Strategies in Cleft Palate Speech—with Special Reference to Danish

BIRGIT HUTTERS, M.A.
KIRSTEN BRØNDSTED, M.A.

In the first part of this paper speech problems as a consequence of cleft palate are described in the light of three strategies: one passive and two active. In the passive strategy, the speaker does not attempt to reduce the inevitable consequences of insufficient velopharyngeal closure. In the active strategies, the speaker attempts to reduce these consequences by compensation or by camouflage. In the second part of the article the strategies are applied to classify the persisting speech problems in five Danish children with cleft palate (4 to 5 years of age) based on a phonetic transcription of their consonant production.

Both from clinical experience and from the literature, "cleft palate speech" appears to be clearly different from other forms of pathological speech (Bzoch et al, 1984; Edwards, 1980; Morley, 1970), even though the consequences of congenital cleft palate for communication are so varied that Morris (1979) states that "it is difficult if not downright impossible, to describe meaningfully 'cleft palate speech'" (p 193). For example, congenital cleft palate, even when surgically repaired, may impair not only velopharyngeal function but also the function of the tongue tip and blade which, for reasons as yet only partly explainable, may have reduced sensibility (Edwards, 1980) and discoordinated mobility (Fletcher, 1978; Shelton, 1979).

Dental and occlusal anatomical abnormalities also represent hazards to speech production for the cleft palate population, but in spite of comprehensive research on this subject, no clear conclusions as to cause and effect have been drawn (Starr, 1979). Fluctuating conductive hearing-impairment should also be mentioned as a probable cause of deviating sound production. Finally, it has been shown in several studies that congenital cleft palate may be accompanied by delayed language development (Fox et al, 1978; Clifford and Clifford, 1979; Pannbacker, 1975). The characteristics are mainly expressive in character and may include all aspects of language.

Ms. Hutters is Associate Professor at the Institute of Phonetics, University of Copenhagen in Copenhagen, Denmark. Ms Brøndsted is Speech Pathologist in the Cleft Palate Department at the Institute for Speech Disorders in Hellerup, Denmark.

This paper consists of two parts. In the first part, speech problems as a consequence of cleft palate are described in the light of speech strategies. The second part of the paper describes how articulatory characteristics arising from cleft palate interfere with normal consonant production in Danish, based on a detailed phonetic transcription of the spontaneous speech of five children. The speech characteristics of each child are then discussed in the light of strategies. Finally, some aspects of universal and language dependent characteristics in cleft palate speech are considered.

STRATEGIES IN CLEFT PALATE SPEECH

Speech characteristics associated with cleft palate relate primarily to insufficient velopharyngeal function, but discoordinated mobility because of reduced sensibility in the anterior part of the tongue is also considered. In the child with velopharyngeal insufficiency, the physiological conditions for speech production are abnormal, resulting in articulatory abnormalities. If the abnormal articulation is a consequence of insufficient velopharyngeal valve function only, with the glottal and supraglottal articulations being normal, the resulting abnormal speech is an unavoidable consequence of the abnormal physiological conditions in the vocal tract. The speaker does not attempt to reduce the unavoidable speech consequences induced by insufficient velopharyngeal closure. Thus, the attitude of the speaker may be considered passive in nature. This "laissez-faire" or passive attitude to the speech problems we call

the *passive strategy* in cleft palate speech. Contrarily, if the speaker attempts to reduce the unavoidable consequences of his or her handicap, abnormal speech production is at least in part the result of an active behavior. There are two techniques of reduction, the compensatory and the camouflage technique, and these may be considered as the *active strategies* in cleft palate speech. In the present description, the characteristics of cleft palate speech are classified according to strategy, and within each strategy they are systematized according to the type of speech sound to which the abnormal physiological conditions are applied.

The Passive Strategy

Some speech sounds need increased intraoral pressure (compared to the atmospheric pressure), and others do not. The first sound category comprises the obstruents, i.e., the stops and the fricatives ("pressure sounds"), and the other comprises the sonorants, i.e., the vowels and the other consonants ("non-pressure sounds"). The consequences of the passive strategy depend on the vocal tract configuration, i.e., on the type of speech sound to which it is applied. In the present description of these consequences, velopharyngeal insufficiency is presumed to prevent any considerable increase in the intraoral air pressure, while the glottal and supraglottal articulations are as in the target sound except for the velopharyngeal behavior. Thus, in principle, the passive strategy prevents production of true obstruents. Another general consequence of velopharyngeal insufficiency is nasalization of voiced sounds. Since nasal vowels and consonants in the target norm are not influenced by velopharyngeal insufficiency, these types of sounds do not need further comment. Thus, the following description includes oral sounds only.

Voiced Obstruents. Voiced *stops* are nasalized, i.e., they are realized as voiced nasal consonants. Voiced *fricatives* are not only nasalized but also realized with less friction, since the conditions for friction are substantially reduced by the combination of voicing and velopharyngeal insufficiency. In this context, Ohala (1975) should be mentioned because he questions the existence of friction noise in speech sounds categorized as nasal voiced fricatives.

