Phonological assessment of eleven prelingually deaf children’s consonant

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PHONOLOGICAL ASSESSMENT OF ELEVEN PRELINGUALLY DEAF CHILDREN'S CONSONANT PRODUCTION*

Anne-Marie Öster

Abstract

The present study describes what the speech of eleven prelingually deaf children express through a phonological assessment of the speech sounds that the children articulate correctly. All children were educated by sign-language. The children's speech was video-recorded and given a narrow phonetic transcription. The phonetic inventory of consonants used by the children in initial, medial, and final word positions was established. The intention was to form an opinion of average phonetic and phonological competence of a group of prelingually, profoundly deaf children, with pure tone averages between 90-108 dB at 0.5, 1, and 2 kHz. Analyses were made to establish the amount and the type of deviations that occurred in spoken language for the speech sounds that the children could articulate correctly at least once in the collected speech material. Hence, only consonants for which the children had productive knowledge were phonologically assessed to eliminate articulatory disorders.

INTRODUCTION

Sign language is the accepted communication language in schools for the deaf in Sweden. Swedish is primarily learnt, as a second language, in its written form. Speech training, based on the children's individual possibilities, is given in special clinics only for about 40 minutes a week. This being the case, speech training primarily implies that prelingually deaf children might develop intelligible speech for the purpose of making statements (survival speech) and more seldom for the purpose of communication. Since some years, the Hearing Technology Group has been working in a joint project together with the School for the Deaf in Stockholm. The aim has been to develop more efficient, individualized speech-training methods.

Prelingually deaf children do not acquire speech spontaneously. They have to learn to speak mainly through visual information, and they have to rely primarily on orosensory motor-control and possible residual hearing to control speech movements. Since the deaf child does not have a complete speech target to imitate, his speech will often be characterized by many deviations.

Phonetics and phonology

Deaf children's speech has been studied a great deal but these studies have mostly been descriptive and qualitative in nature. However, speech can be described on two levels: the phonetic and the phonological. A phonetic description can be made more or less detailed and it shows how the sounds are produced (articulatory phonetics) or what the acoustical signal looks like (acoustical phonetics). A phonetic description does not have to pay attention to a specific language. The aim of a phonological assessment, on the other hand, is to investigate which phonetic elements (phonological contrasts) are used to achieve contrast of meaning in a specific language.

Phonetic analysis and phonological assessment of deaf speech

Within a speech-training program, it is necessary to continuously assess the children's speech to find those deviations which need to be corrected. Many assessment procedures have been constructed over the years (Ling, 1976). However, these procedures are often based on traditional phon-

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ngetic analyses which describe the quality of a child's production compared to the production of normally hearing persons, without any reference to the contrastive function of the production in spoken language. The conventional error-analysis may, therefore, often provide misleading information. Distortions, substitutions, and omissions are listed that show what the child is not capable of articulating while the sounds that the child articulates correctly often are disregarded. However, it has been shown that even if a child knows how to articulate a sound correctly, this does not imply that the usage is correct in his spoken language.

A deviant production may, on the other hand, be an attempt to realize a speech-sound contrast (Monsen, 1976). This was also shown by Öster (1989a). In that study, a child made systematical deviations from normal when he produced Swedish stops. A deviant contrast was found in initial position between voiced and unvoiced bilabial stops and in final position between voiced and unvoiced dental and velar stops. The child contrasted unvoiced stops from their voiced cognates in initial position by lip protrusion and in final position by adding a neutral vowel instead of a voicing contrast.

It is, therefore, very important that a phonetic analysis is supplemented by a phonological assessment of the phonemes for which a child has productive knowledge to define what the speech does express (Saben & Ingham, 1991). Such an assessment determines if the speaker uses the same kind of distinctive features that is used in normal speech. A more complete assessment, however, would investigate the deviant contrasts to determine if they are systematic, and if so, to determine the way they differ from normal. To be able to assess deviant speech phonologically, the assessment must be based on a detailed phonetic transcription in different word positions. Otherwise it is possible that articulatory important elements, that the speaker uses to realize a phonological contrast, will be ignored.

