

FROM PRELEXICAL TO LEXICAL IN THE SPOKEN UTTERANCES OF DEAF CHILDREN

A design for research

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Abstract

This paper concerns a research design for the Ph.D.-project titled 'From prelexical to lexical in the spoken utterances of deaf children' which has just started in 1996. Some general research questions will be mentioned as well as the methods that we intend to use. The various aspects of the speech development which will be studied are separately described together with some relevant literature. Specific questions for research are formulated and ways are indicated to analyze them.

1 Introduction

In the literature about early speech development there is a growing interest in the prelexical period and the transition to the lexical period. The role of more or less adequately functioning audition in this development is an important aspect as well.

A hearing-impairment leads to several difficulties for the acquisition of spoken language. The language experience of hearing-impaired children is qualitatively and quantitatively different from that of hearing children. Also the interaction between hearing mothers and their deaf children probably proceeds less smoothly than with hearing children (Gallaway & Woll, 1994). The problems in the communication between hearing parents and deaf children have their influence on more aspects than only the child's language development. Also the coordination and timing of interactions is influenced. Parents responding adequately to their hearing child, facilitate the child's transition to the next phase of the development. But hearing parents of deaf children may continue to rely largely on vocalizations that are inaccessible to the deaf child. Without compensatory use of other modalities to stimulate the visual attention of the child, these vocal responses of the parents are ineffective in deaf children. For these children the visual and tactile channels are very important (Koester, 1994). During the preverbal period mothers of deaf children use more the tactile and kinesthetic channels for gaining and holding the attention of their child rather than well-known child-directed-speech characteristics such as shorter utterances (Gallaway & Woll, 1994).

Another important aspect in the communication with deaf children is eye-contact. Koester (1994) reports that in general eye-contact allows the child to regulate the amount of stimuli which is addressed to him. If there are too many stimuli, the child can close his eyes or turn his head away. The contact with the interaction partner is maintained by the auditive channel. For a deaf child the visual contact is crucial in the

communication. A deaf child cannot break eye-contact because of the risk of ending the interaction, except when there is also tactile contact (Koester, 1994).

It is clear that this will have implications for the development of language. As Gallaway & Woll (1994) mentioned, a prerequisite for the acquisition of a linguistic system is the recognition that words refer to objects and events in the world. The acquisition of this awareness is more difficult for deaf children because they cannot visually explore the world while simultaneously receiving the language that refers to it (Gallaway & Woll, 1994). For a deaf child the visual attention to an object or a person and communication about that object or person typically occurs in a sequential rather than a parallel order (Koester, 1994). As a result, there are already early in the speech development differences between hearing and deaf children.

Several researchers reported that deaf children do start babbling, but much later (after their first year of age) than normal hearing children. Van der Stelt & Koopmans-van Beinum (1986) reported that normally hearing children started to babble at a mean age of 7 months. Oller & Eilers (1988) also found normally hearing children already producing babbles at an average age of about 7 months, while hearing impaired children started babbling between the age of 11 and 25 months. Spencer (1993) reported that at 12 and 18 months of age normally hearing children produced more vocalizations with canonical syllables than deaf children. For both groups of children this increases with age.

Also the quality of the utterances seems to differ 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) found, from 8-15 months of age, clear qualitative differences in the utterances of a deaf boy and his normally hearing twin brother. Oller et al. (1985) also found differences in the utterances of hearing impaired and normally hearing children between 8-13 months of age. All these studies point into the direction that the auditive perception really has an influence on the production of speech already in the first year of life. Research of Clement et al. (1994, 1995) has partially confirmed these findings from the literature and partially disproved some of them. In her Ph.D.-project named 'Development of early vocalizations of severely hearing-impaired infants' Clement, studies the vocalizations of six deaf children from 2.5 months until 11.5 months of age. These vocalizations are compared with those of hearing children.

