The link between hearing loss, language, and social functioning in childhood

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CHAPTER 3

EARLY IDENTIFICATION: **LANGUAGE** SKILLS AND **SOCIAL FUNCTIONING** IN DEAF AND HARD OF HEARING PRESCHOOL CHILDREN

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ABSTRACT

Objective

Permanent childhood hearing impairment often results in speech and language problems that are already apparent in early childhood. Past studies show a clear link between language skills and the child's social-emotional functioning. The aim of this study was to examine the level of language and communication skills after the introduction of early identification services and their relation with social functioning and behavioral problems in deaf and hard of hearing children.

Study design

Nationwide cross-sectional observation of a cohort of 85 early identified deaf and hard of hearing preschool children (aged 30-66 months).

Methods

Parents reported on their child's communicative abilities (MacArthur-Bates Communicative Development Inventory III), social functioning and appearance of behavioral problems (Strengths and Difficulties Questionnaire). Receptive and expressive language skills were measured using the Reynell Developmental Language Scale and the Schlichting Expressive Language Test, derived from the child's medical records.

Results

Language and communicative abilities of early identified deaf and hard of hearing children are not on a par with hearing peers. Compared to normative scores from hearing children, parents of deaf and hard of hearing children reported lower social functioning and more behavioral problems. Higher communicative abilities were related to better social functioning and less behavioral problems. No relation was found between the degree of hearing loss, age at amplification, uni- or bilateral amplification, mode of communication and social functioning and behavioral problems.

Conclusion

These results suggest that improving the communicative abilities of deaf and hard of hearing children could improve their social-emotional functioning.

INTRODUCTION

Permanent Childhood Hearing Impairment (PCHI) is a chronic handicap that affects approximately 1 to 1.3 out of every 1000 live births.[1,2] As a result of diminished auditory input, hearing impairment causes speech and language problems.[3-6] These problems can reduce the child's ability to communicate and to understand the refinements of social language.[7]

Extensive research in young hearing children has shown a clear relation between language delays and poor acquisition of social and emotional competencies which lead to problem behavior.[5,8-11] Both impaired language development and social-emotional problems are linked to poorer social skills and academic achievement, and fewer friendships.[8,11] Others have observed this link in deaf and hard of hearing (DHH) children.[12] Besides language problems, these children have also been shown to develop more social and emotional problems than hearing peers.[13-17] For example, DHH children experience a lower quality of life and more mental health problems such as anxiety, depression, and behavioral problems than their peers without hearing loss.[18-27] However, these studies were conducted before the introduction of early identification services.

Early identification and intervention programs have improved speech and language development in DHH children.[7,28,29] It is expected that these improvements also benefit the child's ability to communicate with others as the child becomes more able to express him or herself and to interact with peers. Yet, it remains unknown if this increased ability to communicate and participate in a sound-dominated world also benefits social functioning and prevents the development of behavioral problems. In this nationwide study, we examine the level of language and communication skills after the introduction of early identification services and their relation with social functioning and behavioral problems in DHH children.

METHODS

Procedure

This study was conducted as part of the large DECIBEL-study in the Netherlands.[2] DECIBEL is an acronym for Developmental Evaluation of Children: Impact and Benefits of Early hearing screening strategies Leiden. Its purpose was to define the effect of early identification and intervention services which were introduced in the Netherlands from 2002 compared to the previously used distraction screening method. The DECIBEL collaborative study group identified and evaluated all children with a positive screening result during either the Newborn Hearing Screening (NHS) or the distraction hearing screening in whom PCHI was confirmed at an audiological center after diagnostic testing. PCHI was defined as a hearing loss of 40 dB or more in the better ear. All children were

born in the Netherlands between January 2003 and December 2005. For the present study, only DHH children who had been identified by the NHS were included since this is regarded as standard care in Western society nowadays.
Between 2008 and 2010, parents of DHH children who were born after introduction of the NHS completed several questionnaires after informed consent was obtained. With their permission, audiological and medical records were checked for background information and hearing-loss-related outcomes such as the auditory thresholds, mode of rehabilitation and speech and language development. Permission for this study was granted by the Medical Ethics Committee of the Leiden University Medical Center.

