SPEECH DEVELOPMENT IN CHILDREN WITH CLEFT LIP AND PALATE

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ABSTRACT

This investigation presents the results of a longitudinal study into the phonetic and phonological development of children with cleft palate and cleft lip and palate from pre-speech to the age of 4;6. The aim of the project was to investigate the extent to which the cleft palate condition affects the nature and chronology of phonetic and phonological development. The investigation comprised two studies. Eight children were studied; five in Study 1 and three in Study 2. The aims of both studies were to determine the existence of any abnormal patterns in pre-speech vocalisations, the relationship between phonetic and phonological patterns in the children's speech, the nature and extent of any delay in development and whether any delay or deviance could be attributed to physical, phonetic or phonological factors. In Study 2 the period between 1;6 and 3;0 was investigated more closely in order to determine whether there is a point at which it is possible to predict subsequent abnormal phonological development.

Audio recordings were made prior to, and at regular intervals following, the operation to repair the palate. The pre-speech vocalisations were transcribed phonetically and classified using an auditory phonetic framework. The speech data were also transcribed phonetically. Phonetic inventories of the pre-speech vocalisations and speech were constructed. Phonological and word analyses were carried out on the speech data.

The results of both studies confirm that there is phonetic deviance particularly in the pre-speech vocalisations of these subjects. In addition there appears to be a relationship between phonetic and phonological development in these cleft palate children. Characteristics associated with cleft palate speech patterns can be detected in the data of all the children but at different stages and to different extents. There are some common tendencies but there is considerable individual variation and it appears that each child has his/her own route for phonetic and phonological development.

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CONTENTS VOLUME 1

CONTENTS - VOLUME 2

APPENDIX III - FIGURES FOR CHAPTERS 5 and 6

STUDY 1 (CHAPTER 5)

STUDY 2 (CHAPTER 6)

CHAPTER 1

INTRODUCTION

It is well known that the cleft palate condition which affects the physical structure of the mouth and face has potential consequences for normal speech and language development. However, the nature of the relationship between the physical defect and subsequent speech development has not been clearly established. The purpose of this project is to investigate the developmental changes in the vocalisations and speech of children with cleft palate and cleft lip and palate, from pre-speech to the age of 4;6. The need for such research is indicated by Crystal (1981,1987) who stresses the importance of using phonological as well as phonetic analyses to study the speech of children with cleft lip and palate in order to

> "determine the extent to which an adequate phonological system is being obscured by purely phonetic deviance, or whether there is in addition an underlying disturbance of a phonological type; if the latter, whether it is something unique to the cleft palate condition, or a manifestation of some general pattern of delay."
>
> (Crystal, 1981, p193)

The aim of this project, therefore, is to study in depth the pre-speech vocalisations and speech development of children with palatal clefts in order to investigate:

1) the relationships between the physical defect and phonetic and phonological patterns

2) the relationship between pre-speech vocalisations and the early stages of speech development

3) the extent and nature of any delay in development

4) whether any differences can be attributed to phonetic, phonological or physical factors.

The literature review in Chapter 2 describes previous studies of the pre-speech vocalisations and speech development of cleft palate children. These are discussed in the light of current thinking about the development of babbling and its relationship with speech. In addition previous studies of the established speech patterns of cleft palate children are described. The effects of otitis media with effusion (OME) on speech development are also discussed with reference to the prevalence of this condition in the cleft palate population. It is established that there is a need for further longitudinal studies of the phonetic and phonological development of cleft palate children.

Theoretical issues in the investigation of cleft palate speech are explored in Chapter 3. It is demonstrated that there is a need to address these issues from a developmental perspective commencing in the pre-speech stage of development. In addition Chapter 3 outlines the two studies which were undertaken to investigate these theoretical issues. Both studies investigated the phonetic and phonological development of cleft palate children from immediately prior to the operation to repair the palate to 4;0 or 4;6. In total eight children were studied; five in Study 1 and three in Study 2. The aims of both studies were to determine: the existence of

any abnormal phonetic patterns in pre-speech vocalisations; the relationship between phonetic and phonological patterns in the children's speech; the nature and extent of any delay in development and whether such a delay could be attributed to physical, phonetic or phonological factors; the existence of common tendencies as well as individual variation in the children's speech development. In addition in Study 2 the period between 1;6 and 3;0 was investigated more closely in order to determine whether there is a point at which it is possible to predict subsequent abnormal phonological development in cleft palate children.

Chapter 4 describes the methodology of the investigation. Audio recordings were made prior to, and at regular intervals following the operation to repair the palate up to the age of 4;0 or 4;6. The pre-speech vocalisations were transcribed phonetically and classified using an auditory phonetic framework. A computer program was used to identify single units of vocalisation and to measure durational aspects of the children's vocalisations. In addition a statistical analysis was carried out on the pre-speech data. The speech data were also transcribed phonetically. Phonetic inventories of the children's pre-speech vocalisations and speech were constructed. Phonological analysis was carried out on the speech data. In Study 2 a word analysis was undertaken in addition to the phonetic and phonological analyses.

The results of Study 1 are presented in Chapter 5 and those of Study 2 in Chapter 6. The results of both studies confirm that there is phonetic deviance

particularly in the pre-speech vocalisations of these subjects. In addition there does appear to be a relationship between phonetic and phonological development in these cleft palate children. Characteristics associated with cleft palate speech patterns can be detected in the data of all the children but at different stages and to different extents. There are some common tendencies but there is also considerable individual variation and it appears that each child has his/her own route for phonetic and phonological development. The presence of conductive hearing loss associated with OME appears to be a contributory factor to delayed and deviant speech development for some children.

In Chapter 7 the results are discussed with reference to the theoretical issues explored in Chapter 3. The inter-relationship between the physical condition and phonetic and phonological development is examined. Natural explanations are proposed for some aspects of the results. It is concluded that the cleft palate condition has consequences for both phonetic and phonological development. It is contended that it is possible to identify children who may subsequently experience difficulty with speech development from their pre-speech vocalisations. The implications of these findings for the management of cleft palate children are also discussed in Chapter 7.

CHAPTER 2

LITERATURE REVIEW

PREVIOUS STUDIES OF THE BABBLING PATTERNS AND EARLY SPEECH DEVELOPMENT OF CLEFT PALATE CHILDREN

Until recently there was a lack of studies of the pre-speech patterns and early speech development of cleft palate children. The early reports of Westlake & Rutherford (1966) and Ross & Johnston (1978) both cite Olsen's 1965 study of unoperated babies between the age of five and thirty months of age. This study indicated a delay in the onset of babbling and a tendency to articulate sounds using the 'posterior part of the vocal tract' rather than the lips and front of the tongue. On the basis of Olsen's study, Westlake & Rutherford (op cit) state that 'some of the characteristics of later cleft palate speech are discernible in the pre-speech vocalisations of these children.'

One of the more recent studies was conducted by O'Gara & Logemann (1988) in the United States. They analysed pre and post-operative recordings of cleft palate children aged between six and thirty six months. There were two groups of children: the 'earlier/greater tissue' group had a greater amount of palatal tissue and palate repair was carried out prior to or at twelve months; the 'later/lesser tissue' group had less palatal tissue and, therefore, a more extensive cleft of the palate. In this

second group palate repair was delayed until after twelve months. The results of this study indicated a predominance of glottal articulations for both groups of children. In the earlier/greater tissue group, however, a decrease in glottal articulations and an increase in oral stops and fricatives occurred sooner than for the second group. Even though the mean age for palate repair in the first group was 9.3 months, their use of oral plosives and fricatives post-operatively was much less than that of normal children. O'Gara & Logemann (op cit) suggest that the delayed onset of more normal phonetic patterns post-operatively 'may be governed by the structural constraints present in the first months of life , despite an intact learning system.'

Mousset & Trichet (1985) in France, carried out a longitudinal study of the acquisition of the plosive consonants [p] [t] and [k] after palate repair. They compared two groups of children who had undergone repair at different ages (six and eighteen months). None of the group who had their operation at eighteen months produced plosives prior to palate repair and four months later only 67% of this group were using all three plosives. In the group who were repaired at six months, 83% of the children were using at least two of the plosives at eighteen months.

Dorf & Curtin (1982) also studied two groups of children who had 'early' (prior to twelve months) and 'late' (after twelve months) repairs. They found a higher incidence of 'compensatory articulations (mid-dorsum palatal stops, posterior nasal fricatives, velar

fricatives, pharyngeal stops, pharyngeal fricatives, and glottal stops)' in the group who had later palatal repair. In addition, they comment that there seems to be a link between the child's pre-operative articulatory ability and post-operative patterns. Two children in the early repair group who did use compensatory articulations post-operatively had already developed these articulations pre-operatively. Conversely, children in the late repair group who did not develop compensatory articulations had been reported to be extremely delayed in their articulatory development pre-operatively.

Henningsson (1989) compared two studies of the babbling and early speech development of cleft palate children. In one study palatal repair was carried out at eighteen months and in the other study, at twelve months. The results of this comparison indicated that in both studies there was a delay in phonetic development prior to palate repair. Post-operatively, the children who had palate repair at twelve months showed an increase in the quality and quantity of babbling and moved towards more normal phonetic patterns sooner than the children repaired at eighteen months. However, even the earlier repair group continued to evidence delay in comparison with normal development.

Estrem & Broen (1989) investigated lexical choice in the speech patterns of cleft palate children acquiring their first fifty words. They examined the word-initial target phonemes and the realisations of those phonemes used by five cleft palate and five normal children. The cleft palate group 'tended to target more words with word-

initial nasals, approximants and vowels ([+sonorant] phonemes) and fewer words with word-initial stops, fricatives and affricates ([-sonorant] phonemes)' than the normal children. In addition, with regard to place of articulation, the cleft palate children targeted more word-initial consonants articulated 'at the periphery of the vocal tract ([-coronal])', whereas the normal group targeted more 'consonants articulated at the center of the vocal tract ([+coronal])'. Estrem & Broen (op cit) report that the same patterns occured in the speech production of both groups. Within the cleft palate group, however, there were individual differences and the authors acknowledge the possible influence of conductive hearing loss, physical structure and timing of palatal surgery.

These studies provide evidence that the cleft palate child is at risk for abnormal and delayed phonetic development. In addition, they suggest that earlier repair facilitates earlier development of more normal phonetic patterns post-operatively.

BABBLING PATTERNS AND THE RELATIONSHIP BETWEEN BABBLING AND SPEECH IN NORMAL DEVELOPMENT

Jakobson (1968) considered that babbling was produced purely for pleasure and vocal play and that it was not related to meaningful speech. This classic theory has now been discredited by evidence from subsequent studies which supports the view that babbling is 'an important

prerequisite to future articulation development.' (Mowrer 1980). Furthermore, it has now been clearly established that there is an almost isomorphic link between the phonetic repertoire of babbling and the basic sound system of a child's language, whatever that language may be (Oller, Wieman, Doyle & Ross 1975; Locke 1983).

Oller et al (1975) studied the babbling patterns of ten children and found that the phonetic characteristics of early meaningful speech could be found in the pre-speech vocalisations of these children. Locke (1983) describes how 'the infant's variegated babbling is intimately related to his early speech patterns...' and illustrates that there are cross-linguistic tendencies in the development of phonetic features. For example, 'there is a tendency for stops to be acquired prior to fricatives.' He states that 'it should be possible to predict the patterns of a particular child speaker from his articulatory patterns as a babbler.' It can therefore be hypothesised that, if the same relationship exists in the cleft palate population, that the early speech patterns of cleft palate children will be related to their babbling patterns.

The stages in the development of early vocalisation, babbling patterns and early speech have been clearly outlined by Stark (1980,1986), Oller (1980), Locke (1983) and Roug, Landberg & Lundberg (1989). There is general agreement that there are five major stages in the development of babbling but as Roug et al (1989) point out there is some disagreement regarding the age of onset and duration of each stage. They suggest that this is due

to differences in methodology and to individual variation in the groups of subjects studied. In addition, as Stark (1986) comments, there is considerable overlap between the different stages of vocalisation development.

Stark (1986) describes in detail five stages covering the period from birth to eighteen months, and relates the child's vocal output to the anatomical and physiological changes which take place in the vocal tract as the child grows and develops motor control. The first stage is 'reflexive vocalization' which occurs during the first few weeks of life when the infant makes crying and vegetative sounds. At about six weeks the infant enters the 'cooing and laughter' stage when 'comfort' sounds are produced, often in interactive situations. Stark (1986) states that these sounds contain some consonantal elements which are all produced at the back of the mouth 'where the tongue and palate are most likely to resume contact with one another during vocalic sound'. In the 'vocal play (16-30 weeks)' stage longer segments are produced and 'consonantal elements are now produced more anteriorly in the mouth.' Non speech-like segments which Stark terms 'primitive segment types' are used repetitively in a variety of different situations. At the end of this third stage 'mixed vocal play' occurs, in which consonantal and vocalic elements are used in longer series of segments. In other respects, however, 'they do not resemble syllables of adult speech in their durational aspects or other articulatory features' (Stark 1980). Oller (1980) describes this stage as 'marginal babbling' which occurs during his 'expansion stage.'

Like Stark (1980,1986), Oller (1980) also describes five stages in vocalisation development but he relates them to the sounds of speech and excludes non speech-like or vegetative sounds. He focuses on sounds which the infant produces frequently, inferring that this indicates a measure of control as opposed to accidental usage. Stark's and Oller's five stages are complimentary because of the different emphasis each adopts to the study of infant vocalisation. Oller's 'phonation' and 'GOO' stages provide more information about the speechlike sounds used during Stark's 'reflexive vocalisation' and 'cooing and laughter' stages. Oller describes the sounds in terms of 'quasi-resonant nuclei (QRN)' and 'fully resonant nuclei (FRN).' QRNs 'include normal phonation ...but do not seem to involve any systematic contrast between opening and closure of the vocal tract, and do not make full use of the vocal cavity as a resonating tube.' FRNs are vowel-like elements. In order to relate infant vocalisations to speech Oller (1980) uses a metaphonological approach. Oller (1986) illustrates how such an approach can be used to bridge the gap between acoustic and auditory phonetic analyses.

The timing aspects of babbling patterns begin to resemble speech more closely in stage four which Stark (1980) terms 'reduplicated babbling' and Oller (1980) 'the canonical stage'. It is at this stage that Oller (1986) states that 'if the infant sounds are canonical and obey all the restrictions of metaphonology, then transcription can be performed with reasonable reliability and insight' thus indicating that the infant has achieved a greater

measure of phonetic skill and control. In this canonical stage, sequences of consonant-vowel syllables are produced in which the same consonant is used in every syllable. In addition, nonreduplicated utterances, often containing a single consonant also feature in the child's vocalisations (Oller,1980). In stage five which Stark calls 'nonreduplicated babbling' and Oller, perhaps more appropriately, 'variegated babbling,' different consonants and vowels are used within a sequence and there are a greater variety of different stress and intonation patterns. It is during this stage that the child's 'first words' begin to be identified by adults.

Roug et al (1989) studied the phonetic development of four Swedish children from 0;1 to 1;5 and also report five stages in the development of early vocalisations. The first stage is termed 'the glottal stage' because of the predominance of glottal articulations during this period. The second stage which corresponds with Oller's 'GOO stage' and with Stark's 'cooing and laughter' stage (Oller 1980, Stark 1980) is the 'velar/uvular stage'. In this stage non-nasal supraglottal articulations which are 'typically velar/uvular voiced fricatives' occur (Roug et al, op cit). The third stage described by Roug et al (1989) is the 'vocalic stage' when infants are using 'relatively long vocalizations with non-speech-like intonation patterns resembling singing patterns rather than speech.' They suggest that during this stage the infant is exploring the sound sources of the vocal tract. The fourth and fifth stages are the 'reduplicated consonant babbling stage' and 'the variegated consonant

babbling stage' which are similar to both Stark's (1986) and Oller's (1980) final two stages. In stage four, Roug et al (1989) identify the sudden and stable onset of 'reduplicated babbling prime', which involves the use of stop consonants and occurs between 0;6 and 0;11, as 'a major phonetic milestone'. Following comparison of their own data with that of other studies including Oller (1980) and Stark (1980), Roug et al (op cit) tentatively conclude that there is a universal course of phonetic development in babbling during the first year of life.

Locke(1983) discusses in detail, with reference to his own and other studies, the relationship between pre-speech patterns and phonological development. He considers 'phonological development to be a continuous process whose beginnings predate the child's first words' and describes three stages in the development of the child's phonological system. In the 'pragmatic stage' the child learns that vocalisation can convey messages to others; a scream, for example, can attract an adult's attention. Then in the 'cognitive' stage which begins at about 12 months, the child realises that particular phonetic combinations have meaning and he begins to use his first words. These are based on the same phonetic inventory as his most recent pre-speech babbling patterns. In the third 'systemic stage' further phonetic development occurs and 'the child's system moves in the direction of the adult system in ways it would not be expected to without environmental stimulation.' During this stage the child begins to use consonants which were not present in his pre-speech inventory and decreases his

use of those, such as glottal stops, which are not required in the language of his environment. At this stage, therefore, it might be expected that a cleft palate child with an efficient velopharyngeal mechanism would move towards a pattern of more normal phonological development.

NORMAL PHONETIC AND PHONOLOGICAL DEVELOPMENT

It is during the 'cognitive stage' described by Locke (1983) that a child gradually develops a vocabulary of single words. The child's first words usually consist of simple CV and VC structures with some CVC forms occurring during the first fifty words (Ingram 1976,1989). During the child's acquisition of his/her first fifty words, the speech production system is essentially word based. 'Each word is phonetically related to its adult model, but has a "life of its own", in terms of its phonetic variants and the progressive changes in its pronunciation' (Grunwell 1981). There is considerable variability in the production of the same and different words and as Leonard et al (1980) observed 'children's use of sounds often varied with the lexical item being produced'. Ingram (1986) comments on the frequent occurrence of homonyms which are identical realisations used by the child for several different adult target words. Because of the variability in consonant usage which may change from word to word, Ferguson & Farwell (1975) comment that more traditional systems of consonant analysis are not

sufficiently sensitive. Some studies of this stage of development have, therefore, employed lexical tree analysis (Ferguson & Farwell 1975, Shibamoto & Olmsted 1978, Leonard, Newhoff & Mesalam 1980).

Using the word as the framework for analysis, Ferguson & Farwell (op cit) constructed 'phone classes' from words with the same word initial phone or set of variant phones. 'Phone trees' were then created from the phone classes used by the child at different recording sessions. This analysis was applied to the data of three children and the results revealed overall trends and individual differences in consonant usage. In addition the words used by the children indicated that there was individual lexical selectivity. Shibamoto & Olmsted (1978) extended the analysis used by Ferguson & Farwell (1975) to include within-word consonants. The results of this investigation led the authors to hypothesise that 'lexical selectivity operates on the first phone to determine whether the child will attempt the word or not; thereafter phonological rather than lexical processes shape the reminder of the word'. Common trends with considerable variation in the production of word-initial consonants is also reported by Leonard et al (1980). In comparing their results with those reported for other studies the authors comment that 'particular phones are reflected in the early speech of most if not all young English-speaking children, other phones tend to be used by only a small percentage of children, and still other phones may not be reflected in the early speech of any child.'

