Notes and Discussion

Active versus passive cleft-type speech characteristics

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Abstract

Cleft palate speech is generally described in terms of nasal resonance, nasal emission and compensatory articulations. A longitudinal study of children at different stages of surgical treatment revealed a distinction between passive and active cleft-type speech characteristics whereby passive characteristics were thought to be the product of structural abnormality or dysfunction and active characteristics were specific articulatory gestures replacing intended consonants. Passive and active patterns of articulation are described and defined in the context of three longitudinal studies of subjects who were at various stages of two different surgical regimes: five bilateral cleft lip and palate (BCLP) subjects aged 1;6–4;6, 12 mixed unilateral cleft lip and palate (UCLP) and BCLP subjects aged 4;6–7;6 and nine mixed UCLP and BCLP subjects aged 9;0–11;0. Reference is also made to data from 12 mixed cleft-type subjects aged 13;0 who had been treated with different surgical timing regimes. Comparison is made between the incidence of active versus passive processes in relation to oral structure. At age 4;6 speech samples taken from BCLP subjects who had been treated with 1-stage versus 2-stage palate repair all evidenced both active and passive processes. The lack of differentiation in speech results irrespective of their current surgical status, i.e. completely repaired palates versus residual cleft of the hard palate, was unexpected. Cleft-type processes in completely repaired subjects might be accounted for by the inevitable anterior defect following repair of a bilateral cleft. Older subjects with structural defects also evidenced more cleft-type processes. The relevance of distinguishing between active and passive processes is underlined by consideration of the effects of structural changes following surgery. The effect of surgery on seven subjects’ speech is discussed using the active/passive distinction. Active cleft-type characteristics did not change as a direct result of surgery, whereas passive characteristics were largely eliminated following surgery. A specific distinction is made between active and passive nasal fricatives, with the implication that active nasal fricatives may not be affected by surgical intervention, whereas passive nasal fricatives may be eliminated by surgery. Accurate distinction between active and passive patterns of articulation may serve to identify those cleft-type speech error patterns most likely to respond to surgical intervention. Indications from this study are that active cleft-type characteristics require destabilization in a course of speech and lan-

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guage therapy before the potential benefits of surgery can be properly assessed. An analytical protocol for the interpretation of speech samples is presented and some therapy strategies are proposed for active and passive processes.

*Keywords*: active/passive processes, cleft palate, speech and language therapy, surgical timing.

**Introduction**

Whilst ‘cleft palate speech problems’ are commonly regarded as ‘articulatory disorders’, Russell and Grunwell (1993), Harding and Grunwell (1993), and Harding and Grunwell (1996) have reconsidered cleft palate speech characteristics in the context of phonological development. The outcome of this phonological and developmental perspective on cleft palate speech influenced the GOS.SP.ASS protocol (Sell et al. 1994) and GOS.SP.ASS’98 (Sell et al. 1998) which has recently been selected by a panel of experienced clinicians as the preferred protocol for assessing cleft palate speech in the UK. It is sensitive not only to the articulatory effects of the cleft but also to idiosyncratic phonological processes commonly heard in cleft palate speech.

As described by Harding and Grunwell (1996), Hutters and Brondsted (1987) observed that some children with a cleft palate apparently respond to a subconscious awareness of their limited phonetic and phonological repertoire by actively employing non-native sounds from their phonetic repertoire in order to maximize their range of meaningful contrasts. Other children, more passively, continue to make the appropriate articulatory movements with no apparent response to the absence of adequate contrasts in their speech. This distinction between active and passive responses to the articulatory constraints imposed by the cleft forms the basis of the 1987 theory of Hutters and Brondsted of active and passive strategies. Morley’s (1970) categorized her speech results into Groups A and B such that Group A made no adaptations to articulation but nasal escape, nasal tone and weak consonants were noted. These characteristics resemble Hutters and Brondsted’s (1987) passive strategies, whereas speech characteristics in Group B included additional symptoms of nasopharyngeal snort, glottal and pharyngeal articulation and incorrect articulation. Morley’s (1970) Group B is equivalent to Hutters and Brondsted's (1987) active strategies. Subjects with normal velopharyngeal function but persisting articulatory errors were included in this group. Trost-Cardamone (1990) made a similar distinction in her description of categories I and II in cleft palate speech characteristics. Category I: misarticulations were said to be ‘structurally based and revealed in audible nasal emission of high pressure consonants’, (stops fricative and affricates); and Category II misarticulations were compensatory articulations and atypical backed distortions. Category I is equivalent to Hutters and Brondsted's (1987) passive strategies and Category II, to active strategies. Golding-Kushner (1995) distinguishes between compensatory and obligatory articulatory errors. Compensatory errors would be product of active strategies and obligatory errors would be the product of passive strategies. Obligatory errors are described as resulting from an anatomic defect and are ‘not easily amenable to therapy’ (Golding-Kushner 1995).

The four ways of grouping cleft-type characteristics described above all indicate that some characteristics are an inevitable consequence of structural imperfection
and/or velopharyngeal dysfunction. However, none of the distinctions have been expressed with reference to their potential impact on phonological development. Stengelhofen (1989) noted that reduced intra-oral pressure may result in nasal realization of voiced plosives /b d g/—[m n η]. This can have a devastating effect on speech development because plosives [b d] usually represent most fricative target consonants in early speech acquisition (age 1:0–2:0, approx). The phonological consequence of loss of intra-oral pressure may be that a child’s early consonant repertoire could be restricted to nasals and approximants [m n η w j] with [h] sometimes representing voiceless plosive and fricative targets. Russell (1991) and Harding (1993) observed nasal fricative consonants in developing speech patterns which in some, but not all, cases resolved. Russell and Grunwell (1993) considered the effect of abnormal learned neuromotor patterns which can dominate phonological development. A restricted phonetic repertoire in babble can persist into early speech irrespective of increasing potential for velopharyngeal function. In the work of Russell (Russell 1991, Grunwell and Russell 1993), established articulatory patterns were more readily modified by some children than others. Harding (1993) found that some speakers made placement distinctions in their nasal fricative realizations but others used one nasal fricative [ŋ] for all fricative target consonants. Application of the phonetic repertoire into speech is usually systematic and as a result most families are able to understand their child’s distinctively cleft-type speech. Strategies employed in early speech inevitably affect phonological processes. Errors are process-specific not phoneme specific. A phonological perspective in interpretation of speech assessments is therefore both necessary and enlightening.