An important question is how the transition from the prelexical stage to the lexical stage develops within these children. In the literature there are some studies about this topic, but sometimes results are just in contrast with each other. For instance about the articulation of the children, Stoel-Gammon (1988) reported differences between deaf and hearing children of 4-18 months old, while Smith (1988) found no differences until about 12-15 months of age. He reported differences between deaf and hearing children 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 project is a follow-up of the study of Clement and investigates 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 matched normally hearing children.

General questions for our research project are: Does the speech development of young deaf children follow the same course as the speech development of hearing children but is it only delayed, or is there a deviant speech development? Which similarities and differences can be found in the speech development of deaf and hearing children? What is the role of residual hearing on the speech development?

2 Subjects and recordings

Twelve mother-child pairs participated in the above mentioned study of Clement. Of these twelve pairs, 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 normal hearing group (group NH). No clear health problems were found. 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).

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.

3 Methods of analysis

From each of the audio-recordings a 10-minutes period will be 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. Most analyses will be made of 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 will be digitized with a sample frequency of 48 kHz and stored for further analysis.

The audio-track of the video-recording at 24 months will be analyzed in the same way as the audio-recordings and will be used in combination with the video-track for information about the production of words (signed and spoken).

The other video-recordings will only be used if the results of the analyses of the audio-recordings give rise to specific questions about e.g. the development. In general they will serve as a supplement to the results of the audio-recordings.

A perception-experiment will be done to find an answer to the question whether listeners are able to identify deaf and hearing children on the basis of their spoken utterances. And if so, on the basis of what characteristics of the speech and at what age. Probably this will give information about which aspects of the spoken utterances are important to distinguish deaf from hearing children.

4 Aspects of the utterances to be studied

On the basis of these recordings the following aspects of the speech of the children will be studied:

4.1 Number of utterances

In the related study of Clement et al. (1994, 1995) it was found that from 2.5 until 9.5 months the children of the group HI produced more utterances than the children of the group NH.

Two other studies reported about the number of utterances of HI children compared with NH children. Oller et al. (1985) found in a longitudinal study of one deaf child compared with eleven hearing children that there was no decrease in the number of vocalizations of deaf and hearing children from 8-13 months. Spencer (1993) reported about a longitudinal study of several moderate-to-profoundly hearing impaired children, 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.

According to Oller and Spencer there is no decrease in the number of vocalizations of deaf and hearing children until 18 months. They both produce roughly the same number of vocalizations. According to Clement, hearing impaired children produce more utterances than normally hearing children at least until 9.5 months of age.

The question in our study is whether there is a decrease in the number of utterances of deaf and hearing children in the second year of life and whether there is a difference between deaf and hearing children in this respect.

This will be analyzed by counting the number of utterances of each child in the 10 minutes period of each recording.

4.2 Duration of the utterances

Some researchers reported about differences in the duration of the utterances between deaf and hearing children. Results of these studies indicate that the duration of the utterances of the deaf children are slightly longer than those of hearing children, but these differences are not significant. For instance, Ryalls & Larouche (1992) found in a cross-sectional study of imitated speech of ten moderate-to-severely hearing impaired children of about 6-10 years old, that the HI group had a slightly longer duration of the utterances than the NH group. But this difference was not significant. Also Clement et al. (1996) found a longer duration of the utterances of deaf children of 2.5 - 11.5 months old, but this too was not significant.

Our research question is whether there is a difference in the duration of the utterances between deaf and hearing children in the period from about 12 months onwards, or no significant difference.

This will be analyzed by measuring the duration of the utterances of the children.

4.3 Type of phonation and articulation

Until now almost no literature has been found about the type of phonation and type of articulation in the utterances of deaf children. Only Clement et al. (1994, 1995) reported that deaf children until 9.5 months produce mainly utterances with variation in phonation, while hearing children of that age vary more in articulation. The development of phonation and articulation after the age of 9.5 months is still unclear at this moment.