Unvoiced Obstruents. Production of the obstruent categories unvoiced fricatives and aspirated stops presupposes a high rate of airflow. Such a high rate of airflow can only be generated with a relatively large glottal opening. Because of the high rate of airflow, nasal friction is easily created when the air leaks via the velopharyngeal port through the nasal airways. Thus, the *aspirated stops* will be realized as unvoiced nasal consonants with more or less nasal friction. The unvoiced *fricatives* are realized as a combination of oral and nasal friction, one of them being more dominant.

A special unvoiced obstruent category comprises *unaspirated stops* produced with a state of the vocal folds that results in voicing when the airflow passes between them. This is the case in Danish unvoiced, unaspirated stops (Hutters, 1985). When a blockage of the airflow is impossible in the individual with velopharyngeal leakage, the Danish unaspirated stops will be voiced with the passive strategy. Thus, the consequence of velopharyngeal insufficiency is that the Danish unaspirated stops are realized as nasal voiced sounds with oral closure, i.e., as voiced nasal consonants. The only means to devoice these stops is to abduct the vocal folds or to make a glottal closure. But then the strategy is no longer passive, since it presupposes that only the velopharyngeal articulation deviates from the normal articulation.

Sonorants. By definition sonorant consonants are voiced, and they are produced without any noticeable increase in the intraoral pressure. Thus, with sonorants the consequence of the velopharyngeal leakage is that they are realized as the nasalized counterpart to the normally produced sonorants (e.g., nasalized *l* and nasalized vowels).

Thus, characteristic features of the passive strategy are nasalization and nasal friction. In the present description it is supposed that any considerable increase in intraoral pressure is prevented by the leakage of air through the velopharynx. However, in practice the resistance to airflow may in fact be sufficient for production of consonants that are more similar to the intended obstruents than appears from the present description. The better pressure conditions may be due not only to a less open velopharyngeal passage but also to the anatomic physiologic conditions in the nasopharynx and in the nasal airway. These factors, of course, also influence the degree of nasalization. It should be added that the anatomic physiologic conditions may result in nasal snort instead of normal nasal friction.

The Active Strategies

There are two active strategies that cleft palate speakers may utilize in order to reduce the unavoidable consequences of the organic handicap. One strategy is to *compensate* for some or all of the obstruents normally produced at or in front of the velopharyngeal valve by making constrictions posterior to the valve. The place of articulation is changed to an area in the vocal tract where

obstruction of the airflow is possible, resulting in an increased intraoral pressure in spite of the velopharyngeal leakage. Thus, by definition, this compensatory strategy only applies to obstruents, i.e., to "pressure consonants." The other types of sounds are normally realized by means of the passive strategy. The compensatory sounds are primarily glottal stops and pharyngeal fricatives. However, pharyngeal stops have been observed in individuals with cleft palate (Trost, 1981; Lawrence and Philips, 1975; Philips and Kent, 1984). This finding is interesting, since it is assumed that many speakers with normal anatomic physiologic conditions in the vocal tract are not able to establish a pharyngeal closure, i.e., a closure between the posterior pharyngeal wall and the tongue root (Ladefoged, 1982). (This may explain why pharyngeal stops have not been registered as speech sounds.)

The other active strategy is to mask or *camouflage* the unavoidable consequences of the organic handicap by means of weak articulation—frequently including weak and breathy phonation—resulting in weak sound production. The strategy of camouflage can be applied to all types of speech sounds. One characteristic of this strategy is frequent use of [h] for obstruents, since [h] is a weak sound. Thus, the use of [h] should not be considered a consequence of the compensatory strategy, even though it is normally classified as a glottal sound.

In the light of the above mentioned strategies the realization of /s/ and other sibilant fricatives deserves a special note. These sounds are sometimes realized as a dental/alveolar "nasal fricative", i.e., an unvoiced nasal consonant with nasal friction. There may be two explanatory reasons for this realization. One is that the speaker wants to produce a more audible friction noise than can be created with the airflow passing the oral as well as the nasal cavities. If so, the strategy can be considered of the compensatory type, even if this change in articulation is better described as a change in manner, rather than in place of articulation, that is a nasal versus an oral fricative. Another reason why /s/ may be realized as a nasal fricative could be a reduced sensibility of the tongue tip and blade combined with discoordinated mobility. Since the production of sibilants is very demanding on tongue articulation, the speaker with tongue problems may "choose" the much simpler closing tongue gesture required for the nasal fricative. Notice that a dental/alveolar nasal fricative may also be a consequence of the passive strategy, but in this case it is an abnormal production of dental/alveolar stops.

Another conceivable consequence of reduced sensibility and discoordinated mobility of the tongue tip and blade would be a tendency to articulate with the front of the tongue rather than with the tongue tip and blade. It may also be that the place of articulation of dental/alveolar consonants is retracted to the hard palate which means that these sounds are palatalized.[1] This tendency to articulate with the front of the tongue may also explain the paradox that the same consonants, i.e., those articulated with tongue tip and blade, may be produced with interdental articulation—provided that the interdental articulation is considered a consequence of the front of the tongue articulating against the teeth and the alveolar ridge.