This paper proposes a phonologically based categorization system for cleft palate speech patterns observed in a longitudinal study of pre-speech and speech development in different groups of children whose ages ranged from 1;6 to 13;0. The proposed system predicts an association between certain speech characteristics and the structure and function of the speech mechanism. Since subjects had been treated with either 1-stage surgery or 2-stage repair in which the hard palate remained unrepaired until between 4 and 8 years, the speech data could be considered in relation to a range of oral structures. Two subjects were recorded before palate surgery at age 1;6; other samples were taken when palates were partially repaired, or when fully repaired, with or without fistulae, and with or without suspected velopharyngeal incompetence. During the course of the longitudinal studies, seven subjects underwent surgery and the effects of surgery on speech were monitored.

Pre-speech and speech samples were taken at 6-monthly intervals at different stages of surgical repair, and at different stages of speech development. Detailed analysis of 141 speech samples led to the identification of the active/passive framework which is described here.

Four concurrent studies, three of which were longitudinal, included subjects born with complete clefts of lip and palate, aged between 1;6 and 13;0. Study 1 followed pre-speech vocalizations into speech from ages 1;6 to 4;6 and Study 2 recorded patterns of change in speech production from ages 4;6 to 7;6. Studies 3 and 4 comprised 2 groups of older subjects. Study 3, ages 9;0–11;0 and Study 4, 13;0 were primarily included to facilitate comparison between speech and facial growth.

**Method**

Speech samples were elicited from younger subjects by use of the prototype of the PACSTOYS Screening Assessment (Grunwell and Harding 1995), whereas older
subjects were asked to describe PACS pictures (Grunwell 1987). Speech was transcribed both live and from audio recordings. Live transcription was thought to be an essential supplement to audio recordings since some visually perceived characteristics could not be detected on the audio-recordings e.g. labiodental nasal [m] might be perceived as a bilabial nasal on audio recording. Slight audible nasal emission as in [p] might be suspected on audio but it would be confirmed by live transcription.

The following speech parameters were studied: nasal resonance, nasal emission, nasal turbulence, voice, lip posture, intelligibility and consonant production. Speech samples were taken in the home and hence routine endoscopy and fluoroscopy were impracticable. It is furthermore questionable whether such investigations would be thought ethical unless they were necessary for clinical management. The primary area of interest in this investigation has therefore been detailed examination of the nature of consonant production in relation to oral structure. Harding and Grunwell (1996) have identified articulatory errors of place as: glottal, pharyngeal, uvular, velar, lateral, palatal; double articulations. For the seven individuals who underwent surgery, the pre-operative data were compared with the processes observed post-operatively to ascertain whether any trends in post-operative consonant production could be identified. Phoneme realizations were transcribed and charted on to phoneme evolution charts (Harding 1993) and phonetic diagrams (Harding and Grunwell 1993) were completed for each speech sample.

Analytical approach

Initially, cleft-type consonant production errors were distinguished from those developmental errors thought to be unrelated to the cleft. Errors related to the cleft palate were categorized as Cleft-Type Realizations (CTRs) (Harding and Grunwell 1993).

Since most articulatory errors affected groups of consonants speech errors were further categorized within a phonologically based framework of cleft-type processes. The specific processes were defined within the 1987 concept of Hutters and Brondsted’s active versus passive strategies.

Active/passive analytical framework

Active processes are defined here as alternative articulations thought to have been actively generated in order to establish the necessary phoneme distinctions between individual consonant targets. Where one strategy systematically affected more than one consonant target and these targets were phonologically related, then that strategy was identified as a process, a cleft-type phonological process. For example, backing usually affected several alveolar targets, /t d n s z/ resulting in a backing process. In this definition, alternative articulations include both non-English consonant realizations e.g. /s/ to [x] and alternative English consonants as in /t/ backed to [k].

Figure 1 illustrates the nature of realizations involved in active processes. As a group they resemble, but are not the same as, Trost’s (1981) compensatory articulations. In early speech, attempts at several fricative target consonants might all be realized by a single realization, for example /s z ʃ ʒ/ might be any of the following: nasal fricative [n]; post-oral glottal [h] or pharyngeal, [h]; backed to uvular [ɣ] or to velar [x] lateral [ɻ], palatal [ç]. A backing process affecting production of [s] might also result in backing of both alveolar target plosive consonants, e.g. /t/ to
[k] and of nasal and/or lateral alveolar target consonants /n l/ to [ŋ]. Whilst these characteristics might, as has been assumed in the past, be pure articulatory errors, there are phonological consequences (Grundy and Harding 1995) when several classes of consonants, e.g. voiced and voiceless alveolar fricatives and alveolar plosives, are realized by one consonant [g] resulting in multiple loss of phonological contrasts or systematic sound preference (Grunwell 1985).

In viewing figure 1, it is worth noting that pharyngeal and glottal articulation, are ‘non-oral’ productions which do not require intra-oral pressure or velopharyngeal closure and their production would not evoke sphincter movement. A speaker must at least intend an oral production if potential velopharyngeal sphincter function is to be accurately assessed. Hence, predominance of glottal and pharyngeal patterns of articulation imply, but do not prove, the existence of an inadequate sphincter.

‘Active’ processes which establish meaningful contrasts did not account for all the cleft-type speech patterns observed in the data. Consideration is now given to the cleft-type realizations thought to be passive products of either structural defect or dysfunction. Hypernasal resonance co-occurring with passive patterns of articulation are frequently a direct consequence of weak or absent intra-oral pressure. In a passive realization there is no alteration of the articulatory pattern for the intended consonant, e.g. the bilabial /b/ in ball is produced [m], [m̩]. As shown by figure 2, exclusively passive patterns of articulation employ few consonants (approximants and nasals and glottal [h]) [m n ŋ w j l h] to represent all adult consonants. This range of consonants when associated with nasalized vowels suggests a lack of potential to establish intra-oral pressure for speech. To date passive consequences of the cleft on speech have received minimal attention, perhaps because they do not involve non-English consonant realizations. Lack of intra-oral pressure is associated with hypernasal resonance and nasal emission (Kummer et al. 1992). Nasal emission is perceived either accompanying or replacing voiceless pressure consonant targets hence it will not be present until a child is actively targeting voiceless pressure consonants (Sell et al. 1994). Severely hypernasal speech may not evidence nasal emission until fricative targets are intended and realized as [(s)ŋ], for example.