Grunwell (1981) compares the initial consonants used in the first fifty words of the children investigated in the three studies described above. This comparison highlights the individual variability and also indicates common features. Grunwell (op cit) suggests that it is appropriate 'to describe the phonology of the first fifty words as the stage at which systemic phonological development is incipient.' Ingram (1989) suggests that there are three patterns of sound development during the child's early word acquisition:- '(1) lexical, i.e. a sound only found in a single word, (2) gradual, i.e. a sound spreading gradually to more and more words and, (3) abrupt, i.e. a sound shows a sudden occurrence in several words.' Furthermore, he proposes that the sounds included first in the child's 'basic' set are 'phonologically more prominent' than those acquired later.

During the child's acquisition of his/her first fifty words, therefore, 'the phonetic inventory is small, with some basic segments as well as individual variation' (Ingram 1976,1989). In addition the word appears to play an important part in this stage of development and as Ingram (1976) states 'the child does not seem to have a productive sound system'.

The 'systemic stage' (Locke 1983) begins at about 1;6-2;0 after the child has acquired a basic vocabulary of at least fifty words. Ingram (1989) describes the rapid increase in vocabulary at this age as a milestone which 'suggests that a significant change in phonological organization has taken place.' It is during this stage that the child begins to use perceptual and cognitive

information to establish the 'rules' of his phonological system. As Grunwell (1981) points out, this is an active process on the part of the child. In addition, Ingram (1986) illustrates that some children have individual phonological preferences. During the gradual development of the child's phonological system, phonological simplifying processes are evidenced (Ingram 1986, Grunwell 1987a). These processes are used by the child to simplify the phonological units of the adult pronunciation system. Grunwell (op cit) describes two types of simplification processes and provides a 'chronology of phonological processes' based on her own and other studies. Structural simplifications are 'simplification in the structure of phonological units, words or syllables,..', for example Final Consonant Deletion. Systemic simplifications are 'simplification in the system of contrasts', for example Stopping, when plosive consonants are used to realise fricative targets. During phonological development these processes are gradually modified and eventually disappear leading to more adult-like pronunciation patterns (Grunwell 1987a). With regard to the development of the child's contrastive system, there are gradual changes as new sounds are introduced into the system enabling the child to use new contrasts. Grunwell (1981) compares data from previous studies which investigated the development of correct consonant pronunciations. Despite some differences in the methodology employed in these studies it is evident that there is a similar developmental sequence. Grunwell (1987a) uses this developmental information to construct

a profile of the development of the child's pronunciation system of consonants but emphasises that this should be interpreted flexibly in order to account for the fact that 'children tend to follow somewhat idiosyncratic routes in developing their phonological systems.' Ingram (1976) also highlights the considerable individual variation between children with regard to their acquisition of different sounds. Grunwell (1985,1987a) combines the profile of the child's consonant development with the chronology of phonological processes in order to construct a profile of phonological development which can be used as a 'Developmental Assessment' (Grunwell 1985). This is a clinically useful tool which outlines six stages of development from Stage I (0;9-1;6) to Stage VII (4;6<).

It is evident, therefore, that although there are individual differences, normal children follow a similar sequence in phonetic and phonological development. It might be expected that cleft palate children would follow a similar path of development once the operation to repair the palate has provided them with an intact intra-oral mechanism.

PREVIOUS STUDIES OF THE SPEECH PATTERNS OF CLEFT PALATE CHILDREN

In regard to studies of the speech of children with cleft lip and palate, the focus in the past has been on phonetic rather than phonological abilities and these

studies have usually been conducted when the children were at least 3;0. For example, McWilliams & Musgrave (1971) point out that the 'articulatory ability' of children with clefts 'lags behind that of children who have acquired speech skills at an earlier stage.' Fletcher (1978) reports scores on the Iowa Pressure Articulation Test for 70 children aged 5 to 15 years for whom he judged velopharyngeal function to be normal or nearly normal. The average score was similar to the test norm for age 3;5.

Deviant phonetic patterns have also been reported. Bzoch (1979) and Morris (1979) both describe the predominance of glottal stop articulation, the use of pharyngeal fricatives and the lack of normal plosives and fricatives. Both authorities attribute these characteristics to velo-pharyngeal insufficiency or abnormal learned motor patterns. Bzoch (op cit) comments that the abnormal learned motor patterns can be identified 'as early as 3 years of age...' Edwards (1980) points out that there is a tendency for some cleft palate children to articulate sounds further back in the mouth than is normal, 'diminished use of the tongue tip' and also lateral realisation of /s/. Lateralisation and palatalisation of alveolar phonemes have been associated with dental and occlusal abnormalities (Foster & Greene 1960, Albery & Hathorn 1985). Foster & Greene (op cit) found a high incidence of lateralisation of /s/ in children with lip and palate clefts. More recently Albery & Hathorn (1985) found a high incidence of lateralisation and/or palatalisation of /s/, /z/, /t/ and /d/ in a

similar group of children, with no occurrence of these features in a group of children with clefts of the palate only. Close to the target sounds in terms of manner, these deviations are primarily phonetic, do not generally affect intelligibility and therefore do not have the same implications as a preponderance of glottal stops and pharyngeal fricatives in speech.

McWilliams, Morris & Shelton (1984) in an extensive review of the literature, illustrate the high risk of disordered articulation for cleft palate children and the occurrence of improvement with age, especially in the articulation of plosives and fricatives. They also point out the considerable variability between individual cleft palate children in the extent and nature of their speech sound errors and conclude that they are a heterogeneous population in this respect.

Riski & DeLong (1984) in a longitudinal study which investigated the articulation development of 108 children from 3;0 to 8;0 years of age, also conclude that children with palatal clefts are a heterogenous group. In addition they demonstrate that children with clefts of the lip only constitute a homogenous group which evidences normal articulation development. In this study it was found that children with more extensive clefts tended to evidence poorer articulation skills but for all cleft types there was improvement with age. Both age and type of cleft were statistically significant. With regard to the heterogenous nature of the cleft palate group the authors comment 'although articulation skills of cleft palate children are generally deficient.....some cleft palate

individuals follow almost normal articulation skill development.'

Ingram (1976) demonstrates by analysing data from previous studies of cleft palate speech that there are patterns i.e. systematic processes in this type of disordered speech. Following Ingram's lead, reports employing phonological techniques in the investigation of cleft palate children's speech, have begun to appear in the literature. (Broen, Felsenfeld & Kittleson-Bacon 1986; Hodson, Chin, Redmond & Simpson 1983; Lynch, Fox & Brookshire 1983). Crystal (1981) highlights the need to investigate the speech of cleft palate children using phonological as well as phonetic analyses in order to determine the extent and nature of any deviance or delay and whether these result primarily from phonetic or phonological bases. As Grunwell (1987) comments 'After all a child with a repaired cleft is developing a phonological system as well as coping with and compensating for the effects of the organic malformation.' McWilliams et al (1984) also comment on how information about the child's phonological system helps in clinical speech therapy management. Grunwell & Dive (1988) demonstrate how a combined articulatory and phonological approach to therapy 'facilitates the reorganisation and expansion of previously static phonological systems, sometimes in spite of persisting articulatory disabilities, sometimes accompanied by improvements in articulatory abilities.'

Broen et al (1986) illustrate how phonological analysis helped to identify, at the age of 2;6, children requiring

secondary surgery for velopharyngeal insufficiency. Of their subjects, the children who required secondary surgery showed considerable variability in their production of target phonemes and a higher use of '[+ sonorant] substitutions for oral stop consonants' than a group of children who did not require secondary surgery and a group of normal children. Lynch et al (1983) studied two children between the ages of 2;5 and 3;1 with follow up at 5;0 and 7;0 years. They found differences in the children's developing phonological systems. For one subject, phonological analysis revealed the characteristics of developmental delay rather than deviation, whereas in the other subject deviant characteristics of 'structural inadequacy' were detected. Both of these subjects and those in Broen et al's (1986) non surgical group differed from normal subjects with regard to phonetic development.

The deviant and delayed phonetic and phonological development highlighted in these studies and the abnormal phonetic patterns in the babbling of cleft palate children, suggests that a relationship between pre-speech vocalisations and later speech patterns in this population has already been evidenced. There is, however, a need for further longitudinal studies to investigate how the phonetic patterns of babbling develop into the phonetic and phonological patterns of meaningful speech in the cleft palate population.

THE EFFECTS OF OTITIS MEDIA WITH EFFUSION ON SPEECH DEVELOPMENT

Otitis media is an inflammation of the middle ear and is the major cause of hearing loss in childhood with up to 70% of all children having at least one episode (Teele, Klein & Rosner 1984). Bamford & Saunders (1985) describe it as 'an accumulation of fluid in the middle ear as a result of a failure of the ventilating function of the eustachian tube.' The fluid is described as effusion and varies in consistency from thin and watery (serous) to thick, mucus-like (mucoid) to pus-like (purulent). Otitis media may be an acute condition but if middle ear effusion persists after three months it becomes chronic (Bluestone & Klein 1988).

Friel-Patti & Finitzo (1990) comment that 'Otitis media is a disease that varies daily along a continuum.' The fluid in the middle ear generally results in a variable conductive hearing loss. As the volume of air in the middle ear decreases the eardrum stiffens and becomes less sensitive to low frequency sound. The hearing threshold deteriorates further as the air is completely replaced by fluid and affects the perception of sound across all frequencies (Bamford & Saunders 1985). The fluctuating nature of the hearing loss in early life has implications for speech and language development and may have a greater adverse effect than a comparable or worse sensorineural deficit which produces a constant hearing loss. Bamford & Saunders (op cit) describe how even a mild conductive hearing loss can cause difficulties for

young children acquiring speech and language skills. In addition they comment that a similar conductive loss in adults does not markedly affect their speech discrimination because of their ability to adopt compensatory strategies.

Episodes of OME may be treated using antibiotics to control infection. In addition some medical practitioners prescribe nasal decongestants. When there is chronic OME surgical intervention is usually indicated. This involves myringotomy and the insertion of grommets (also termed tubes or tympanostomy tubes). (See Paradise (1980) and McWilliams et al (1984) regarding medical and surgical treatment of OME). For children with cleft palate (see further below) grommets may be inserted at the time of the operation to repair the palate.

In the literature there is general agreement that there is a link between recurrent episodes of otitis media with effusion (OME) resulting in conductive hearing loss and speech and language delay but the precise nature of this association has not been established. As Ventry (1980) comments 'A careful evaluation of the published research on the relationship between conductive hearing impairment and language and learning difficulties suggests that the relationship has been poorly documented, that methodological flaws have contaminated the data and confounded the reported results.' Acknowledging these flaws, Bamford & Saunders (1985) review the findings of a number of different types of study and conclude that 'There is sufficient evidence to consider a child who repeatedly has periods of otitis media as a high risk for

language delay.' Hall & Hill (1986) present ten case studies which suggest that for some children OME can have a devastating effect on language development, whereas for others the effect is negligible. Hall & Hill (op cit) suggest that these differences may be accounted for by five variables which are: age of onset, duration of episodes of OME, the severity of the hearing loss, intrinsic qualities in the child and the child's environment. In a prospective study Friel-Patti & Finitzo (1987) suggest that OME may be a contributory rather than a causal factor to language delay.

With regard to speech production, there are a number of studies which report a delay in articulation development for children with histories of OME (Holm & Kunze 1969; Needleman 1977; Silva, Kirkland, Simpson, Stewart & Williams 1982; Shriberg & Smith 1983). However few studies identify the speech characteristics evidenced in this delay. One exception is Shriberg & Smith (1983) who report two sound changes. In 'Change I' word-initial consonants are deleted or realised as glottal plosives or fricatives; and in 'Change II' nasal consonants are realised as other nasals, partially denasalised, realised as plosives or accompanied by an 'epithentic stop.' These changes are not, however, evidenced in other studies (Bishop & Edmundson 1986, Paden, Novak & Beiter 1987). It is noteworthy that 'Change 1' is similar to the pattern of glottal articulation that has been reported in studies of the speech patterns of cleft palate children (Bzoch 1979, Morris 1979).

Paden et al (op cit) studied children with OME who were under three years of age in order to determine factors which might identify which children would subsequemtly require phonological therapy. They identified three areas which, in combination, were good predictors of later phonological difficulty. These areas were low scores in relation to age for the 'production of velars, liquids and post-vocalic singleton obstruents, along with elevated thresholds at 500Hz and a history of early onset and late remission of OME..' It is evident, therefore, that although the precise nature of the relationship between OME and speech and language difficulties has not been established, children who suffer from frequent episodes of OME early in life are "at risk."

It has long been established that there is a very high incidence of middle ear disease associated with palatal clefts (Paradise, Bluestone & Felder 1969, Heller 1979, Lencione 1980, McWilliams et al 1984, Maw 1986). McWilliams et al (op cit) comment that OME is universal in infancy and persists in an estimated 50% of older children and adults. In a recent prospective study by Robinson, Lodge, Jones, Walker & Grant (1990) the presence of OME prior to palate repair was confirmed in 93% of children aged between 0;2 and 1;6 with minimal improvement occurring post-operatively. In addition the authors found that the condition persisted in children up to 4;0 years of age and that there was no evidence to suggest that age at repair or type of cleft were influencing factors.

Because of the presence of many of the variables cited by Hall & Hill (1986, see above) especially the early age of onset and the persistence of OME, cleft palate children are obviously "at risk" for conductive hearing problems. In addition, as described above, they are also "at risk" for deviant and delayed phonetic and phonological development. It is possible, therefore, that in cleft palate children the presence of fluctuating hearing loss associated with OME will combine with other etiological factors and may lead to more severe speech problems. In view of the high risk for conductive hearing loss and its possible sequelae for speech development, early intervention and aggressive management of ear problems in children with cleft palate is generally recommended (Heller 1979, Paradise 1980, McWilliams et al 1984). This recommendation is supported by the findings of a study undertaken by Hubbard, Paradise, McWilliams, Elster & Taylor (1985). They investigated articulation development in two groups of cleft palate children who were treated for OME at different centres. The group which received more aggressive management and earlier treatment of OME were found to have significantly better articulation than the group which received later treatment and more conservative management. Unfortunately Hubbard et al (op cit) do not describe the differences in articulation between the two groups as the analysis was based on correct/incorrect consonant production.

This literature review has confirmed that there is a need for further longitudinal studies of the pre-speech vocalisations and speech development of cleft palate children. In order to investigate the relationship between the physical defect and phonetic and phonological patterns, it is necessary to commence data collection during the pre-speech stage of development. In addition, in view of the increased risk of OME for cleft palate children, hearing and middle-ear status needs to be carefully monitored.

CHAPTER 3

THEORETICAL ISSUES IN THE INVESTIGATION OF CLEFT PALATE SPEECH

The child born with a cleft palate has a structural defect which, in advanced countries, is routinely surgically repaired, usually in early childhood. This type of treatment, however, does not completely overcome the consequences of the original physical disability which involves important anatomical and physiological aspects of the speech production mechanism. Under normal circumstances, the child will be in an environment which should provide opportunities for normal development and maturation and will, therefore, learn to 'speak' but may encounter difficulties associated with the structural defect. The aim of this study is to investigate speech development in a small population of such children. It has been observed that some children with cleft palate develop normal speech patterns whilst others experience considerable difficulties. Although this is a small scale study, it is hoped to discover information relating to that observation.

As indicated in Chapter 1, the original impetus for this study arose from the statement made by Crystal (1981) regarding the need to investigate the relationship between the phonetic and phonological aspects of cleft palate speech. Hewlett (1990) also highlights the need to address the relationship between 'phonological representation and phonetic implementation' in order to

explain speech disorders arising from structural anomalies. Hewlett (op cit) proposes that speech disorders associated with structural anomalies occur at the lowest level of his model of speech production, that is at the Vocal Tract Shape/Movements level but that these may result in compensatory strategies at a higher level in 'the intact remainder of the speech production system'. There is, therefore, the possibility of an unimpaired phonology underlying a primary phonetic disorder. Although this may be applicable to some types of speech disorder associated with cleft palate, for example where there is velopharyngeal incompetence, it seems insufficiently far-reaching to describe some of the different and more complex difficulties. As Grunwell (1988) stresses it is important to address 'the possibility that in the developmental process the inadequacies of a deficient or inefficient phonetic mechanism may impact upon the nature of the knowledge acquired at the phonological level.' There is, therefore, a need to address these issues from a developmental perspective.

This study begins at the pre-speech stage in order to investigate the relationship between the physical defect and the development of phonetic and phonological patterns in cleft palate children. If there are identifiable characteristics in the pre-speech vocalisations of cleft palate children which differ from known normal characteristics, they could arguably be attributed to the physical defect and associated factors. If the same phonetic patterns are subsequently found in the speech

(i.e. phonologically structured utterances) of these children, it could be concluded that they were physically based and indicative of phonetic rather than phonological deviance. Furthermore, if these phonetic restrictions give rise to abnormal phonological patterns, it could be inferred that phonetic deviance has the potential to influence subsequent phonological development in cleft palate children. In other words, a secondary phonological disorder may result from a primary phonetic deviance arising from the physical defect.

In the pre-operative stage, when the child has an open palatal cleft, the vocalisations which the child is able to produce will be different from those employed by normal children, because of the physical limitations. The cleft palate child is unable to achieve the intra-oral pressure required to articulate obstruents, particularly plosives. In addition, place of articulation may be affected because the part of the palate which the tongue needs to articulate against is apparently missing. It can be hypothesised, therefore, that there will be phonetic deviance in the pre-operative pre-speech vocalisations of cleft palate children as a result of the structural abnormality.

As described above in Chapter 2, in studies of normal children a link between the phonetic repertoire of babbling and the basic sound system of a child's language, has been clearly established. (Oller et al 1975; Locke 1983). It can be hypothesised that this relationship would also exist in the cleft palate population. Therefore, if abnormal phonetic

characteristics are found to exist in the pre-speech vocalisations of cleft palate children, they might also be expected to be present in their early speech patterns. In addition if the same phonetic characteristics persist and are similar to those reported for older cleft palate children's speech patterns, it can be argued that later speech patterns can be predicted from pre-speech vocalisations.

Such a finding would have important implications for therapeutic management and early intervention. Children who require intensive speech therapy could be identified in the pre-speech stage of development so that programmes of intervention could be implemented at a very early stage, possibly preventing secondary problems and the establishment of abnormal habitual articulatory patterns. Evidence of phonetic patterns indicating that the intra-oral mechanism is inadequate for the production of normal speech would also help in the early identification of children requiring secondary surgery for velopharyngeal insufficiency. (i.e. a rehabilitative operation to provide the child with an efficient velopharyngeal mechanism, which is essential for the normal production of plosive and fricative consonants).

If the children's phonetic inventories show deviant characteristics prior to the operation to repair the palate but progressively move towards more normal patterns post-operatively, it could be inferred that the operation in providing an intact oral mechanism has facilitated progressively more normal phonetic development. The child is, therefore, able to articulate

sounds such as plosives which it can be assumed were impossible pre-operatively due to insufficient intra oral pressure. Given such a pattern of progressively normal phonetic development it could be predicted that there would subsequently be normal phonological development. However, as a result of the physical defect there may be a delay in phonetic development which could cause a further delay in the establishment of the child's phonological system.

