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NUMBER AND DURATION OF SPOKEN UTTERANCES OF DEAF AND NORMALLY HEARING CHILDREN BETWEEN TWELVE AND EIGHTEEN MONTHS

Some preliminary results

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Abstract

Several studies about the speech development of deaf children suggest that their speech development differs from that of normally hearing children. To establish in which respect this development differs and from what age onwards, the spoken utterances of deaf and normally hearing children from 12.5 until 17.5 months of age are studied. This paper reports about some preliminary results of a study on the total number of spoken utterances in a 10-minutes period of monthly recordings and on the average duration of 50 utterances in the speech of deaf and normally hearing children. It became clear that at this age there are already some differences between deaf and normally hearing children.

1 Introduction

Many studies indicate that the auditory perception influences the production of speech as early as in the first year of life. This is concluded along studies that compared the speech of normally hearing children with that of hearing impaired children. It seems that already early in the speech development there are differences in sound production between hearing and deaf children. For instance, there are differences concerning the start of babbling. Normally hearing children start to babble at a mean age of 7 months (Van der Stelt & Koopmans-van Beinum, 1986), while hearing impaired children may start babbling after the age of eleven months (Oller & Eilers, 1988). The quality of the utterances also seems to differ in some aspects between normally hearing children and hearing impaired children already early in the development. Stoel-Gammon (1988) found that hearing impaired children between 4-18 months of age produced less different types of sounds in their utterances than normally hearing children. Kent et al. (1987) also found clear qualitative differences in the utterances of a deaf boy and his normally hearing twin brother from 8-15 months of age. Oller et al. (1985) found differences in the utterances of hearing impaired and normally hearing children between 8-13 months of age. Research of Clement et al. (1994, 1995) has partially

confirmed these findings from the literature and partially disproved some of them. They studied the vocalizations of six deaf children from 2.5 months until 11.5 months of age. These vocalizations were compared with those of six hearing children. Clement et al. found that hearing impaired children produced more spoken utterances than normally hearing children. Clement (to appear) however also found clear qualitative differences. The hearing impaired children produced less different types of sounds than the normally hearing children. Oller et al. (1985) found that there was no increase in the number of vocalizations of deaf and hearing children from 8-13 months old. Spencer (1993) reported that at the age of 12 and 18 months there was no significant difference in the number of (communicative) vocalizations between hearing impaired and normally hearing children.

More confidence is there about differences in the duration of the utterances of deaf and hearing children. Results of Clement et al. (1996) and Ryalls & Larouche (1992) indicate that the duration of the utterances of the deaf children is slightly longer than that of hearing children. But these differences are not statistically significant.

An interesting question is how the transition from the prelexical stage to the lexical stage develops within these children. There are some studies found in the literature about this topic but sometimes the results are in contrast with each other. For instance there are differences found in the articulation between deaf and hearing children of 4-18 months of age by Stoel-Gammon (1988). It should be mentioned that the differences she found are spread over a long age period. In contrast, Smith (1982) found no differences between deaf and hearing children in the first year of life. He found differences from about 15-18 months until 3.5 years of age.

As far as we know no systematic study has been performed about the transition period from prelexical to lexical. The present study is part of a larger project, which is a follow-up of the study of Clement. We will investigate the spoken utterances of the same young deaf children, from about 1 until 3 years of age. The utterances will be studied and compared with those of the same matched normally hearing children. The present study reports on longitudinal data of five deaf and five matched normally hearing children of 12.5 until 17.5 months of age. The goal of this study is to investigate whether hearing impaired children differ from normally hearing children in the number of spoken utterances and in the duration of the utterances in their speech production.

2 Subjects and recordings

Ten mother-child pairs participated in the present study: five children (all boys) in the profoundly hearing impaired group (group HI) and five matched children in the normally hearing group (group NH). These ten mother-child pairs are part of the twelve pairs in the study of Clement. Two mother-child pairs (one hearing-impaired child and one normally hearing child, both girls) were excluded from the present study because of some problems with the continuity of the recordings. The NH children were matched with the HI children on the criteria sex, birth order, duration of pregnancy, age of the mother, socio-economical status of the parents and dialect of the parents (see Clement et al., 1995). No clear health problems were found. Specific information of the hearing status of the deaf children is shown in table 1.