Speech Strategies in Spontaneous Speech of Five Danish Children

The existing studies of speech sound production in children with cleft palate are based on tests, not on spontaneous speech, with Lynch et al (1983) as an exception. Sound production in spontaneous speech shows greater variation than in speech elicited from tests, and because great variation in sound production is sometimes characteristic for individuals with cleft palate, spontaneous speech seems more suited to reveal the true extent of this variation.

Further, most of the existing studies of cleft palate speech are frequency studies that deal with the frequency of correct or deviant pronunciation of a given phoneme or the frequency of certain categories of deviations (Moll, 1968; Fletcher, 1978; Van Demark, 1974). There are very few phonetic descriptions of cleft palate speech, although this is a necessary basis to describe how a cleft palate speaker deviates phonetically and phonologically from a target norm. Such descriptions are important for the following reasons: first, the phonetic and phonological competence of the speaker plays an important part in the communicative problems caused by the cleft palate. Secondly, it is possible to classify the speech in categories that are based on well-defined phonetic and phonological criteria. Van Erp (1984) performed a phonetic transcription of Dutch cleft palate speakers, but their deviant sound production is not presented in terms of well-defined phonetic and phonological error categories.[2] Finally, the

[1] This use of the term palatalization should not be confused with palatalizing as secondary articulation, i.e., that the main articulation is accompanied by a raising of the frontal part of the tongue in the direction of the hard palate.

[2] The categories "distortion," "substitution," "omission," and "addition" used to describe language development are frequently used also in connection with cleft palate speech (excepting "addition"). These categories are ambiguously defined as to phonetic and phonological criteria.

vast majority of studies of cleft palate speech are based on American English speaking individuals. But one cannot implicitly assume that what is true about cleft palate speech in speakers of one language (e.g., American English) will necessarily be true about cleft palate speakers of other languages.

For these various reasons we found it relevant to look at the phonetic and phonological consequences[3] that arise from cleft palate in the spontaneous speech of some Danish children with cleft palate and to classify the persisting speech problems of these children according to strategies.

Method

Subjects. The East-Danish population of individuals with cleft palate consists of about 35 births per year, not counting submucous cleft palate or cleft lip only. Two-thirds of these births occur in the greater Copenhagen area. All births are centrally registered, and surgery and follow-up are taken care of by the Copenhagen cleft palate team. Lip surgery, including closure of primary palate, but not alveolus, is performed at 2 months; the secondary palate is closed at 22 months, according mainly to the Wardill-V-Y-method.

Because of the preconditions described below, the number of children suited for the study was limited to five. The children (one girl and four boys) ranged in age from 4.2 to 5.2 years, mean age 4.8 years. All five children were operated on by the same surgeon at the ages stated above.

Velopharyngeal function was assessed by the team otolaryngologists at 6 to 12 month intervals for each child, by oral mirror-inspection of phonation.[4] Nasal resonance was assessed by the team speech pathologists (including the logopedic author) auditorily on a 4-point scale. Intelligence testing was performed with the Leiter nonverbal test, showing normal intelligence. Hearing was tested with pure tone audiometry and was less than 20 dB hearing loss at the time of the study. History of hearing was obtained from the case files of assessments by the team otolaryngologists from 0 to 5 years. Language development was measured with a standardized Danish picture test of vocabulary and morphology (Language-test I),[5] and a test of elicited parallel sentences evaluating sentence structure and complexity (Ringsted-materialet).[5] Phonological development was tested with a standardized test using sentence imitation (SITO-test).[5]

At the age of 4 to 5 years, according to the above mentioned standardized test of Danish phonology (SITO-test),[5] normal children master all consonants in initial position. In a study of speech sound acquisition in noncleft Danish children, Heger (1979) concludes (allowing for the complexity of the subject) that the sequence of sound acquisition is similar to that of English-speaking children as are the processes common to emerging language: e.g., stopping, fronting, assimilation, addition. The same applies to noncleft language-delayed children, as far as can be judged from the only Danish study on the subject (Abrahams, 1955), and from a recent study of Swedish children (Nettelbladt, 1983).

None of the five children had pharyngeal flaps or other secondary surgery. All were receiving speech therapy when they took part in the study. Data for each of the children is given in the results section as well as in Table 1.

Phonetic Transcription. A video tape of about 30 minutes duration was made showing each child playing with a parent. The verbal communication between parent and child was transcribed orthographically. Furthermore, a narrow segmental transcription of the child's speech was performed in the IPA system supplemented by some ad hoc symbols (see Appendix).[6] The transcription was undertaken by a trained phonetician (BH, the first author) and discussed with a speech pathologist (KB, the second author) who, unlike the phonetician, has specialized in cleft palate. Since segmental transcription is extremely

[3] In this paper the term "phonology" refers to the structure and the linguistic function of speech sounds, whereas the term "phonetic" refers to the physiological, physical, and perceptual properties of speech sounds. Thus, the phoneme is considered an abstract functional unit with one or more phonetic realizations. In the description of the phonetic and phonological competence of each child, two types of interference with normal Danish are considered, namely interference with the *realization* of the phonemes and with the *number* of phonemes. Interference with realization causes pronunciation to deviate more or less from the target norm, which does not necessarily damage intelligibility seriously, if the phonemes are still identifiable. Contrarily, interference reducing the number of phonemes—which occurs when it is not possible to distinguish between two or more phonemes—is in principle always damaging to intelligibility, as it may cause words that are distinguished in the norm language to be pronounced homophoneously.