The remaining question is which type of utterances deaf children produce from about 12 months onwards and whether there is a difference with hearing children.

To answer these questions, the utterances of the children will be classified into possible types of phonation and articulation, based on an earlier study on infant speech development of Koopmans-van Beinum & Van der Stelt (1986). The following five types of phonation and three types of articulation are possible in this classification (Clement et al. 1994, 1995):

Phonation:

1. uninterrupted phonation
2. interrupted phonation
3. variegated phonation (variation in intonation, pitch, loudness etc.) with uninterrupted phonation
4. combination of interrupted and variegated phonation
5. no phonation

Articulation:

1. no articulatory movement
2. one articulatory movement
3. two or more articulatory movements during two or more syllables (= babbling)

4.4 Articulation characteristics

Place of articulation

According to Stoel-Gammon (1988) severe-to-profoundly hearing impaired children of 4-18 months old produce more front than back sounds. In a study of Clement et al. (1995) deaf children until 7 months of age produce more back than front sounds. Examining the number of voiceless utterances, Clement et al. (1996) found that deaf children between 2.5 until 11.5 months of age produce more voiceless utterances than hearing children of the same age do. These utterances concern mainly velar fricative or trill sounds. This could imply that deaf children still produce more back sounds until they are about 12 months old. Smith (1982) reported that until about 12 to 15 months of age the pattern of consonant productions appear quite similar among hearing-impaired and normal hearing children. Until this age both groups of children produce mostly back and central consonants. From about 15-18 months of age until about 3.5 years front sounds dominate the consonant productions of deaf children, according to the study of Smith.

Our research question here is whether there can be found a transition from back to front articulation by deaf children in the period from 12 months onwards or whether they still continue producing back sounds like they did until 12 months of age. And, is there an influence of a visual component? In other words, do deaf children produce more articulations which are well visible than hearing children do?

This will be analyzed by classifying the articulations in the selected utterances of the children into the categories front, central, and back.

Manner of articulation

Several researchers (Clement et al., 1995, 1996; Stoel-Gammon & Otomo, 1986; Stoel-Gammon, 1988) found that deaf children produce more fricative or trill sounds than stop sounds. This difference would increase with age. According to Stoel-Gammon & Otomo (1986) and Stoel-Gammon (1988) deaf children produce less different types of utterances than hearing children do. The number of different types of consonant-like sounds first decreases and then remains constant or slightly increases until approximately 18 months.

Our research question here is how the manner of articulation develops within deaf children from about 12 months onwards. And, is there an influence of a tactile component? In other words, do deaf children prefer sounds with a tactile component because these are better to control for them?

The manner of articulation will be analyzed by classifying the articulations in the utterances into the categories fricative, trill, stop, nasal, glide, and lateral.

4.5 Syllables

Number

Almost no literature has been found yet about the number of syllables in the utterances of deaf children. Only Clement et al. (1994) reported that in the first months of life deaf as well as hearing children both produce utterances with a few syllables. When age increases (5.5 -9.5 months) deaf children produce utterances with one syllable or with 4 or more syllables, while hearing children produce utterances with 2 or 3 syllables. Important to know here is that a syllable does not need to have an articulatory movement. Thus an utterance with two or more syllables does not necessarily have to be a canonical babble, but may exist of "glottal" babbling, i.e. utterances with interrupted phonation, without articulations.

The research question here is how the number of syllables in the utterances of deaf children develop in the period between 1-3 years of age.

This will be analyzed by counting the number of syllables in the utterances of the children.