Participants
During the introduction of the NHS from January 2003 till December 2005, 279 babies were identified and confirmed to have bilateral permanent childhood hearing impairment (PCHI).[30] All these children were invited to participate in our study. Parents of 98 children granted permission to participate and 85 of these completed the questionnaires. The final study sample consisted of 85 children with bilateral hearing loss; 47 boys and 38 girls. At the time of assessment, children were between the ages of 30 and 66 months old (mean age 46 months). The degree of hearing loss varied widely. Thirty-eight children (45%) experienced moderate losses (41-60 dB), 28 children (33%) experienced severe losses (61-90 dB) and 19 children (22%) were diagnosed with profound hearing loss (> 90 dB). Most children were equipped with conventional hearing aids (n = 61; 72%), 20 children (24%) were fitted with a cochlear implant (CI) of which 4 were bilaterally implanted. Three children were amplified with a bone conduction device (BCD). In one case, the child did not wear any form of hearing amplification anymore because of poor device acceptance due to psychomotor retardation. The majority of children communicated via spoken language (n = 37; 44%) or sign-supported language (n = 35; 41%). The remaining children either used sign language (n = 9; 10%) or an individually tailored form of communication using other senses, because of additional disabilities (n = 4; 5%). In the families of nine participating children, at least one of the parents was DHH. Two children were born to families in which both parents were DHH. Background information regarding the study sample can be found in Table 1.

Materials
Receptive and expressive spoken language
The Dutch translation of the 'verbal comprehension' scale of the Reynell Developmental Language Scale (RLDS) was used to determine receptive language skills. The Schlichting Expressive Language Test (SELT) measures vocabulary by means of the subtest 'word development' and syntax by means of the 'sentence development' subtest.[31] These tests are standardized oral language tests that are part of the clinical follow–up for children with PCHI in the Netherlands and were derived from the child's medical records. As a consequence, they were conducted at a different time and age of the child than when parents completed the questionnaires. Therefore, time of assessment varies considerably

in this study (mean difference between tests 7.0 months ± 10 months *SD*). However, age-equivalent scores which represent the language development of typically developing children are available. Both language tests provide a calculation tool to convert age-equivalent scores into normally-distributed standard scores.

Communicative development

Parents completed the MacArthur-Bates Communicative Development Inventory (CDI-III) to assess communicative language development (vocabulary and syntax) and understanding.[32,33] The first part of the questionnaire contains 100 words. Parents reported whether their child currently used these words in spoken language, sign-language, or both. The second part consists of 9 nine items, each containing three sentences of increasing length and difficulty. Parents reported the degree of complexity of sentence structure that their child produced, in spoken language, sign-language, or both. They were also requested to write down three sentences that their child recently produced. The total number of utterances was counted and the mean of these three sentences was calculated and named the Mean Length of Utterance (MLU). The third part consists of 12 questions (e.g., *"Does your child ask questions starting with the word "why"?"*) that parents answered on a 3-point Likert scale (0 = *"Not Yet",*1 = *"Sometimes",* 2 = *"Often"*) to measure language understanding (comprehension, semantics, and syntaxis). Parents of 11 children reported that their child was not yet able to connect words to create short sentences. Therefore, these parents did not complete section two and three (i.e., sentence complexity and understanding). The CDI-III was originally designed to measure communicative abilities in hearing children aged 30-37 months. However, research has shown that because of their language problems, the CDI-III is a useful measurement for DHH children with a CI within the age range 32-86 months.[34] However, age-appropriate percentile-scores are not available for the 38-86 months age range. Therefore, percentile-scores from hearing children between the ages of 36-37 months old were used to calculate percentile scores for children older than 37 months.

Social functioning and behavioral problems

Behavioral problems were identified with the *Strengths and Difficulties Questionnaire* (SDQ).[35] This parent report consists of 25 statements to be answered on a 3-point Likert scale (*"Not True", "Somewhat True", "Certainly True"*) and is used to screen for mental health problems in children. From these items, two scales were calculated: social functioning and behavioral problems.[36,37] The social functioning scale consists of five items concerning 'peer problems' (e.g., *"Picked on or bullied by other children"*) that were reverse scored and five items concerning prosocial behavior (e.g., *"Often offers to help others"*). The behavioral problems scale is constructed by combining the five items from the 'behavioral problems' scale (e.g., *"Often loses temper"*) with the five items from the 'hyperactivity' scale (e.g., *"Restless, overactive, cannot stay still for long"*). The fifth scale 'Emotional symptoms' was omitted from the analyses as this scale reflects behavior and feelings that were rarely reported by parents resulting in a very low reliability (Cronbach's