If there is different or abnormal development post-operatively this may be manifested in different ways. Phonetic deviance may occur without a phonological consequence which means that the child is able to signal meaning differences even though phonetic realisation is abnormal. There may, for example, be unusual fricative realisations such as the palatalisation or lateralisation of alveolar fricatives. Phonetic deviance may, however, have implications for phonological development. Given the possibility that phonetic inadequacies may be present, it might be expected that phonological development may also be deviant and subsequently, because of the phonetic restrictions, may mirror phonetic development. When there are abnormal phonetic patterns, for example, these may give rise to unusual phonological processes such as Backing, when there is a lack of consonants which involve the use of the tip and front of the tongue in the phonetic inventory. When the child is unable to produce, or is not yet producing the sounds required to make specific phonological contrasts, he will not be capable of signalling differences in meaning. The underlying

phonetic deviance in leading to unintelligible speech results in ineffective communication on the part of the child, who thus cannot be responded to normally by his peers and the adults in his environment. This will, therefore, inhibit and impoverish the child's experience of communication and may lead to general restrictions and delay in linguistic development. In this instance persisting phonetic deviance may result in restricted and deviant phonological development.

If developmentally abnormal patterns are detected in the speech of cleft palate children, it is important to establish whether there are natural explanations for them (Harris & Cottam 1985). In cases where the child is unable to achieve intra-oral pressure for the production of obstruent consonants because of velopharyngeal insufficiency, the link between the speech characterisitcs and the natural explanation appears relatively straightforward. However some cleft palate children who evidence similar characteristics are subsequently found to have competent velopharyngeal sphincters. It would seem, therefore, that the relationship between the potential of the articulatory mechanism and the way in which the child learns to organise and automate phonological knowledge needs to be considered. The question needs to be asked regarding whether the impaired mechanism impairs phonological learning.

Another factor which is known to be present during the period of speech development for many cleft palate children is the possibilty of recurrent periods of

hearing loss due to otitis media. As discussed in Chapter 2, this type of hearing loss can adversely affect the child's auditory skills and may result in deviant or delayed phonetic and phonological development. If there are frequent episodes of hearing loss in these cleft palate children in addition to phonetic deviance, it can be predicted that the combination of auditory and physical factors will lead to more severe patterns of deviant and delayed speech development.

In order to address these theoretical issues it was decided to undertake a longitudinal investigation into the phonetic and phonological development of a small population of cleft palate children, commencing at the pre-speech stage prior to palate repair. The investigation comprises two studies. In Study 1 five subjects were recorded immediately prior to the operation to repair the palate, six to eight weeks post-operatively, six months after the second recording and then at about 2;6. Susequent recordings were made at six-monthly intervals until 4;0 or 4;6. In Study 2 three subjects were recorded at the same intervals for Study 1 until the third recording (at 1;6 for these three subjects). An increased number of data collection points was established between 1;6 and 3;0 with recordings at three-monthly intervals. From 3;0 recordings were made at six-monthly intervals until 4;0 or 4;6.The aims of both Study 1 and Study 2 were to compare the results from different recordings longitudinally, with patterns reported for other cleft palate populations and with

patterns of normal development, using data available in the literature, in order to address the following issues:-

1. To determine the existence of any abnormal phonetic patterns and whether those detected in pre-speech vocalisations were also present in the children's first words and later grammatically structured utterances.
2. To determine the relationship between phonetic and phonological patterns in the children's speech.
3. To determine the extent and nature of any delay in development and whether such a delay could be attributed to physical, phonetic or phonological factors.
4. To determine whether there were common tendencies and/or individual variation in the phonetic and phonological development of the children.

A fifth issue addressed in Study 2 was:-

To determine whether there is a critical point in development when it is possible to identify children who will subsequently experience difficulty in developing phonology as opposed to those whose system apparently develops spontaneously.

CHAPTER 4

METHODOLOGY

In order to investigate the relationships between the physical defect and phonetic and phonological patterns in the speech of children with cleft lip and palate, it was decided to begin recording the children at the pre-speech stage and to make a longitudinal study of the changes in vocalisation and speech through to the age of 4;6. The first recording was made prior to the operation to repair the palate (in this population palate repair was usually carried out at some time between about 0;9 and 1;0) in order to establish a baseline. A pilot study was undertaken to determine the most practicable time for resuming data collection post-operatively. The pilot study, (which is described in detail in Grunwell & Russell 1987 - see Appendix I), investigated the effects of palatal surgery on pre-speech vocalisations, established a data collection protocol and evaluated the analytical framework devised to classify the vocalisations. The results of this pilot study indicate that the operation had an appreciable effect on the children's vocalisations for a limited time. In addition the method of data collection proved to be practicable and the analytical procedures employed provided appropriate quantitative and descriptive classification systems for pre-speech vocalisations (Grunwell & Russell 1987).

A second pilot study was undertaken in order to make a preliminary investigation of some of the theoretical issues outlined above in Chapter 3, and to establish data collection and analytical procedures for the speech part of the longitudinal study (Grunwell & Russell 1988 - see Appendix II). The study was designed to describe the phonetic patterns of the pre-speech vocalisations and the phonetic and phonological patterns of the children's speech. This study which investigated data from two children was replicated with three further children and is incorporated into Study 1 which is described below. In addition Study 2 investigated another three children using the same methodology as Study 1 but with an increased number of data collection points and additional analysis between 1;6 and 2;6.

SUBJECTS

Eight subjects were selected from a clinical population for which the author has responsibility. Five were included in Study 1 and three in Study 2. Because of the detailed nature of the investigation the population was deliberately constrained to a small number of children.

Study 1

AU (female) originally presented with a cleft of the secondary palate which was repaired at 0;11. The cleft

was described as long but not broad and the nasal septum was not visible.

AB (male) also presented with a cleft of the secondary palate which was repaired at 0;10. The cleft was described as narrow but long and extended well into the hard palate. The nasal septum was visible in the anterior part of the cleft.

DD (male) presented with a bilateral cleft of the primary and secondary palates. The primary palate cleft was more extensive on the right with only a minor defect in the lip and a notch in the alveolus on the left. It appeared, therefore, more like a right unilateral cleft of the primary palate. The lip was due to be repaired at 0;4 but as DD had an upper respiratory tract infection at that time the operation had to be postponed until 0;7. The palate was repaired at 1;0.

SB (female) presented with a right unilateral complete cleft of the primary and secondary palates. The lip was repaired at 0;4 and the palate at 0;11. Unfortunately, immediately following palate repair, this subject was ill with gastro-enteritis and there was some dehiscence of the posterior palatal muscles. Anteriorly, the muscles appeared to be well united but the uvular part of the palate separated as the palate lifted. Technically this should not, and probably in fact did not, impair velopharyngeal closure. A further repair to correct this was carried out when the subject was 2;7. SB also had a small anterior fistula just behind the alveolus.

FS (male) presented with a bilateral cleft of the primary palate and a complete extensive cleft of the secondary

palate. The lip was repaired at 0;5 and the palate at 1;2. The operation to repair the secondary palate was delayed because of the size of the cleft. The surgeon was anticipating the possibility of further growth of the palatal shelves prior to palate repair.

Study 2

PJ (male) presented with a left unilateral complete cleft of the primary and secondary palates. The lip was repaired at 0;3 and the palate at 0;9.

JA (female) presented with a cleft of the secondary palate which was repaired at 0;9. The cleft was described as quite broad and the nasal septum was exposed. This subject was fitted with an intra-oral appliance in order to protect the septum during feeding and to encourage growth of the palatal shelves. The appliance was fitted by the orthodontist in the first few days of life and was worn up until the time of the operation to repair the palate.

AC (male) presented with a unilateral complete cleft of the primary and secondary palates and the nasal septum was exposed. The lip was repaired at 0;4 and the palate at 0;9...

In total, therefore, there were three subjects who had clefts of the palate only (CP) and five who had clefts of the lip and palate (CLP). All the CLP subjects had pre-surgical orthodontic treatment prior to lip repair. This involved the use of an intra-oral appliance and external

strapping (Foster 1980, Gornall, Bryan Jones & Russell 1990, Russell 1989). All the children are from English speaking backgrounds and have caring and responsive parents. Apart from the cleft palate there were no other known physical or neurological factors affecting the children's development. However, as discussed in Chapter 2, it is well known that children with oro-facial clefts are prone to middle ear disease and conductive hearing problems and this issue had to be addressed in both studies. The subjects all received routine audiometric screening tests, including middle-ear impedance measurements and regular otological examinations. Any occurrence of OME and treatment for this condition was documented and is included at the appropriate point in the results below (Chapters 5 and 6).

The speech and language progress of all the subjects was reviewed regularly by the author. Subjects AB, SB and PJ required some direct speech therapy intervention and this is described in the results below (Chapters 5 and 6).

PROCEDURE

Pre-speech vocalisations

The same procedure for data collection of pre-speech vocalisations was followed in both Study 1 and Study 2. Audiotape recordings were collected using a Sony TC-D5M portable stereo cassette recorder with a Sony F99T stereo microphone. The pre-speech recordings were made for the

most part in the subjects' own homes, although some took place in the speech therapy clinic. Recordings 1 and 2 were in two parts. The first part lasted a minimum of five minutes (usually at least ten minutes) and provided a sample of the child's vocalisations during play. Parents were permitted to co-operate in play but were requested not to respond vocally. The second part of the recording also lasted a minimum of five minutes and sampled parent-child interaction. In recording 3 the parent usually participated throughout as it was found that this encouraged the child to vocalise. The parent was instructed to converse with the child in their usual manner but not to interrupt the child during vocalisation. Recording 3 was a minimum of ten minutes long and was usually at least thirty minutes.

Recording 1 (R1) took place in the week prior to the palate operation. The second recording (R2) was made six to eight weeks after the operation when, as established in the first pilot study (Grunwell & Russell 1987 - see Appendix I), the operation had ceased to have an effect on the child's vocalisations. Recording 3 (R3) was made six months after R2 when the children were about 1;8 and the parents reported that they could identify some meaningful utterances.

Study 1 - Speech

In Study 1 the fourth recording (R4) was made between 2;0 and 2;6 when the parents reported that the children had a vocabulary of at least fifty words and were begining to

put words together. In R4, which was at least thirty minutes long, the child's speech during play, looking at pictures and in conversation with the parent was recorded.

In the second pilot study (Grunwell & Russell 1988, see Appendix II) the fifth and final recording took place at 3;6. However, as a result of that study, it was decided that a recording at 3;0 was required and that data collection should continue at six monthly intervals until 4;0 or 4;6. In Study 1, therefore, R4i took place at 3;0. There is, however, no recording at 3;0 for subjects SB and FS who were included in the second pilot study (Grunwell & Russell 1988) and who were, therefore, over 3;6 when the decision to make a 3;0 year recording was made.

At R4i (3;0) the recording was at least thirty minutes in length. Where possible a sample of speech was elicited using PACS Pictures (Grunwell 1987b). When the child was unable or unwilling to comply with this, the procedure described above for R4, was adopted.

For subsequent recordings, which were all at least thirty minutes long, a sample of speech was elicited using PACS pictures (Grunwell, op cit). R5 was made when the children were 3;6, R6 when they were 4;0 and R7 when they were 4;6. Table 1 shows the subjects' ages at each recording. Data collection stopped at 4;0 if the child's phonological system was considered to be developmentally normal at that age.

The fourth recording (R3i) for Study 2 took place at 1;9. The recording was a minimum of thirty minutes long and the same procedure as used at R3 was followed. Subsequent recordings were made at three monthly intervals (see Table 2). Recordings R3ii (2;0) to R4i (2;9) followed the same procedure as described for R4 in Study 1, that is, each recording was at least thirty minutes long and the child's speech during play, looking at pictures and conversing with the parent was recorded. This procedure was also used at 3;0 (R4ii) if a sample of speech could not be elicited using PACS Pictures (Grunwell 1987b). Subsequent recordings were made at 3;6 (R5), 4;0 (R6) and 4;6 (R7). These recordings were also at least thirty minutes long and the same procedure as described above for Study 1, was followed. As for Study I, data collection stopped at 4;0 if the child's phonological system was considered to be developmentally normal at that age.

TABLE 1 : Subjects' ages at each recording for Study 1

Subjects	Recordings							
	R1	R2	R3	R4	R4i	R5	R6	R7
AU	0;11	1;1	1;7	2;3	3;0	3;6	4;0	-
AB	0;10	1;1	1;7	2;6	3;0	3;6	4;0	4;6
DD	1;0	1;2	1;8	2;4	3;0	3;6	4;0	4;6
SB	0;11	1;2	1;9	2;6	-	3;6	4;0	4;6
FS	1;2	1;4	1;9	2;4	-	3;6	4;0	-

TABLE 2 : Subjects' ages at each recording for Study 2

Subjects	Recordings											
	R1	R2	R3	R3i	R3ii	R3iii	R4	R4i	R4ii	R5	R6	R7
PJ	0;9	0;11	1;6	1;9	2;0	2;3	2;6	2;9	3;0	3;6	4;0	4;6
JA	0;9	0;11	1;6	1;9	2;0	2;3	2;6	2;9	3;0	3;6	4;0	4;6
AC	0;9	0;11	1;6	1;9	2;0	2;3	2;6	2;9	3;0	3;6	4;0	-

ANALYSIS

An auditory articulatory phonetic transcription was made from the audio recordings. The transcription system was based on the IPA (revised to 1979) and the PRDS recommended additional symbols (PRDS Group, 1983). It was occasionally found necessary to devise new symbols for aspects of vocalisations which could not be represented by the published conventions. The transcriptions were made by the author and parts of each transcription of pre-speech vocalisations were checked by Professor Grunwell. Any discrepancies in the analysis were resolved by discussion leading to consensus. A randomly selected section of one pre-speech recording of each subject was retranscribed at least one month after the first transcription, in order to establish intra-transcriber reliability. Transcription of the pre-speech data was facilitated by describing the articulations according to the active articulator (see below).

With regard to the speech data, once again intra-transcriber reliability was established. Retranscription of part of each speech sample was carried out by the author at least one month after the original transcription. No appreciable variations resulted with regard to manner of articulation, apart from detecting the presence of audible nasal emission, especially in word final position. With regard to articulatory placement there were occasional discrepancies between

velar and uvular plosives and fricatives, and between labial and labio-dental fricatives.

Analysis of pre-speech vocalisations

For the pre-speech data 'vocalisation units' which are defined as *a stretch of continuous vocalisation bounded by pauses of at least 250msec duration*, were identified using computer assisted analysis (Grunwell & Russell 1987, see Appendix I). In R1 and R2 the vocalisation units were identified in a five-minute section of the sample. In R3 they were identified throughout the recording. The pre-speech vocalisations were classified into speech-like and non speech-like according to the classification system devised in the first pilot study. This system classifies the vocalisations in impressionistic terms and uses broad phonetic categories. Non speech-like vocalisations are, for example, grunts, cries and sneezes. Speech-like vocalisations are babbled utterances which contain at least one vocoid (vowel-like) or one contoid (consonant-like) element. The analysis reported here concentrates on the contoid articulations and compares them with the consonants used in the later data samples when the children were using spoken language.

Contoid articulations are described in terms of the manner of articulation, that is nasal, plosive, fricative and approximant, and of the active articulators, that is lips, tongue, pharynx and glottis. See Figure 1 for the location of these articulatory positions and their

relationships to the passive articulator (based on Catford 1977; Ladefoged 1982). Phonetic inventories of contoids for recordings 1-3 were constructed for each child for the whole of each recording. An example of a contoid phonetic inventory is illustrated in Figure 2. The categories for the active articulators are on the horizontal axis, that is, labial, antero-dorsal, postero-dorsal, pharyngeal, glottal and contoid combinations. The different manner of articulation categories are on the vertical axis. A consonant phonetic inventory is also presented in Figure 2 for comparison. Distribution of contoids was analysed according to their position in the vocalisation units as established by the computer analysis. Three positions were analysed: vocalisation initial (VI); within vocalisation (WV); and vocalisation final (VF). These analytical categories were selected to afford comparison with the speech data where PACS analysis was being used (*Phonological Assessment of Child Speech (PACS)*, Grunwell 1985). A second analysis examined the phonotactic structure of the child's vocalisations, i.e. the range and frequency of syllabic structures, defined in terms of C, V, and combinations of C and V. The structural analyses do not form a major part of these studies but information regarding structure is reported below in the results (Chapters 5 and 6) when it is of relevance.

Most of the data in these studies were not amenable to statistical analysis. It was, however, possible to use a non parametric test on the pre-speech data. A Friedman two-way analysis of variance was carried out on the data

of all eight subjects (Friedman 1937). This test statistically analysed the frequency of occurrence of the different manner of articulation categories, that is, nasal, plosive, fricative and approximant, and the frequency of use of each active articulator over the first three recordings. The results of this analysis are reported in Chapter 6.

Analysis of speech data

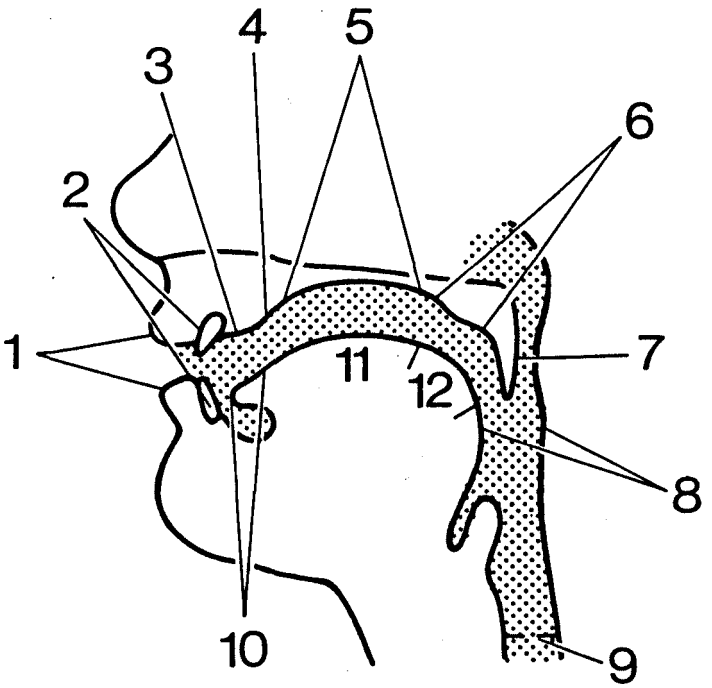
In both Study 1 and Study 2 phonetic inventories of consonants were constructed (using the procedure from PACS, Grunwell 1985) for each child for the whole of each recording (see Figure 2 for an example of a consonant phonetic inventory). In addition, the distribution of consonants according to their position in syllable and word structure was analysed. Phonological analysis was carried out when sufficient data was available. For most subjects this was from about 2;3 - 2;6. Procedures drawn from *Phonological Assessment of Child Speech (PACS)* (Grunwell 1985) were employed. The procedures selected were a contrastive analysis of phones used word initially (SIWI), syllable initial within words (SIWW) and word finally (SFWF), and a developmental assessment derived from the systems of contrastive phones and an analysis of the phonological processes operating in the children's speech.