Structure

A number of researchers reported about the syllable structure of utterances of deaf children compared with hearing children. Kent et al. (1987) compared a profoundly hearing impaired boy and his hearing twin brother from 8-24 months old. They found that the hearing impaired child had less different syllable structures in his utterances than the hearing boy. Oller et al. (1985) found that their HI child produced no repetitive canonical babbles and only two canonical syllables between 8 and 13 months old, while the hearing children produced already repetitive canonical babbles at the age of 10 months and started with canonical babbling at the age of about 7-8 months. A study of Spencer (1993) reported that NH children at 12 and 18 months of age produced significantly more vocalizations with canonical syllables than HI children of the same age and that the production of canonical syllables increased with age for both hearing impaired and normal hearing children. Stoel-Gammon and Otomo (1986) found that 5-18 months old hearing children produced more multisyllabic CV-utterances than HI children of the same age.

In the above mentioned literature all hearing-impaired children started to produce canonical syllables and babbles. In the study of Clement et al. (1994) only one of the three hearing-impaired children studied so far started to babble at the same time as hearing children do. The other hearing-impaired children did not start babbling in the period studied. Whether they start babbling after this age is not known yet.

Our first question to be answered here is whether deaf children do start producing babbles. If they do not, than probably their syllable structure will remain simple. The second question is which syllable structures are used by deaf children and how these structures develop with age.

This will be analyzed by describing the syllable structure of the utterances of the children in terms of V (vowel-like) and C (consonant-like).

4.6 Fundamental frequency

Various researchers reported higher mean and peak F_0 -values for deaf children than for hearing children. Clement et al. (1996) found significantly higher mean and peak F_0 -values in the period of 9.5 until 11.5 months of age. Kent et al. (1987) reported higher mean and peak F_0 -values until 15 months of age, but they did not mention

whether this was significant. Also Ryalls & Larouche (1992) found higher mean and peak F_0 -values with children aged about 6-10 years old, but this was not significant.

Our research question here is whether deaf children really have higher mean and peak- F_0 values and a larger range in F_0 -values in their utterances than hearing children.

This will be analyzed by measuring the mean, highest, and lowest F_0 -values of the utterances of the children. The deviant phonation of young children compared to adults will cause specific problems with F_0 measurements. F_0 measurements will be performed with an autocorrelation algorithm (Boersma, 1993) as mentioned by Clement (1996).

4.7 Formant frequencies

According to the literature there is a difference in the formant values of deaf and hearing children already early in the speech development of the children. Kent et al. (1987) found a normal vowel triangle for the hearing child in the period between 8 and 15 months of age and a normal gradual decrease of the F_1 - F_2 region. For the deaf child they found at 8 months a large F_1 - F_2 region (larger than for the hearing child) and at 15 months a very small region (smaller than for the hearing child). At 15 months there were no F_2 -values found above 3000 Hz. At all three ages (8, 12 and 15 months) they found a different F_1 - F_2 region for the deaf child compared with that of the hearing child. Oller et al. (1985) reported for the hearing children less 'Quasi-resonants' and more 'Fully-resonants' with an increase of age (which resembles adult speech which has mainly 'Fully-resonants'). The deaf child showed no increase of the Fully-resonants but a decrease.

Different results were reported by Ryalls & Larouche (1992). They did not find significant differences for deaf and hearing children of 6-10 years of age.

Our research question here is whether deaf children in the period from about 12 months onwards still have different vowel formant values compared to hearing children or whether these values are not significantly different when the age of the children increases.

This will be analyzed by measuring the average values of the three formants F_1 , F_2 and F_3 in the vowel-like sounds of the utterances of the children. Methods to be used here will be considered carefully because of problems to be expected in measuring high-voiced frequencies.

4.8 Intonation pattern

Clement et al. (1996) as well as Kent et al. (1987) found differences in the variation of F_0 within an utterance. Clement et al. (1996) reported that deaf children between 2.5 until 11.5 month of age had more variation of F_0 within an utterance than hearing children of the same age. Kent et al. (1987) found the same for deaf children at 8, 12, and 15 months of age. Deaf children would have a larger variation in F_0 within an utterance, at least until 15 months old. This could point into the direction that deaf children have intonation patterns different from those of hearing children. Monsen (1979), in a cross-sectional study of 24 severe-to-profoundly hearing impaired children and 6 normally hearing children aged 3;6 - 6;3 years old, found that hearing children as well as hearing impaired children vary F_0 within an utterance, but that this variation in F_0 is not a specific feature by which hearing and deaf children can be distinguished.