Passive processes which severely limit the range of consonants can impair communication more than a combination of active processes. Speech samples
containing active processes usually sound distinctive, but communicative competence can be impressive because more meaningful differences can be signalled than may be possible with the restricted phonetic repertoire of passive processes. Given that the velopharyngeal sphincter is complex and dynamic, it is possible for a restricted phonetic repertoire with hypernasal resonance to persist into early speech development because a child has been unable to achieve velopharyngeal function for speech after palate repair.

The distinction between active and passive cleft-type processes has been integrated into the revised cleft palate speech assessment, GOSSPASS’98 (Sell et al. 1998). Definitions of cleft-type characteristics are given in GOSSPASS’98 but GOSSPASS does not interpret the phonological consequences of the cleft-type characteristics. The following definitions of active and passive cleft-type processes are based on data analysis in the present study and on Harding and Grunwell’s (1996) characteristics of cleft palate speech. Analysis of patterns of phoneme evolution throughout speech acquisition has generated a hierarchy of error-severity. The following descriptions of the different types of processes are illustrated by reference to the data collected in the research studies (Harding 1993).

**Active cleft type processes**

**Active nasal fricatives**

\[\text{[\text{m}^\circ \text{k}]} \quad [\text{n}^\circ \text{k}] \quad [\text{‡}^\circ \text{k}];\] Nasal realizations of voiceless, and sometimes voiced, fricative targets /f v s z \(\tilde{f}\) \(\tilde{z}\)/ were categorized as nasal fricatives. Comparison of figures 1 and 2 shows that nasal realizations occurred in both passive and active processes. In production of active nasal fricatives the pulmonary air is actively directed nasally, as an alternative articulation to an oral fricative realization. Figure 3 illustrates that oral airflow is stopped by either lips or tongue thus achieving 100% nasal airflow. This strategy is developed in order to signal the fricative nature of intended target fricative consonants. In the active nasal fricative, \([\text{m}^\circ] \quad [\tilde{\text{n}}] \quad [\tilde{\text{t}}]\) for /f/, \(\tilde{\text{p}}\) for /s/, \([\text{n}^\circ \text{c}]\) for ‘sore’, \([\text{m}^\circ \text{c}]\) for ‘four’ is the product of actively directed nasal air. Where fricative consonants are the only targets affected by a cleft-type process, the presence of nasal fricatives have been referred to as phoneme specific nasality (Trost-Cardamone...
Active versus passive cleft-type speech characteristics

Figure 3. Active nasal fricative [ŋ].

1990). This characteristic has been found in speakers with no cleft palate history, often with no explanation for its occurrence.

Different places of articulation signalled placement contrasts between nasal fricative consonants in the same way that target nasal consonants [m n ŋ] are differentiated by place of articulation; [m] for /f/; [ŋ] for /s ʃ/. Where a strong backing process existed alveolar and post-alveolar fricatives were realized by velar nasal fricatives [ŋ].

Occasionally, nasal airflow was constricted such that nasal fricatives were produced with a noisier turbulent quality [m] [n] [ŋ]. In a detailed assessment of cleft palate speech, GOS.SP.ASS’98 (Sell et al. 1994, 1998), these turbulent realizations would be categorized in the resonance section as ‘nasal turbulence replacing consonants’, and in the cleft-type characteristics section as either ‘active nasal fricatives’ or passive nasal realization of fricatives.

Glottal articulation

[?] frequently occurred in early plosive and affricate production [p b t d ʧ] up to age 4;6. Sometimes this process affected only alveolar plosives /t d/ in SIWI and SIWW position. At times glottal stop represented voiced plosives [b d g] while [h] represented voiceless plosives [p t k]. In SFWF position glottal stop represented both voiced and voiceless plosives. It may be the case that different strengths of glottal stop were used to distinguish voiceless and voiced plosives but this could not be reliably judged without spectographic analysis. An undergraduate study of spectographic analysis (Shorter 1995) of cleft palate speech identified some subtle differences in glottal stop productions which suggests a need for further investigation into the phonological functions of glottal stops in cleft palate speech.

Pharyngeal fricatives

[ʃ ʃ] Early attempts at fricatives (ages 2;0–3;0) were frequently realized with a combination of posterior fricative cleft-type realizations (CTR). Where plosives were exclusively glottal, fricative consonants were frequently realized as pharyngeal
fricatives. In early phonological development obstruent realizations were commonly non-oral but gradually moved anteriorly to uvular and velar positions. Target consonants were not generally corrected independently of each other. The gradual movement of pharyngeal realizations towards oral, uvular/velar articulation which underlines the relevance of a phonological interpretation of cleft palate speech characteristics.

Exclusively pharyngeal/glottal patterns of articulation might imply velopharyngeal insufficiency but it is noted here that all infants use pharyngeal and glottal articulation until they acquire velopharyngeal competence during the first 6 months of life. It is possible for children with cleft palate to persist with this phonetic repertoire for some time after palate repair. Indeed, such cases have been reported by Russell and Grunwell (1993). Non-oral articulatory patterns indicate that the sphincter is not employed during speech, which implies that the sphincter may not be functional but unless oral airflow is consciously intended, it cannot be assumed that the sphincter is unable to function in speech (Henningsson and Isberg 1986).

**Backing [k ɣ q ɣ]**

A backing pattern is described by Stengelhoven (1989) as a ‘tendency for oral contacts to be to the back of the oral cavity’. GOSSPASS’98 (Sell et al. 1998) makes a distinction here between backing to uvular and backing to velar place of articulation.

- **Backing to uvular [q ɣ χ ɣ].** Alveolar target consonants were backed to uvular realizations and occasionally, velar targets were backed to uvular. The presence of velar and uvular realizations indicated the presence of some VP function but this might have been achieved with tongue humping. In the data, acquisition of uvular and velar fricatives generally co-occurred with acquisition of /ʃ ʋ/ which provides further evidence of velopharyngeal function. In the longitudinal study from age 1;6 to 4;6, subjects with bilateral clefts spent a period of months realizing all alveolar and post-alveolar, voiced and voiceless consonant targets, in uvular placement. This degree of backing is deemed to be more severe and distracting for listeners than backing to velar perhaps because uvular articulation is more distinctively non-English. However uvular fricatives are frequently used to achieve some meaningful contrasts which improve intelligibility.