Audio recordings of 30 minutes of mother-child interaction were made monthly from the age of 12.5 until 17.5 months. Video recordings were made of deaf children when they were 24, 30 and 36 months old and of hearing children at 24 months registering their spoken and signed communication.

Table 1. Characteristics of the hearing impaired children (see also Clement et al., 1995).

Subject	Hearing loss best ear (dB)	Loss with hearing aids (dB)	Age at diagnosis (months)	Hearing aids from age (months)	Language method *
HI-1	97	55	1.5	2.0	Oral
HI-2	93	55	3.0	3.5	TC
HI-3	110	65	4.0	4.5	Oral/TC
HI-4	>120	not tested	0.5	-	NGT/TC
HI-5	120	not tested	3.0	6.5	NGT/TC

* Oral = Oral language method, TC = Total Communication, NGT = Dutch Sign Language

3 Methods of analysis

This study reports on data obtained from the audio recordings when the children were 12.5 until 17.5 months of age. From each of these audio recordings a 10-minutes period was selected for every mother-child pair in which the communication between mother and child is as optimal as possible. These selected 10 minutes form the basis for our analyses. The number of utterances of the child spoken in these 10 minutes was counted. The analyses of the duration of the utterances were made based on 50 utterances of the child randomly selected out of these 10 minutes. An utterance is defined as a sound production during one breath cycle starting with inspiration. Vegetative sounds, laughing, and crying are not taken into account. All utterances were digitized with a sample frequency of 48 kHz and stored for further analysis. The utterance duration was measured in ms if possible on positive zero-crossings.

4 Results

4.1 Number of spoken utterances

The results of the number of spoken utterances in the speech of the deaf and hearing children are shown in figures 1a and 1b. These figures show for each child the number of spoken utterances in the 10-minutes period of every monthly recording. These figures also show the mean number of spoken utterances of all children per monthly recording. More specific data about the number of spoken utterances of the children are given in table 2. This table shows for every monthly recording the mean number of utterances, the standard deviation, and the minimum and maximum number of spoken utterances of the deaf and hearing children.

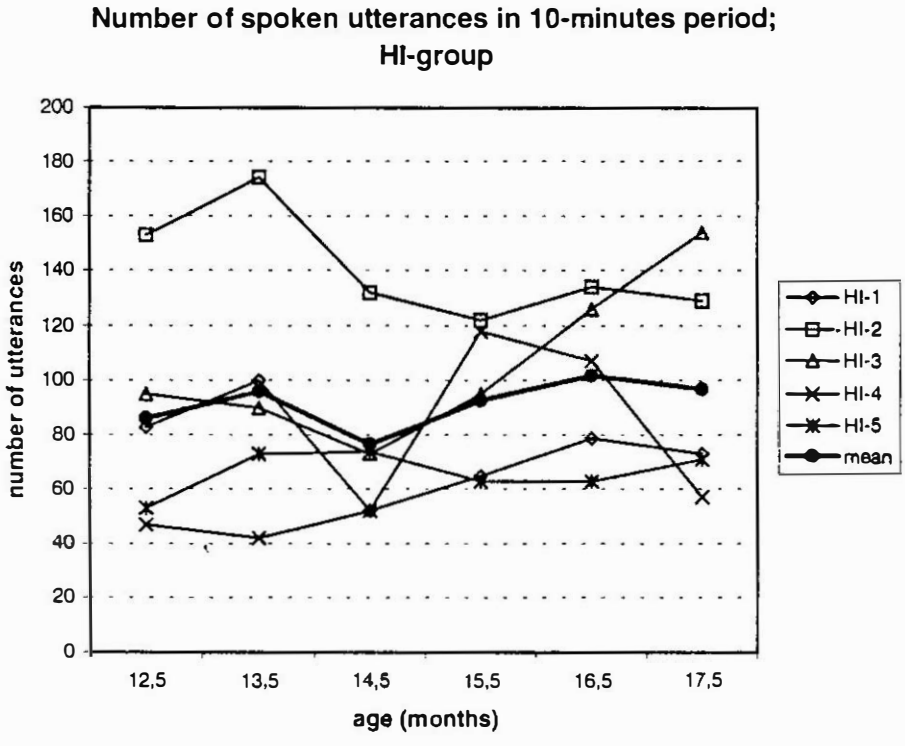

Figure 1a. Number of spoken utterances of the hearing impaired (HI) children in the 10-minutes period of every monthly recording.