Our research question here is whether there is indeed a different intonation pattern in the utterances of deaf children from about 12 months onwards. If there is a difference, which intonation patterns are used by deaf children and what can be said about the development.

This will be analyzed by measuring the intonation contour of the utterances of the children. The intonation contour has to be classified into a number of categories (e.g. flat, falling, rising, or a combination).

4.9 Production of spoken words

Number of words

Not much literature has been found yet about the number of words in the speech of deaf children. Only Spencer (1993) mentioned that most HI children of 12 and 18 months of age produced mainly prelexical utterances and less than 8 one-word utterances (spoken or signed) in 10 minutes. Only a few HI children produced more than 8 one-word utterances, but they had no or almost no multiword utterances.

It is clear that deaf children do produce some spoken words. The question is how many words these children produce and whether there is a developmental course in the production of spoken words. Also a question of interest is which influence residual hearing has.

For analyzing this, we will count the number of spoken words in the 10-minutes period. If there are no spoken words found in this period, then the remaining part of the recording will be inspected to see if there are any spoken words produced. For this analysis also the audio-track of the video-recording at 24 months will be used. A 10-minutes period will be selected from this recording in the same way as for the audio-recordings. We will also count the number of spoken words in this period.

Type of words

This aspect concerns word classes like function words, content words, and Phonetically Consistent Forms (PCFs).

PCFs were described by Dore et al. (1976) and are considered to be intermediate between prelexical babbling and the production of early words. Gilles et al. (1986) characterizes PCFs as clusters of consistent sounds which exhibit a functional content. According to them, the following course can be found in the development: first the child acquires an initial set of PCFs. Then a sort of plateau-stage occurs, in which the child does not acquire any new PCFs. During this stage the child's use of PCFs is decontextualized. Finally there is an considerable increase in the acquisition of PCFs.

Another study about word classes in the speech of deaf children is that of Brannon (1968), who reported about a cross-sectional study on the linguistic word classes in the spoken language of normal hearing, hard-of-hearing, and deaf children with a mean age of 12.6 years (range from 8.7 until 18.5 years). He found that hard-of-hearing and deaf children used less adverbs (content words), auxiliaries, and pronouns (function words) and overused nouns (content words) and articles (function words) in contrast with normal hearing children. Deaf children, compared to hard-of-hearing children, seemed to underuse prepositions, quantifiers, and indefinites (function words).

Our research question here is which types of spoken words deaf children produce in the period from 12 months onwards. Is there a difference with hearing children and what can be said about the development.

This will be analyzed by classifying the produced words of the children into various categories (e.g. content words, function words, and PCFs).

4.10 Production of signs

It is clear that deaf children will start producing signs. Several researchers reported about the production of signs by deaf as well as by hearing children (see e.g. Volterra & Erting, 1990).

In our study we will make an analysis of the video-track of the video-recording at 24 months of the deaf and hearing children. Our first research question is how many signs deaf children produce in comparison with hearing children at 24 months of age. The second question is which types of signs deaf children produce at 24 months of age and whether there is a difference with hearing children. The third question concerns the total production of words (spoken and signed), namely which differences and similarities can be found in the production of words (spoken and signed) between deaf and hearing children at 24 months of age.

For analyzing this, we will count the number of signs and gesticulations in the 10-minutes period of the video-recordings at 24 months and classify them in the same way as the spoken words (e.g. content words, function words, and PCFs).

5 Results

Because this project just started, no results can be given about these aspects of the utterances. At this moment we are working on transcribing the recordings and digitizing the utterances. At the same time we are counting the number of utterances and measuring the length of them. Results will be given in the near future.

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