- **Backing to velar.** In the younger subjects (aged 1;6–4;6), as articulatory patterns progressed anteriorly, a preference for [ɣ] was common. Most commonly backing resulted in /t d/ realized as [k ɣ] and /s z/ as [x ɣ] which contrasts with the fronting pattern seen in normal development.

**Double articulation**

This is defined as two simultaneous equal stricture at two places of articulation which was frequently noted in realizations of target alveolar consonants /t d/ when alveolar/velar contacts [tk ñg] were used. Double articulation may have been developed to distinguish between alveolar and velar consonants in the presence of a backing pattern. Interestingly double articulation became evident in these developing speech patterns with the emergence of fricative realizations. Both plosives and fricatives tended to be realized with double articulation, e.g. /t/–[tk], /s/–[sˀ].
Palatal fricatives \([\mathcal{C}\mathcal{J}]\)

These fricative realizations of alveolar target consonants appeared towards the end of the study period (ages 1;6–4;6). They were the most common realizations of alveolar fricatives in older children (4;6–7;6 and 10;0–11;0). This finding was in accordance with Albery’s results (Albery 1991, Albery and Grunwell 1993).

Lateral fricatives \([\mathcal{L}\mathcal{H}]\)

As with palatal fricatives, lateral fricatives were frequently present as realizations of fricative consonant targets, becoming particularly prevalent in later phonological development.

Gliding of fricatives \(/s\mathcal{J}/ = [\mathcal{J}]\) or \([w]\)

This phenomenon is seen in the non-cleft population as an uncommon developmental process (Grunwell 1987). It is classified here as an active process because \([\mathcal{J}]\) was consistently produced as an apparently active alternative to target consonant \(/s\mathcal{Z}\mathcal{J}/\). \([\mathcal{J}]\) is a normal consonant-like production in non-cleft babble which cleft palate children often integrate into their phonological system. It may be, therefore, that it is a persisting immaturity in the cleft palate population. In these data \([\mathcal{J}]\) was effective in signalling a contrast between plosives and fricatives in SIWI position. It functioned for the following consonants in different speakers: \([\mathcal{J}]\) for \(/s\mathcal{Z}\mathcal{J}/\); \([\mathcal{J}]\) for \(/m\mathcal{P}\mathcal{F}\mathcal{S}\mathcal{Z}\mathcal{H}\); and co-articulation, \([\mathcal{H}\mathcal{J}]\) for \(/\mathcal{G}\mathcal{F}/\).

Passive cleft type processes

The criteria for passive cleft type processes is that they are (1) an attempt to produce the correct articulatory placement and stricture (manner) which (2) fails because of a lack of intra-oral air pressure. For example, voiced plosives realized as nasals: \(/b/ \Rightarrow [m], /d/ \Rightarrow [n], /g/ \Rightarrow [\mathcal{N}]\). No compensatory articulatory pattern has been used to replace the intended consonant. As the above examples demonstrate, target realizations often match a similar English consonant.

Absence of pressure consonants/predominantly sonorant articulation

This phenomenon is defined here as a pattern of articulation which was restricted to English nasal and approximant articulations \([m\ n\ \mathcal{W}\ w\ j]\) and \([h]\). Some of the voiced consonants were also employed as voiceless counterparts \([\mathcal{M}\ \mathcal{N}\ \mathcal{W}\ j]\) thereby increasing the range of available consonants for distribution in the phonological system. Despite the limited consonant repertoire, these patterns were often effectively interpreted by close family members.

Weak articulation \([b\mathcal{V}\ d\mathcal{V}]\)

This category refers to normal articulatory movement in the production of obstruent targets (plosive, fricative and affricate targets) which were produced with reduced oral air pressure and therefore articulation was considerably weakened. In the speech sample data (ages 1;6–4;6) many target consonants were weakened to some degree, and at times may have been realised as nasals.
Passive nasal fricative [(f)m (s)n]

Incomplete velopharyngeal closure inevitably reduces control of oral airflow with a passive loss of airflow and an increase of resonance in the nasal cavity. Grunwell and Harding (1996) defined the passively nasal fricative as an unreleased [(s)] double-articulated with a lowered voiceless nasal [n]. This realization is the product of an intended /s/ with an unintended nasal airflow (see figure 4). The precise transcription for a passive nasal transcription is [(s)n] but an acceptable simplification for transcription purposes is [(s)n] This is distinct from the active nasal fricative which involves stopping of the oral airflow and active direction of air nasally which can be transcribed as a voiceless nasal with additional nasal emission [n]. Nasal emission signals the fricative nature of, for example, target consonant /s/. These two productions can sound the same and might initially be transcribed as [n]. Nasendoscopic investigation of velopharyngeal activity during active and passive nasal realizations of /s/ both show a lack of velopharyngeal closure. It is predicted that close examination by use of electropalatography might show slight differences in tongue tip posture for an active and passive nasal fricative as illustrated in figures 3 and 4. Passive nasal fricatives were converted into oral fricatives with nose-holding.

Voiceless [h] for voiceless plosives

There was evidence that voiceless plosives were at times passively realized as [h]. The consequence of reduced oral air pressure on production of voiceless plosives can leave aspiration as the only perceptible distinctive feature. This process usually affected all voiceless plosive targets /p t k/. Where this process was a passive process, use of noseholding during speech facilitated accurate target production. However, it would also be possible for this distribution of [h] to be an active cleft-type process which would be part of a pharyngeal/glottal pattern/process.

Nasal realization of voiced plosives /b d g/ ⇒ [m n η]

Some subjects with residual clefts, fistulae or suspected VPI realized voiced consonants as nasal counterparts. As summarized by Harding and Grunwell (1996), voiced

Figure 4. Passive nasal fricative [(s)n].
consonants can be more difficult to produce than voiceless consonants (Isshiki and Ringel 1964). Distinction between active versus passive nasal realizations of plosive targets was made in the same way that active and passive nasal fricatives were distinguished, by observing the effect of noseholding on consonant production. In passive nasal realizations, noseholding facilitated normal consonant production. (Golding-Kushner 1995).

**Nasal emission accompanying consonants** [p s]

Nasal emission was frequently heard accompanying consonants but on occasions it apparently replaced consonants. It has been linked with velopharyngeal incompetence (VPI) (Kummer et al. 1992).