[4] Instrumental assessment of velopharyngeal function is only available to clarify indication for secondary surgery, which is not performed until the age of 6 years.

[5] SITO-test of phonology, standardized 1973, State Institute for Speech Disorders, Odense, Denmark.
Ege, B. Language-test I, standardized 1974, Copenhagen.
Ege, B. Ringsted-materialet: test of syntax, published 1974, not standardized.

[6] A transcription system especially designed for pathological speech has been proposed by Vieregge and Jansen (1981), and by Vieregge (1985c).

TABLE 1 Clinical Information About Five Danish Children Included in the Study

Child	*Age (yr)*	*Sex*	*Cleft Type*	*Age at Primary Palatal Repair (mo)*	*IQ*	*Velopharyngeal Function*	*Hypernasality*	*Hearing up to Present Age*	*Development of Language*
1	5.0	M	Bilateral lip/palate	22	Normal	Adequate	None	Normal	Delayed
2	4.10	M	Palate only	22	Normal	Slightly inadequate	Mild	Well-treated, fluctuating	Normal
3	4.9	M	Unilateral lip/palate	22	Normal	Inadequate	Severe	Well-treated, fluctuating	Normal
4	4.2	F	Palate only	22	Normal	Inadequate	Moderate	Normal	Normal
5	5.2	M	Palate only	22	Normal	Adequate	None	Well-treated, fluctuating	Slightly delayed

time consuming, we had to confine the number of transcribers and transcriptions to just one, in spite of the fact that transcriptions made by more transcribers show inter- as well as intra-transcriber variation (Vieregge, 1985a). However, since the transcription was based on video recordings including visual as well as auditory information, the transcription task was somewhat facilitated. Theoretical and practical aspects of transcription are treated in Vieregge (1985b).

Speech Material. The sounds analyzed are limited to consonants. Consonants are described in the following position: single consonant in syllable-initial position preceding a full vowel (e.g., *p*enge, Ja*k*ob). The Danish consonant system and its phonetic realization in this position are shown at the top of Figure 1.[7] Notice that in Danish both of the stop series are completely unvoiced in this position. They are separated by a difference in aspiration, so that /ptk/ are aspirated, /bdg/ unaspirated, but they only contrast in syllable-initial position preceding a full vowel. However, the main difference between /t/ and /d/ is one of affrication rather than aspiration. In other positions only the unaspirated series /bdg/ occur. A general comparison between the Danish and English consonant system is found in the Appendix.

In speakers who suffer from velopharyngeal insufficiency, the obstruents are the most seriously affected because the intraoral pressure demanded for production of these sounds cannot be established. Also, these sounds may be disturbed by nasal friction. Contrarily, the oral sonorant sounds are usually normally articulated, except for hypernasality, which is less disturbing to communication. Nevertheless, only the vowels are excluded from the analysis, since consonants classified as sonorants may be affected in other ways than by nasalization. Some utterances or single words are left out because of uncertainty of their semantic content, or because the pronunciation was impossible to transcribe meaningfully, or both, but there were no inter-subject differences in the distribution of the various consonants. The speech output varied from child to child so that the number of consonants analyzed ranged between 305 and 809.

Results

In Figure 1, below the normal consonant system and its realization, are shown the realizations most frequently used by each child for a given phoneme, called the primary variant(s). Also shown for each child is how often the primary variant(s) is/are used in relation to other variants. As the phonetic/phonological competence in normal 4- to 5-year-old Danish children is equal to that of adults as far as the consonant material analyzed in *this* study is concerned, the phonetic/phonological competence in the five children will be compared to normal adult language. Encircling of the phonetic symbol indicates that the primary variant is in accordance with this norm.

Child 1

Child 1 was born with a complete, wide, and almost symmetrical bilateral cleft of the lip and the alveolus, and a total palatal cleft. The center of the maxilla deviates to the left. As yet he has had no orthodontic treatment. The velopharyngeal function is normal, there is no hypernasality, and hearing is normal. Testing of language development shows delay in syntax and morphology; vocabulary is normal, but phonology is seriously disordered as well as delayed.

Child 1's realization of stops and fricatives is dominated by glottal stops [ʔ]. Only the bilabial stops are, with a few exceptions, pronounced according to the adult pattern and never as [ʔ]. Notice also that /f/ is realized as [ʔ], whereas /s/ is realized almost equally frequently as [ʔ] and as [h]. Although /h/ is correctly produced as [h], [h] is also the frequent pronunciation of /r/. The remaining voiced consonants are usually pronounced according to the adult pattern. Moreover, child 1 in nearly all cases adds an [h] in front of word initial vowels, a position where /h/ occurs in the nor-

[7] In Hutters and Brøndsted (1986) syllable-final position and consonant clusters are also included.