Obviously, it is important that the speech-therapist is aware of which level, phonetic or phonological, he or she is working on. If an assessment shows that the child understands a phonological contrast but has difficulties realizing it correctly, the training can be concentrated on articulatory training. However, the child must first be made aware of his deviant way of expressing this contrast in different contexts. If, on the other hand, the assessment shows that the child does not understand a phonological contrast, this contrast must be learned simultaneously with articulatory training of how to realize it.

If training is made without awareness of a child's phonological system, this may destroy already established couplings between the abstract linguistical level and articulation. The result may then be that the child's phonological system will collapse and the intelligibility will decrease.

Phonological rules in the speech of the deaf
A number of studies about the phonology of deaf speech (Dodd, 1974; 1976; Oller & Eilers, 1981; Oller & Kelly, 1974; West & Weber, 1973; Öster, 1989a) have shown that prelingually deaf children can develop a stable and systematic phonological system through the information available from vision and the fragmentary auditory signal. However, these systems will differ in some respects to those of normally hearing children. Insufficient knowledge about pronunciation rules may also result in typical and systematical deviations.

Many of the omissions, insertions, or substitutions that normally hearing children produce to simplify the pronunciation can also be found in prelinguually deaf children's speech. Normally hearing children produce these simplifications during a short period of their development. However, prelingually deaf children often preserve these deviations together with other deviant processes that are due to the special condition, under which they learn to speak (Dodd, 1974; Oller & Kelly, 1974). It is important to find the deviations that differ from normal development since it can provide valuable pedagogical information in a speech-training programme.

Aim of the study
The aim of the present study was to get a general view of the average phonetic and phonological competence of a group of prelingually deaf children. This group can be seen as representative of a
typical child from a deaf school in Sweden of today. The intention was to illustrate the importance of a phonological assessment based on a detailed phonetic analysis. Assessments were made to establish which speech sounds most of the children could articulate correctly at least once in the collected speech-material, without any reference to their contrastive function in language. Through a phonological assessment, it was then possible to establish which of these sounds were used correctly in initial, medial, and final position in their spoken language and which systematical deviations that occurred.

MATERIAL AND METHODS

Subjects and evaluation of the intelligibility of the children's speech

Eleven prelingually deaf children, educated by sign-language, participated in the study. One child was eleven years of age, while the others ranged from fifteen to seventeen years. Their pure-tone averages were between 90-108 dB in the better ear at 0.5, 1, and 2 kHz. Age, sex, and auditory data are given in Table I.

<table>
<thead>
<tr>
<th>Child</th>
<th>Age</th>
<th>Sex</th>
<th>Hearing loss, dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>F</td>
<td>70  80  85  90  95  95  90  89</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>F</td>
<td>30  40  75  100 100 110 92  85</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>F</td>
<td>60  65  80  100 105 95  95  89</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>F</td>
<td>75  75  90  95  95  95  92  89</td>
</tr>
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<td>5</td>
<td>16</td>
<td>F</td>
<td>75  85  90  100 95  100 95  94</td>
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<td>8</td>
<td>16</td>
<td>M</td>
<td>75  85  95  105 110 115 103 102</td>
</tr>
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<td>9</td>
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<td>11</td>
<td>17</td>
<td>M</td>
<td>70  75  90  120 120 120 108 105</td>
</tr>
</tbody>
</table>

Table I. Age, sex, and hearing loss in the better ear for the eleven subjects in the study.

The intelligibility of their speech varied from very poor to very good. The intelligibility was evaluated through listening-tests, consisting of simple questions read by the children and recorded on audio-tape. The questions were so-called Helen-questions (Ewertsen, 1973) of the type "What colour is a lemon? How many legs does a cow have?" which can be answered with one word only. Five different questions read by each child were presented via head-phones at a comfortable level to 24 normally hearing listeners; 16 inexperienced, and eight experienced in listening to deaf children's speech. The listener's task was to answer the question with one word.

