents reported having received little support to facilitate language development in their children. While no inferences can be drawn about directions of causality, one possible interpretation of these results is that greater support in communication development may not only allow children with hearing loss to develop more age-appropriate communication skills, but it may also positively affect their HR-QOL. This emphasizes the need for better follow-up at an early age. However, as suggested by Laugen et al. [51], language skills alone may not be sufficient to eliminate the increased risk of psychosocial difficulties for children with hearing loss. Early interventions may thus be more effective by also focusing directly on psychosocial skills in addition to language outcomes.

The design of our study does not provide us with information on what specifically causes parents to perceive the HR-QOL, and specifically the school functioning, of their children as poor, but previous literature may give us some indications as to what can be improved. One might question whether everyday hearing functioning may be an influencing factor. Although we did not have a measure of how the children in this study hear in everyday situations, it has previously been shown that children with hearing loss experience greater cognitive fatigue than their typical-hearing peers. Poor language skills have been associated with greater fatigue [76]. Children with hearing loss are believed to experience greater fatigue because listening in adverse conditions requires greater effort [77]. Speech perception in noisy conditions does not depend solely on whether a child can hear. Some studies have found an association between language skills and speech perception under noise, even on speech perception tests that are constructed to have low language demands [25,78,79]. Improving the language and communication skills of a child may thus improve his/her ability to not only communicate but also perceive speech under noisy conditions. In addition to cognitive abilities and the degree of hearing loss, classroom acoustics may also affect listening effort [77]. School functioning may thus be improved for children with HAs by ameliorating certain environmental aspects, such as listening conditions.

In a study by Sæbø et al. [80], eight Norwegian CI users aged 8–12 years were interviewed in-depth about their social participation. Two of the key issues they raised were discomfort due to noise in the classroom and problems with speech perception in social interactions during breaks. Some of the children expressed limited confidence in solving the noise problem and felt that telling their teachers and other adults about their difficulties with noise had not helped. Although this was a small sample of children with CIs, some of these findings may also apply to children who use HAs.

In summary, as we know that many parents in this study perceived difficulties in the school situation of their children. Taking social or pragmatic communication difficulties into account in planning language interventions for children with hearing loss by including parent-coaching in use of promotion strategies of social communication in everyday life, learning how we adapt language according to whom we speak, training programs for mentalization and theory of mind, learning unspoken social rules, and training group communication skills, may positively affect their well-being. Furthermore, in school, teachers may be educated on how classroom communication can be adjusted to better suit the needs of children with hearing loss. Outside of the classroom the acoustic environment may be more challenging to modify (e.g., background noise, several speakers, and distance between listener and speaker), but smaller groups may ease listening and thus allow for more opportunities for natural learning of social communication though interaction with peers.

The results of the present study highlight the importance of increasing our knowledge about how moderate to severe hearing loss in children may adversely affect their communication outcomes, even in children who wear their HAs daily and display no other additional disabilities. The challenges faced by this group are not as well-known to hearing professionals, and any interventions given to these children may therefore have been less systematic or intensive than interventions given to children with more profound hearing loss. Increased awareness by parents and clinicians as well as specific knowledge regarding the challenges faced by children wearing HAs could encourage the use of preventive interventions at an early age, thus reducing later difficulties in school. Language and communication lay the foundation for later academic success in reading and reading comprehension [81] and are also associated with the HR-QOL of children. The relationship between these factors suggests that interventions should not only target structural language, but also social communication as well as consider how other aspects of the life of a child may be affected.

4.3. Strengths and limitations

The two major measures in this study rely solely on how parents perceive the skills or well-being of their children. Comparing parent reports with more objective measures would normally be beneficial; however, the main outcomes measured in this study are not easily measured with standardized tests. These outcomes require information on how an individual functions across a number of situations over time and with many different people; thus, proxy reports may be suitable sources of information for these particular areas of research.

Furthermore, no medical records that could be used to either confirm the parent reports or estimate age at diagnosis, age at HA fitting, or consistency of amplification use were available for this study. Previous studies have established the importance of early identification and intervention in children with hearing loss using HAs, and this could have been an important predictor of both their social communication and HR-QOL. As several other background predictors did not affect social communication and HR-QOL, future studies should include measures related to diagnosis, audibility, and consistency of HA use. Also, to further examine social communication in an educational setting, teacher-reported social communication skills would be an interesting approach for future studies.

A clear strength of the present study is how the groups were matched for possible confounding variables, such as age, gender, nonverbal IQ, and parental educational level. This matching gives us more information on how the hearing loss specifically affects communication and HR-QOL. In addition, the strict inclusion criteria led to a well-described group of children, eliminating sources of variability such as presence of additional disabilities or differences in hearing technology. This study contributes to the existing literature by providing information on the specific subgroup of children with hearing loss in the moderate to severe

range who use HAs and have otherwise typical development. More research is needed to increase our knowledge of how hearing loss affects communication and interaction in everyday situations and how we may increase the number of opportunities for communication and social and emotional learning through interaction and incidental learning.

5. Conclusion

The parents of children using HAs reported more communication difficulties in their children than did the parents of children with TH. The parents of the children with HAs reported equal difficulties with structural language and social communication in their children. Half of the children with HAs were reported by their parents to have either overall communication difficulties or a need for further assessment compared to 16% of the TH group. The mean overall communication score of the children in the HA group was approximately one SD below that of the TH group. The parents of the children with HAs were twice as likely to report lower HR-QOL than the parents of their TH peers. The school functioning domain was reported as the most problematic, with the other domains being seemingly less affected. After controlling for other variables, there was a significant association between level of structural language skills and social communication skills and parent-reported HR-QOL in children using HAs respectively. The association was stronger between social communications and HR-QOL, than between structural language and HR-QOL. For future interventions targeting language in children using HAs, communication enhancement should not be limited to structural language skills. The results of the present study suggest that intervention studies should also target social communication abilities. Difficulties with social communication is an area that has often been overlooked when compared to structural language abilities, as there are more tests available for structural language skills. However, our study finds that social aspects of language are in fact equally problematic for children with HAs and thus should receive more attention in future studies. Overall, the parent-reported overall communication difficulties of children with HAs suggest a need for a universal and intensified early follow-up of communication and language development in these children and their parents—even in the absence of additional disabilities.

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