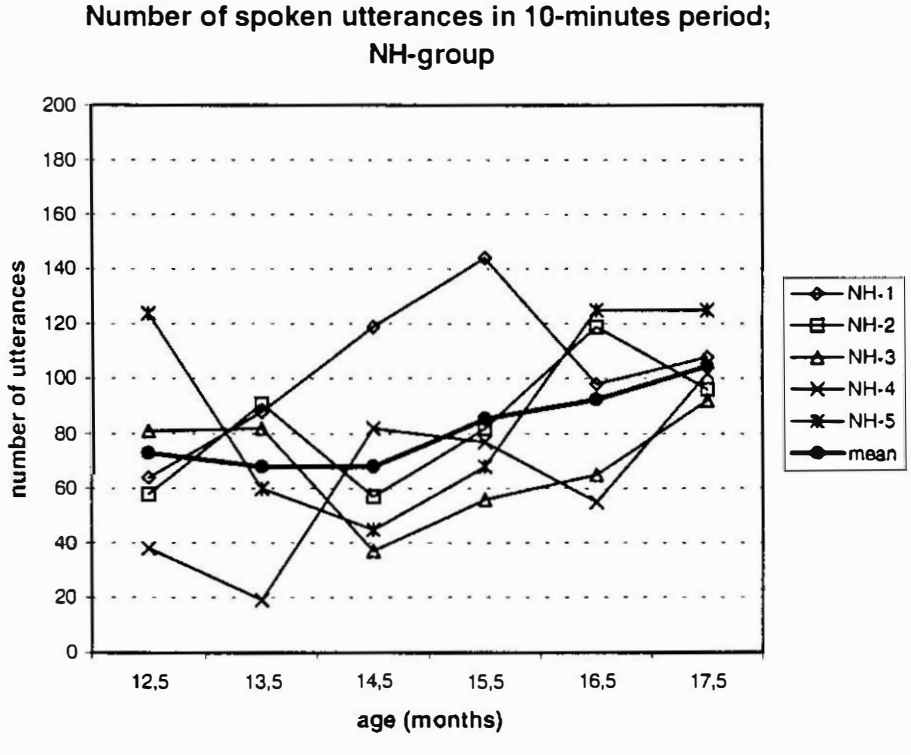

Figure 1b. Number of spoken utterances of the normally hearing (NH) children in the 10-minutes period of every monthly recording.

Figure 1a shows the results of the hearing impaired group. It can be seen that there is a large variation between the children (sd = 35,74 in table 2). Especially child HI-2 produces many more utterances than the other children do. The mean number of utterances of all children in this period is about 92.

Figure 1b shows the results of the normally hearing group. Here it can be seen that there is not as much variation between the children although NH-1 clearly exceeds the others at 14.5 and 15.5 months. In table 2 can be found sd = 30,52 for the normally hearing group. The mean number of spoken utterances for all children in this period is about 82. After the age of 14.5 months there is an increase in their production of spoken utterances.

Table 2. Results of the number of spoken utterances by deaf and hearing children in the 10-minutes period. Results are given per monthly recording and for the whole period.