**Results**

**Comparison of active/passive processes in the speech data**

Quantitative results of Harding’s research into the relationship between timing of surgery and speech development have already been published (Harding and Grunwell 1993). The following interpretation of the data specifically identifies active/passive cleft-type processes in relation to oral structure in a wide age range of subjects (1;6–13;0). Tables 1, 2, 3 and 4 show the passive and active processes on the left-hand column, and the subject’s code along the top. The code identifies those subjects who were treated with 1-stage versus 2-stage surgery. Comparison of the 4 tables at age 4;6 (BCLP and UCLP), at age 9;0 and at age 13;0 illustrates a pattern of diminishing cleft-type processes with increasing age. Irrespective of surgical timing, few cleft-type processes remained at age 13;0 (table 4). A general observation was that earlier speech samples (ages 1;6–7;6) frequently combined

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<thead>
<tr>
<th>Passive cleft-type processes</th>
<th>1-stage surgery</th>
<th>2-stage surgery</th>
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<td>predominantly sonorant articulation</td>
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<td>weak articulation</td>
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<td>voiceless /h/ for plosive</td>
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<td>nasal release of plosives</td>
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<td>passive nasal fricative</td>
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<td>Active cleft-type processes</td>
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<td>nasal fricatives</td>
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<td>pharyngeal glottal articulation</td>
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<td>lateral, palatal fricatives</td>
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<td>double articulation</td>
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<td>gliding fricative</td>
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f = post-operative fistula.
Table 2. Cleft-type processes in UCLP subjects at age 4;6 (study 2)

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<th>1-stage surgery</th>
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<td>SE</td>
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Passive cleft-type processes
- predominantly sonorant artic
- weak articulation
- voiceless /h/ for plosives
- nasal release of plosives
- nasal emission with consonants
- passive nasal fricative

Active cleft-type processes
- nasal fricative
- pharyngeal, glottal articulation
- backing to uvular
- backing to velar
- lateral, palatal fricatives
- double articulation
- gliding fricative

Table 3. Cleft-type processes at age 9;0

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<thead>
<tr>
<th>1-stage surgery</th>
<th>2-stage surgery completed at 4 yrs</th>
<th>2-stage surgery completed at 8 yrs</th>
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<td>DAF</td>
<td>SBf</td>
<td>RL</td>
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Passive cleft-type processes
- predominantly sonorant artic
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- nasal emission with consonants
- passive nasal fricatives

Active cleft-type processes
- nasal fricatives
- pharyngeal, glottal articulation
- backing to uvular
- backing to velar
- lateral, palatal fricatives
- double articulation
- gliding fricative

f = subject had a fistula.

both active and passive strategies, whereas later samples (ages 9;0–13;0) rarely evidenced passive processes.

At age 4;6 four out of five BCLP subjects used active, non-oral pharyngeal and glottal processes and oral, velar and uvular fricatives, irrespective of surgical status (see table 1). All had some anterior palatal defect which might have reduced their potential to achieve intra-oral pressure.

By comparison two out of three partially repaired 2-stage UCLP subjects at age 4;6 (table 2) showed evidence of passive processes. This suggested that their
Table 4. Speech in relation to surgical timing at age 13:0

<table>
<thead>
<tr>
<th>1-stage surgery subjects</th>
<th>2-stage surgery completed at 4 yrs</th>
<th>2-stage surgery completed at 8 yrs</th>
</tr>
</thead>
</table>

Passive cleft-type processes
- predominantly sonorant artic
- weak articulation
- voiceless /h/ for plosives
- nasal release of plosives
- nasal emission with consonants
- passive nasal fricatives

Active cleft-type processes
- nasal fricatives
- pharyngeal, glottal articulation
- backing to uvular
- backing to velar
- lateral, palatal fricatives
- double articulation
- gliding fricative

m = missing

1 = 1-stage surgery subjects.
2/4 = 2-stage surgery hard palate repaired at about 4 yrs.
2/8 = 2-stage surgery with hard palate repaired at about 8 yrs.
unrepaired hard palates had, in fact, restricted their phonetic repertoire imposing a need for individual adaptability. The additional active processes employed by these subjects were presumably a response to the restrictions imposed by their oro-nasal structure and velopharyngeal function at the time of consonant acquisition. As shown in table 2, the most common active cleft-type processes persisting at age 4;6 with a residual cleft of the hard palate were backing, double articulation and lateral/palatal articulation. Two 1-stage surgery subjects whose entire palates had been repaired at ages 0;9 and 0;10 did not use any cleft-type processes at age 4;6.

By age 9;0 (table 3), a much diminished number of cleft-type processes was evident, except in subjects with sizeable anterior fistulae who had received little speech and language therapy. A similarity was noted between the speech patterns of 1-stage surgery subjects with fistulae (DA and SB) at age 9;0 (table 3) and the younger BCLP subjects at age 4;6 (table 1) who also had anterior palatal defects. They included non-oral realizations of /t d s k g/, occasional nasal fricatives and pharyngeal/glottal articulations. Fistulae had apparently continued to influence articulation and phonological development in these subjects.

Finally, at age 13;0 (table 4) the differences between 1-stage and 2-stage surgery subjects had diminished leaving only one 2-stage subject with occasional backing and four subjects with slight palatal and lateral release of fricative consonants. Only two of the 1-stage surgery subjects were using minor distortions of grooved fricative production.

Whilst there were apparent trends in speech production relating to surgical timing and oral structure, it is noted that there were exceptions to each tentative generalization. Subjects with marked structural imperfections occasionally produced realizations of which they would not have been thought capable, and subjects with no visible imperfections produced inexplicably distorted speech patterns. It is therefore concluded that whilst there is homogeneity in the range of processes produced by this population, assumptions cannot be made about speech based on surgical timing or type of cleft. Tentative predictions based on detailed assessment may be clinically very useful.

Effects of surgery on speech

Active/passive processes have identified those cleft-type characteristics thought to be associated with a physical inability to produce pressure consonants. The following analysis of speech changes after surgical intervention at different ages identifies the changes effected by surgery when intra-oral pressure could be more readily achieved.