Table 1. Demographic characteristics of participants

	Total study population N = 85
Age at time of assessment	
Mean - in months (*SD*)	46 (10)
Range - in months	30-66
Gender (%)	
Male	47 (55)
Preferred mode of communication (%)	
Oral language only	37 (44)
Sign-supported Dutch	35 (41)
Sign language only	9 (10)
Other	4 (5)
Type of education (%)	
Mainstream education	21 (25)
Special education for the hearing impaired	51 (60)
Special education for developmental disabilities	6 (7)
Unknown	7 (8)
Degree of hearing loss - Low Fletcher Index (%)	
Moderate 41-60 dB	38 (45)
Severe 61-90 dB	28 (33)
Profound >90 dB	19 (22)
Hearing amplification type (%)	
Hearing Aid	61 (72)
Cochlear Implant	20 (24)
BCD	3 (3)
No adjustment	1 (1)
Age at diagnosis of hearing loss - in months (*SD*)	7 (11)
Age at first amplification - in months (*SD*)	14 (13)
Duration of amplification use - in months (*SD*)	31 (13)
Additional disabilities (%)	13 (16)
CI characteristics	
Age at implantation - in months (*SD*)	25 (14)
Duration of CI use - in months (*SD*)	18 (11)
Bilateral CI (%)	4 (5)

Abbreviations: BCD Bone Conduction Device, CI Cochlear Implant, HA Hearing Aid, SD Standard Deviation alpha = 0.51). Composite scores show good psychometric properties (Cronbach's alpha = 0.78 and 0.80 for social functioning and behavioral problems, respectively). To be able to interpret the outcomes of the SDQ, scores were compared with previously published norm-scores.[38] Psychometric properties of all tests can be found in Table 2.

Table 2. Psychometric properties

	No. of items	Answer range	Mean (SD)
Strengths and Difficulties Questionnaire			
Total difficulties	20	0-2	8.7 (5.2)
Social functioning	10	0-2	15.4 (3.6)
Behavioral problems	10	0-2	5.9 (4.0)
Language skills			
RDLS - verbal comprehension quotient	67		83.2
SELT - word development quotient	62		84.6
SELT - sentence development quotient	40		85.3
Communicative development inventory			
Total words known	100	0-1	54 (32)
Total words spoken	100	0-1	50 (35)
Total words signed	100	0-1	14 (19)
Total words bimodal	100	0-1	9 (16)
Sentence complexity	9	1-3	16.7 (7)
Sentence understanding	12	1-2	13.2 (7)
Mean Length of Utterance	3	0-∞	5.4 (2.4)

Abbreviations: SD Standard Deviation, RDLS Reynell Developmental Language Scale, SELT Schlichting Expressive Language Test
Note. Language skills are displayed as standard scores with a mean of 100 and a SD of 15.
For all communication skills, raw scores are reported.

Statistical analyses

Pearson's correlations between language scores and outcomes from the CDI-III were calculated to define the relation between receptive and expressive language skills and communicative development as reported by parents. Gender differences in behavioral problems were detected using Analysis of Covariance (ANCOVA) in order to control for covariates such as age and language skills. To examine risk and protective factors influencing behavioral problems, Pearson's correlations were carried out. Because multiple correlations were computed for the relation of communication and language skills with social functioning and behavioral problems, all *p*-values were adjusted using Bonferroni correction for multiple testing. Statistical analyses were carried out using *SPSS* version 21.0 (IBM Corp., Armonk, NY).

Multiple imputation of missing data

As a result of the study design, we were confronted with missing data. Language test results were derived from the children's medical files, and these scores were absent or untraceable in 23 (receptive language) and 30 (expressive language) cases. Many statistical methods for analyzing datasets assume complete cases. Consequently, these analyses remove incomplete cases beforehand, introducing bias and a drop in statistical power.[39] Therefore, the multiple imputation technique was used to handle this problem. This technique involves filling in the missing data based on known characteristics of the participant and the relations observed in the data for other participants with complete data.[40-42]

Little MCAR's test was significant for the language scores which meant that our data was not Missing Completely at Random (MCAR) but either Missing Not at Random (MNAR) or Missing at Random (MAR). The MAR condition assumes that the underlying reason for data being missing is related to other known characteristics of the participant.[39] In clinical practice, most often language scores are missing if children are not able to complete the test session because of low verbal language skills. In our sample, it was therefore expected that language test scores were missing because of the lower spoken language abilities of these children. This assumption was underlined by the fact that children with absent language test scores more often used sign-language and more often attended special schools for the DHH than children with complete language scores. We therefore assumed the data to be MAR and multiple imputations were used to handle the missing language scores. Research on this topic has shown that five imputations are seen as sufficient to create a good estimate for each entered data point.[40] We performed five imputations and analyzed the newly formed datasets using standard techniques (i.e., ANCOVA's and Pearson's correlations).

