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Main Article

Assessment of expressive vocabulary outcomes in hearing-impaired children with hearing aids: do bilaterally hearing-impaired children catch up?

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Abstract

Objective: To evaluate expressive vocabulary growth in hearing-impaired preschool children wearing hearing aids.

Design: Prospective analysis of the outcomes of children included in the 1994 German 'Goettinger Hoer-Sprachregister' (GHR) series, using a repeated-measures paradigm in six- to nine-month intervals (t1–t3).

Subjects: Twenty-seven children (aged 2.0–4.4 years) with bilateral sensorineural hearing loss (with averages at frequencies of 0.5, 1, 2 and 4 kHz of >20 to >90 dB in the better ear) from the 1994 GHR series. The children were diagnosed at a mean age of 31.4 months (standard deviation (SD) 10.6 months) and fitted with a binaural hearing aid at a mean age of 32.3 months (SD 10.5 months). Nonverbal intelligence was average (five missing data entries). Standardized, age-appropriate picture naming tests (the 'Sprachentwicklungstest für 2-jährige Kinder', the Kaufman Assessment Battery for Children subtest vocabulary, and the 'Aktiver Wortschatztest für drei- bis sechsjährige Kinder') were carried out at three time points and results compared with data from children with normal hearing. The test raw scores were converted to T scores (mean = 50; SD = 10).

Results: On average, the children scored far below the normative population at t1 (mean = 28.9; SD = 11.3) and slowly improved as they got older (at t3, mean = 34.1; SD = 16.1; $p = 0.010$). Children with mild or moderate hearing loss improved most notably (mean difference t1–t3; $p = 0.001$), except for one child of deaf parents. Two of the five mildly hearing-impaired children and two of the eleven moderately hearing-impaired children caught up with their normal hearing peers with regards to expressive vocabulary. Such expressive vocabulary achievements were not seen in any children with >70 dB hearing loss or in six of the eleven children (55 per cent) with a 40–70 dB hearing loss, despite receiving adequate personal amplification.

Conclusion: Testing expressive vocabulary size is a useful clinical tool in assessing linguistic lexical outcome.

Key words: Child; Hearing Loss, Sensorineural; Language; Vocabulary; Hearing Aids

Introduction

Oral language development is highly dependent upon what an infant can hear. Receptive vocabulary development (i.e. word understanding) in a child's native spoken language precedes expressive vocabulary development in the process of vocabulary acquisition. The learning of words with a phonological form naturally occurs through hearing the flow of spoken language, or in the context of hearing names of concrete objects, actions and cognitive-relational words. Vocabulary, the store of words, is one fundamental measure of spoken ability; it is the building block of language[1] and the basis for syntactic and morphologic development. Vocabulary learning has to cope with many developmental changes, e.g. two-word phrases and reading comprehension.

Persistently, mainly prelingually hearing-impaired children frequently present with reduced language skills because of their auditory deprivation. Especially, the onset of speech production is delayed and vocabulary is diminished, compared both with children with specific language impairments and with hearing peers.[2] The few studies that have been undertaken have focused primarily on receptive English vocabulary development, using the multiple choice-style Peabody Picture Vocabulary Test expounded by Dunn and Dunn.[3–10] To date, the

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expressive vocabulary of young children with permanent hearing loss who receive hearing aids has been studied less extensively.[11–13]

This study aimed to provide information on expressive vocabulary growth as a global measure of language performance in young hearing-impaired and hearing-aid-wearing children, using standardized measures. It was hypothesized that their vocabulary would be less than that of normally developing German children with normal hearing. In addition, hearing-impaired children who were diagnosed early were expected to demonstrate more rapid development of vocabulary than their later-diagnosed counterparts, because of their shorter period of auditory deprivation.

Methods

All participants were drawn from a homogenous population of persistently hearing-impaired children in a defined geographical area of Germany (Lower Saxony) (the database of the 'Goettinger Hoer-Sprachregister' (GHR) series, see Appendix). Our selection criteria were: (1) three individual outcome measurements (labelled as t1, t2 and t3); (2) the presence of a bilateral, sensorineural hearing impairment of at least 21 dB of hearing loss (HL); (3) the habitually binaural use of personal hearing aids; (4) the absence of major co-morbidities; and (5) enrolment in an educational programme using spoken language (see below).