PHONEMES REALIZATION	/p [b̥ʰ	t d̥ˢ	k g̊ʰ	b b̥	d d̥	g g̊	f f	s s	h h	v l r j m n / v l ʁ j m n]
Child 1										
Primary variant(s)	[ⓑ̥ʰ	ʔ	ʔ	ⓑ̥	ʔ	ʔ	ʔ	ʔ/h	ⓗ	ⓥ ⓛ h ⓙ ⓜ ⓝ]
Frequency (%)	94	90	75	82	82	80	95	50/ 43	100	78 91 75 89 100 57
Child 2										
Primary variant(s)	[F	F	ʔ/ʔʰ	ʔm	ʔn	ʔ	ⓕ	s̊/n̥	ⓗ	ṽ l̃ ʁ̃ j̃ ⓜ ⓝ]
Frequency (%)	71	45	44/ 31	100	68	56	75	24/ 22	91	74 75 50 97 100 100
Child 3										
Primary variant(s)	[ⓑ̥ʰ	n̥/ⓓ̥ʰ	n̥	ⓑ̥/m	n/ⓓ̥	n	ⓕ/f̊	s̊	ⓗ	ṽ l̃ ʁ̃ j̃ ⓜ ⓝ]
Frequency (%)	43	30/ 25	36	46/ 31	56/ 21	44	44/ 32	38	100	76 70 75 100 100 100
Child 4										
Primary variant(s)	[m	h	h	m	n/ʔ	h/ʔ	h	h/ʔ	ⓗ	ṽ l̃ ʁ̃ j̃ ⓜ ⓝ]
Frequency (%)	71	56	67	91	60/ 14	27/ 27	86	71/ 29	89	58 83 43 99 94 93
Child 5										
Primary variant(s)	[ⓑ̥ʰ	ⓓ̥ʰ	h	ⓑ̥	ⓓ̥	d̥	ⓕ	ⓢ	ⓗ	ⓥ ⓛ ⓚ ⓙ ⓜ ⓝ]
Frequency (%)	71	100	68	100	97	94	98	99	100	98 98 100 95 98 93

FIGURE 1 At the top of the figure is shown the Danish consonant system and its normal realization for consonants in syllable-initial position preceding a full vowel. Below are indicated the primary realizations—primary variants—used by each child. Also, the frequency of occurrence for each variant is shown (in percent). Encircling of the phonetic symbol indicates that the primary variant is in accordance with the normal adult realization. For child 2, no primary variant can be decided for /p/ and /t/; instead the frequency of variants produced with any kind of friction is indicated, symbolized by [F]. With child 4, the interdental realization of /n d l/ is included in the frequency of occurrence. [·] means "nasal friction." Further explanation of the phonetic symbols is given in the Appendix.

mal language, so that this "addition" of [h] may cause confusion of words.

It should be added that Child 1 has a number of assimilations of word initial consonants, both progressive and regressive (e.g., *v*[m]arm̃ere, *n*[l]emlig, larm̃er *l*[m]idt, læ̃se *n*[l]ogen). Also, the way in which child 1 treats the Danish stød is worth a comment. Physiologically the Danish stød is irregular vocal fold vibrations as in creaky voice. It is considered a prosodic phenomenon with the syllable as its domain: if the vowel is long, the stød will appear at the end of the vowel; if the vowel is short, it appears on the following voiced consonant. In Child 1's sample 67 words should be produced with stød, but he only uses stød in 10 percent of these words. In most cases, where stød should have occurred on the vowel, it is omitted while keeping the vowel long (e.g., sol [so:'l]→[ʔo:l],træ [d̥ ʁ̥ ɛ:']→[ʔ ɛ :]). In the remaining cases with stød on the vowel, child 1 uses a short vowel. In the words occurring in the sample where stød should have been on the voiced consonant, he sometimes lengthens the preceding vowel (e.g., hånd [h ʌ n']→[h ʌ :n]), but more often the stød is just omitted.

As Child 1's velopharyngeal function is normal, his comprehensive and persisting use of glottal stops may be reinforced by his language delay, even though the (unpublished) status of the total East Danish cleft palate population born between 1970 and 1979 (N=293) shows no relationship between language delay and the use of compensatory glottal stop. Use of a compensatory glottal stop seems unlikely in noncleft language delayed children, but hard vowel onset may be interpreted as substitution with a glottal stop instead of omission of the initial consonant. No information is available about this problem in Danish language-delayed children. The assimilations and the addition of word-initial [h] are probably also associated with his language delay, while the origin of his difficulties with stød is problematic. In spite of his severe clefting, none of his phonetic errors seem to be related to dental status. Apart from his frequent use of glottal stops, the consonants are predominantly normally articulated. The analysis shows that the consequence of his dominant use of glottal stop and of [h] is that both the phonetic realization and the number of phonemes deviate considerably from the adult norm.

Child 2

Child 2 was born with an isolated cleft of the soft palate extending partly into the hard palate. Independently of the clefting he presents with an open bite.