RESULTS

Language and communicative development

Language skills

Of all participants, language scores revealed that 47% scored one standard deviation below the mean or higher (quotient ≥ 85) on receptive language (M = 82.3). On expressive language, 57% (M = 85.1) and 56% (M = 86.2) scored one standard deviation below the mean or higher for word- and sentence development, respectively.

Communication skills

Outcomes of the parent report revealed that, compared to percentile-scores, 48 children (56%) scored one standard deviation below the mean or higher on the produced words scale of which nine children (10%) scored at ceiling. Concerning language complexity and understanding, 37 (44%) and 38 children (45%) scored one standard deviation below the mean or higher. No ceiling effect was found on these scales. The MLU of 19 of the 85 children (22%) was one standard deviation below the mean or higher, without any children scoring at ceiling.

Significant correlations were found between parent-reported communicative development and language test scores. Receptive and expressive language quotients positively related to the total words spoken by the child, MLU, sentence complexity and sentence understanding (Figure 1). Negative correlations were found between the child's spoken language scores and the total number of words signed (Table 3).

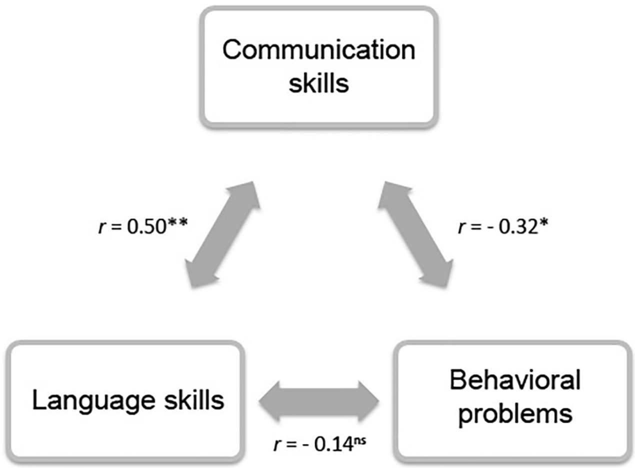

Figure 1. Pearson's correlations between language skills, communication skills and behavioral problems *$p < .01$, **$p < .001$, ns = non-significant result

Table 3. Pearson's correlations between language and communication scores

	4	5	6	7	8
1. Receptive language	.47**	-.24*	.48***	.53***	.50***
2. Expressive language sentence development	.52**	-.30**	.39**	.54**	.48***
3. Expressive language word development	.42**	-.25*	.51***	.57***	.52***
4. Words spoken		-.23*	.59***	.74***	.78***
5. Words signed			-.02	-.11	-.11
6. Mean Length of Utterance				.66***	.67***
7. Sentence complexity					.84***
8. Sentence understanding					

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Social functioning and behavioral problems

Compared to the norm-scores of the SDQ, the DHH children scored lower on social functioning $t(84) = -3.29$, $p < .001$, and higher on behavioral problems $t(84) = 2.09$, $p < .05$, regardless of gender. Pearson's correlations revealed that only the child's communicative abilities were related to the level of social functioning and behavioral problems. Higher (spoken) vocabulary was related to more social functioning and less behavioral problems. Lower sentence complexity, sentence understanding and shorter MLU were related to more behavioral problems (Table 4). In partial correlations that controlled for the age of the child, only the relation between communicative abilities and behavioral problems remained. No relation was found between the child's language skills and the level of social functioning or behavioral problems.

Table 4. Pearson's correlations between social development and communication scores

	Words spoken		Words signed		Mean Length of Utterance		Sentence complexity		Sentence understanding	
	r	Partial r	r	Partial r	r	Partial r	r	Partial r	r	Partial r
Social functioning	.26**	.25**	.08	.08	.17	.15	.14	.10	.22*	.23*
Behavioral problems	-.29**	-.27**	.00	.00	-.27*	-.23*	-.27**	-.23*	-.35**	-.32**
Total difficulties	-.29**	-.28**	.00	.00	-.21*	-.16	-.25*	-.22*	-.36**	-.34**

Note. The partial correlations were controlled for age. * p (one-tailed) < .05, ** p < .01

The influence of audiological and medical factors

Several audiological and demographic factors were entered in the correlation matrix to determine their relation to the reported levels of social functioning and behavioral problems: age at detection of hearing loss, age at first amplification, duration of amplification use, degree of hearing loss, level of maternal and paternal education, type of amplification, uni- or bilateral amplification, mode of communication, family support, speech and language therapy, and age. After Bonferroni's correction for multiple testing, no relations were found.