Subjects

A total of 27 children who had been medically diagnosed in the out-patient clinic of the Department of Phoniatrics/Pedaudiology, University of Goettingen, were selected for the study. Their mean age at diagnosis was 31.4 months (standard deviation (SD) 10.6 months) and ranged from 14 to 52 months. Mean age of hearing aid fitting was 32.3 months (SD 10.5 months). The average duration of auditory experience after hearing aid fitting was 20.7 months (SD 5.5 months) (range, 13–33 months). Most of the children had hearing impairments of congenital onset ($n = 15$), but 10 children had noncongenital hearing impairment of unknown age of onset. Two children demonstrated postnatal causes of hearing impairment (i.e. scarlatina and meningitis). Forty per cent of the study group had a moderate level of residual hearing (41–70 dB HL), 30 per cent showed severe hearing impairment (71–90 dB HL), 19 per cent were mildly hearing impaired (21–40 dB HL) and 11 per cent demonstrated profound hearing loss (>90 dB HL).

The children had normal nonverbal intelligence (mean T score 54.9, SD 7.8, range 38–68, five missing data entries). All were enrolled in an early oral/aural habilitation at home scheme (carried out by a hearing-impaired children's teacher during an hour-long, once-weekly visit) that emphasized spoken German language skills. Additionally, the children received oral speech-language therapy by a speech therapist once a week for 30 minutes. Twenty children used oral communication, and seven children grew up in a bilingual communication environment. The mean age at testing was 35.2 months (SD 9.1 months) at t1, 43.7 months (SD 10.4 months) at t2 and 53.0 months (SD 11.0 months) at t3. Table I shows some of the characteristics of the study group.

Measures

Audiological assessment. This consisted of: the child's clinical history (also noting any family history of hearing impairment); prenatal, birth and perinatal data; otoscopic examination; tympanometry (to rule out middle-ear pathologies, conductive component); computerized tomography in individual cases (to reveal associated congenital malformations); vestibular evaluation in selected cases; hearing sensitivity, assessed by pure-tone audiometry (with headphones from 0.5 to 4 kHz (air and bone conduction thresholds), respectively); brainstem evoked response audiometry (when considered necessary, e.g. below the age of three years or in difficult-to-test children); and degree of hearing loss (measured by calculating the average hearing threshold in decibels across the frequencies of the speech range [0.5, 1, 2 and 4 kHz] in the better ear).

Psychometric assessment. Three vocabulary outcome measures were collected over nearly 18 months to assess expressive vocabulary growth. The children were individually examined using established tests norm-referenced to normally developing, non-hearing-impaired German children. The items of all picture-naming tests were arranged in increasing order of difficultly. All of the tests were administered by a licenced psychologist and scored according to the test manual instructions. Higher scores indicated larger vocabulary size. Testing was performed orally. During testing, all children used their own, well fitted hearing aids. The tests comprised: (1) the 'Sprachentwicklungstest für 2-jährige Kinder' test subtest of expressive vocabulary for children aged 24 to 35 months, composed of 30 items;[14] and (2) the 'Aktiver Wortschatztest für drei- bis sechsjährige Kinder' (AWST 3–6) for children aged 36 to 71 months, composed of 82 items.[15]

As a second-order test, the subtest vocabulary of the German version of the Kaufman Assessment Battery for Children (24 items)[16] was conducted in children aged 30 to 59 months, if the AWST 3–6 (i.e. the first-order test) proved to be too difficult because of its length.

Nonverbal cognitive ability was assessed with the Columbia Mental Maturity Scale,[17] using Eggert's age-normative values for German children from the age of three years.[18] From a chronological age of 4.9 years onwards, the German version of Raven's Coloured Progressive Matrices[19] was administered. All tests had been found to be reliable and valid.

Assessments were conducted between February 1995 and February 2005. The average interval between identification of hearing impairment and first (baseline) psychometric examination was 3.8 months (SD 4.1 months), and the mean difference between t1 and t3 was 17.8 months (SD 4.8 months).