Two children were first recorded prior to the first stage of a 2-stage procedure. Their lips were repaired at approximately 6 months of age and soft palate repair was carried out at ages 1;8 and 1;9, respectively. Their hard palates were left unrepaired to facilitate unrestricted growth of the mid-face (Hotz et al. 1978). Pre- and post-operative consonant-like sounds present in the recorded speech samples are listed in table 5. Interestingly, prior to soft palate repair both these children produced some oral consonants. Subject B was producing pressure consonants [k g] in his babble prior to soft palate repair. Considering that he had an unrepaired bilateral cleft palate at this point, it was surprising that he had any oral consonants. Post-operatively, at 2;0 years, he used [b m t d g gb] which indicated that surgery to repair the soft palate had facilitated an increased range of oral pressure consonants. Subject D was producing [p b k g] pre-operatively. Post-operatively, following soft
<table>
<thead>
<tr>
<th>Study 1</th>
<th>Surgery</th>
<th>Pre-operative speech pattern at age 1:6</th>
<th>Post-operative changes in speech at age 2:0</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Soft palate repair at 1:6</td>
<td>Adult targets /k g/</td>
<td>At 2:0 [b bm gb t d g]</td>
</tr>
<tr>
<td>D</td>
<td>Soft palate repair 1:7</td>
<td>Adult targets /p b k g/</td>
<td>At 2:0 [p b d bd k g]</td>
</tr>
</tbody>
</table>

**Table 5. Effects of soft palate repair at age 1:6 on BCLP subjects: hard palate remains un repaired**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Surgery</th>
<th>Pre-operative speech pattern</th>
<th>Post-operative changes in speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>Hard palate repair</td>
<td>6:6</td>
<td>7:6 Eliminated passive process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passive process</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Variable nasal release of consonants</td>
<td></td>
</tr>
<tr>
<td>JF</td>
<td>Hard palate repair (unsuccessful)</td>
<td>6:6</td>
<td>7:6 Active processes remained</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Several active and passive processes</td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>Fistula repair</td>
<td>10:0</td>
<td>11:0 Elimination of pharyngeal/glottal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variability+ +</td>
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<tr>
<td></td>
<td></td>
<td>Articulatory variability+ +</td>
<td></td>
</tr>
</tbody>
</table>
palate repair but with a residual cleft in the hard palate, his range of consonants included [d] which was particularly surprising since the hard palate remained unrepaired. Whilst it is unlikely that toddlers of 18 months could be consciously trying to compensate for articulatory inadequacy, in producing velar plosives in babble prior to soft palate repair and an alveolar plosive prior to hard palate repair, both these subjects showed evidence of actively pursuing their articulatory potential.

Table 6 summarizes changes following surgery to repair the hard palate in more mature speech patterns. These subjects, who were aged 6;6 and 10;0 pre-operatively, had learned to speak with residual clefts and were apparently unaware of the consonant productions that failed to match normal production.

Subject MS used only passive processes in his speech pattern. He realized some consonants nasally such that ‘ball’ was [mɔ] and ‘sock’ was [(s)ɒk]. Looking at post-operative changes at age 7;6, his consonant production was normal but his resonance had become hyponasal. Pre-operatively, at age 6;6, Subject JF, was using several active and passive processes. The active processes were unaffected by surgery but passive processes were eliminated.

Fistula repair was carried out at age 10;0 on Subject DA, who had many active processes and very variable articulation pre-operatively. Post-operatively, at age 11;0, he was not using non-oral, pharyngeal and glottal active processes or nasal realizations but many oral cleft-type realizations remained.

As shown in table 7, hard palate re-repair and pharyngoplasty was carried out on two subjects whose hard palate repairs had been unsuccessful at approximately 4 years. Subject NC assessed pre-operatively at age 5;6, was using predominantly passive processes in her speech. She was also using [j] for fricatives /s/ and /ʃ/ which was thought to be an active process. At age 6;0, following hard palate re-repair and pharyngoplasty, all cleft-type processes had been eliminated without post-operative speech therapy. Since [j] for /s/ apparently resolved spontaneously following surgery it can be assumed that this was a passive process in this speech sample.

Subject CP who underwent this procedure presented pre-operatively at age 4;6 with both passive and active processes but his nasal resonance was not consistently hyponasal. In addition to his cleft-related speech disorder this subject had additional developmental speech difficulties which were identified as being unrelated to the cleft. Post-operatively at age 5;6, little had changed—notably the passive process nasal [m] for /b/ was retained. His nasal resonance had become hyponasal and there was no apparent benefit from surgical intervention. The realization of /b/ as [m] had become phonologically stable and surgery alone had not destabilized the phonological system. This realization may have been a passive product of VPI in early speech acquisition which had subsequently become part of a phonological disorder. Post-operatively CP’s phonetic repertoire did increase but the phonological distribution was variable. Plosive targets were still realized as nasals in spontaneous speech at the final speech recording at age 7;6. This was not as an inevitable consequence of VPI, but a result of an inability to destabilize the phonological process determining that voiced plosives would be realized as nasals. This result following surgery highlights the importance of identifying phonological learning problems and distinguishing them from structural constraints on articulation. In CP’s case, pre-operative exploration of the effect of nares occlusion during speech might have indicated that structural change would not improve consonant production spontaneously.

A general observation was that consonant realizations did not move rapidly
<table>
<thead>
<tr>
<th>Subject</th>
<th>Surgery</th>
<th>Pre-operative speech pattern</th>
<th>Post-operative changes in speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 2</td>
<td>Hard palate re-repair and pharyngoplasty 5:10</td>
<td>5:6 Passive cleft-type processes [ j ] for fricatives [ h ] for plosives SIWI Variable articulary precision</td>
<td>6:0 All cleft-type processes eliminated</td>
</tr>
<tr>
<td>CP</td>
<td>Hard palate repair and pharyngoplasty 5:0</td>
<td>4:6 Passive and active processes</td>
<td>5:6 Passive process [ m ] for [ b ], retained Hyponasal nasals Persisting phonological confusions</td>
</tr>
</tbody>
</table>
from incorrect to correct but progressed incrementally towards normal realizations, as described by Morley (1970). Where an early realization of target /s/ might be glottal [h], a gradual pattern of change showed subsequent realizations to be pharyngeal [h], then uvular [χ] then velar [x] and eventually palatal [c] or lateral [l]. It was interesting to note that speech patterns continued to change as late as 9;0–11;0 years with the result that differences related to surgical timing and cleft-type gradually disappeared. Persisting fistulae were thought to account for the most marked cleft type processes at age 9;0.

Implications for surgical management

This analysis of speech changes following surgery suggests some implications for surgical management which are compatible with Sell and Grunwell’s (1990) findings in the Sri Lankan study.