In Study 2, it was necessary to investigate the period between 1;6 and 2;6 in more detail in order to examine the relationship between the children's phonetic

potential and their developing phonologies. Consideration was given to using a phone tree analysis (Leonard 1980). However, after initial investigation, it was evident that such an analysis did not provide the information required for this study. It was, therefore, decided to undertake a word analysis. In this analysis words were grouped together according to their initial target phone or cluster. The realisation of the word initial target was charted across all of the speech samples for that subject, that is from 1;9 to 4;0 or 4;6. It was possible to identify when the child used the same and/or different words starting with the same target consonant or cluster, in different recording sessions. In this way it was possible to determine changes in the realisations, especially in the earlier recordings when there was insufficient data to undertake a contrastive assessment. In addition consonants used in within word (WW) and word final (WF) positions were examined using the same procedures.

Analyses were made of the pre-speech and speech data of each subject using the procedures described above. Comparisons were made within and across the two study groups. ..

LOCATION OF ARTICULATORY POSITIONS



1	Labial	7	Uvular
2	Dental	8	Pharyngeal
3	Alveolar	9	Glottal
4	Postalveolar	10	Apical/laminal
5	Palatal	11	Antero-dorsal
6	Velar	12	Postero-dorsal

FIGURE 1: Location of articulatory positions. This figure shows the relationship between active and passive articulators

CONTOID PHONETIC INVENTORY

	LABIAL	APICAL/ LAMINAL	ANTERO -DORSAL	POSTERO -DORSAL	PHARYNGEAL	GLOTTAL	CONTOID COMBINATIONS
NASAL							
PLOSIVE							
FRICATIVE							
APPROXIMANT							
OTHER							

Phonetic Inventory

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Name .....

	Labial	Dental	Alveolar	Post-Alveolar	Palatal	Velar	Glottal	Other
Nasal								
Plosive								
Fricative								
Affricate								
Approximant								
Other								

Marginal Phones:

FIGURE 2: Top - Contoid phonetic inventory
Bottom - Consonant phonetic inventory

CHAPTER 5

RESULTS - STUDY 1

For ease of reference the illustrations for the results of both studies reported in Chapters 5 and 6 are in Volume 2 - Appendix III.

PRE-SPEECH VOCALISATIONS

Figure 3 presents the contoid phonetic inventories for each subject at the first three recordings. In Figure 4 graphs show the percentage frequency of occurrence of the different manner of articulation categories, that is nasal, plosive, fricative and approximant, at the first three recordings for each subject. The proportion of glottal versus labial or lingual articulations is indicated by hatching in the appropriate section of each graph. The graphs in Figure 5 show the frequency of use of the active articulators, that is the percentage use of labial, front of tongue (apical/laminal and antero-dorsal), back of tongue (postero-dorsal) and pharyngeal and glottal articulations at the first three recordings for each subject.

R1 - pre-operative recording

In R1 the contoid phonetic inventories (Figure 3) and the graphs in Figure 4 indicate a marked lack of plosive

contoids using the front and tip of the tongue. Three of the subjects use some postero-dorsal plosives but SB does not use any and FS uses only one [g]. AU is the only subject who has a bilabial plosive. For all subjects the glottal plosive [ʔ] is the predominant plosive. Similarly the glottal fricative [h] is the predominant fricative articulation for all subjects. It is the exclusive fricative used by DD, FS and SB, but AB uses some postero-dorsal fricatives and AU uses two postero-dorsal and two bilabial fricatives. All subjects use some approximants, in particular the postero-dorsal approximant [ɻ].

With regard to the frequency of use of the active articulators (Figure 5), FS is the only subject who does not use any bilabial articulations. All the other subjects do use a bilabial nasal. SB's graph clearly indicates a marked predominance of glottal and pharyngeal articulations. For AB postero-dorsal and glottal and pharyngeal articulations predominate. Over 30% of DD's and FS's articulations and 25% of AU's articulations involve the front of the tongue (apical/laminal and antero-dorsal). It is possible that the lack of bilabial articulations for FS and the low percentage (2%) for SB could be related to the fact that they both have repaired lip clefts. DD, however, also had a lip cleft and 25% of his articulations are bilabial. In addition AB has a cleft palate only and less than 10% of his articulations are bilabial. It should be noted, however, that FS's lip cleft was bilateral and therefore more severe than the unilateral lip clefts of SB and DD.

The results at R1 indicate a pattern of deviant and restricted phonetic development for all subjects. The lack of labial and lingual plosive contoids and the predominance of glottal fricatives and plosives is in agreement with the patterns reported in other studies of the pre-speech vocalisations of cleft palate children prior to palate repair (Westlake & Rutherford 1966, Ross & Johnston 1978, O'Gara & Logemann 1985, 1988).

R2 - post-operative recording

At R2 all the subjects have extended the type and range of contoid articulations in their inventories (Figure 3). Bilabial plosives and plosives using the tip, front and back of the tongue are evident in the inventories of both AU and AB. In addition AB has a similar range of fricatives. DD, SB and FS, however, still exhibit a marked lack of plosives and fricatives using the lips, tip and front of the tongue, although DD has a bilabial fricative. There is, therefore, at R2 a difference between the subjects who had clefts of the palate only (AU, AB) and those who had complete clefts of the lip and palate (DD, FS, SB). All subjects are using some postero-dorsal plosives but glottal articulations still predominate for both plosive and fricative contoids (Figure 4). All subjects are using a range of approximants but AU does not use the postero-dorsal approximant [ɰ] and SB does not use the bilabial approximant [w].

It is evident from Figure 5 that at R2 all the subjects are using a higher percentage of lingual articulations. SB is the only subject using more back of tongue (37%) than front of tongue (21%) articulations. AU is using a much higher percentage of front (41%) versus back (2%) of tongue articulations. SB has no bilabial articulations at R2 but 5% of FS's and 27% of AB's articulations are now bilabial.

At R2, therefore, although all subjects evidence more lingual articulations and there is an increase in plosives, particularly in the inventories of AU and AB (both CP), there is still an overall pattern of phonetic deviance.

R3 - six months post R2 (subjects' ages 1;6-1;9)

Further development has occurred in the inventories of all the subjects at R3 except for AB (Figure 3). In particular AB is no longer using labial and apical/laminal approximants and voiceless fricatives. This may have been due to the influence of fluctuating hearing levels. Although AB's response to a free-field hearing test at the time of R3 was considered to be within normal limits, his tympanic membranes were reported to be mobile but dull, and flat tympanograms provided evidence of otitis media with effusion (OME). There has, however, been an increase in the percentage of plosives used by AB (Figure 4) which account for over 75% of his total articulations, although only 26% are labial

or lingual plosives. The glottal plosive [ʔ] predominates.

AU's inventory at R3 shows a normal pattern of development especially with regard to plosives. Over 65% of her total articulations are plosive with only 17% being glottal articulations (Figure 4). She is using both voiced and voiceless productions for bilabial, apical/laminal and postero-dorsal plosives (Figure 3).

DD and FS still lack bilabial plosives and fricatives, although both subjects now evidence plosives and fricatives using the tip and front of the tongue (Figure 3). Figure 4 shows that the frequency of use of plosives by DD at R3 has increased but not to the same extent as for AB and AU. Only 8% of DD's plosives are glottal however. FS at R3 shows a decrease in the frequency of nasal articulations (from 61% at R2 to 19% at R3) but only a slight increase in plosives (6% to 15%) with 10% being glottal. There is however an increase in fricative articulations with the development of apical/laminal and antero-dorsal fricatives (Figure 3).

In SB's phonetic inventory at R3 (Figure 3) voiced bilabial and apical/laminal plosives are present and there is some evidence of labial and apical/laminal fricative articulations. In addition there is an abnormal range of postero-dorsal, pharyngeal and glottal fricatives. For this subject at R3 Figure 4 indicates that there has been no increase in the frequency of plosive articulations, a slight reduction in the use of the glottal fricative [h] and an increase in nasals from 6% at R2 to 15% at R3.

With regard to frequency of use of the active articulators at R3, it is evident from Figure 5 that AU's use of each articulator is virtually equal. AB has a high number of pharyngeal and glottal articulations which are attributable to his frequent use of the glottal plosive in R3. DD and FS who both had lip clefts have a low number of bilabial articulations which is due to the absence of labial plosives and fricatives. In addition over 80% of DD's articulations are lingual (front of tongue 54%, back of tongue 31%). FS's use of front of tongue articulations has increased slightly and there is a decrease in back of tongue articulations from 16% at R2 to 7% at R3. The higher number of back articulations at R2 are predominately the postero-dorsal nasal [ŋ], whereas at R3 most of the back articulations are the plosives [k] and [g]. At R3 41% of FS's articulations are glottal. Although 35% of SB's articulations at R3 are pharyngeal or glottal this represents a decrease from 52% at R2. At R3 SB is also using bilabial articulations in addition to more front of tongue and fewer back of tongue articulations.

The results at R3, therefore, indicate that all five subjects are continuing to move towards more normal phonetic patterns, particularly with regard to the increase in non-glottal plosive contoids. Individual differences are begining to emerge but there is still evidence of restricted and deviant phonetic development for all subjects except AU.

Phonetic Distribution and Phonotactic Structure

In addition to the analyses reported above (see also Chapter 4 on Methodology), the distribution of contoids according to their position in vocalisation structure was analysed. A phonotactic analysis of vocalisation structure was also carried out. These results are described at appropriate points in the text.

In all five subjects the full range of contoids in their inventories at each recording is only used at vocalisation initial (VI) and within vocalisation (WV) positions. Very much smaller ranges of contoids occur at vocalisation final (VF) position. A small increase in the range of contoids used at VF position occurs at R3 for all subjects except AB. At R3 AB uses a wider range of contoids at WV position and the most frequently occurring contoid at both VI and WV positions is the glottal plosive [ʔ]. The results of the distribution analysis, therefore, suggest that VF is a non-preferred position in structure, an observation which is borne out in the phonotactic analysis.

With regard to the phonotactic analysis, open syllable structures in both monosyllables and disyllables are canonical for all three recordings for all subjects. At R3 the phonotactic structure of AU's vocalisations closely resembles her first recognisable words. CV is the canonical structure with CVC being the next most frequently used. CV is also the canonical structure at R3 for all the other subjects except FS. The canonical structure for FS is VCV. The next most frequently used

structure at R3 for all subjects, apart from AU, is CVCV. At R3 all subjects were reported to be using some recognisable words consisting mainly of CV and CVCV structures.

The phonotactic structures used by each child at each recording were also examined to determine any evidence of the different stages of vocalisation development as described by Oller (1980). At R1 all subjects are using some "glottal sequences" which have been reported in the babbling patterns of deaf children (Oller 1986) and in the vocalisations of very young infants (Stark 1980, Roug et al 1989). Roug et al (op cit) describe this as the "glottal stage". SB uses glottal sequences almost exclusively but in the vocalisations of AB, DD and FS there is evidence of Roug et al's "velar/uvular stage" which corresponds with Oller's "expansion stage". In normal children this stage occurs at 4-6 months (Oller 1980). AU is the only subject who is using some reduplicated and non-reduplicated babbling, for example, [mæmæ, GæGæ, bəbə, Læ, æləɹ]

This occurs in Oller's "canonical babbling stage (7-10 months)" (AU is 0;11 at R1).

Post-operatively at R2 each subject has made some progress but the extent of this varies. AU is using both canonical and variegated babbling and has some proto-words. Oller (1980) suggests that variegated babbling occurs at 11-12months. AB still uses some glottal sequences but to a much lesser extent and is now using reduplicated and some variegated babbling and is therefore at the canonical stage. DD, however is only

using a very small amount of reduplicated and non-reduplicated babbling and most of his vocalisations are still at the velar/uvular stage. FS's vocalisations evidence the canonical stage with, in particular, long sequences of reduplicated babbling using nasal contoids. In addition there is also some evidence of variegated babbling. There has only been a minimal change in SB's vocalisations. She is still using mainly glottal sequences but in addition there is also evidence of the velar/uvular or expansion stage.

Because R3 was six months after R2 it is inappropriate to make a direct comparison with Oller's stages of vocalisation development as it can not be determined at what age each child moved onto to the later stages. It can be observed, however, that each child is using some variegated babbling and proto-words.

The results reported above clearly indicate that there is phonetic deviance in the pre-speech vocalisations of all five subjects, both pre- and post-operatively. This finding is in agreement with studies reported for other cleft palate populations. Henningsson (personal communication) has described the vocalisations of cleft palate children as being characterised by "glottal babble". O'Gara & Logemann (1985) also report a predominance of glottal articulations at approximately the same period in cleft palate children's development as that investigated in Study 1. In addition they report the frequent occurrence of glides (approximants), especially

[w], and the bilabial nasal. The data reported here would appear to a large extent to replicate these findings, especially with regard to the regular appearance of glottal contoids and approximants (especially, in all subjects except AU, potero-dorsal approximants) in the phonetic inventories.

All the subjects evidence some progress towards more normal phonetic development post-operatively at R2 with an increase in lingual articulations and in plosives other than the glottal plosive. At this stage, however, the two CP subjects would appear to be more advanced than the CLP subjects. It has been suggested with regard to the speech patterns of older cleft palate children that those who originally had more extensive clefts are likely to have more severe speech problems (McWilliams et al 1984). It is possible, therefore, that the subjects in this study who had clefts of the lip and palate are experiencing more difficulty in phonetic development than those who had clefts of the palate only. In addition, it is possible that a more extensive initial defect could have resulted in a higher incidence of abnormal learned neuromotor patterns (Bzoch 1979).

At R3 AU's contoid phonetic inventory is within normal limits for her age (1;7). The apparent regression for AB would seem to be attributable to fluctuating hearing levels as a result of OME, as described above. AB and the three CLP subjects continue to evidence delayed plosive development. In addition FS and SB in particular exhibit phonetic deviance with regard to their frequent use of glottal articulations.

Comparing the vocalisation patterns of these subjects with the characteristics of the babbling patterns of normal children, there are notable similarities in the phonotactic structures used, in that the open syllable is predominant (Oller 1980). In addition the presence of the structural abnormality obviously causes delay in vocalisation development. This delay is still evident post-operatively for all subjects except AU, even though the operation has provided an intact intra-oral mechanism.

PHONETIC AND PHONOLOGICAL DEVELOPMENT

Subject AU

At R3 (1;7) as described above AU's contoid phonetic inventory contained labial and lingual plosives and fricatives and was within normal limits for her age. Figure 6 presents the phonetic inventory for AU at R4 (2;3).This inventory is based on meaningful words. In comparison with the contoid phonetic inventory at R3 (1;7), it is evident that labial, antero-dorsal and postero-dorsal plosives have become established as labial, alveolar and velar plosive consonants. There has also been further development of fricative articulations and the labio-dental [f] and alveolar [s] and [z] are now present in the inventory. It should be noted, however, that the palatal fricatives [ç] and [j] which were evident as antero-dorsal fricatives at R3 (1;7) are also

present in the inventory (see further below). In addition the voiceless affricate [ʧ] is evident. Consonant clusters are developing and AU is using obstruent+ approximant clusters and also some /s/ clusters, for example [sp].

Figure 7 shows the child's phones mapped onto the adult target phones and reveals a normal developmental pattern apart from the realisation of some target alveolar and post-alveolar fricatives as palatal fricatives. Unusual fricative articulations sometimes referred to as 'compensatory articulations' (Dorf & Curtin 1982) and also palatalisation of alveolar consonants (Albery & Hathorn 1985) has been reported in the speech patterns of cleft palate children and is often attributed to dental and/or occlusal problems (Albery & Russell 1990). With regard to AU, however, she had a cleft of the palate only, the alveolus was not affected and her dental and occlusal development was normal. Developmentally (Figure 8) AU has already reached Stage V (3;0-3;6) well in advance of her chronological age (2;3). This normal pattern of development continues through the next three recordings at ages 3;0, 3;6 and 4;0 years (see Figure 8).

Figure 9 presents the Contrastive Assessment at R4i (3;0). It is evident that there is still some variability in the production of fricatives. In within word (WW) and word final (WF) positions alveolar and post-alveolar fricatives are still sometimes realised as palatal and alveolo-palatal fricatives but there is evidence that this is decreasing as accurate realisations of the target

phones occur more frequently. By 3;6 (Figure 10) the realisations always correspond with the target phone. At 4;0 AU has reached Stage VII (4;6<) on the Developmental Assessment (Figure 8) again in advance of her chronological age. There was, therefore, no recording at 4;6.

It is evident from these results that AU follows a near normal pattern of phonetic and phonological development. The only evidence of any characteristics of cleft palate speech is the occurrence of the palatal fricatives which have disappeared by 3;6. AU had some ear problems associated with upper respiratory tract infections during the period studied, but whenever OME was detected it was always unilateral and her hearing in the other 'good' ear was always within the normal range. The OME responded to antibiotic treatment when necessary. It is noteworthy that AU's language development in other respects also followed a normal pattern.

Subject AB

AB's consonant phonetic inventory at R4 (2;6, Figure 11) is very similar to his contoid phonetic inventory at R3 (1;7, Figure 3). There are virtually no Word Final consonants and there is a restricted range of consonants which occur in WI and WW positions. These are the nasals [m] and [n], the voiced plosives [b],[d],[g], the glottal plosive [ʔ] and the approximant [l]. Other approximants

only occur once and are therefore marginal. In addition to these phones, antero-dorsal fricative articulations which were present in the inventory at 1;7 also occur in non-meaningful vocalisations at 2;6. There are no voiceless phones in the inventory at R4 (2;6).

Figure 12 presents the consonant phonetic inventory for AB at R4i (3;0) and it is evident that there is virtually no change from R4 (2;6). There was insufficient data to complete a Contrastive Assessment at R4 (2;6) but there are indications of the development of some unusual patterns which are subsequently evidenced in the limited data available at R4i (3;0, Figure 13). In addition to the developmentally normal process of Final Consonant Deletion, there are some developmentally unusual realisations, for example, voiceless bilabial plosives and labio-dental fricatives are realised as nasal consonants, and the glottal plosive is used for some alveolar plosives and fricatives and voiceless velar plosives:-

Puffer train: [ˈnʊʔəˌneɪ] *fork:* [nɔ]

cat: [ʔæ] *tap:* [ʔæ]

sock: [ʔɒ]

It can be concluded that at this data point (R4i, 3;0) there are still phonetic restrictions affecting AB's phonological development. Nasal and glottal realisation of plosives and fricatives could indicate that AB is having difficulty achieving velopharyngeal closure (Bzoch 1979, Morris 1979) but this is unlikely as AB is producing voiced plosives. It is possible, therefore,

that these unusual realisations are a result of abnormal learned motor patterns (Bzoch op cit). In addition a further influencing factor is that at 3;0 there is evidence that AB had OME. The type of fluctuating hearing loss associated with OME may affect the child's perception and production of fricatives and of voiceless phones (Bamford & Saunders 1985). Bilateral grommets were inserted when AB was 3;1 and improved hearing levels were reported at a post-operative review by the otolaryngologist at 3;4.