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TABLE I

CHARACTERISTICS OF THE 27 HEARING-IMPAIRED CHILDREN

Pt no	Gender	HI severity	HL (dB)	HI onset	HI diagnosis age (months)	Expressive vocabulary*						Nonverbal intelligence (T score)	Auditory experience (months)
						t1	Test	t2	Test	t3	Test		
1	F	Mild	22.5	Unknown	52	49	K	52	A	62	A	56	19
2	M	Mild	33.8	Congenital (deaf parents)	28	23	K	30	K	23	A	59	20
3	F	Mild	34.5	Congenital	45	51	K	42	A	66	A	55	17
4	M	Mild	35.0	Unknown	21	26	S	26	S	44	A	–	23
5	M	Mild	35.0	Congenital	29	23	K	23	K	45	K	51	17
6	F	Mod	41.0	Unknown	25	26	S	18	K	28	K	62	26
7	M	Mod	42.5	Congenital	35	18	K	37	K	29	A	43	13
8	F	Mod	43.8	Unknown	36	40	K	40	A	50	A	56	22
9	M	Mod	45.0	Congenital	40	19	K	27	K	23	A	52	21
10	M	Mod	46.3	Congenital	38	52	A	66	A	65	A	56	32
11	F	Mod	50.0	Congenital	37	20	K	23	K	27	K	57	20
12	M	Mod	50.0	Unknown	49	21	K	21	A	23	A	40	19
13	M	Mod	58.8	Unknown	50	37	A	43	A	55	A	68	23
14	M	Mod	60.0	Congenital	23	30	K	39	K	45	A	46	33
15	F	Mod	65.0	Postnatal (meningitis)	18	58	K	54	K	64	A	59	30
16	F	Mod	66.3	Unknown	22	26	S	23	S	31	A	57	19
17	F	Sev	73.8	Unknown	23	26	S	23	K	19	K	–	22
18	F	Sev	73.8	Congenital	43	19	K	21	K	23	A	38	13
19	F	Sev	75.0	Postnatal (scarlatina)	28	23	K	23	K	30	K	50	16
20	M	Sev	76.3	Congenital	26	26	S	23	K	25	K	64	15
21	M	Sev	80.0	Congenital	31	23	K	20	K	21	K	64	20
22	M	Sev	81.3	Congenital	42	17	K	21	K	29	K	61	16
23	M	Sev	88.8	Congenital	14	26	S	23	K	20	K	61	25
24	F	Sev	90.0	Congenital	22	26	S	23	S	18	K	–	14
25	F	Prof	91.0	Unknown	26	26	S	22	K	17	K	52	16
26	F	Prof	93.5	Congenital	18	26	S	23	S	18	K	–	18
27	F	Prof	95.0	Unknown	27	23	K	18	K	21	K	–	29

*Expressive vocabulary scores were taken at 3 time points (t1–t3) and are given as T scores (mean = 50, standard deviation = 10): >50–60 = above-average language development; 50–40 = low-average language development; <40 = below-average language development (compared with the performance of normally developing normal hearing children). Pt no = patient number; HI = hearing impairment; HL = hearing loss; M = male, F = female; S = Sprachentwicklungstest für 2-jährige Kinder subtest (2.0 to 2.11 years); A = Aktiver Wortschatztest für drei- bis sechsjährige Kinder (3.0 to 5.11 years); K = German version of the Kaufman Assessment Battery for Children (2.6 to 4.11 years); – = missing data; Mod = moderate; Sev = severe; Prof = profound

Data analysis. The average rate of vocabulary growth between the time points t1 and t3 was computed. Single descriptive statistics (means, SDs and ranges) and group comparisons were carried out. Statistical comparisons of mean values of subgroups were performed using Student's two-tailed *t*-test for related groups (t1–t3) respectively unrelated groups the significance criteria being established at $p < 0.05$. Correlations were calculated with Spearman's rank coefficient (rho), where one or both variables were not normally distributed. A multiple regression analysis was conducted to determine what factors accounted for variance in vocabulary outcome. The Statistical Package for the Social Sciences Version 11.5 software was used throughout.