His velopharyngeal function is slightly inadequate, with mild to moderate hypernasality. Hearing is normal, but he has a history of fluctuating but well-treated conductive hearing problems. Testing of language development shows above-average status in all areas but phonology.

Child 2 also uses glottal stops, but mainly for the stop consonants. The glottal stops, however, in most cases are articulated in combination with the correct supraglottal place of articulation as mentioned by Trost (1981). Only the velar stops are most frequently realized as simple glottal stops. Also, Child 2 is characteristic in that he shows a large variation in his realization of stops, except for /b/, which is always realized as [?m̆]. For /pt/ the variation is so great that the occurrence of the different variants is too small to decide which is the primary variant for these stops. But there is a clear tendency to maintain a distinctive difference between aspirated and unaspirated stops, friction of some kind being frequent in the manifestation of /ptk/.

Although /s/ also has many variants, there are two primary variants, namely the nasal fricative [ṅ̥] and *s* with audible nasal emission, that is with nasal friction [ṡ]. The remaining /s/-variants generally have a weaker and more diffuse friction noise, but the place of articulation for all of them—including the primary variants—is dental/alveolar. The voiced consonants and /h/ and /f/ are mostly correct, except that the oral voiced consonants are nasalized.

Thus, Child 2's pronunciation of consonants deviates considerably from the normal adult pattern, while the decrease in number of phonemes is limited. His language development is normal, so that his consonant problems appear to be directly related to insufficient velopharyngeal function. As mentioned, Child 2 has an open bite, but this does not appear to influence his consonant production.

Child 3

Child 3 was born with a unilateral partial clefting of the left lip and alveolus, and a cleft in the soft palate extending partly into the hard palate. There is a moderate inward collapse of the maxilla on the left side. As yet he has had no orthodontic treatment. The velopharyngeal function is inadequate, with severe hypernasality. Hearing is normal, but there is a history of fluctuating but well-treated conductive hearing problems. Testing of language development shows normal vocabulary and syntax, but slight symptoms of delay in phonology.

Child 3's realization of stops is often correct, except for the velar stops, as they are nearly always assimilated to the surrounding consonants in place of articulation, nasality, or both. Other realizations of the stops are voiced nasal consonants and unvoiced nasal consonants with nasal friction (i.e., nasal fricative), but other variants occur as well. However, even in cases with a deviant realization, there is a clear difference between aspirated and unaspirated stops, since the voiced nasal consonants are the dominant deviant realization of the unaspirated stops, and the unvoiced nasal consonants are dominant for the aspirated ones. The fricatives are often correct according to the adult pattern, but *f* accompanied by nasal friction also occurs ([f̥]). The primary variant of /s/ is *s* accompanied by nasal friction ([ṡ]). There is, however, great variation in the fricatives /f/ and /s/, although the place of articulation is nearly always correct. The voiced consonants are usually correctly produced, except for nasalization of the oral consonants. It should be added that Child 3 shows examples of correct manifestation of all consonants (except /s/) in spite of evident hypernasality.

Also, both progressive and regressive assimilation occurs in Child 3's speech, most frequently "fronting" of the velars accompanied by assimilation of nasality (*g*[n]år d̃[n]e, hen̄de *g*[n]år).

In short, Child 3's number of phonemes and their realizations are found to deviate only moderately from the adult pattern, judged by the primary variants. His abnormal bite does not seem to influence his consonant production.

Child 4

Child 4 was born with an isolated cleft palate, extending through the soft palate and one-third into the hard palate. Her velopharyngeal function is inadequate, with moderate hypernasality. Hearing is normal. Testing of language development shows normal status in all areas but phonology.

Child 4's realization of stops and fricatives is dominated by nasal consonants, [m] for /p/ and /b/, and [n] for /d/, and by [h] for the remaining stops and for the fricatives. Also, the glottal stop frequently replaces /d/, /g/ and /s/. For nearly all the voiced consonants, [h] and [ʔ] occur sporadically, and even /h/ may be realized as [ʔ]. Voiced consonants are usually correctly pronounced, though, except for nasalization of the oral consonants. It should be mentioned, too, that Child 4 shows a rather large variation in her realization of alveolar and velar stops. Further, Child 4 speaks with a very low intensity, and her speech is frequently interrupted by superficial snatchings of breath. Her comprehensive use of nasal consonants, [h] and to a lesser degree [ʔ], means that both number of phonemes and their realizations deviate considerably from the adult pattern. Also, her [n], which is the realization of /n/ and frequently also of /d/, is in many cases produced with interdental articulation. This also applies to /l/. As her bite and dental condition are normal, the frequent interdental articulation of alveolar sounds can hardly be related to these factors. Child 4's use of glottal stop is noticeable, as it occurs also sporadically for sonorant consonants and /h/ where compensatory articulation is unexpected.

Thus, it is evident that in Child 4's speech the interference with both realization and number of phonemes deviate considerably from the normal adult pattern. As she shows no language delay, her consonant problems seem clearly associated with her insufficient velopharyngeal function.