Surgery can change passive speech processes, but it is also possible that speech therapy may be able to change passive patterns. Surgery alone is unlikely to modify active cleft-type processes, whereas speech therapy should be able to modify active processes. Indications from these case studies is that where speech is the primary problem, speech assessment should distinguish between active and passive processes in order to evaluate the necessity for full investigations and to plan therapeutic intervention. Where past speech therapy has not been successful, it cannot be assumed that surgical intervention will facilitate further speech progress. A further course of speech therapy which is sensitive to active versus passive processes, to developmental phonological influences on cleft-type speech development and to articulatory difficulties in different speech contexts might facilitate optimal progress. Where structural imperfection exists, it is quite possible for single-word production to be more precise than target realizations in spontaneous speech. This may not be a failure of phonological generalization (Grunwell 1992) but the result of difficulty sustaining the necessary ‘articularatory effort’ (Harding and Grunwell 1993) resulting in articulatory imprecision. Deteriorating articulatory accuracy should not be overlooked in interpretation of speech results.

An analytical protocol

As a result of analysing the speech data and identifying the active and passive processes a protocol has been developed which records examples of each cleft-type process over a series of assessments. It demonstrates the progression of individual processes towards an adult target (see the Appendix). At each assessment one column is used to indicate nasal resonance, nasal emission and nasal turbulence ratings and cleft-type processes. Changes in the nature of error realizations might show progress towards target consonants. Hence, whilst the total correct score might not have increased increments of change can be observed. This observation of patterns of change may function as an adjunct to GOSSPASS’98 (Sell et al. 1998) giving access to a greater depth of both quantitative and qualitative data about consonant production in relation to resonance, nasal emission, nasal turbulence, oral structure and cleft-type.
Diagnostic implications

Passive versus active nasal fricatives

The important management consideration related to this distinction is that an active nasal fricative is an established phonological process which is unlikely to be directly affected by surgery alone. Therapy would be necessary to destabilize nasal realizations of oral consonants. In contrast, passive nasal fricatives may be eliminated by surgery. Of particular relevance is differential diagnosis between passive and active nasal fricatives in surgical and therapeutic management. When hypernasality co-occurs with nasal airflow during consonant production which can be redirected by nose-holding, passive nasal fricatives are diagnosed. These would be transcribed as [(s)n] passive alveolar nasal fricatives, [(F)m] bilabial nasal fricatives or [(f)m] labiodental nasal fricatives. Full VPI investigations would be recommended to diagnose the nature of the structural or functional deficiency and distinguish between velopharyngeal incompetence and velopharyngeal mislearning.

It is highly likely that plosive targets would be affected by reduced intra-oral air pressure such that plosives would either be realized by nasal counterparts, e.g. /bd/ => [mn] or [bd] may be nasalized and weak. Voiceless plosives may be either accompanied by nasal emission [ptk] or realized as glottal fricative [h].

Production of the target sentence ‘I saw Sam sitting on a bus’ might be:

[ai (s)n (s)æm (s)hin (n) m (s)n]: passive processes, and
[ai xɔ xæm xikn (n) ɔ ɡax]: active processes.

Contribution to surgical management decisions

Passive/active interpretation of clinical assessments might facilitate surgical management decisions. If noseholding does not facilitate correct production of target consonants then it is likely that an alternative articulatory pattern has become phonologically established, i.e. particular realizations for one or more targets are consistently distributed in the phonological system. These realizations may have evolved because of initial difficulty producing articulatory targets and subsequently stabilized within the phonological system. Grundy and Harding (1995) refer to this phenomenon as an ‘articulatory disorder with phonological consequences’.

Therapy

Where obvious structural defects or diagnosed dysfunction exists, clinicians frequently defer therapeutic intervention until surgery has been undertaken. The expectation would be that normal structure and function is essential for normal speech. However, pre-operative therapy may facilitate oral consonant production which may serve to reduce hypernasal resonance. Hence, therapy prior to surgery may avoid unnecessary surgery or reduce the extent of surgery required. All active processes are likely to require therapy.

Principled selection of targets for therapy

Speech patterns frequently evidence a mixture of apparently passive and active processes which complicates decisions about target selection. Target selection can
be based on assessment of which consonant targets can be most easily elicited in isolation (stimulability). This may lead to a sequence of target selection which is opposite to the sequence of consonant acquisition in normal development. For example, where reduced intra-oral pressure is present in a passive pattern, [ʧ] may be easier to elicit in imitation than more finely grooved [s] or [ʃ]. Therapy may target [ʧ], followed by [ʃ] and finally [s]. As in non-cleft phonological therapy, where a class of consonants is affected by the cleft then it is helpful to target the entire class. The following decision-making process can be applied for both active and passive processes.

Decision making procedure for target selection:

1. Voiced versus voiceless targets.
2. Front versus back placements.
3. Syllable initial versus syllable final targets.
4. Plosives versus fricative targets.

Voiceless plosives and fricatives are produced with an open glottis which facilitates topping up of airflow from the lungs, hence voiceless plosive and fricative targets are frequently more successful than voiced counterparts (Isshiki and Ringel 1964). Front targets usually cause more difficulty than back, particularly where an alveolar defect or fistula exists. Contrary to normal development, back targets may be targeted before front. Word-final targets generally require less oral air pressure than word initial targets and similarly fricatives may be more easily elicited than plosives. Fricatives do require a greater volume of air than plosives (Fletcher 1985) but in the presence of nasal escape, weak fricative production appears to be more readily achieved than weak plosive production. Since final fricatives would normally be acquired in advance of word-initial fricatives (Ferguson 1978), targeting word-final fricatives is frequently a productive starting point for therapy.

**Principles of therapy for passive processes**

1. Use of soft attack similar to gentle whisper for all target models ensures minimal articulatory effort (Harding and Grunwell 1993) and requires minimal intra-oral air pressure. It may be appropriate to gradually increase the articulatory attack when the articulatory posture and evidence of intended oral airflow have been established.
2. Slightly stretched duration of segment transitions in models of: consonant to vowel (C–V) or vowel to consonant (V–C) facilitates review of motor planning and extends the available time for execution of the new motor programmer whilst maintaining control of the oral airstream.
3. Noseholding can be used to provide exclusively oral airflow. Gradual release of the nostrils during production of sustained [fmmm[m]f] or [00000 ] allows the child to attempt to sustain an oral consonant despite increasing nasal emission. This maximizes the use of available oral airflow. Procedures for using noseholding are described in some detail by Golding-Kushner (1995).