Results and analysis

Table II presents the mean expressive vocabulary data for the whole group and for subgroups. The sample as a whole demonstrated substantial gaps in vocabulary performance compared with mean normative age-related values for non-hearing-impaired children (T score 50) at all time points. However, the results revealed a significant average increase over time. Female subjects showed on average a vocabulary advantage at t1, compared with males, who exhibited greater, significant improvement over time. The difference in the mean improvement rate between boys and girls at all time points was not statistically significant.

The children were divided into subgroups according to their hearing impairment degree, onset age and diagnosis age. Children with less hearing impairment had a significantly greater mean vocabulary size at all time points than those whose hearing loss exceeded 70 dB. Children with less hearing impairment demonstrated the greatest developmental increase from t1 to t3 (mean rate, 10.1 T scores). Four children (patients number four, five, 13 and 14; see table I) had reached the normal range at t3. The children with larger hearing loss had a mean T score >2.5 SDs below the mean at all time points; on average, they did not show any improvement.

The mean achievement scores of children whose hearing impairment was identified prior to 32 months of age was smaller at all time points than those of individuals with a later diagnosis age, whose mean increase rate (9.9 T scores from t1 to t3) was statistically significant. The vocabulary development of the earlier-identified group showed very limited progress (average rate of 2.0 T scores)

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TABLE II

EXPRESSIVE VOCABULARY OF BILATERALLY SENSORINEURAL HEARING-IMPAIRED CHILDREN

Subgroup	Mean age at diagnosis (SD) (months)	Expressive vocabulary*						
		Mean t1 (SD)	Children scoring >1 SD below mean (*n*) (%)	Mean t2 (SD)	Mean t3 (SD)	Children scoring >1 SD below mean (*n*) (%)	Mean difference (t1 − t3) (SD)	95% CIs
Total ($n = 27$)	31.4 (10.6)	28.9 (11.3)	22 (81.5)	29.8 (12.5)	34.1 (16.4)	18 (66.7)	+5.2 (8.9)	1.71–8.74
Boys ($n = 13$)	32.8 (10.8)	26.2 (9.3)	12 (92.3)	30.7 (13.0)	34.4 (14.7)	8 (61.5)	+8.2 (9.1)	2.67–13.64
Girls ($n = 14$)	30.1 (10.7)	31.4 (12.6)	10 (71.4)	28.9 (12.5)	33.9 (19.1)	10 (71.4)	+2.5 (8.1)	−2.16–7.16
Degree of HI								
'Lower' (20–70 dB) ($n = 16$)	34.3 (11.0)	32.4 (13.5)	11 (68.8)	35.3 (13.8)	42. 5 (16.4)	7 (43.8)	+10.1 (6.6)	6.54–13.58
'Higher' (71–>90 dB) ($n = 11$)	27.3 (8.9)	23.7 (3.2)	11 (100)	21.8 (1.7)	21.9 (4.4)	11 (100)	−1.8 (6.9)	−6.45–2.82
Age at diagnosis								
≤31 months ($n = 16$)	23.8 (4.6)	27.3 (8.4)	15 (93.8)	25.7 (9.0)	29.3 (13.5)	12 (75.5)	+2.0 (9.6)	−3.12–7.12
>31 months ($n = 11$)	42.5 (5.9)	31.2 (14.7)	7 (63.6)	35.7 (14.8)	41.1 (18.4)	6 (54.5)	+9.9 (5.1)	6.50–13.31
Onset								
Congenital ($n = 15$)	31.4 (9.6)	26.6 (10.7)	13 (86.7)	29.4 (12.3)	31.8 (16.0)	11 (73.3)	+5.2 (9.3)	0.05–10.35
Postnatal ($n = 2$)	23.0 (7.1)	40.5 (24.7)	1 (50.0)	38.5 (21.9)	47.0 (24.0)	1 (50.0)	+6.5 (0.7)	NE
Unknown ($n = 10$)	33.1 (12.6)	30.0 (8.9)	8 (80.0)	28.6 (11.9)	35.0 (16.4)	6 (60.0)	+5.0 (9.6)	−1.89–11.89

*Expressed as mean T score (mean = 50, standard deviation = 10) at 3 time points (t1–t3). SD = standard deviation; 95% CIs = 95% confidence limits; HI = hearing impairment; NE = not examined and this considerable retardation was maintained, whereas, on average, the later-identified group reached a low-normal range.