Figure 1. shows the percentage of correctly understood questions for each child averaged across all listeners, based on 120 responses. The average result for all speakers was 59% for all listeners: 54% for inexperienced and 65% for experienced listeners. Three of the children's speech were unintelligible (the listeners understood only 7-34% of their questions). Five of the children had semi-intelligible speech (57-79% of their questions were understood). Three children had intelligible speech (81-98% of their questions were understood). This shows that some prelingually deaf children are able to develop intelligible speech.

Speech material and procedures for the phonetic transcription

The children were video-recorded while they read a list of familiar words also illustrated by pictures. The word-list contained at least two presentations of all Swedish consonants in initial, medial, and final position, if phonotactically possible. A narrow phonetic transcription was made from the videorecorded speech using IPA symbols and some additional diacritics developed to transcribe babbling or early infant productions (Bush & al., 1973; Grunwell, 1987; Roug, Landberg, & Lundberg, 1987). A phonetic inventory of segments in different word positions was established.
RESULT AND DISCUSSION

Phonetic analysis

Figure 2 shows the number of children who, at least once in the material, articulated each Swedish consonant correctly regardless of position and without any reference to contrastive function. Each consonant occurred at least six times, if phonotactically possible. The children, as a group, articulated 70% of the Swedish consonants correctly. From these data, it is obvious how deaf speaker's pronunciation is influenced by the visibility of the consonant articulation. The consonants which most of the children articulated correctly were those that are visually contrastive and easy to lip-read, such as bilabial and dental stops, labiodental fricatives, and the lateral consonant. The children also produced the unvoiced stops /p, t, k/ much better than the voiced stops /b, d, g/.

Fig. 2. Correctly articulated consonants by eleven prelingually deaf children. sj denotes /ʃ, ʒ, ɥ/ and tj /ç/.

Phonological assessment

Figure 3 shows the result of the phonological assessment, based on the phonetic analysis, versus the result of the phonetic analysis. Grey bars show the number of children who at least once, regardless
of position, articulated each consonant correctly. Black bars show the number of children who
made correct use of each consonant in initial, medial, and final word position. Only consonants for
which each child had productive knowledge were phonologically assessed. This was done to obtain
a clear distinction between articulatory disorders and articulatory deviations in realizing a
phonological contrast. The difference in heights between the two bars, representing each consonant
in Fig. 3, shows the number of children who showed a deviant pronunciation or inconsistent use or
absence of a consonant that they articulated correctly without any reference to contrastive function.
A large difference indicates that the consonant is difficult for deaf children to realize correctly in
this position.

Fig. 3. Grey bars show the number of children who articulated each consonant correctly at least once.
Black bars show the number of children, who made correct use of their articulation in initial,
medial, and final position in spoken language. sj denotes /ʃ/, ng /ŋ/ and tj /ʤ/.
The children, as a group, articulated 70% of the Swedish consonants correctly but they could only make correct use of 43% of them in initial position, 50% of them in medial position, and 50% in final position. This indicates a discrepancy between the children's phonetic and phonological competence.

Only a few consonants were controlled as well phonetically and phonologically as /t/ in initial position, /p/ and /m/ in medial position, and /θ/ in final position. Others varied in correct use according to word position. For example, five children could articulate /ʃ/ but none could use it in initial position, only three in medial position, and four in final position. Five of seven children were able to use /s/ correctly in initial position, five of seven in medial position, and four of seven in final position. None of the four children who articulated /v/ correctly used it in initial position. However, three of the children used /v/ correctly in medial and final positions. In general, some of the consonants /j, d, k, b/ were equally difficult to use in all positions.