Age (months)	Hearing status (deaf/hearing)	N	Mean number	Std. Deviation	Minimum number	Maximum number
12,5	deaf	5	86,20	42,39	47	153
	hearing	5	73,00	32,39	38	124
13,5	deaf	5	95,80	48,94	42	174
	hearing	5	68,00	29,96	19	91
14,5	deaf	5	76,60	32,78	52	132
	hearing	5	68,00	33,20	37	119
15,5	deaf	5	92,60	28,08	63	122
	hearing	5	85,40	34,22	56	144
16,5	deaf	5	101,80	30,31	63	134
	hearing	5	92,40	31,43	55	125
17,5	deaf	5	96,80	42,20	57	154
	hearing	5	104,60	12,92	92	125
total 12,5 -17,5	deaf	30	91,63	35,74	42	174
	hearing	30	81,90	30,52	19	144

When comparing the results of the HI group with those of the NH group it can be seen that until 17.5 months of age the hearing impaired children produce more spoken utterances than the normally hearing children do (mean HI group is 91,63, and for the NH group is 81,90). But there is much variation between the hearing impaired children (sd = 35,74). Some children produce extremely many utterances while others produce even fewer utterances than the normally hearing children do. For the normally hearing children there is not such a variation between the children (sd = 30,52).

Overall, the mean number of spoken utterances produced during the whole period is roughly the same for the HI group and the NH group. There is no significant difference between the two groups ($p > 0.05$ and $t = 1.13$, $df = 58$). As a group, they also follow the same pattern in their production of spoken utterances in this period. It has to be taken into account that the quantitative similarity between the two groups of children does not mean that there is also a qualitative similarity. The present results give no information about the quality of the utterances.

4.2 Duration of the utterances

The results of the analysis of the duration of the utterances are shown in figures 2a and 2b. These figures show for each child the mean duration of the 50 randomly selected spoken utterances of every monthly recording. These figures also show the mean duration of the spoken utterances of all children within one monthly recording. More specific data about the duration of the spoken utterances of the children are given in table 3. This table shows for every monthly recording the mean duration, the standard deviation, and the minimum and maximum duration of the utterances of deaf and hearing children.

Figure 2a shows the results of the hearing impaired group. It can be seen that at first there is less difference between the children than there was with respect to the number of utterances. Until 15.5 months they roughly follow the same pattern. From 15.5 months onwards the variation between the children increases. The children HI-2, HI-4, and HI-5 show a decrease in the duration of their utterances, while the children HI-1 and HI-3 show an enormous increase. The mean duration of the utterances of all children in this period is about 1092 ms.

Figure 2b shows the results of the normally hearing group. Here it can be seen that with respect to utterance duration there is also less variation between the normally hearing children than in the number of utterances. They roughly follow the same pattern. The mean duration of the utterances in this period of all children is about 817 ms.

Table 3. Results of the duration measurements of 50 randomly selected spoken utterances from deaf and hearing children. Results are given per monthly recording and for the whole period.

Age (months)	Hearing status (deaf/hearing)	N	Mean duration (ms)	Std. Deviation (ms)	Minimum duration (ms)	Maximum duration (ms)
12,5	deaf	5	1088,47	216,02	866,08	1427,10
	hearing	5	789,67	183,68	595,22	1068,54
13,5	deaf	5	1045,93	156,65	859,22	1276,74
	hearing	5	840,76	175,05	661,54	1071,90
14,5	deaf	5	1098,23	131,77	919,86	1253,34
	hearing	5	715,88	169,69	559,64	999,96
15,5	deaf	5	939,80	306,34	630,44	1431,86
	hearing	5	872,93	268,34	518,92	1272,92
16,5	deaf	5	1320,12	405,73	979,82	1913,34
	hearing	5	880,21	165,11	639,38	1105,68
17,5	deaf	5	1059,69	478,79	553,96	1665,58
	hearing	5	805,42	173,25	497,54	914,72
total 12,5-17,5	deaf	30	1091,87	305,06	553,96	1913,34
	hearing	30	817,48	184,18	497,54	1272,92