In children with hearing impairments of early (i.e. congenital), postnatal or unknown onset, the mean improvement rates for expressive vocabulary from t1 to t3 were not notably different. However, the mean increase of 5.2 T scores in children with congenital hearing impairment was not statistically significant, and they did not reach the normal range (see Table II).

Age at diagnosis was not significantly related to expressive vocabulary size at t3 for the group as a whole (rho = 0.36), regardless of whether hearing losses were identified before the age of 32 months (rho = 0.05) or later (rho = 0.16). The strongest significant correlation was found between diagnosis age before 32 months of age and expressive vocabulary measured at t1 (rho = −0.77, $p < 0.001$); this declined over time (at t3 rho = 0.05). This suggests that, after hearing aid fitting, vocabulary development was stimulated and children 'caught up'. Expressive vocabulary at t3 was only marginally related to an early diagnosis age. The correlations obtained are shown in Table III. The negative correlation of hearing loss with expressive vocabulary at t1 (rho = −0.16; not significant) increased over time (at t3 rho = −0.64, $p < 0.001$). The positive correlation between auditory experience (calculated by subtracting the child's hearing aid fitting age in months from their chronological age in months at t3) and productive vocabulary decreased over time (at t1 rho = 0.47, $p = 0.014$; at t3 rho = 0.26, not significant), because degree of hearing loss was a confounding variable. No correlation was found between nonverbal intelligence and vocabulary.

A multiple regression analysis was performed to examine which of five variables were significant predictors of expressive vocabulary size at t3. Results are shown in Table IV. The full model predicted a significant amount of the variance in the vocabulary outcome measure at t3 (87 per cent). Potential predictors were the severity of hearing impairment (dB HL) and expressive vocabulary performance at t1. That is, expressive vocabulary scores were higher in children with higher vocabulary scores at t1 and mild to moderate hearing loss.

Discussion

A group of sensorineural hearing-impaired children with aided pure-tone threshold averages of between >20 and >90 dB exhibited on average a growth of expressive vocabulary over a period of 18 months. These findings are consistent with reports demonstrating that cochlear implants, as personal acoustic amplification in the aural habilitation process, enhance children's vocabulary development after the post-implantation period.[8,20] Nonetheless, even though the present study group showed on average a significant increase, the vocabulary size of most individuals who were successful users of hearing aids and were enrolled in speech and language intervention schemes was still substantially delayed compared with their hearing peers of the same chronological age, with the exception of four subjects with mild hearing loss and five subjects with moderate hearing loss. Females (on average, earlier-identified) demonstrated higher vocabulary performance at t1 than males, although all girls suffered from profound hearing loss. At t3, boys had statistically significantly caught up, and boys and girls had nearly the same, subnormal vocabulary size on average.

Children with less hearing impairment showed a quicker vocabulary acquisition rate in the observed time course compared with children with severe or profound hearing impairment (except for one child of deaf parents, who had congenital mild hearing impairment). Profoundly hearing-disordered children did not benefit from well fitted hearing aids and exhibited a decreasing vocabulary size, as did five out of the eight severely hearing-impaired children. Both these groups were candidates for cochlear implantation, and five children eventually underwent implantation. The gap between the vocabulary of children with worse hearing loss (>70 dB HL) and that of their hearing peers generally increased with age (except for patients number 18 and 22, who had late-identified

TABLE III

CORRELATIONS OF OUTCOME MEASURES WITH SELECTED VARIABLES

Patient parameter	Mean age at diagnosis (months) (SD)	Expressive vocabulary*					
		t1		t2		t3	
		ρ	*p*	ρ	*p*	ρ	*p*
≤31 months at diagnosis (*n* = 16)	23.8 (4.6)	−0.77	<0.001	−0.39	NS	0.05	NS
>31 months at diagnosis (*n* = 11)	42.5 (5.9)	0.29	NS	0.12	NS	0.16	NS
Total (*n* = 27)	31.4 (10.6)	−0.21	NS	0.14	NS	0.36	NS
Age at 1st hearing aid fitting (months) (*n* = 27)		−0.16	NS	0.22	NS	0.40	0.037
Hearing loss (dB) (*n* = 27)		−0.16	NS	−0.54	0.004	−0.64	<0.001
Auditory experience (after aid fitting) (months) (*n* = 27)		0.47	0.014	0.27	NS	0.26	NS
Nonverbal intelligence (T score) (*n* = 22)		0.27	NS	−0.03	NS	−0.01	NS