Child 5

Child 5 was born with an isolated cleft palate, extending through the soft palate and one-third into the

hard palate. His bite and dental conditions are normal. Velopharyngeal function is adequate, without hypernasality. Hearing is normal, but there is a history of fluctuating but well-treated conductive hearing problems. Language testing shows normal status in vocabulary and syntax, although there are slight symptoms of delay in phonology.

In Child 5's sample, only few sporadic deviations from the adult pattern occur, except for the velars /k/ and /g/, which are realized as [h] and [d̥], respectively. Since his velopharyngeal function is normal, [h] for /k/ may be reminiscent of an earlier insufficiency. His "fronting" of /g/, however, may be seen as a symptom of delay in phonology. Also, Child 5 uses many assimilations in his speech. Assimilations over distance are regressive (*k*[f]om til at få, *d*[b̥]e͡m), and contact assimilations are mainly progressive (fars *k*[s]ammerater).

It may be concluded that in Child 5's speech the interference with both realization and number of phonemes is very limited. Furthermore, it is supposed that his slight consonant problems are related to his velopharyngeal insufficiency as well as to language delay.

DISCUSSION

Only individuals who suffer from a persisting velopharyngeal insufficiency need to "choose" a strategy for their speech production, since these strategies are a direct consequence of the velopharyngeal insufficiency. Only children 2, 3, and 4 answer to this description. However, they differ as to "choice" of strategy, which is reflected in the realization of the obstruents. Both children 2 and 4 use active strategies.

Child 2 uses a glottal stop for the stops—frequently articulated in combination with the correct supraglottal articulation—while /s/ is realized either as a nasal fricative or as an *s* accompanied by nasal friction. Thus, Child 2's realization of the obstruents is dominated by the compensatory active strategy.

Child 4's realization of the obstruents is dominated by [h] and weak sound production, which are characteristics of the active camouflage strategy. However, the pronunciation of some of her stops is dominated by nasal consonants produced with correct place of articulation. In the pure passive strategy only unaspirated stops will be realized as voiced nasal consonants, but in this child's speech the aspirated stops are also realized as voiced nasal consonants. The weak articulation in the camouflage strategy also applies to the articulation of the vocal folds: the vocal folds are not abducted as they are in normally articulated aspirated stops, but remain in adducted position. Therefore, the vocal fold vibrations continue during the oral closure because of the velopharyngeal leakage. Thus, the aspirated as well as the unaspirated stops are realized as voiced nasal consonants. Surprisingly, glottal stops—characteristic of the compensatory strategy—also occur in Child 4's speech. However, her use of glottal stops does not seem to be compensatory in nature, since they replace not only obstruents but also sonorants, and these sounds do not need compensatory articulation owing to the physiological conditions. Further, it should be recalled that Child 4 shows interdental articulation, but since her bite is normal, the interdental articulation may be related to a vacillating use of the tip and blade of the tongue as was previously described.

In Child 3's speech the fricatives are frequently realized with nasal friction, and the realization of the aspirated and unaspirated stops is dominated by unvoiced nasal consonants and voiced nasal consonants, respectively. Thus, Child 3's obstruents are dominated by the passive realization when they are not correctly produced.

The speech of Child 1 is dominated by glottal stops instead of normal obstruents, in spite of the normal velopharyngeal function. This child exemplifies that what was formerly an active strategy, intended to compensate for a velopharyngeal insufficiency, becomes a very ingrained habit, persisting after velopharyngeal function is no longer insufficient. Henningsson and Isberg (1986) have demonstrated that in speakers with good or moderate velopharyngeal activity and with persistent use of glottal stops, the velopharyngeal activity is considerably reduced during pronunciation of these glottal stops and a following vowel, and thus give a false impression of organically caused velopharyngeal insufficiency. This observation may apply to Child 2, who employs compensatory glottal stops combined with hypernasality, but not to Child 1, who uses glottal stops without any hypernasality.

In normal speech the same connection between glottality and the velopharyngeal mechanism has been observed, namely that the velopharyngeal port may be opened or closed during production of glottal stop and [h] according to the context (Ohala, 1972). This optional velopharyngeal leakage has been proposed to explain that the nasal vowels, which are normally developed from a context of nasal consonants, as in say French, may develop from oral vowels preceded by a glottal stop and [h] (Matisoff, 1975). From this it may be worthwhile to examine [h] in cleft palate speakers with good or moderate velopharyngeal activity to see if the velopharyngeal behavior is the same as with glottal stop.

Characteristics that originate directly from the organic conditions of the speech production apparatus are by definition universal rather than language dependent. As described above, the strategies in cleft palate speech are related to the

organic conditions; thus, the strategies per se must be considered universal. Also, within obstruents produced by cleft palate speakers the frequency of deviation has been reported to vary with place and manner of articulation. This variation, provided that it originates from the organic conditions, should be observed in cleft palate speech irrespective of language and then be universal in nature. But because of the very restricted amount of data in the literature stemming from languages other than English, our knowledge is only fragmentary.