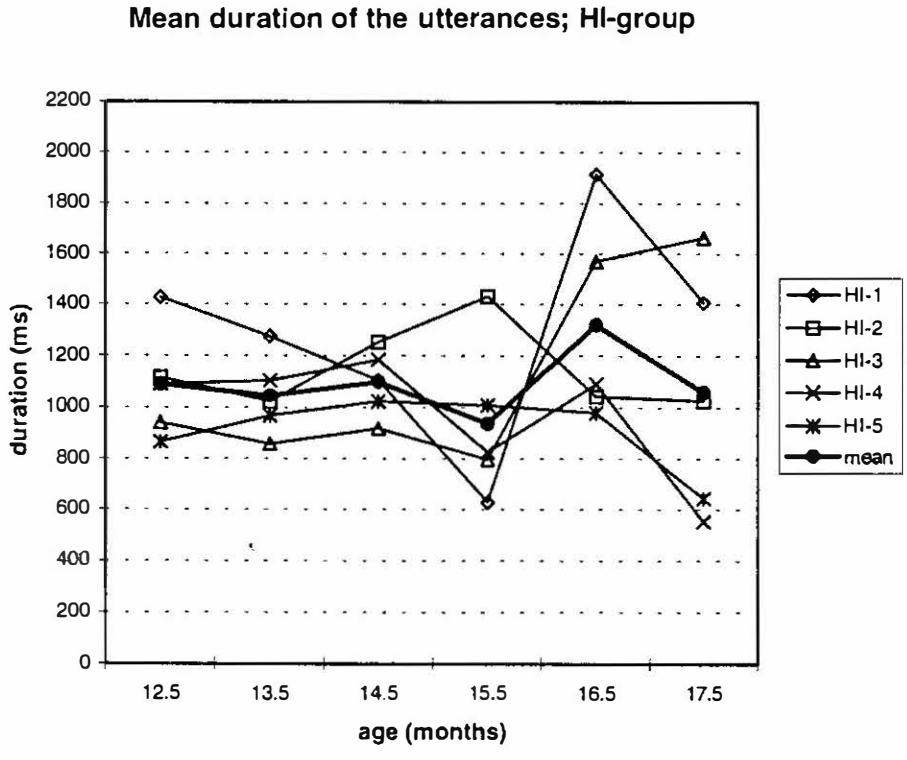

Figure 2a. Mean duration of 50 randomly selected spoken utterances of the hearing impaired (HI) group in every monthly recording.

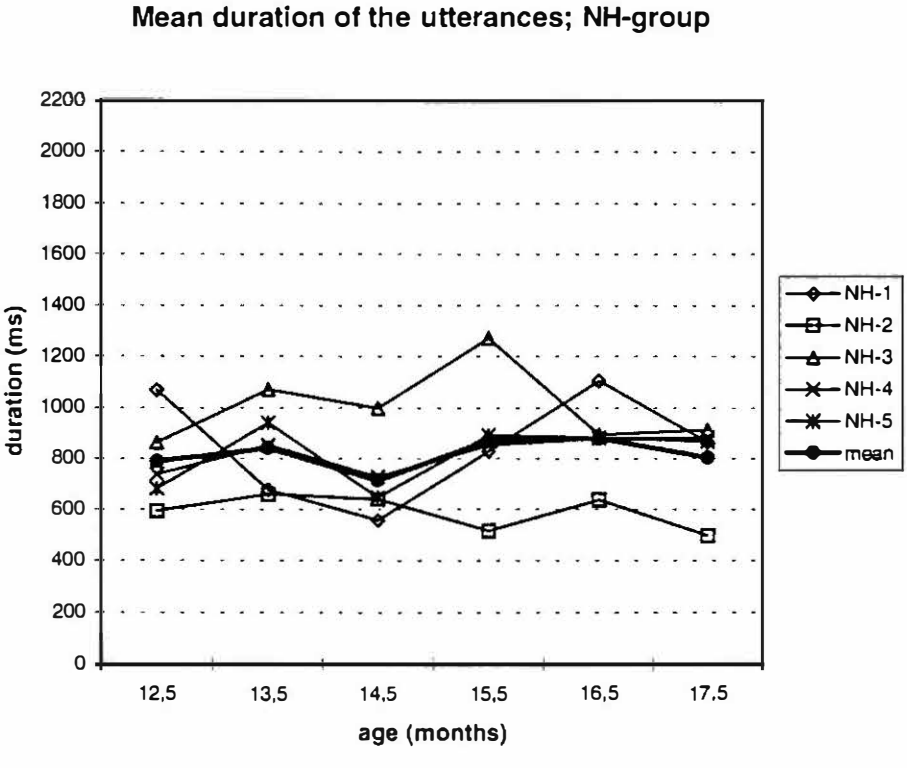

Figure 2b. Mean duration of 50 randomly selected spoken utterances of the normally hearing (NH) group in every monthly recording.