Figure 14 presents the phonetic inventory for AB at 3;6 (R5). It is evident that there is a more normal pattern with regard to plosive development in that AB is now using the voiceless equivalents of the voiced plosives he was using at 3;0 (R4i). The only fricative productions, however, are marginal phones and AB is using a few consonant clusters in WF position only. The Contrastive Assessment at 3;6 (Figure 15) reveals variability with regard to plosive and fricative production and there remains a serious phonological mismatch with the adult system. There are nasal realisations of fricatives and affricates, particularly in WI position, and some glottal realisations of voiceless plosives and fricatives both WI and WW. In WF position nasals and some plosives are evident but for the remaining phones the process of Final Consonant Deletion persists.

At 3;6, therefore, there is evidence of delayed and deviant phonetic and phonological development. There are still nasal and glottal realisations of target

obstruents. In addition the process of Final Consonant Deletion persists and there is virtually no development of consonant clusters. In normal development by 3;0-3;6 WF consonants and also obstruent+approximant and /S/ +consonant clusters are being used (Grunwell 1985).

AB had been referred for speech therapy at 3;0 but this did not commence until he was 3;8. He received weekly therapy from 3;8 until 3;11 when the therapist left her post. Treatment focused on fricatives, particularly the production of /f/ and /S/. It was reported that AB was making good progress despite the fact that at 3;8 it was found that both grommets has extruded and that there was a recurrence of OME. Bilateral grommets were inserted again at 3;11. No further speech therapy was provided for AB during the period of this study.

At R6 (4;0) significant change can be seen in both AB's Phonetic Inventory (Figure 16) and Contrastive Assessment (Figure 17). In particular fricatives now occur in all word positions and any variability is confined to fricatives and affricates. However, nasal realisations are still dominant for the sibilant fricatives and affricates in WI position, for example:-

shop: [nɒp] *chips:* [nɪps]

jumping: [nʌmpɪŋ] *jelly:* [ʤeli]

soldier: [nəʊʤə] *sugar:* [nʊgə]

Developmentally (Figure 18) it would appear that AB has reached Stage VI (3;6-4;6). In terms of phonotactic development, however, there is still cluster reduction, especially in WI and WW positions. In WF position there

is a range of consonant clusters including some /s/ clusters.

It is evident from Figure 19 that at R7 (4;6) AB has a much wider range of consonant clusters. There is still, however, some reduction of /r/ clusters. Developmentally AB's phonological system is age appropriate (see Figure 18). The Contrastive Assessment (Figure 20) indicates that there is still some variability in the production of affricates and of /ʃ/; /ʃ/ is realised as [s] in WI and sometimes in WF position. Both /tʃ/ and /dʒ/ are usually realised as the alveolar fricatives [s] and [z] in WI position. Within words /tʃ/ is realised accurately but word finally it is usually realised as an alveolar affricate [ts]. Similarly /dʒ/ is realised as [dz] in WF position. This type of variability in affricate production and the realisation of /ʃ/ as [s] do occur in normal development and are not characteristics of cleft palate speech. They are, therefore, evidence of delay. Most children are producing affricates and also /ʃ/ correctly by 3;6 (Grunwell 1985).

For AB, therefore, these results indicate a pattern of deviant and delayed phonetic and phonological development. There is late development of plosive and fricative consonants. Some cleft palate speech characteristics such as nasal and glottal realisations of target obstruents are evident. Glottal realisations have disappeared by 4;0 (R6) and nasal realisations by 4;6. At 4;0 there is still delay in the development of clusters.

By 4;6 AB's phonetic and phonological patterns are within the normal range but there is still some evidence of delay. It would appear, therefore, that for AB the cleft palate condition combined with intermittent hearing difficulties resulted in deviant and delayed phonetic and phonological development which was virtually resolved by 4;6.

Subject DD

At R3 (1;8 see Figure 3) DD was using plosives and fricatives involving the tip, front and back of the tongue but still lacked bilabial plosives and fricatives. At 1;11 bilateral OME was diagnosed and grommets were inserted at 2;0.

Figure 21 presents DD'S phonetic inventory at R4 (2;4) and it is evident that there has been further development of plosives and fricatives. DD is using bilabial plosives; the glottal plosive which was present in the contoid phonetic inventory at R3 (see Figure 3) has now disappeared. Although there was an apical/laminal approximant [ɻ] at R3 there is no equivalent alveolar lateral at R4. It is evident from the phonetic distribution that the fricative consonants apart from [h] and [ʃ] only occur in WF position. Some of these fricatives, especially the palatal fricatives, do not occur in normal development but have been reported in the speech patterns of cleft palate children (Albery & Russell 1990). It is noteworthy, however, that the normal

fricative articulations are occurring slightly earlier than expected in normal development. Most children have acquired /ʃ/ by 2;6-3;0 (Grunwell 1985).

Although data for the Contrastive Assessment at 2;4 (R4) is limited (see Figure 22) it is evident that it does not reflect the more normal phonetic inventory. There is variability particularly in the realisations of plosives and fricatives in WF position. Word initially all plosives except two [k] are voiced but there are more voiceless phones word finally. There is a Stopping process operating for target fricatives and affricates in WI position but in WF position DD is using variable fricative realisations for target fricatives, for example *Thomas:* [domaç, domaʃn] *find:* [baɪnd] *fish:* [bɪç]. In addition there is Backing of some target affricates and of /d/. There are nasal realisations of some target fricatives in WI and WW positions and of /d/ in WF position.

Stopping of fricatives and voicing of voiceless targets is not unusual in normal phonological development at 2;4. Backing is developmentally unusual but has been reported in the speech patterns of cleft palate children (Albery & Russell 1990). Nasal realisations of obstruents may also be attributed to the cleft palate condition as discussed for AB above. At R4 (2;4), therefore, DD is evidencing normal development and also some features which may be associated with cleft palate.

Figure 23 presents the phonetic inventory for DD at R4i (3;0). Affricates are now marginal phones and there has

been further fricative development. DD is now using [s], [z] and [ʃ] and there are three WI occurrences of [ð]. The palatal fricatives are no longer present but the alveolo-palatal [ɕ] is still present as a marginal phone and occurs only in WF position. There is evidence of cluster development. DD has some obstruent+approximant clusters in WI position and nasal+obstruent and obstruent+fricative clusters in WF position.

The Contrastive Assessment at 3;0 (Figure 24) indicates that there are accurate matches with the adult system for plosives in WI and WW positions. This represents a major advance since 2;4 (R4) when voiceless plosive targets in these word positions were voiced and /d/ was sometimes Backed. In WF position there is still variability in the production of plosives but this is not developmentally unusual, for example some /t/ and /k/ targets are omitted and some /t/ targets are realised as glottal. Unfortunately there is no data for WF /p/ and /b/. With regard to fricative development there are accurate matches for target /z/ in all word positions. /s/ and /ʃ/ are usually realised accurately in WF position although there is a small amount of variability. /s/ also occurs WW but the only occurrence of /s/ in WI position is Stopped and realised as [t]. WI realisation of /ð/ is variable although there are three accurate matches with the target. In addition there are two nasal, two approximant and two plosive realisations of this target phone. Labio-dental fricatives in WI and WW positions are Stopped. The realisation of /θ/ as [p] probably indicates

that DD was attempting to realise this as a labio-dental fricative, i.e. /θ/ → /f/ → [p].

Figure 25 presents the Developmental Assessment for DD from 2;4 onwards. At 3;0 DD would appear to be at Stage IV (2;6-3;0) but without /f/ and with [z] and [ʃ]. The results of the phonetic and phonological assessment at 3;0 indicate that DD has made developmentally normal progress since 2;4. In addition the Backing process and nasal realisations of target phones have virtually disappeared. There is one realisation of /ʧ/ as [k] and two nasal realisations of /ð/ all in WI position. There is, therefore, almost no evidence of any characteristics related to the cleft palate condition.

At 3;3 the otolaryngologist reported that both grommets had extruded and there was a recurrence of OME. Bilateral grommets were reinserted at 3;5. At R5 (3;6), however, it is evident from figure 24 that there has been further fricative development. [f] is now present in the phonetic inventory and [v] is a marginal phone. The affricates [ʧ] and [ʤ] and the dental fricatives [θ] and [ð] are also marginal phones. There are also two occurrences of the alveolar approximant [ɹ] which did not occur at 3;0. There has also been further development of clusters with /s/ + consonant clusters occurring in WI and WW positions. In addition there is a wider range of clusters in WF position.

The Contrastive Assessment at 3;6 (Figure 27) reveals that there is still some variability particularly for affricates and labio-dental fricatives which are just

entering the system. Developmentally (Figure 25) DD is at Stage V (3;0-3;6) and has continued to progress normally.

The Contrastive Assessments at R6 (Figure 28) and R7 (Figure 29) together with the Developmental Assessment (Figure 25) indicate further normal phonological development. At R6 (4;0) there is still some variability in the production of affricates but these are fully established at R7 (4;6). Target /l/ is realised accurately in WI and WW positions at 4;0 and also in WF position at 4;6. There is a small amount of variability in fricative production at 4;0 but this has virtually disappeared at 4;6.

The results reported above indicate that there is some delay in the development of bilabial plosives and labio-dental fricatives. There is evidence of some characteristics which could be attributed to the cleft palate condition, for example, Backing and nasal realisations of obstruents but these have virtually disappeared by 3;0. Even when they do occur there are always other developmentally more appropriate realisations of the target phone, for example, at 2;4 WI /ʤ/ is realised as [g] and [d], and WF /d/ as [n] and [d]. Apart from these characteristics and the delay described above DD follows a pattern of normal phonetic and phonological development.

Subject SB

SB's contoid phonetic inventory at R3 (1;9) contained a range of plosive articulations. In addition she was also using a range of predominately posterior fricatives, that is, postero-dorsal, pharyngeal and glottal fricatives (see Figure 3).

Figure 30 presents the consonant phonetic inventory for SB at R4 (2;6). It is evident that the labial, antero-dorsal, and postero-dorsal plosives which occurred at 1;9 (R3) have become bilabial, alveolar and velar plosives. Both the voiced and voiceless phones are used although [p] is marginal. There are no longer any anterior fricatives but SB is using palatal, velar and uvular fricatives. These correspond with the posterior fricatives which were present in her pre-speech contoid phonetic inventory at 1;9. This pattern of posterior fricatives is not found in the speech of normal children but has been reported in the speech patterns of cleft palate children (Dorf & Curtin 1982, Bzoch 1979).

Figure 31 presents the Contrastive Assessment for SB at R4 (2;6). It is noteworthy that there is a high degree of variability in the realisations of the same target phones. (The most frequently occurring realisation of the target phone is circled). The variability affects both manner and place of articulation, for example, WI /ʃ/ is realised as [ç, x, χ, h, ɡ, ɲ, j], that is, as fricative, plosive, approximant and as alveolar, palatal, velar, uvular and glottal articulations. In addition there is evidence of a Backing process operating on all target

phones including velars. Backing is not a normal developmental pattern but has been reported as a feature of cleft palate speech (Edwards 1980, Bzoch 1979). With regard to the Developmental Assessment (Figure 32), SB is most closely identified with Stage III (2;0-2;6), in terms of her contrastive system but the variability and the phonetic restrictions suggest that this contrastive system is not yet well established.

It can therefore be concluded that at 2;6 (R4) SB's speech patterns are not moving towards the adult pronunciation system but are still reflecting restrictions on her phonetic potential as a result of the cleft palate condition. It is noteworthy that at this time it is possible that there were still physical limitations on SB's articulatory ability. As discussed in the methodology (see Chapter 4) because of illness in the immediate post-operative period there was some dehiscence of the posterior palatal muscles. Anteriorly, the muscles appeared to be well united but the uvular part of the palate separated as the palate lifted. A further repair to correct this was carried out when SB was 2;7. In addition, because of the deviant nature of SB's speech patterns speech therapy intervention was implemented between 2;8 and 3;3. Treatment focused on the discrimination and production of bilabial and alveolar consonants. Apart from demonstration by the therapist, most of the work was carried out by SB's mother at home.

As discussed in the methodology there is no R4i (3;0 year) recording for SB.

At R5 (3;6) the phonetic inventory (Figure 33) shows a much more normal pattern. The unusual posterior fricative articulations have disappeared and SB now has [S] and [Z] in addition to labio-dental and dental fricatives. With regard to plosives, however, it should be noted that the velar plosive [k] is now marginal. SB is also begining to use some consonant clusters. In WI position there are obstruent+approximant clusters and in WF position nasal+obstruent and some /s/+consonant clusters.

The Contrastive Assessment (Figure 34) indicates that there remains a phonological mismatch with the adult system. There is now a significant and remarkable decrease in SB's use of velars for targets other than velars, but target velars are usually realised as glottal articulations, although there is one accurate WI [k] and three [g] in WF position. Glottal realisations have been reported as a characteristic of the speech patterns of cleft palate children (McWilliams et al 1984), although it is unusual for them to be used almost exclusively for target velars. For SB, however, this could be related to the surgery she received at 2;7 which will have involved the velar and uvular parts of the palate in particular.

In addition, at R5 (3;6) there continues to be some variability, particularly of some fricatives in WI position and plosives in WF position. The labio-dental fricatives [f] and [V] only occur in WI position. Target /V/ is realised as [b] in WW position thus evidencing a Stopping process. In WF position, however, /V/ is variably realised as the fricatives [S] and [Z] or is deleted. There is no data for /f/ in WF position but in

WW position it is realised as [S]. There is, therefore correct manner of articulation although the placement is incorrect. Developmentally (Figure 32) it would appear that SB has virtually reached Stage VI (3;6-4;6), but without velar plosives. In addition labio-dental fricatives and also /s/+consonant clusters are not well established.

Figure 35 presents the Contrastive Assessment for SB at 4;0 (R6). It is evident that there are still some glottal realisations of velar plosives. Target /k/ is realised as the glottal plosive [ʔ] in WW and WF positions but in WI position it is variably realised as [k,h,ʔ]. Target /g/ is usually accurately realised in WW and WF positions but is realised as the glottal plosive [ʔ] in WI position. The cleft palate characteristic of glottal realisations is, therefore, still influencing SB's phonological system at 4;0. It should be noted that velar plosives do occur in the clusters [kw,gw,skw] in WI position.

With regard to fricatives the labio-dental fricatives are now well established in all word positions and the dental fricative [ð] occurs in WI position. There is, however, some lateralisation of alveolar fricatives in all word positions and of /ʤ/ in WF position. A high incidence of lateralisation and/or palatalisation of /S/ and /Z/ has been reported in the speech of children with lip and palate clefts, with no occurrence of these features in a group of children with clefts of the palate only (Albery & Hathorn 1985). It has been suggested that palatalisation and lateralisation of alveolar phones are

associated with dental and occlusal abnormalities (Stengelhofen 1989, Albery & Russell 1990). This is applicable in SB's case as there was some collapse of the lesser segment resulting in misalignment of the dental arch. In addition she had a small anterior fistula just behind the alveolus.

Developmentally (Figure 32) SB is now clearly at Stage VI (3;6-4;6) although velar plosives are still not established in her phonological system. There has been further development of consonant clusters, particularly of /s/+consonant clusters in WI position. It is evident, however, that there are still some characteristics of cleft palate speech, such as glottal realisations of some target velars and lateralisation of alveolar fricatives.

It is apparent from Figure 36 that at 4;6 (R7) velar plosives are now accurately realised in all word positions. In addition lateralisation of alveolar fricatives has virtually disappeared. There are single occurrences of [ʃ] and [ʒ] in WF position and there are also two examples of lateralisation of target /tʃ/ in WI position. Developmentally (Figure 32) SB has reached Stage VII (4;6<) and there is minimal remaining evidence of any characteristics associated with cleft palate speech.

These results indicate that for SB there is evidence that the physically based phonetic deviance restricts phonological development. Although there is a more normal phonetic inventory at 2;6 (R4), when the child's system

of phones is mapped onto the adult target system, developmentally unusual matches are evidenced and there is considerable variability. In particular there is a strong Backing process operating on all target phones. At this point SB's speech patterns are clearly constrained by phonetic factors.

Following R4, at 2;7 SB underwent further palatal surgery on the posterior part of the palate. In addition she received some direct speech therapy intervention as described above. This would seem to have had some effect as she uses many more appropriate consonants in R5 (3;6). It is noteworthy, however, that the occurrence of velar articulations is greatly diminished in SB's sample at 3;6. This phonetic lacuna, which could be associated with the palatal surgery, results in a developmental phonological mismatch. The glottal realisations of velar plosives provide evidence that phonetic factors are continuing to restrict phonological development. These factors still persist at 4;0 (R6) and in addition there is evidence of some lateralisation of fricatives which is another characteristic associated with cleft palate. By 4;6 (R7), however, velar plosives are established in SB's phonological system and the lateralisation of fricatives has virtually disappeared. The phonetic restrictions on SB's phonological development have, therefore, resolved by 4;6.

With regard to hearing, SB did have some episodes of OME during the period studied. However, this was usually associated with upper respiratory tract infections and did not persist or cause significant hearing loss.

As illustrated in Figure 3 FS's contoid phonetic inventory at R3 (1;9) lacked bilabial plosives and fricatives although there were some plosives and fricatives involving the tip and front of the tongue. Figure 37 presents the consonant phonetic inventory for FS at R4 (2;4). It is evident that there has been further development of plosives, particularly the bilabials, and of fricatives. However, the voiced alveolar plosive [d] is marginal and there are a low number of voiceless alveolar plosives and of bilabial plosives. With regard to fricatives, the alveolar fricatives [S] and [z] occur predominantly in WF position. In addition two developmentally unusual fricatives are present in FS's phonetic inventory at 2;4; the retroflex fricative [ʂ] and the palatal fricative [ç]. Phonetically deviant realisations of fricatives have been widely reported in the speech patterns of cleft palate children (Albery & Russell 1990, McWilliams et al 1984).

It is noteworthy that affricates are also evident at R4 (2;4) as it is unusual for them to start appearing in normal development until 3;0-3;6 (Grunwell 1985). FS, however, does not use affricates to realise target affricates except for two [ʤ] in WW position. [ʤ] is used to realise the target cluster /gr/ in WI position, for example, *grass:* [ʤæʂ]. It is also used as one of the variable realisations of target /tr/. [ʧ] is also used to realise the target cluster /gr/. In addition [ʧ] is used to realise the labio-dental fricative /f/ in *fish:* [ʧɪʃ],

which is an example of the developmentally normal process of Consonant Harmony.

Although the phonetic inventory at 2;4 (R4) shows a more normal pattern overall, the Contrastive Assessment (Figure 38) indicates that the phonological mismatches with the adult system are not always developmentally normal. There is also some developmentally unusual variability. One aspect of the variability is a Backing process with the use of velars for many target phones. As described above, Backing is a characteristic associated with cleft palate speech (Albery & Russell 1990). Another aspect of the variability is the variable realisations of fricatives, for example /s/ in WI position is variably realised as [s, ç, t, ʃ, g]. In addition to some accurate realisations there is evidence of phonetically deviant realisations [ç], Backing [g], and a developmentally normal Stopping process [t, g].