DISCUSSION

This nationwide study aimed to examine the level of language and communicative skills and their relation with socio-emotional functioning and the presence of behavioral problems in DHH children who received early detection services. The main findings showed that the language skills of the DHH children in this study were just within the normal range, but their communicative abilities were below average. A positive relation was found between children's communication skills in spoken language and their social functioning. Additionally, DHH children with lower communicative abilities showed behavioral problems more often.

Not surprisingly, children's level of spoken language and their communication skills were highly related in this study. Nevertheless, only communicative skills were related to children's social-emotional functioning, which emphasizes the importance of communication skills for social learning.[5,8] This can be explained by the concept of 'incidental learning': unplanned and unintended learning outside of educational settings.[43] Incidental learning is essential for social learning.[44] For example, social rules that are mostly implicit, are learned by observing and overhearing how others interact. Overhearing others can be challenging for DHH children for obvious reasons. Consequently, they miss frequent exposure to this type of social learning. It seems only reasonable that for incidental learning to succeed, this requires communication with others rather than an increase in passive vocabulary alone. Additionally, fewer communication skills could also impede children from expressing themselves, causing frustration and subsequently inducing behavioral difficulties.

It should be noted that the causal link between children's communication skills and their social-emotional functioning could be reciprocal. Good communication skills will enhance children's social functioning. In turn, lower levels of social functioning might discourage children from seeking contact with others, resulting in fewer communicative opportunities from which to benefit.

In our study, we found that parents are very capable of evaluating the speech- and language abilities of their DHH child by using the CDI-III. In line with standard language tests, parents of children with higher language skills also reported that their child was able to express longer and more complex sentences, and showed higher language understanding. These results are useful in clinical settings because language tests cannot be assessed too often due to learning and remembrance effects. Therefore, parent-reports are a useful tool to keep track of speech and language development in the meantime. Despite these promising findings we have to point out that the accuracy of parental reporting has previously been found to be influenced by the SES of the parents. In families with very low SES, the communicative abilities of the children were sometimes overestimated.[45] However, we did not find an effect of SES on the parental evaluation of the child's communication skills in this study.

In line with previous studies, the majority of children in our study sample did not show age adequate language skills although their group mean was within the normal range.[7,28,29] Despite an improvement of children's language skills after early detection and intervention services, DHH children's language levels are not yet on a par with their hearing peers, and the improvement was not sufficient to protect children from developing behavioral problems.[46] These language skills might further improve in later cohorts, because the children in our study did not always receive early intervention, despite the early detection. At the time that these children were detected, the early detection program by the NHS had just started and was still in the implementation phase during data collection.

During this period children with moderate losses received intervention relatively late due to various reasons such as lack of guidelines on reimbursement of costs.. Post-hoc analyses revealed that children with moderate losses received their first hearing aid at approximately 16 months of age whereas children with more severe losses received amplification at 12 months. Moreover, as the results of this study indicate, it might even be more favorable to focus on the development of children's communicative abilities instead of language skills only since these were related to the child's social functioning.
However, we have to note that our study sample comprised approximately one third of the total DHH cohort. It is possible that parents of children with additional handicaps or very low language skills decided not to participate, introducing a selection bias. It is also possible that parents of children who were developing well had no interest in participating in the study. For future research, it is desirable to identify reasons for non-responding.
Contrary to our hypothesis, we did not find a relation between the time of intervention and the level of social functioning or behavioral problems; neither between the age at intervention, types of support, or degree of hearing loss. Fellinger pointed this out by asking the question: "*What kind of evidence-based interventions need to follow UNHS in order to support families to actively foster the development of a strong identity and positive mental health of their child with PCHI, beyond the drive for 'normalization'?"*.[47]
This question calls for longitudinal research designs with a detailed follow-up of DHH children in order to study treatment effects and causality.

CONCLUSION

The communicative abilities of early identified DHH children are not yet on a par with hearing peers. This study shows the important relationship between these skills and DHH children's social-emotional functioning. Future studies should focus on the causality of this relationship in order to improve these skills in DHH children and allow them to reach their full potential.

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