*Measured at 3 time points (t1–t3). ρ = rho; NS = not significant

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TABLE IV
MULTIPLE REGRESSION ANALYSIS

Criterion	Independent variable	T	p
Expressive vocabulary	Constant	0.744	NS
	Hearing loss (dB)	−3.096	0.005
	Age at HI diagnosis	−1.005	NS
	Auditory experience (after aid fitting)	0.227	NS
	Age at 1st aid fitting	1.284	NS
	Expressive vocabulary at t1	7.722	<0.001
		F	
	Regression	28.438	<0.001

$R^2 = 0.871$. NS = not significant; HI = hearing impariment

congenital hearing loss, and patient number 19, who had postnatal hearing impairment).

In children, vocabulary skills are closely related to the hearing impairment diagnosis age.[12,21–25] Significantly better language scores are associated with early diagnosis and early interventions that actively involve children's families.[6] At this point, it is worth pointing out that the literature has now defined six months as the definitive cut-off point for 'early diagnosis'.[12,25] Because universal newborn hearing screening programmes are not obligatory in Germany (although sometimes carried out regionally), the age of hearing loss diagnosis was considerably delayed in our children (minimum age at identification, 14 months (one case); average age, 31.4 months; median age, 28 months). Surprisingly, the earlier-diagnosed group in this study performed on average more poorly at t1 than the later-diagnosed group (i.e. diagnosed at >31 months of age), which showed a greater rate of improvement over time. This may be partly explained by the degree of hearing impairment, because the later-diagnosed group included only 25 per cent of the severely hearing-impaired children and no child with profound hearing loss. The two postnatal hearing-impaired children were included in the earlier-identified group; the elder child, having had a longer period of normal hearing before becoming severely hearing-impaired, may have caused a bias in the mean vocabulary T score, because (unexpectedly) this child's vocabulary growth was small until t3. Moreover, one child of deaf parents was included in the earlier diagnosis group, due to hearing impairment being identified at the age of 28 months. It is likely that this child was mostly confronted with a nonverbal, gestural communication code at home and primarily built up a signed vocabulary in combination with oral–aural methods. It should also be mentioned that the individual process of word learning changes over the course of language development. This may be explained by increasing cognitive abilities, e.g. 'nominal insight' and its relation to referential word use in the single word period, phonological working memory, and phonological awareness.

The multiple regressions model suggests that hearing threshold level and size of expressive vocabulary at t1 explain a significant amount of the variance in vocabulary size obtained at t3. Children with an age-appropriate productive vocabulary remained in the age-range or showed a slight upward trend. Severely and profoundly hearing-impaired children with a very age-deviant vocabulary size demonstrated a downward trend over time or tended to stay in the bottom range. It is rather improbable that minimally hearing-impaired children will catch up at a later age.

The rates of expressive vocabulary development of children wearing hearing aids demonstrated considerable individual variation, as is also the case with cochlear-implanted children.[26–28] Individual differences in underlying cognitive abilities may explain some of this variance.[12] In the study by Suonpää and Salmivalli,[29] the vocabulary scores (i.e. number of correct written names of coloured picture of familiar objects) of deaf pupils with a mean age of 17 years had been increased significantly within five years with intelligence and only slightly with age. In the present study, five children had no recorded intelligence test result, for unknown reasons (i.e. two children with severe hearing impairment, two with profound hearing impairment and one with mild hearing impairment), but we found no strong or significant correlation between intelligence and vocabulary size. Presumably, other factors may have influenced children's vocabulary development (e.g. educational experience, motivation, and family support and responsiveness to the child).