On the Developmental Assessment (Figure 39) FS can be most closely identified with Stage IV (2;6-3;0); although the absence of the voiced alveolar plosive [d] and the labio-dental fricative [f] must be noted. This is to a certain extent compensated by the presence of the fricatives [S] and [Z]. The variability and the phonetic restrictions suggest, however, that the Contrastive System is not yet well established. It can, therefore, be concluded that at 2;4 physically based phonetic deviance is restricting FS's phonological development.

Following R4 (2;4) FS's mother was given advice on how to encourage the development of bilabial and alveolar consonants but FS did not receive any direct speech

therapy intervention. In addition, FS was subsequently found to have bilateral OME and required grommet insertion at 2;7, three and a half months after R4.

As for SB there is no R4i (3;0) recording for FS.

Figure 40 presents the phonetic inventory for FS at R5 (3;6). It is evident that there has been considerable progress since R4 (2;4) particularly with regard to the development of clusters. FS is using obstruent + approximant and also /s/ + consonant clusters. The labio-dental fricatives are now present in the phonetic inventory and [ð] is present as a marginal phone. The palatal fricative [ç] is still evident and in addition there is a palatal plosive [ɟ]. Both these phones do not occur in normal development but, as discussed above, palatal articulations have been reported in the speech of cleft palate children (Albery & Russell 1990).

The Contrastive Assessment (Figure 41) at R5 (3;6) shows that there are still a number of abnormal phonological mismatches with the adult target system. There is continued Backing of some alveolar plosive targets, in particular /d/ in all word positions. In addition there are variable realisations of target fricatives some of which are developmentally unusual, for example, the palatal fricatives for target /S/ in WI and WF positions. There are also some variable realisations of affricates in WW position, and in WF position /ʧ/ is realised as [ʔs].

Developmentally (Figure 41), FS can now be placed at Stage VI (3;6 - 4;6) and is thus giving evidence of near

normal phonological development. However, some characteristics associated with the cleft palate condition, for example, Backing and palatal articulations, are still present in his phonological system.

Figure 42 presents the Contrastive Assessment for FS at R6 (4;0). It is evident that the Backing process has now resolved. There is some variability in the production of affricates in WF position but accurate realisations of the target phones do occur. The palatal fricative and plosive which were present at 3;6 have now disappeared. Developmentally FS has reached Stage VII (4;6<) on the Developmental Assessment (Figure 39), in advance of his chronological age. There was, therefore, no recording at 4;6.

It is evident from these results that for FS phonetic deviance restricts early phonological development. There is, however, gradual and spontaneous recovery from the abnormal Backing process and palatal realisations of target obstruents. This recovery is first evident at 3;6 and by 4;0 FS's phonological system is developmentally normal. Apart from these characteristics FS follows a pattern of normal phonetic and phonological development.

COMPARISON BETWEEN SUBJECTS

Comparison of the five children's developing phonological systems indicates that there is considerable individual variation but there are also common tendencies. Characteristics associated with cleft palate speech patterns can be detected in the data of all the children at some stage but the number and type of characteristics vary. The characteristics which occur are palatal, nasal and glottal realisations of target obstruents and a Backing process. In addition, for all subjects except AU there is evidence of delayed development. All these characteristics have been reported in the speech patterns of cleft palate children (Albery & Russell 1990, Bzoch 1979, Dorf & Curtin 1982, McWilliams et al 1984).

Palatal realisations of target obstruents are evidenced for all the children except AB. For AU, DD and SB these palatal realisations have disappeared by 3;6; for FS they are greatly diminished at 3;6 and have disappeared by 4;0. It should be noted, however, that some lateralisation of alveolar fricatives is evident for SB at 4;0 although accurate realisations of the target phones predominate. Nasal realisations of target obstruents occur for AB and DD. For AB they do not resolve until 4;6 but for DD they have virtually disappeared at 3;0. Glottal realisations are still evident in the data of SB at 4;0 but they have disappeared by 4;6. For AB glottal realisations are no longer evident after 3;6.

A Backing process is present in the developing phonological systems of DD, SB and FS, the three CLP subjects. It is first detected at R4 (2;4-2;6) when there is sufficient data to complete a Contrastive Assessment. For DD the Backing process has resolved by 3;0. For FS and SB it is greatly diminished at 3;6 and has resolved by 4;0.

When the pre-speech and speech results for each subject are compared, it is noteworthy that AU whose pre-speech contoid phonetic inventory at 1;6 was developmentally normal goes on to evidence a near normal pattern of phonetic and phonological development. All the other subjects continued to evidence restricted and deviant phonetic development at R3 although there were indications of the emergence of more normal phonetic patterns. Subsequently these four subjects continue to evidence some delay in the development of plosive and fricative articulations but to different extents. DD, SB and FS all show a delay in establishing bilabial plosives in their Contrastive Systems. In addition for DD and SB there is a delay in the development of labio-dental fricatives. AB evidences the most marked delay in development. For this subject there is late development of plosive and fricative articulations. In addition there is late development of consonant clusters and at 3;6 the persistence of the developmentally normal process of Final Consonant Deletion. The delay in AB's phonetic and phonological development has largely resolved at 4;6 but there is some remaining evidence of developmentally normal delay.

One factor which distinguishes AB from the other subjects is that he had more frequent episodes of intermittent hearing loss due to OME. AU and SB never required grommets during the period of this study. DD had OME at 1;11, grommets were inserted at 2;0 and he was subsequently symptom free. Similarly FS only needed one set of grommets which were inserted at 2;7. AB, however, had evidence of OME at R3 (1;7), 3;0 and 3;8. Grommets were inserted at 3;1 and at 3;11. It would appear, therefore that for AB the intermittent hearing loss combined with the effects of the cleft palate resulted in a more severe delay than that evidenced for the other subjects.

AB and SB were the only subjects who received direct speech therapy intervention. Both of these subjects demonstrate that there can be persisting phonetic influence on phonological development. The results for the other subjects, however, indicate that there is the possibility of spontaneous recovery from phonetic deviance and of relatively normal phonological development once the palatal surgery has provided an intact intra-oral mechanism. It can be concluded that each child has his/her own route for phonetic and phonological development but there are some common tendencies. These results are in agreement with the observations of McWilliams et al (1984) who point out the considerable variability between individual cleft palate children in the extent and nature of their speech sound errors and conclude that they are a heterogeneous population in this respect. In addition they comment on

the occurrence of improvement with age, especially in the articulation of plosives and fricatives. The results of Study 1 would support this.

CHAPTER 6

RESULTS - STUDY 2

Contrary to the organisation of Study 1 where all the pre-speech results are presented together, in Study 2 it is essential to trace each child's development through individually. In this study, therefore, all the results of each child will be considered separately.

SUBJECT PJ

Pre-speech vocalisations

Figure 43 presents the contoid phonetic inventories for PJ at the first four recordings. For this subject the 1;9 (R3i) recording is presented as a contoid and not as a consonant phonetic inventory because, of the 59 identifiable words which occurred in the sample, only 18 were different spontaneous words. The rest of the words (n.41) were either repetitions (n.16) or modelled utterances (n.25). The percentage frequency of use of the active articulators at each recording is shown as Graph A in Figure 44. Graph B in Figure 44 shows the percentage frequency of occurrence of the different manner of articulation categories i.e. nasal, plosive, fricative and approximant.

It is evident from Figure 43 and from Graph B in Figure 44 that at R1 the only plosive and fricative articulations are glottal. In this sample PJ used many vocalisations of five or more syllables in length some of which consisted only of vocoids. At R1 PJ is using more nasal articulations than any of the other subjects except DD in Study 1. At least 30% of the total contoids used by DD and PJ are nasals, both the bilabial nasal [m] and the antero-dorsal nasal [n]. With regard to frequency of use of the active articulators, it is apparent from Graph A in Figure 44 that 38% of PJ's articulations are bilabial. This is a greater percentage than for any of the other subjects in both studies and is particularly noteworthy as PJ had a repaired unilateral cleft of the lip.
At R1, therefore, PJ is evidencing deviant and restricted phonetic development. This corresponds with the results for the other subjects in both studies although PJ is evidencing higher percentages of bilabial and of nasal articulations.

There is little change in the range of contoids which occur in the post-operative phonetic inventory in R2, although as indicated in Graph A (Figure 44) there is an increase in front of tongue articulations. The nasal contoids [m] and [n] occur even more frequently in R2 and the range of nasal contoids has increased with the addition of an antero-dorsal nasal [ɲ] and a postero-dorsal nasal [ŋ]. Nasals now account for over 57% of the total contoids in the sample (see Graph B). Although PJ is using more front of tongue articulations, there are

still no plosive contoids apart from the glottal plosive. At R2 PJ continued to use many multisyllabic vocalisations but these contained more contoids than at R1, although they often commenced with a vocoid.
The results for PJ at R2 indicate that there continues to be deviant and restricted phonetic development. The increase in front of tongue articulations corresponds with the results for all the other subjects at R2. PJ is not, however, using any bilabial or lingual plosives. All the other subjects (except JA in Study 2) are at least using some postero-dorsal plosives.

At R3 (1;6) PJ's vocalisations were shorter than in the previous recordings and there is evidence of some variegated babbling (Oller 1980). It is evident from Figure 43, however, that PJ's contoid phonetic inventory is still very restricted. There are single occurrences of two lingual plosives but nasals, in particular the antero-dorsal nasal [ɲ], predominate (see Graphs A and B, Figure 44). At this stage PJ's phonetic development is appreciably delayed in terms of normal development and in comparison to all the subjects in both studies at R3 (except subject JA). The phonetic inventory is significantly different in the lack of development of plosive and fricative articulations.

The most frequently used contoids in R3i (1;9) are still nasals (see Graph B, Figure 44) but these now account for a lower percentage (45%) of the total contoid articulations. With regard to the use of the active

articulators, over 50% of PJ's articulations involve the use of the tip and front of the tongue (see Graph A, Figure 44). It is evident from the phonetic inventory that PJ is now using both labial and lingual plosives (the number of occurrences of each plosive is indicated in superscript in Figure 43, R3i).

There is evidence, therefore, that at 1;9 a normal phonetic inventory is emerging although phonetic development remains very delayed and deviant. PJ's phonetic inventory at 1;9 (R3i) is similar to the inventories of the subjects in Study 1 at R3 (1;6-1;9) with regard to plosive development. However, he continues to lack the range of fricative articulations evidenced by the subjects in Study 1. In this respect his phonetic inventory at 1;9 is similar to that of AC at 1;6 (see below).

It is noteworthy that at 1;9 there was evidence of expressive language delay. PJ's verbal comprehension appeared to be within normal limits and his mother reported that he was very vocal throughout the day but he only had a small vocabulary of single words. It should be noted that none of the bilabial and lingual plosives occurred in spontaneous words in the sample at R3i (1;9). One word initial [b], one word initial [g] and one within word [b] occurred, all in modelled words. The majority of the lingual plosives therefore occurred in PJ's variegated babble.

These results indicate that, pre-operatively, PJ's vocalisations evidenced restricted and deviant phonetic

development. This is in agreement with the results for all the other subjects in both studies. PJ does, however, differ slightly from the other subjects in that he uses more bilabial and more nasal articulations at this stage. Post-operatively PJ is, like all the other subjects, using more front of tongue articulations but, like JA at R2 he lacks oral plosives. Bilabial and lingual plosives are still lacking at R3 (1;6) for both PJ and JA. At 1;6, however, PJ is using many more nasals and fewer glottal articulations than JA. At R3i (1;9) despite the development of some lingual plosive articulations there is a persisting pattern of delay and deviance with the additional evidence of delayed expressive language development.

Factors which may have influenced the delay in phonetic and language development include hearing, familial disposition to language delay and family circumstances. PJ was found to have OME pre-operatively so bilateral grommets were inserted when the palate was repaired. Post-operatively in the period during which the recordings for R2 to R3i were made PJ suffered some upper respiratory tract infections which resulted in otorrhea and variable hearing levels, despite the presence of the grommets. At 1;9 (R3i) the otolaryngologist reported that one grommet was partly blocked but that the other was in situ and hearing was judged to be acceptable.

With regard to familial disposition to language delay, PJ's mother reported that his elder brother (two years older) had begun to speak later than most children and that his speech had only been intelligible to his

immediate family until he was over 3;0. He had not required speech therapy.

A further possible influencing factor is that PJ's younger sister was born when he was only 0;11 (therefore near R2). The presence of a new baby in the household will have had some effect on family dynamics and may have resulted in PJ receiving less individual attention from his mother. At 1;9 PJ was reported to be imitating his sister's babbling and also to be exhibiting some aggressive and destructive behaviour. Prior to his sister's birth there was also concern in the family regarding the possibility of another child having a cleft lip and palate.

Phonetic Development - from 2;0 to 2;6

Figure 45 presents the phonetic inventories for PJ from 2;0 to 2;6. By 2;0 PJ had made significant progress with regard to language development. The inventory at 2;0 is based on 119 meaningful words which occurred in the sample. There were 71 different spontaneous words. PJ was still using some non-meaningful utterances but these were similar in structure to the meaningful words. In addition these utterances contained contoids which corresponded in terms of articulatory characteristics with the consonants used in the meaningful words. In comparison to the inventory at 1;9 (Figure 43) it would appear that there has been some regression although at 1;9 most plosives occurred in babble and not words. In addition, as

described above, the three plosive realisations which did occur in words at 1;9 all occurred in modelled words.

At 2;0 (Figure 45) it is apparent that most plosives apart from word initial [g] are marginal phones (including the glottal plosive). There is, however, no lack of opportunity for plosive consonants to occur. There are, for example, five target /p/ and six target /b/ in word initial (WI) position. Although there is some variability, which is not unusual in a child's first words, many obstruent targets are realised by nasal consonants, for example:-

teddy: [nɛnɛ]	*car:* [nɑ]
say: [neɪ]	*cat:* [gæ, næ]
dog: [nɒn]	*pig:* [mɪ]

Overall, nasal consonants predominate and the next most frequently occurring consonants are approximants. [ɡ] is used to realise a number of different WI targets, for example:-

duck: [gʌ]	*quack:* [gæ]
green: [gi]	

Most words end in an open syllable, the only word final consonants being [m], [n] and [l].

PJ's phonetic inventory at 2;0 is similar to that of JA (see below) although at 2;0 JA is evidencing a wider range of consonants. It is noteworthy that for PJ the glottal plosive is marginal and occurs once only in WW and WF positions. Both subjects are using nasal realisations of target obstruents which could indicate difficulty in achieving velopharyngeal closure or abnormal learned neuromotor patterns (Bzoch 1979).

At 2;0 one grommet was blocked and the other had extruded resulting in a recurrence of fluid in that ear and PJ's hearing levels were reduced. However, as indicated above, PJ had made progress with regard to language development since 1;9. His mother reported that he was now using a large vocabulary of single words and some two and three word phrases. Phonetic development, though, remains severely restricted with a marked lack of plosive consonants.

The phonetic inventories for PJ at 2;3 and 2;6 are presented together because they are virtually identical (Figure 45). It is apparent that PJ has still made no progress with regard to the development of plosive articulations. He is no longer using the velar plosive and in both recordings there are only a few occurrences of the glottal plosive [ʔ]. At 2;3, as at 2;0, there is only one occurrence of the bilabial plosive [b] and at 2;6 this does not occur at all. This pattern is different from that reported for other cleft palate populations. PJ is not, for example, using "compensatory articulations" as reported by Dorf & Curtin (1982) or predominantly glottal stop articulation as reported by Bzoch (1979) and Morris (1979). PJ is infrequently attempting any plosive or fricative consonants and uses few approximants. As at 2;0 there is no lack of opportunity for non-nasal consonants to occur but nasal consonants predominate in all word positions, for example,

come: [mʌm] *daddy:* [nænɪ]

fish: [ɲɪ] *gone:* [ɲɒɲ]

key: [ɲi] *sheep:* [ɲi]

It is evident from the data that the developmentally normal process of Final Consonant Deletion is operating for all phones except nasal consonants. This process occurs in the speech patterns of normal children at 2;3 and 2;6 (Grunwell 1985).

At 2;3 and 2;6, therefore, there is evidence that for PJ phonetic deviance is restricting phonological development. As discussed above, the nature of the phonetic deviance is different from that reported for other cleft palate populations. In addition PJ's speech pattern differs from those of the other subjects in both Study 1 and Study 2. Although JA also evidenced delayed plosive and fricative development she was beginning to attempt plosives and fricatives at this stage, albeit with nasal emission (see below). For PJ, however, it is possible that the predominance of nasals in his speech is an indication that, like JA, he is experiencing difficulty with the velopharyngeal mechanism as a result of velopharyngeal insufficiency (VPI) (Stengelhofen 1989). Alternatively his speech patterns could be the result of abnormal learned neuromotor patterns (Bzoch 1979).

At 2;3 the otolaryngologist reported that both grommets had extruded and that there was a recurrence of OME with reduced hearing levels. PJ was given antibiotic treatment which appeared to have improved his hearing levels in response to free-field testing at 2;5, but because there was evidence of eustachian tube dysfunction it was

decided to reinsert bilateral grommets. This took place two and a half weeks prior to R4 (2;6). Variable hearing levels could, therefore, have contributed to PJ's extremely restricted phonetic inventories at 2;3 and 2;6. It was noted that in addition to responding poorly to auditory stimuli when his hearing levels were reduced, PJ also exhibited a deterioration in behaviour. A few weeks after the insertion of the grommets there was an improvement in both behaviour and in auditory response. PJ was reported to be conversing more often with everyone.

There had been some progress in language development between 2;0 and 2;3. PJ had extended his vocabulary and was putting two words together but there was little further progress by 2;6 when it was considered that PJ's expressive language development was again delayed. A slight delay in verbal comprehension was also detected but it was considered that this was probably due to poor attention and listening skills as a result of OME. Because of concern about PJ's expressive language development and, in particular, his severely restricted phonetic inventory, regular speech therapy was instigated at 2;6. Treatment focused on general attention and listening tasks, auditory discrimination, verbal comprehension and games to encourage PJ to 'experiment' with his articulators.

Figure 46 presents the phonetic inventories for PJ at 2;9 and 3;0. It is apparent that there has been no significant progress and both inventories show the same restricted and deviant pattern that was apparent in previous recordings. The only minor change is the ocurrence of one alveolar plosive [d] as a marginal phone at 2;9 and the subsequent inclusion of the same plosive in the inventory at 3;0. This plosive has not featured in PJ's phonetic inventories since it occurred as an antero-dorsal plosive in the pre-speech contoid phonetic inventory at 1;9.