**Principles of therapy for active processes**

This is more like phonological therapy and can follow Grunwell’s (1991) processes for phonological change and principled decision-making (Grunwell 1992). Some
examples are given here by way of illustration, of ways to effect the first two processes of change which may need to be approached differently in cleft palate versus non-cleft speech disorders. Different approaches may also be appropriate for modifying active versus passive cleft-type processes.

Innovation: production of new targets. Some useful principles:

1. Introduction of new ‘non-speech like’ targets in sound play using a consonant sound segment model such as [pʰ]; note not a syllable like [pə] which is the type of pronunciation used when target sounds are presented as letters for reading. Target [s] might be introduced as a ‘Train Slowing Down Noise’ [ts ts ts tsssssss].

2. ‘New consonants’ can later be modelled and elicited in soft productions of syllable structure: [tssss–i] [i–tssss] which can subsequently be identified as similar to words ‘sea’ and ‘eats’.

3. ‘Deferring responsibility’ transfers responsibility or ‘blame’ for errors from the child and attributes it to the articulators e.g. ‘your tongue is having trouble with …’, ‘Let’s show your tongue how to …’.

4. New targets can be modelled repeatedly, and recorded on audio or video tape which can be listened to at home.

5. Targeting classes of consonants (e.g. alveolars /t d s n l/, voiceless fricatives /f s ʃ/ perhaps with affricate /ʃʃ/ avoids phonological confusion which might occur if production of /s/ is achieved whilst other alveolar targets remain backed. The risk is that /s/ might not integrate into the phonological system unless all backed alveolar consonants are destabilized.

6. Increased eye contact during auditory and production work can be invaluable in holding visual and auditory attention and ensures that visual information about the sound has been processed. This is easily achieved by the clinician lifting any focus of the child’s attention close to his/her mouth at the precise moment when the target is modelled.

Stimulation of non-speech related sounds, such as a ‘Train Slowing Down Noise’ [ts ts ts ss], confirms that target [s] is physically achievable whether or not [ssss] can be imitated. Some children continue to access [s] through the ‘Train Slowing Down Noise’ throughout therapy until it is occurring spontaneously, without conscious planning. This can be an effective means of undermining established motor programmers (Hewlett 1990) for active cleft-type processes.

Destabilizing active processes

As it is likely that children will be unaware of each occurrence of their alternative articulatory pattern for specific consonant errors, it is preferable to destabilize active processes with minimal conscious effort by the child. As children become aware of their mismatches, they frequently add the newly acquired target realization to their existing production, e.g. target word /tu/; child’s old realization [ku]; child’s corrected realization [t-ku]. Destabilization can be achieved with minimal conscious effort through input therapy techniques such as auditory bombardment (Lancaster and Pope 1989), auditory decision-making, such as ‘which bear says this word properly?’ Red Bear says: ‘two’ or Blue Bear says: ‘coo’. This type of strategy often precipitates attention to the target consonant with possible ‘replay’ and ‘review’ of
their own production. Frequent stimulation of cognitive alertness to the target consonant can develop awareness without confronting the child with errors or risking his/her failure. The child is then free to attempt to repair his/her own realization, to continue to reflect and to silently rehearse the adult realization. Traditional articulation therapy is thus combined with development of metaphonological skills, i.e. the ability to reflect upon one’s own speech production. The result should be that new target realizations will be more phonologically stable than exclusively production-based articulation therapy might have facilitated.

Stabilization/generalization

Procedures to ensure stabilization and generalization of new target consonants would be as described by Grunwell (1992). Success may be constrained by the considerable articulatory effort sometimes required to maintain pressure consonant production in spontaneous speech (Harding and Grunwell 1993).

Conclusions

In speech assessment, it is helpful to distinguish between errors which are cleft-type and non-cleft type, and those which are part of active versus passive processes. The active and passive processes have been defined and their phonological implications discussed. Focus on active and passive processes has facilitated focus on the phonological consequences of cleft palate on speech development. In the future, awareness of the likely effect of a cleft palate on normal phonological development could avoid extended periods of unsuccessful clinical intervention. Furthermore, sensitivity to the relationship between phonological processes and structural constraints should facilitate theoretically based management decisions. Incidences such as the case of CP in which nasal realizations were thought to indicate VPI but were subsequently unaffected by surgery, might be avoided if phonological analysis contributes to management decisions.

Surgery did improve hypernasal resonance and eliminated passive processes but had little effect on active processes. Active processes in younger subjects were thought to require therapeutic intervention, but in the longer term, the older subjects showed few cleft-type processes. Whilst it is possible that active cleft-type processes may resolve with increasing age the implication for the future is that active cleft-type processes should be treated with skilled therapeutic intervention, not surgery. Therapy which addresses the phonological consequences of cleft palate on speech development by combining metaphonological/phonological/articulatory approaches is likely to be successful.

References


Active versus passive cleft-type speech characteristics


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KUMMER, A. W., CURTIS, C., WIGGS, M., LEE, L. and STRIFE J. L., 1992, Comparison of velopharyngeal gap size in patients with hypernasality, hypernasality with nasal emission and nasal emission, or nasal turbulence (rustle) as the primary speech characteristic. *Cleft-palate-Craniofacial Journal, 29* 152–156.


Appendix. Active passive analysis of cleft palate speech

Name: JW  Age (y) 5.0  5.6  DoB:  Type of Cleft: BCLP

<table>
<thead>
<tr>
<th>Date of Assessment</th>
<th>CA 5.0</th>
<th>CA 5.6</th>
<th>CA</th>
<th>CA</th>
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</thead>
<tbody>
<tr>
<td>Nasality and Nasal Air Flow</td>
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<tr>
<td>Hypernasality</td>
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<tr>
<td>Absence of pressure consonants</td>
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<td>Weak articulation</td>
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<td>Voiceless affricates for plosives</td>
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<td>Nasal release of plosives</td>
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<td>Nasal emission with consonants</td>
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<td>Passive nasal fricatives</td>
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<td>Active nasal fricatives</td>
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<td>Pharyngeal, glottal articulation</td>
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<tr>
<td>Backing to velar</td>
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<tr>
<td>Double articulation</td>
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<td>Gliding fricatives</td>
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</tbody>
</table>

### Summary

- Date: 10.90 CA 5.0
- Date: 4.91 CA 5.6

- Marked backing pattern affecting all alveolars

- Alveolar realization more stable; only /l/ is consistently backed velar