When comparing the results of the HI group with those of the NH group it can be seen that the mean duration of the utterances of the hearing impaired children is longer than for the normally hearing children (HI mean = 1092 and sd = 305, NH mean = 817 and sd = 184). This is a significant difference between the two groups ($p < 0.01$ and $t = 4.22$, $df = 58$). As a group, it seems that they roughly follow the same pattern in the duration of their utterances in this period.

5 Discussion

In this study it was observed that from 12.5 until 17.5 months of age hearing impaired children produce more utterances than normally hearing children. But this difference is not significant.

The results of this study so far agree with the results of Spencer (1993), who also found that there was no significant difference in the number of (communicative) vocalizations between hearing impaired and normally hearing children.

In a study of Clement et al. (1995), who studied the utterances of the same deaf and hearing children as in this study from 2.5 until 7.5 months of age, it was found that the HI children produced significantly more spoken utterances than the NH children. They also found a significantly higher production of spoken utterances for the HI group at the age period from 5.5 until 9.5 months (Clement et al., 1994). According to the present study there is no significant difference in the production of spoken utterances of deaf and hearing children from 12.5 until 17.5 months of age.

It can be concluded that there is no clear decrease in the production of spoken utterances of deaf children after their first year of life or at least until 17.5 months of age. The suggestion of e.g. Maskarinec et al. (1981) that there is a decrease in the production of spoken utterances by deaf children after the first year of life can not be confirmed by this study, at least in so far as utterances are considered quantitatively.

The duration of the spoken utterances in this period is significantly longer for the hearing impaired children than for the normally hearing children. The results agree with results of Clement et al. (1996) and Ryalls & Larouche (1992) who also found that the duration of the utterances of deaf children were somewhat longer in duration than those of hearing children. In the study of Clement et al. (1996), who studied the utterances of the same deaf and hearing children as we did in the present study, they found a mean duration of 940 ms for the HI children and 915 ms for the NH children from 2.5 until 11.5 months of age. In the present study a mean duration of 1092 ms was found for the HI children and 817 ms for the NH children. According to these results it seems that the HI children produced longer utterances after the age of 11.5 months, while the NH children have a decrease in their utterance duration after that age.

This difference in utterance duration can be influenced by several factors. One factor is that the hearing impaired children in this period from 12.5 until 17.5 months of age produced long series of simple sounds and some of them produced babbles while all normally hearing children started spoken word production. It might be that the first words of the normally hearing children have a shorter duration than the utterances produced by the hearing impaired children.

It is important to realize that the present results give no information yet about the quality of the utterances of the children. For instance, a child who produces few

utterances and utterances with a short duration can produce qualitatively very difficult utterances and vice versa. E.g., child HI-3 has an enormous increase in his production of spoken utterances from 14.5 months onwards. There is also an increase in the duration. But the quality of the utterances is very simple. This will be subject to analysis in the near future.

Interesting to note is that in this period only two of the hearing impaired children produced babbles. Child HI-2 started to produce babbles from the age of 7.5 months onwards (Clement et al., 1994), and child HI-1 at the age of 17.5 months. For none of the other hearing impaired children babbles were found in the period studied. It is not known yet whether they start babbling after this age. These results are in contrast with results from e.g. Oller and Eilers (1988) who found babbles after the age of eleven months and Spencer (1993) who found hearing impaired children producing babbles at the age of 12 and 18 months old.

6 Conclusion

A preliminary conclusion of the present study is that until 17.5 months of age there is no signifant difference in the number of spoken utterances between hearing impaired and normally hearing children. But hearing impaired children do produce significantly longer spoken utterances than matched normally hearing children. The number of spoken utterances does not decrease after the first year of life as is mentioned in the literature. Because these are preliminary results no further conclusions will be drawn. These will be given in the near future.

7 Acknowledgments

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8 References

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