Figures 47 and 48 present PJ's phones mapped onto the adult target phones at 2;9 and 3;0. As might be predicted from the restricted phonetic inventories there is an overriding pattern of nasal realisations of plosive, fricative and approximant phones in WI and WW positions. (The most frequently occurring phone is circled). The alveolar approximant /ɹ/ is sometimes realised accurately as [ɹ] but is usually realised as [n] in SIWI position and [n], [ɹ] or [j] in SIWW position. At 3;0 (Figure 48) the alveolar plosive /d/ is predominantly realised as [n] but also as [d] in SIWI position. [d] is also used to realise WI /k/ and /ð/, and WW /t/, for example:-

that: [dæ] *cat:* [dæ]

duck: [dʌ] *door:* [nɔ]

tractor: [næʔdæ, næʔnæ, dæʔdæ]

There is evidence, therefore, that PJ is making some attempt to produce plosion and make a nasal/oral

contrast. In both recordings there is evidence of the developmentally normal process of Final Consonant Deletion operating for all phones apart from the nasal consonants. In addition there are a few occurrences of the glottal plosive [ʔ] to realise the target plosive /k/ and one to realise target /t/. There also appears to be a Fronting process operating for post-alveolar and velar phones, for example, at 3;0 (Figure 48) WI /k/ is realised as [m,n,d], WI /g/ as [n,j], and WI /ʧ/, /ʤ/ and /ʃ/ as [n].Fronting occurs in normal development but Fronting of plosives normally resolves by 3;0 although it may continue to operate for affricate and fricative phones (Grunwell 1985).

Despite minimal indications of plosive development PJ's phonetic inventories at 2;9 and 3;0 remain restricted and deviant. In addition, this phonetic deviance is severely restricting phonological development.

By 2;9 PJ was able to produce the voiceless plosives [p], [t] and [k] in isolation during imitation games and he could select these and other consonants in discrimination games. Progress had been made in language development and PJ now used longer utterances but because of his limited phonetic and phonological system it was often extremely difficult to understand him. The same situation remained at 3;0, although PJ was then able to imitate voiced plosives and these were occasionally heard in spontaneous speech.

At both 2;9 and 3;0 PJ's hearing was reported to be satisfactory and stable with both grommets remaining in position. The month after R4ii (3;0), however, one

grommet had extruded and PJ was again experiencing fluctuating hearing levels. Grommets were subsequently reinserted in both ears at 3;4.

A limited amount of data was collected when PJ was 3;3 but this evidenced no real change from 3;0 (Figure 48) apart from a single occurrence of [d] in SFWF position and [g] in SIWI position. At this time PJ was very talkative but it remained extremely difficult to understand him. His mother reported that his speech was variable and that he seemed clearer on some days than on others. Days when he was less clear were often related to upper respiratory tract infections and fluctuating hearing levels. An improvement was noted following the insertion of grommets at 3;4, which was at the beginning of the summer when upper respiratory tract infections occur less frequently. PJ continued to attend for weekly therapy sessions. Work continued to focus on the discrimination and production of plosives in CV and CVCV words. In addition fricatives were introduced in imitation and discrimination games.

It is noteworthy that PJ's initial attempts to imitate some plosive and fricative consonants were accompanied by a nasal grimace. This subsequently disappeared as his production became more accurate and he was able to produce the same consonants spontaneously. A nasal grimace which often occurs with audible nasal emission is a characteristic of cleft palate speech which is associated with velopharyngeal insufficiency (VPI) (Stengelhofen 1989). For PJ, however, as the nasal

grimace did not persist, it would seem that this characterstic occurred as a feature of the learning process he used while trying to establish an oral air stream for obstruents.

Figure 49 presents the phonetic inventories for PJ at 3;6 and 3;9. At 3;6 a significant change has occurred with regard to the development of plosive consonants. In addition to [d] there is now the voiceless alveolar plosive [t] and PJ is also using the voiced bilabial [b] and the voiced velar [g]. [p] is present as a marginal phone at 3;6 but has become established in the inventory at 3;9 (Figure 49). A further development at 3;9 is the inclusion of the voiceless velar plosive [k] in the phonetic inventory.

The change in the phonetic inventories is also reflected in PJ's phonological system at 3;6 and 3;9. Figures 50 and 51 show PJ's phones mapped onto the adult target phones. At 3;6 (Figure 50) nasal realisations of plosive and fricative target consonants still predominate in WI and WW positions. PJ is, however, begining to use some plosive consonants to signal target plosives. There is considerable variability in the realisations of the same target phones but there is some evidence that PJ's speech pattern is becoming more like the adult pronunciation system. In WI position, for example, the most frequent realisations of target /b/ are [b] and [m], and for target /t/ they are [t] and [n]. For the same target phones in WW position there are variable realisations but nasal realisations still predominate.

At 3;9 (Figure 51) target plosives are virtually always realised as plosives in WI position even though there is variability with regard to the plosives used. The most frequently occurring realisation (circled in the figures) often matches with the target phone. It should be noted that PJ is also using plosives to realise fricative and affricate targets thus evidencing a Stopping process which occurs in the early pronunciation patterns of children who are developing speech normally i.e. at 2;0 - 2;6 (Grunwell 1985). In addition the developmentally normal process of Fronting is evident in some of the variable realisations which occur for target velars. However, Backing which is developmentally unusual also occurs for some alveolar and post-alveolar targets, for example:- [k] is sometimes used to realise /s/, /d/, /ʧ/ and /ʃ/ targets in WI position. There is still considerable variability in the realisations of the same target phones in WW position with nasal realisations of plosive, fricative and affricate targets.

In WF position at both 3;6 and 3;9 the process of Final Consonant Deletion is still predominant for all targets except nasals. At 3;6 some targets are realised as the glottal plosive [ʔ] but this occurs less frequently at 3;9. Some plosives are used to realise /g/ in WF position at 3;6 but at 3;9 there are predominantly zero realisations or nasal realisations of this target phone. It would appear, therefore, that the developments which are occurring in WI and WW positions are offset to some extent by lack of progress in WF position. It should be noted that PJ did not evidence any syllable reduction

patterns, all the words he produced had the correct number of syllables, for example:-

motorbike: [məʊʔəɹɪ] *ghostbuster:* [ɡɒpʌpə]

By 3;9, therefore, PJ has made progress with regard to the development of plosives. He uses plosives to realise some plosive targets accurately but there is considerable variability in his contrastive system. Aspects of the variability include Stopping, Fronting and Final Consonant Deletion which are developmentally normal processes. These processes have normally resolved by 3;0 (apart from Stopping of /v, ð, z /) and are therefore evidence of delayed development (Grunwell 1985). In addition some Backing also occurs and is evidence of a characteristic associated with cleft palate speech (Russell 1989). The results at 3;9 demonstrate that PJ is continuing to evidence very delayed and deviant phonetic and phonological development.

Following the insertion of grommets at 3;4 PJ's hearing was reported to be within normal limits from 3;6 until the end of this study at 4;6. By 3;6 his hearing was being tested by pure tone audiometry. The grommets also remained in situ and patent during this period. Weekly speech therapy continued until 4;0 when it was suspended to allow for consolidation and because evidence of spontaneous improvement was detected. PJ's mother reported that it was easier for other people to understand him both at home and at nursery school.

The phonetic inventory for 4;0 is presented in Figure 52. Phonetic distribution and consonant clusters are also

shown. At 3;9 there were only three clusters in the sample and these consisted of two glottal+nasal clusters in WW position and one nasal+glottal cluster in WF position. It is apparent from Figure 52 that PJ is now using some obstruent+approximant clusters in WI and WW positions and a wider range of clusters in WF position. The phonetic inventory shows a much more normal pattern and now includes some fricative and some marginal affricate consonants but there are also some unusual consonants such as the nasal fricative [n̥ᶠ] and the palatal fricative [ɕ]. Both these consonants are reported in the speech patterns of cleft palate children and may be termed 'compensatory articulations' (Dorf & Curtin 1982).

When PJ's phones are mapped onto the adult target system (Figure 53) it is apparent that there is still considerable variability. Plosives are becoming established in WI and to some extent in WW position. Stopping of fricatives also occurs WI and WW but there is some use of [f] WI to realise target /f/ and also target /θ/ in WI and WF positions. There is still some Backing of alveolar and post-alveolar targets. Approximants in WI and WW positions still have some nasal realisations. The most significant change has occurred in WF position with the resolution of Final Consonant Deletion. There are correct realisations of almost all the target plosives with some variability. There is also the development of a highly variable range of fricative realisations.

Some features of PJ's phonetic inventory and phonological system at 4;0 could be attributed to the cleft palate

condition. Within the fricative variants, for example, there is some lateralisation and some nasalisation both of which have been reported in other cleft palate populations (Albery & Russell 1990). There is also some Backing of alveolar and post-alveolar targets in both WI and WW positions which corresponds with Edwards (1980) description of the 'backward displacement' of plosive and other consonants.

At 4;0, therefore, PJ's speech patterns are becoming more like the adult pronunciation system but there is still considerable variability and developmentally unusual realisations of target phones. In addition with the resolution of Final Consonant Deletion there is evidence of normal though severely delayed development.

Weekly speech therapy sessions were resumed at 4;2 and continued until 4;4. The aims of therapy were to reduce the variability and encourage further development of accurate matches for plosive and fricative targets. PJ's co-operation with therapy tasks varied according to his mood but he continued to make progress. At 4;4 it was reported that he was more intelligible to people who were unfamiliar with him.

The phonetic inventory at 4;6 (Figure 54) shows little change from 4;0. The approximant [j̇] appears to have become marginal but there were fewer /j̇/ targets at 4;6. There are fewer consonant clusters although there are the same number of target clusters. Unusual voiceless nasal consonants still occur. When the child's phones are mapped onto the adult target system (Figure 55) it

appears that these nasals are used as realisations of fricative targets particularly in WF position. Overall there is no major change from the pattern at 4;0 (Figure 53) but there are signs that some progress is being made. There is still considerable variability particularly with regard to fricatives in WF position. The Backing of targets /t/ and /d/ has diminished and [d] is now established as the most frequently occurring consonant in WI as well as WW and WF positions for target /d/. The labio-dental fricatives [f] and [v] are used more consistently in WW and WF positions but there is Stopping of these targets in WI position. Stopping of other fricatives also occurs in WI and WW positions although PJ is obviously attempting to signal fricatives word finally. In WF position some of the fricative realisations still show characteristics reported for other cleft palate populations especially the use of the palatal fricative [ç] (Albery & Russell 1990). Lateralisation of fricative consonants does not, however, occur in the 4;6 sample as it did at 4;0.

Palatalisation and lateralisation can be associated with dental and occlusal anomalies (Albery & Russell op cit). PJ does have a slight anterior crossbite on the cleft side and a normal occlusion on the opposite side of his mouth. In addition there is misalignment of the dental arch and a lateral incisor is palatally displaced. The palate appears to be of normal dimensions including height but there is a small anterior fistula. The crossbite, misalignment and the fistula could be contributing to the unusual fricative realisations but it

should be noted that PJ sometimes uses accurate productions of [S] and [Z].

At 4;6, therefore, PJ has continued to make progress particularly with regard to the development of plosive and fricative articulations. However, fricatives apart from [f] and [ç] are marginal thus giving evidence of delayed phonetic development. In addition the presence of unusual nasals and the palatal fricative provide evidence of deviant development which may be associated with the cleft palate condition. With regard to PJ's Contrastive System it is evident that the phonetic deviance is continuing to restrict phonological development. There are, however, more accurate matches and developmentally normal mismatches with the adult system but there continue to be developmentally unusual realisations. In addition there is considerable variability.

It is evident from the results reported above that PJ follows a different pattern of phonetic and phonological development from the other subjects in both studies. At 1;9, although there was evidence of delayed language development, it appeared that PJ was begining to evidence a more normal, though delayed, contoid phonetic inventory. At 2;0, however, this had not been maintained. Apart from [g] the plosives in PJ's consonant phonetic inventory were marginal. This coincided with reduced hearing levels but an improvement in vocabulary and expressive language development. Plosives continued to be marginal in the phonetic inventories at 2;3 and 2;6 and

nasal realisations of obstruents predominated. Between 2;3 and 2;6 PJ had further hearing problems and at 2;6 a delay in language development was again detected. Speech therapy intervention was instigated at 2;6. At 2;9 and 3;0 the pattern of marginal plosives and predominantly nasal realisations was virtually unchanged and it was not until 3;6 that PJ's phonetic inventory appeared more normal with regard to plosive development. It took, therefore, eighteen months for the development which might have been predicted from the contoid phonetic inventory at 1;9, to take place. By 4;0 it was apparent that PJ was following a path of phonological development which was considerably delayed and not entirely normal. It is noteworthy that following the reinsertion of grommets at 3;4 PJ's hearing was found to be satisfactory from 3;6 until the end of this study. In addition PJ's language development at 3;6 was considered to be normal. At 4;0 and 4;6 there was evidence of fricative development predominantly in WF position. Considerable progress had been made with regard to the establishment of plosives in PJ's contrastive system at 4;6 but there was continuing evidence of phonetic deviance restricting phonological development.

It would appear, therefore, that for PJ the cleft palate condition combined with intermittent hearing difficulties resulted in deviant and severely delayed phonetic and phonological development. This did not resolve spontaneously and required speech therapy intervention. Although progress had been made, evidence of deviant and delayed development was still present at 4;6. With the

development of normal plosives and fricatives, however, velopharyngeal insufficiency as a possible causative factor could be excluded.

SUBJECT JA

Pre-speech vocalisations

Figure 56 presents the contoid phonetic inventories for JA at the first three recordings. The percentage frequency of use of the active articulators at each recording is shown as Graph A in Figure 57. Graph B in Figure 57 shows the percentage frequency of occurrence of the different manner of articulation categories.

It is evident from the contoid phonetic inventory at R1 (Figure 56) and from Graphs A and B (Figure 57) that pre-operatively JA is using no front of tongue articulations and only a small number of bilabial nasals. In addition there is limited use of the back of the tongue (10%) The very frequent use of the glottal plosive [ʔ] accounts for the majority of the glottal and pharyngeal articulations. This pattern of predominantly glottal articulation corresponds closely to the pre-operative patterns of SB in Study 1 and of AC in Study 2. In addition the marked lack of labial and lingual plosive contoids is similar to the inventories of all the subjects in both studies.

At R2 it is apparent from the contoid phonetic inventory and from Graph A that JA has begun to use appreciably more labial and lingual contoids and that there has been a corresponding decrease in glottal articulations. Graph B indicates the decreased use of the glottal plosive but there is still a marked lack of other plosives with only one weak labial plosive and one postero-dorsal plosive occurring in the sample. JA has developed a range of lingual and bilabial approximants in addition to lingual nasal contoids. In R2 the majority of the contoids occur in within-vocalisation position in syllable structure and there is evidence of variegated babbling (Oller 1980).

The results for JA at R2, therefore, evidence an increase in lingual, especially front of tongue articulations. This is similar to the results for all the other subjects in both studies except SB in Study 1. With regard to plosive development, however, JA and PJ (see above) differ from the other subjects who are at least using postero-dorsal plosives.

The contoid phonetic inventory (Figure 56) and the Graphs (Figure 57) at R3 indicate that there has been little change from R2. Graph B shows that nasal occurs more frequently than other manner of articulation categories and graph A indicates that these are both labial and front of tongue nasals. There has been a slight increase in the frequency of use of the glottal plosive and a slight decrease in approximant articulations. There are only two occurrences of plosives other than the glottal plosive and in addition there is one occurrence each of a voiced and voiceless bilabial fricative. At R3,

therefore, JA continues to differ from all the other subjects except PJ because of her lack of plosive development.

It is apparent from these results that, following the operation to repair the palate, JA increases her use of labial and front of tongue articulations which is similar to the development which occurs in the patterns of all the subjects in both studies. With regard to the manner of articulation, however, there is a marked difference from all the other subjects except PJ. Both PJ and JA evidence restricted contoid phonetic inventories and lack of development of plosive and fricative articulations. Another similarity with PJ is that JA also suffered from otitis media with effusion (OME). This was first detected post-operatively following an ear infection and resulted in a conductive hearing loss. The condition responded to antibiotic treatment. The otolaryngologist reported a further episode of OME following an upper respiratory tract infection at 1;6 just after R3. Further antibiotic treatment was not effective and grommets were inserted when JA was 1;8.

Phonetic development 1;9-2;6

Figure 58 presents the phonetic inventory for JA at 1;9. The inventory at 1;9 is based on 121 meaningful words which occurred in the sample. There were 31 different spontaneous words and 27 different modelled words with

the remainder of words being repetitions. This supported JA's mother's report that JA at 1;9 was trying to imitate everything that was said to her. Since the insertion of grommets six weeks previously an increase in vocabulary had been noted and JA's parents commented that her words had seemed clearer and her articulation more accurate. Examination of the words used in the sample reveals that JA sometimes used correct articulatory placement but incorrect manner of articulation, for example:-

dog: [nɑʔ]

ball: [mɔ]

Susie: [nuji]

but there is considerable variability which is not unusual in a child's first words. Few consonants occur in SFWF position, those which do are predominantly nasal consonants with only one WF [k] and two [ɸ]. With regard to syllable structure CV is the canonical structure and CVCV the next most frequently used structure.

It should be noted that although bilabial and palatal plosives occur in the inventory their frequency of use in the sample is very limited: [b]=3, [p]=5, [c]=5, and there is a predominance of nasals, glottals and approximants. There is, however, no lack of opportunity for plosive use. There are, for example, ten spontaneous words with /b/ as the SIWI target consonant but SIWI /b/ is usually realised as [m]. In addition JA's attempts to produce plosives are often accompanied by audible nasal emission which is indicated in the phonetic inventory by the nasality diacritic [~]. There are some apparent clusters in SIWI position which occasionally occur when

JA is attempting to signal an obstruent, as in *bus*: [m̥b̃ʊ] and *chair*: [n̥t̃ɛ] but also where there is a target cluster as in brush [m̥mʌ], *crash*: [n̥k̃æ], *spoon*: [m̥mu]. In view of the fact that cluster reduction would be expected in the speech of normal children at this age (Grunwell 1985) it seems likely that in words such as brush, crash and spoon, JA is attempting to signal an obstruent rather than the cluster. This combined with the evidence that plosives are accompanied by nasal emission suggests that JA may be having particular difficulty with the velopharyngeal mechanism and that there may be velopharyngeal insufficiency associated with the cleft palate condition (Stengelhofen 1989).

At 2;0 (Figure 59) there has been no expansion in the phonetic inventory and there is an apparent reduction in the frequency of use of plosives, those which do occur are marginal. [l] is also marginal although there are no fewer /l/ targets than in the previous sample. /l/ is most frequently realised as [j]. Analysis of the consonants used in SIWI position indicates that there is considerable variability but also the tendency for nasal realisation of some target plosives and fricatives, and glottal realisation of others, i.e. /b/→[m], /f/→[n], /t/→[ʔ], /d/→[n], /k/→[ʔ]. JA's phonetic inventory, therefore, remains restricted and there is evidence of some of the deviant characteristics associated with the cleft palate condition. Nasal and in particular glottal realisations of plosives and fricatives could be attributed to abnormal learned motor patterns or

velopharyngeal insufficiency (Bzoch 1979, Morris 1979), JA's restricted phonetic inventory is similar to that of PJ at 2;0 although he evidences even fewer consonants than JA. She does have bilabial fricatives and approximants and also glottal articulations. For PJ the glottal plosive is marginal, but like JA he is using nasal realisations of target obstruents.