Perhaps the follow-up time of the present study was too short, as assessment of longer term outcomes is crucial. It is assumed that the rate of receptive vocabulary development increases over time more than the rate of expressive vocabulary development. Moreover, the hearing-impaired children had been enrolled at various ages because their hearing impairment was diagnosed at different ages. Thus, their opportunity of taking advantage of the critical, time-sensitive periods for oral language acquisition differed, and, for some children, was been completely lost. The times of observations differed among subjects. Furthermore, we did not have a concurrent control group. The results of the present study should be interpreted with caution, because we used only tests for investigation tools and did not use linguistic analyses of language samples.

However, the study data represent an initial attempt to assess the expressive vocabulary size in young German children who were hearing-impaired and wearing hearing aids. Once again, the study highlights the need for high quality universal newborn hearing screening programs in Germany in order to facilitate age-adequate spoken vocabulary development in hearing-impaired German children.

Conclusion

Expressive vocabulary is a central linguistic skill, and testing it in hearing-impaired children may potentially provide clinically valuable information: (1) as a tool in assessing linguistic vocabulary development; (2) as a practical guideline to evaluate indications for cochlear-implantation referral in children with hearing impairment >70 dB (however, even after

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implantation, these children will find it very difficult to correct their oral language deficits); (3) because it has the advantage of rapid scoring and reduced administration; and (4) as a behavioural measure in psycholinguistic research.

- **This study seeks to evaluate expressive vocabulary growth in hearing-impaired preschool children wearing hearing aids**
- **On average, aided children scored far below the normative population initially and slowly improved as they got older. Children with mild or moderate hearing loss enhanced most notably**
- **Testing expressive vocabulary size is a useful clinical tool in assessing linguistic lexical outcome**