Contrarily, since languages differ as to their sounds and sound structure, the consequences for communication induced by the passive strategy will also differ from language to language. Thus, the unavoidable phonetic and phonological difficulties that cleft palate speakers may have are evidently language dependent. However, the question is whether some of these speakers show language dependent reactions to the passively conditioned characteristics. For instance, why do some cleft palate speakers stick primarily to the passive "laissez-faire" strategy, whereas others supplement with characteristics from the active strategies? It is well-known that all the types of deviant articulation in connection with cleft palate occur in one and the same language, as also appears from our Danish children. Thus, the structure of the speaker's language cannot be decisive for the choice of strategies. But what we do not know is whether one strategy is more dominant in some languages than in others. For instance, it may be hypothesized that the active compensatory strategy is less frequent or is applied in a different manner in languages which include the compensatory sounds in their sound system. These pharyngeal and glottal sounds have a phonemic function in many languages (e.g., Arabic), but unfortunately, the data available in the literature do not permit any suggestions concerning the question.

In conclusion, because of the nature of the passive strategy, speakers suffering from velopharyngeal insufficiency will always show characteristics related to this strategy in their speech. Some speakers then add characteristics from the two active strategies, but because of the antagonistic nature of these strategies, they would seem to be mutually exclusive. However, in Child 4's speech, otherwise dominated by the camouflage strategy, glottal stops, characteristics of the compensatory strategy, do occur, but in an atypical way since they are also used instead of sonorant consonants. This illustrates the complexity of cleft palate speech. It has also become clear that phonetic descriptions of cleft palate speech with speakers of different languages are necessary prerequisites to the solution of the problem of universal and language dependent characteristics in cleft palate speech.

Concluding Remarks

If the speech sounds in cleft palate speech are described not only as isolated units, but also as components forming part of a whole, it may be possible to expose the underlying articulatory mechanisms—here called speech strategies—resulting in the specific sound production of the individual cleft palate speaker. With such description in terms of strategies interindividual variation in cleft palate speech can be classified according to how these strategies are applied. Thus, in this way (contrary to Morris [1979] quoted in the introduction) it does seem possible to describe cleft palate speech meaningfully, including its great interindividual variation.

Appendix

Comparison Between the Danish and English Consonant Systems and Their Phonetic Realization for Consonants in Syllable-Initial Position Preceding a Full Vowel.

The phonetic notation system is IPA (the International Phonetic Alphabet). It appears that the Danish consonant system is less rich than the English one.

The aspiration in /p t k/ is longer in Danish than in English ([^{h}] versus [^{c}]), and Danish /t/ is affricated rather than aspirated ([^{s}]). The difference as to the symbols ([ʈ^{h} ɖ^{s} g̊^{h}] versus [p^{h} t^{h} k^{h}]) used for the realization of /ptk/ indicates that the articulation of the Danish series is weaker. By the way, the articulation of the obstruents is in general weaker in Danish than in English. Furthermore, Danish /bdg/ are always unvoiced in the position analyzed (indicated by [̥], whereas in English the voicing is optional (indicated by [$_{\omega}$]). Note also that /r/ in Danish is realized as a uvular untrilled *r* ([ʁ]) opposed to the alveolar untrilled *r* in English ([ɹ])—which is retroflex in American English. Finally it should be recalled that opposed to the British English /l/ the American English /l/ is velarized also in the position in question.

Other symbols used in the present paper:

[ŋ] = velar nasal consonant
[ʔ] = glottal stop consonant
[ʔm] } =glottal stop articulated in combination with a bilabial and alveolar closure, respectively
[ʔn] }
[~] = nasalization
[·] = nasal friction (ad hoc symbol not included in the IPA system).

Symbols between / / represent phonemes, whereas symbols between [ ] represent the phonetic realization. When the symbols are italicized this distinction is considered irrelevant.

DANISH SYSTEM

System	*Place of Articulation Realization* Labial	Alveolar	Palatal	Velar	Uvular	Glottal	*Manner of Articulation*
							Obstruents
/p t k/	[p̥ʰ	d̥ˢ		g̊ʰ		]	Stops
/b d g/	[b̥	d̥		g̊		]	
/f s h/	[f	s				h]	Fricatives
/v /	[v					]	
							Sonorants
/ l r/	[	l			ʁ	]	Liquids
/m n /	[m	n				]	Nasals
/ j /	[		j			]	Semi-vowels

ENGLISH SYSTEM

System	*Place of Articulation Realization* Labial	Dental	Alveolar	Alveo-Palatal	Palatal	Velar	Glottal	*Manner of Articulation*
								Obstruents
/p t ʧ k/	[pᶜ		tᶜ	ʧ		kᶜ	]	Stops
/b d ʤ g/	[b (o)		d (o)	ʤ (o) (o)		g (o)	]	
/f θ s ʃ h/	[f	θ	s	ʃ			h]	Fricatives
/v ð z ʒ /	[v (o)	ð (o)	z (o)	ʒ (o)			]	
								Sonorants
/ lr /	[		lɹ				]	Liquids
/m n /	[m		n				]	Nasals
/w j /	[w				j		]	Semi-vowels

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