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>MEDIAL</th>
<th>FINAL</th>
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<tbody>
<tr>
<td>p</td>
<td>b, b, m</td>
<td>ʰp</td>
</tr>
<tr>
<td>b</td>
<td>b, p</td>
<td>b</td>
</tr>
<tr>
<td>m</td>
<td>b, ʰb</td>
<td>ⁿb, b</td>
</tr>
<tr>
<td>f</td>
<td>v, vˣ</td>
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<td>v</td>
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<td>t</td>
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<td>n</td>
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<td>l, ʰl</td>
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</tr>
<tr>
<td>s</td>
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<td>k, t, ɾ, ɾ, t</td>
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<tr>
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<td>ɾj</td>
</tr>
<tr>
<td>h</td>
<td>N/A, ɾn</td>
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</tr>
</tbody>
</table>

Table II. Deviations made in various positions for the speech sounds that the children could articulate at least once in the speech material. N/A = not applicable in this position. For an explanation of the diacritics, see Bush & al. (1973), Grunwell (1987), and Roug & al. (1987).
The deviant pronunciations in some positions made by the children who could not make correct use of their articulation in spoken language are shown in Table 11. By studying the table closely, it is possible to determine whether a deviant pronunciation might, in fact, be an attempt to express a phonological contrast. In this study, it is difficult to say something about individual data but probably some of the deviant phone types represent different phonemes despite the phonetic similarity. For example, it can be assumed, despite the phonetic similarity to [b], that some child made contrasts between /p/, /b/, and /m/ in initial position through lip-protrusion ([b] for /p/), devoicing ([b] for /b/), and voicing ([b] for /m/). Another child made perhaps a contrast between /t/, /d/, and /n/ in final position, despite the phonetic similarity to [d], through a non-audible release ([d̪] for /t/), devoicing ([d̪] for /d/) and through nasal air emission ([n̪] for /n/).

Insufficient knowledge about pronunciation rules might in some cases explain the deviations made, for example /s/ and /ʃ/. In Swedish /s/ can be spelled as tj, kj, k, or ch and /ʃ/ can be spelled as sk, sch, sj, skj, stj, and ch. The fact that two, and sometimes three, graphemes are pronounced as one sound is probably not obvious to some children.

**CONCLUSIONS**

The aim of the present study was to investigate what the speech of a group of prelingually deaf children did express. Information was provided of the amount and type of correctly articulated consonants and their usage in spoken language. The children as a group articulated correctly 70% of the Swedish consonants but made correct use of only 43% of them in initial position, 50% in medial position, and 50% in final position. These data were possible to derive through a phonological assessment of a narrow phonetic analysis of each child's consonant production.

Traditionally, assessments of deaf speech provide information about what a deaf child not is capable of articulating. Hence, only the speech sounds that the child never articulates correctly are treated in the speech-clinic. It is then taken for granted that the speech sounds that the child articulates correctly also are used correctly in spoken language. However, one of the two conclusions of this study is that even if a child knows how to articulate a consonant, he/she does not necessarily know, how to use it. Figure 3 shows that several children, who articulated a consonant correctly, pronounced it deviantly in some position, used it for another consonant, or omitted it completely in the spoken language. Without a phonological assessment of the children's productive knowledge, this fact had never been revealed.

The second conclusion of this study is that a deviant production, in fact, may be an attempt to realize a phonological contrast. For example, if one child actually contrasted between /t/, /d/, and /n/ in final position despite the phonetic similarity to [d], through a non-audible release ([d̪] for /t/), devoicing ([d̪] for /d/) and through nasal air emission ([n̪] for /n/), this had never been derived without the phonological assessment. The result of a traditional error-analysis had been that the child was missing /t/ and /n/ in his phonetic repertoire, and the articulatory training of, for example, /t/ might instead destroy the child's phonological system.

In order to increase the intelligibility of the speech, the training programme must simultaneously deal with all three contrasting consonants. The training should first be directed towards making the deaf child aware of his deviant way in expressing contrasts between /t/, /d/, and /n/. Subsequently, correct articulation can be trained with the help of visual, tactile, and if possible auditorily feedback. Computer-based speech-training methods have shown to be promising in the development of contrastiveness in the prelingually deaf children's speech (Abberton, Hazan, & Fourcin, 1990; Öster, 1989b).

**ACKNOWLEDGMENTS**

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**REFERENCES**