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References

1 Golinkoff RM, Hirsh-Pasek K. Word learning. Icon, index or symbol? In: Golinkoff RM, Hirsh-Pasek K, Bloom L, Smith L, Woodward A, Akhtar N, Tomasello M, Hollich G, eds. *Becoming a Word Learner. A Debate on Lexical Acquisition*. Oxford: University Press, 2000;3–15
2 Kiese-Himmel C, Kruse E. Specific versus audiogenic speech development disorder. Quantitative speech development index in a controlled group comparison. *Folia Phoniatr Logop* 1996;**48**:290–300
3 Dunn LM, Dunn LM. *Peabody Picture Vocabulary Test*, 3rd edn. Circle Pines, Minnesota: American Guidance Service, 1997
4 Davis JM, Elfenbein J, Schum R, Bentler RA. Effects of mild and moderate hearing impairments on language, educational, and psychosocial behavior of children. *J Speech Hear Disord* 1986;**51**:53–62
5 Dodd B, Woodhouse L, McIntosh B. The linguistic abilities of young children with hearing impairment: first report of a longitudinal study. *Aust N Z J Dev Disabil* 1992;**18**:17–34
6 Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics* 2000;**106**(3):E43
7 Blamey PJ, Sarant JZ, Paatsch LE, Barry JG, Bow CP, Wales RJ *et al*. Relationships among speech perception, production, language, hearing loss, and age in children with impaired hearing. *J Speech, Lang Hear Res* 2001;**44**:264–85
8 El-Hakim H, Papsin B, Mount RJ, Levasseur J, Panesar J, Stevens D *et al*. Vocabulary acquisition rate after pediatric cochlear implantation and the impact of age at implantation. *Int J Pediatr Otorhinolaryngol* 2001;**59**:187–94
9 Eisenberg LS, Kirk KI, Martinez AS, Ying EA, Miyamoto RT. Communication abilities of children with aided residual hearing. *Arch Otolaryngol Head Neck Surg* 2004;**130**:563–9
10 Wake M, Hughes EK, Poulakis Z, Collins C, Rickards FW. Outcomes of children with mild-profound congenital hearing loss at 7 to 8 years: a population study. *Ear Hear* 2004;**25**:1–8
11 Griswold E, Commings J. The expressive vocabulary of preschool deaf children. *Am Ann Deaf* 1974;**119**:16–28
12 Mayne AM, Yoshinaga-Itano C, Sedey AL, Carey A. Expressive vocabulary development of infants and toddlers who are deaf or hard of hearing. *Volta Rev* 2000;**100**:1–28
13 Kiese-Himmel C, Ohlwein S. Vocabulary of young children with sensorineural deafness. Developmental language test for two year old children (SETK-2). *HNO* 2002;**50**:48–54
14 Grimm H. Expressive vocabulary test for 3 to 6 year old children (AWST3-6, 2nd revised edn. 1996). Goettingen: Hogrefe, 2000
15 Kiese C, Kozielski PM. Weinheim: Beltz, 1996
16 Melchers P, Preuss U. *Kaufman-Assessment Battery for Children (K-ABC)*, 3rd edn. Frankfurt: Swets & Zeitlinger, 1994
17 Burgemeister B, Blum LM, Lorge I. Columbia Mental Maturity Scale. New York: Harcourt Brace Jovanovich, 1972
18 Eggert D. The Columbia Mental Maturity Scale (individual test) for normal children aged three to ten years. In: Eggert D, ed. *Diagnosis of mentally less gifted children*. Weinheim: Beltz, 1972:185–201
19 Becker P, Schaller S, Schmidtke A. Coloured Progressive Matrices. *Coloured Progressive Matrices. German adaption. 2nd revised edn.* Weinheim: Beltz, 1980
20 Dawson PW, Blamey PJ, Dettman SJ, Barker EJ, Clark GM. A clinical report on receptive vocabulary skills in cochlear implant users. *Ear Hear* 1995;**16**:287–94
21 White SJ, White REC. The effects of hearing status of the family and age of intervention on receptive and expressive oral language skills in hearing-impaired infants. In: Levitt H, McGarr NS, Geffner D, eds. *Development of Language and Communication Skills in Hearing-Impaired Children*, American Speech and Hearing Association Monographs, number 26. Rockville, Maryland: 1987;9–24
22 Robinshaw HM. Early intervention for hearing impairment: Differences in the timing of communicative and linguistic development. *Br J Audiol* 1995;**29**:315–334
23 Apuzzo ML, Yoshinaga-Itano C. Early identification of infants with significant hearing loss and the Minnesota Child Development Inventory. *Semin Hear* 1995;**16**:124–39
24 Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. The Language of early- and later-identified children with hearing loss. *Pediatrics* 1998;**102**:1161–71
25 Yoshinaga-Itano C. Benefits of early intervention for children with hearing loss. *Otolaryngol Clin North Am* 1999; **32**:1089–102
26 Szagun G. Language acquisition in young German-speaking children with cochlear implants: individual differences and implications for conceptions of a “sensitive phase”. *Audiol Neurootol* 2001;**6**:288–97
27 Szagun G. Individual differences in language acquisition by young children with cochlear implants and implications for a concept of ‘sensitive phase’. In: Miyamoto R, ed. *Cochlear Implants*. Amsterdam: Elsevier, 2004;308–11
28 Geers AE. Speech, language, and reading skills after early cochlear implantation. *Arch Otolaryngol Head Neck Surg* 2004;**130**:634–8
29 Suonpää J, Salmivalli A. Vocabulary and articulation test scores of deaf pupils. *Scand Audiol* 1978;**7**(suppl 8): 223–6

Appendix

The Goettinger Hoer-Sprachregister (GHR) comprised a consecutive series of children aged up to 10 years diagnosed as having permanent peripheral hearing loss (mean better ear advantage >20 dB hearing loss (HL) to profound >90 dB HL) in a defined geographical area of Germany (Lower Saxony) from 1 October 1994 to 30 September 2004. This covered patients living in a geographical area within a radius of 100 km around the city of Goettingen (about 1 million inhabitants). All children received a prescription for acoustic hearing aids, based on individual audiometric information. Their data were recorded in a database. The children came to the out-patient clinic of the department of phoniatrics/pedaudiology at the University of

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Goettingen because of parental self-referral or referral by paediatricians, otolaryngologists or general practitioners. Data collected included severity of hearing loss, socio-demographic variables and results of performance tests (especially for language skills). The GHR database children were involved in regular, longitudinal monitoring of their developmental status. A battery of tests was administered every six to nine months after hearing aid fitting. The children also received regular hearing aid checks and audiologic evaluations.

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