It was reported that JA's single word vocabulary had continued to expand and at 2;0 she was just begining to put two words together thus possibly evidencing a slight delay in expressive language development. Parent report and informal observation confirmed that JA's verbal comprehension and her non-verbal skills were within normal limits for her age. The expressive language delay corresponds with that widely reported in the literature for cleft palate children (see McWilliams et al 1984 for a comprehensive review). A complicating factor, however, is that JA was experiencing ear problems at 2;0. As a side effect of the grommets there was a discharge from both ears. This did not respond to antibiotic treatment so the grommets were removed at 2;1. Unfortunately recurrence of OME and a conductive hearing loss were detected one month after this procedure and further medication was prescribed by the otolaryngologist.

The phonetic inventory at 2;3 (Figure 60) indicates that there is a slight increase in the use of plosives but it should be noted that these are often produced with audible nasal emission. The only fricative, apart from the glottal fricative [h] is the voiceless bilabial

fricative [ɸ] which has also been present in both the 1;9 and 2;0 inventories. [ɸ] is used to realise target /tr/ and for one realisation of target /b/ and one of target /f/. There is still an overall pattern of glottal and nasal realisations of plosive and fricative targets in SIWI position but JA occasionally appears to be making some attempt to signal correct articulatory placement and/or manner of articulation. In addition, however, there is still considerable variability, for example:

target /d/ - *daddy*: [dæji, jæwi, næji, jæni]
duck: [dʊ̃, nʊk, ʔʊ, nʊ]

target /b/ - *baby* [beɪni, meɪni, ɸeɪni]
bike: [baɪ, maɪ]

target /ʃ/ - *shoe* [çu, ɲu]

At the 2;3 recording JA's mother reported that words such as 'daddy' seemed to be clearer. It was noted at the time of the recording that there was an overall hypernasal tone and, in addition, it was observed that JA often used a nasal grimace. Both these features are clinical indicators of inadequate velopharyngeal closure (Stengelhofen 1989) and provide further evidence that JA might have velopharyngeal insufficiency (VPI). Similar evidence of VPI was not detected in the speech of any of the other subjects in both studies although some subjects evidenced nasal realisations of target obstruents, namely AB and DD in Study 1 and PJ in Study 2. Although JA's phonetic inventory at 2;3 continues to evidence restricted and deviant development, she is using a wider range of manner of articulation categories than PJ at 2;3 and 2;6.

At 2;3 JA was reported to be very congested and on permanent antibiotic treatment for her ear problems. Although she was probably coping with fluctuating hearing levels this did not appear to be impeding her expressive language development. Her vocabulary was increasing and there were 87 different spontaneous words in the sample at 2;3. In addition JA was using many two element phrase and clause structures at Stage II (1;6-2;0) of LARSP (Crystal, Fletcher & Garman 1975). Her expressive language, therefore, remained somewhat delayed but spontaneous progress was occurring. It is noteworthy that at 2;3 PJ was also making progress with regard to expressive language development despite hearing problems due to recurrent OME.

Phonetic and Phonological Development

From 2;6 to 4;6, changes which occur in JA's phonetic inventories are also evident in the Contrastive Assessments. Therefore, only the latter are included in the following figures with reference being made to cluster development in the text.

There is sufficient data at 2;6 to undertake a phonological analysis and Figure 61 shows JA's phones mapped onto the adult target phones. There seems to have been some regression with regard to plosive development. Apart from the glottal plosive all plosives have become marginal and only occur in SFWF position. There continue to be nasal realisations of many target obstruents. It is

apparent though that JA is attempting to use friction for SIWI target fricatives, for example, /f/→[ɸ], /S/→[ɕ̃, ŋ̊]. With regard to placement many of JA's realisations are at or near to the target placement although there are still glottal realisations of some target plosives. In SFWF position there is evidence of the developmentally normal process of Final Consonant Deletion but JA does use some plosive and nasal consonants. The canonical word structure is still CV (43%) and CVCV is the next most frequently used structure (20%).

JA's attempts to produce friction and correct placement indicate the possibility of an incipient phonological system underlying a phonetic disorder. Glottal and nasal realisations of target obstruents is a possible indication that there could be VPI (Bzoch 1979, Morris 1979). Although the same characteristics occurred in the speech patterns of AB and DD in Study 1 both subjects were also producing some normal obstruents with an appropriate oral air stream. This suggests that their unusual realisations were due to abnormal learned motor patterns (Bzoch 1979) and not VPI. In addition, it was observed at 2;6 that JA's fricatives were produced with nasal escape and were often accompanied by a nasal grimace. These characteristics provide further evidence of possible VPI (Stengelhofen 1989).

At 2;6 it was also noted that JA tended to shout and she was again found to have a conductive hearing loss associated with OME. In addition JA had a cough which had been present since she contracted mumps two months previously. The otolaryngologist decided to reinsert

grommets and this was carried out at 2;7. It was hoped that JA would be able to tolerate the grommets better if they were inserted during the summer when upper respiratory tract infections are less prevalent. Despite her obvious hearing difficulties JA remained responsive in communicative situations and had continued to make good progress in expressive language development.

Figure 62 presents the Contrastive Assessment for JA at 2;9. Plosives are now present in all word positions but there are still glottal and nasal realisations of some target plosives, especially in SIWI position. The oral/nasal contrast is, therefore, not yet established but it is emerging. Voiced plosives are, however, generally accompanied by audible nasal emission, for example, [b̃] and [d̃]. Voiceless plosives only occur in SFWF position and may be realised as glottal plosives in WI and WW positions. Approximant/obstruent and approximant/nasal contrasts are well established and there is also a plosive/fricative contrast emerging. The process of Final Consonant Deletion has virtually disappeared and the canonical phonotactic structure is now CVC. It would appear that the relationship between the child and adult targets is becoming closer phonetically with regard to both manner and placement. It is evident though that JA is continuing to experience difficulty in controlling the velopharyngeal mechanism in order to produce obstruents with an exclusively oral airstream.

There is additional evidence of normal phonological development at 2;9 in that JA is using obstruent+approximant clusters which begin to occur in the speech patterns of some normal children between 2;6 and 3;0 (Grunwell 1987a). JA is using [pw], [ɸw] and [gw] for example:-

brush: [gwʊt]

flowers: [pwaʊwəŋ]

swing: [ɸwɪŋg]

grass: [gwaŋˀ]

It should be noted that the Backing of the first element in the /br/ cluster i.e. /br/→[gw] could be attributed to the cleft palate condition as Backing has been reported as a characteristic of the speech patterns of cleft palate children (Albery & Russell 1990, Edwards 1980). In addition, however, there is the possible influence of the back tongue position for the approximant [w] and the vowel [ʊ]. The presence of [w] in the [pw] cluster which JA uses to realise /fl/ in *flowers* (see above) does not, however, result in Backing. JA also attempts to signal /s/+consonant clusters but her difficulty in the realisation of some of these targets provides further evidence of possible velopharyngeal insufficiency, for example:-

scarf: [gɡ̃ap, gɡaɸ]

stopped: [gɔnd]

spoons: [mmʊnŋ]

JA's realisations of /S/+nasal, however, would not be considered unusual in the speech patterns of normally

developing children at this age (Grunwell 1987a), for example:-

snow: [ɲɔʊ]

At 2;9, therefore, the development of clusters and the resolution of the process of Final Consonant Deletion provide evidence of normal phonological development. However, JA's speech patterns continue to evidence characteristics associated with cleft palate, especially nasal and glottal realisations of obstruents and nasalisation of plosives. In addition her speech patterns differ from those of all the other subjects in both studies.

There had been no problems with the grommets following their insertion at 2;7 until JA had an upper respiratory tract infection just before the 2;9 recording. This resulted in a discharge from both ears which responded to antibiotic treatment but there was no evidence of any hearing loss. There was continuing progress with regard to language development which was judged to be within normal limits for JA at 2;9. JA's mother reported that she was intelligible to everyone and that JA attended nursery every morning and playgroup sessions twice a week.

It is apparent from the Contrastive Assessment at 3;0 (Figure 63) that there has been no change with regard to plosive realisations. There has however been further development in fricative production although there is considerable variability. In addition the affricates [ʧ] and [ʤ] are evident in SFWF position. Apart from the

glottal realisation of some target plosives, JA is attempting to use correct articulatory placement for most phones. With regard to manner, there is a Stopping process operating on some target fricatives in particular /f/ and /v/. Stopping of fricatives is a normal developmental process but by 3;0 most children are begining to use /f/ (Grunwell 1985). For JA, therefore, in addition to deviant realisations of fricatives, there is evidence of normally delayed development. There continues to be inappropriate nasal escape on many obstruents, in particular voiced plosives. There has been an increase in the number of clusters used by JA, particularly nasal+plosive clusters in WF position. It would appear, therefore, that JA is continuing to make some normal progress with regard to phonological development but there continue to be phonetic restrictions affecting her speech patterns.

At the 3;0 recording JA's mother commented that JA's repetition of words often seemed better than her spontaneous production. It was noted that there was an overall nasal tone on vowels in addition to nasal escape on consonants as described above. In addition the nasal grimace persisted. There had continued to be intermittent ear discharge but the grommets remained in situ.

Figure 64 presents the Contrastive Assessment for JA at 3;6. Nasal Anemometry (Ellis 1979) was carried out at 3;6 and confirmed that there was inappropriate nasal escape throughout speech. Nasal escape was not always audible especially on voiceless plosives in SFWF position. In

both SIWI and SIWW positions both [p] and [p̃], for example, occurred. To avoid confusion therefore, and in the light of the evidence from the nasal anemometry only the phone with nasal escape is included in the Contrastive Assessment.

At 3;6 (Figure 64) the glottal realisation of target /t/ has decreased considerably but it is still the most frequent realisation for target /p/ in SIWI and SIWW positions and for target /g/ in SIWI position. Stopping of the fricatives /f/ and /v/ still occurs and there is also evidence of Stopping of /θ/ and /ð/. Despite the restrictions of the velopharyngeal mechanism JA's articulatory placement (apart from the glottal realisations as described above) is usually accurate. In addition there is a plosive/fricative contrast. There has been no change with regard to JA's use of clusters which provide further evidence of her velopharyngeal problems, for example:

stamps: [ⁿdzmʔᵑ]

fly: [ᵑnɪ]

squirrel: [ɡwɪjɹ]

At 3;6 JA was once again receiving antibiotic treatment for OME. One grommet had extruded and although the other was still in situ, JA's hearing levels were reduced.

At 4;0 (Figure 65) it is evident that JA has progressed further with regard to using correct articulatory placement despite her velopharygeal insufficiency. Most consonants are produced correctly but with nasal emission. /ʃ/ is established in all word positions but /s/

and /z/ are proving to be more difficult for JA. There is still Stopping of the fricatives /f/, /v/, /θ/ and /ð/ which is a persisting normal developmental process and therefore evidence of delayed phonological development (Grunwell 1987). There has been some cluster development with plosive+approximant clusters, for example [bl, pl, pw, kw, tw] occurrng more frequently.

JA's hearing was reported to be improved and one grommet remained in situ, as at 3;6. Two months later at 4;2, however, JA was found to have a bilateral conductive hearing loss but at 4;3 the otolaryngologist reported normal hearing in one ear following the extrusion of the grommet and a mild conductive loss in the other ear in which there was a perforated ear drum. The cleft palate team decided to carry out further investigations of velopharyngeal function and speech radiography was undertaken at 4;3. The results confirmed good palatal and pharyngeal wall movement but with a consistent velopharyngeal gap during speech. At this stage, therefore, it could be concluded that JA's speech pattern with regard to the nasal emission was a direct result of a structural inadequacy related to the original cleft palate. A pharyngoplasty operation was planned for JA at the age of 4;7.

Prior to the operation a further speech sample was obtained at 4;6 (Figure 66). The persisting Stopping process is still in evidence for /f/, /v/ and /θ/ but [ð̃] is present as a marginal phone. The major change which has occurred is that JA is now realising the fricatives /s/ and /z/ accurately but with nasal emission in all

word positions. Although in SIWW and SFWF positions there is still some Stopping of these fricatives and there is a greater degree of variability for fricatives than for other targets. In WF position nasal escape is often inaudible especially on the voiceless plosives. Also in this word position voiced obstruents are often completely devoiced and therefore almost inaudible. Another major change which has occurred is that JA is now using a full range of clusters in all word positions. In SIWI position /s/+consonant clusters occur usually with nasal emission, for example:

strawberry: [s̃t̃w̃ɔ̃bi̤]

spider: [s̃p̃ãɪd̃ə]

snail: [s̃n̥eɪjv̰l̰]

In an attempt to produce fricatives without nasal emission JA sometimes uses an ingressive airstream (see '*snail*' above). In addition JA continues to use [n̥n] and [m̥m] to realise some /S/ +consonant clusters, for example:

stars: [n̥naz̃]

snake: [n̥neɪk̃]

At 4;6 it was noted that there had been a further deterioration in JA's hearing following a recent upper respiratory tract infection. She had a loss of 30-40dB in the right ear and a loss of 30-50dB in the left ear. The pharyngoplasty operation was carried out at 4;7 and at a post-operative examination at 4;9 the initial results indicated a probable successful outcome. In addition JA's hearing at 4;9 was found to be within normal limits.

A further recording was made following the pharyngoplasty operation and Figure 67 shows the Contrastive Assessment for JA at 4;10. It is evident that JA is now able to produce plosives and fricatives with an exclusively oral airstream which has resulted in virtual eradication of any variability. The variability which does occur indicates that JA is establishing a contrast between labial plosives and labio-dental fricatives. There is, for example, appropriate realisation of /f/ and /v/ although there is still some Stopping of these targets particularly in SIWI and SIWW positions. This sometimes results in variable productions of the same word, for example, *fat*: [fæt , bæt]. This also occurs when the fricative target is the first consonant in a cluster, for example, *flower*: [flaʊwə, plaʊwə]. [ð] is still present as a marginal phone and target /θ/ though subject to some variability is often realised as [f] especially in SFWF position. Realisation of /θ/ as [f] is a normal developmental process at 4;10 (Grunwell 1985). In SIWI position /θ/ is also realised as a bilabial plosive indicating Stopping of /f/ as described above. An additional development is that JA is using the approximant [ɹ] in SIWI and SIWW positions and also in some consonant clusters, for example, [dr].

At 4;10, therefore, following surgery which has provided her with an adequate velopharyngeal mechanism, JA's phonetic and phonological development is virtually normal for her age (Grunwell 1985). The only evidence of delayed phonological development is the Stopping of the fricatives /f/ and /v/ which is, however, resolving.

It is evident from the results described above that JA's development of plosive and fricative articulations was considerably delayed in comparison with patterns of normal phonetic development. From 2;3 onwards, however, it was apparent that JA was attempting to produce plosives with correct articulatory placement. Similarly at 2;6 she was attempting to produce friction and correct placement in order to realise fricative consonants. Subsequently JA gradually achieved correct articulatory placement for most obstruents and established a nasal/oral contrast despite the inadequacy of the velopharyngeal mechanism which resulted in nasal emission. Whilst achieving this there was evidence of normal phonological development. For example, Final Consonant Deletion present at 2;6 was resolving at 2;9 and the development of clusters was evidenced from 2;9. The possibilty first noted at 2;6 of an incipient phonological system underlying a phonetic disorder was, therefore, confirmed. Apart from some delay due to the persisting Stopping process JA evidenced normal phonological development despite the physical restrictions of an inadequate velopharyngeal mechanism and the possible influence of intermittent conductive hearing problems. Once JA could achieve velopharyngeal competence normal phonetic and phonological patterns became evident.

SUBJECT AC

Pre-speech vocalisations

The pre-speech contoid phonetic inventories for AC are presented in Figure 68. In Figure 69, Graph A indicates the percentage use of the active articulators at each of the pre-speech recordings for AC. Graph B shows the percentage frequency of occurrence of the different manner of articulation categories.

At R1, although nasal contoids are present in AC's phonetic inventory (Figure 68), it can be seen from Graph B (Figure 69) that these represent only 2% of the total contoids in the sample. Graph A indicates that there are very few articulations involving the use of the lips or front of the tongue. AC is using predominantly pharyngeal and glottal plosives and fricatives. This pre-operative pattern is similar to that of JA in Study 2 and those of SB, FS and AB in Study 1. In addition the marked lack of labial and lingual plosive contoids is similar to the inventories of all the subjects in both studies.

Post-operatively at R2, there has been a significant change in the type and range of contoids used and in the frequency of use of the different active articulators. In this sample there is also evidence of reduplicated and variegated babbling (Oller 1980). Graph A (Figure 69) shows that AC is now using more front of tongue articulations and many more bilabial articulations with a corresponding decrease in the use of pharyngeal and

glottal articulations. The frequency of occurrence of nasal contoids is greatly increased (Graph B). The phonetic inventory at R2 (Figure 68) shows that AC is now using bilabial and lingual plosives as well as the glottal plosive. The latter, however, still accounts for over 60% of the plosives in the sample.

At R2, therefore, AC is already begining to make progress towards more normal articulatory patterns. With regard to the development of bilabial and lingual contoids, he has made similar progress to subjects AU and AB in Study 1. It is noteworthy that AU and AB both had clefts of the palate only whereas AC had a complete unilateral cleft lip and palate. The increase in the use of nasal contoids for AC at R2 (Graph B) is similar to that for FS at R2 in Study 1.

It should be noted that this phonetic development has occurred despite the fact that AC suffered some respiratory tract infections post-operatively. He contracted German Measles and then had tonsilitis and a throat infection. At the time of R2 he was found to have unilateral glue ear but the other ear was normal and his hearing was reported to be excellent. AC subsequently suffered two episodes of otalgia which required antibiotic treatment prior to R3 but at R3 the otolaryngologist reported that his tympanic membranes and hearing were normal.

From the contoid phonetic inventory at R3 (Figure 68) it can be seen that there has been some change in the plosive contoids. There is only one occurrence of a

plosive using the front of the tongue i.e. [t], but there are more postero-dorsal plosives. Graph B shows that AC is now using more plosive contoids overall. In R3 over 70% of the plosives are lingual or labial as opposed to glottal. A similar increase in the use of plosives other than the glottal plosive at R3 was evidenced in the results for all the subjects in Study 1, with the exception of FS.

AC was reported to be using over twenty single words at the time of R3 (1;6) and eighteen different words occurred in the sample. The consonants used in the words correspond with the contoids used in the rest of the sample. The word structure is predominantly CV with some reduplicated CVCV, for example:-

comb: [kəʊ] *bike:* [baɪ]

bubble: [bʌbu]

It is evident from these results that AC has a restricted and deviant pattern of pharyngeal and glottal articulations pre-operatively but following the operation to repair the palate there is a rapid response to the physical change, particularly with regard to the development of plosive articulations. At R3, however, it should be noted, that the lack of plosives using the front of the tongue differs significantly from patterns reported for normal children (Locke 1983). It could be argued that the cleft palate condition associated with the pre-operative pattern of predominantly 'back' articulations has resulted in lack of experience of front of tongue articulations, although AC does use front of

tongue nasals and approximants. It is more likely, therefore, that this is a feature of delayed plosive development. In normal children glottal and back of tongue plosives predominate in the first six months of life but from about 6 months onwards, front of tongue plosives become more prominent (Locke 1983).

All of the subjects in Study 1 were using front of tongue plosives at R3, although both FS and DD lacked bilabial plosives. With regard to the subjects in Study 2, AC's plosive development, though delayed in comparison with normal development, is more advanced than that of both PJ and JA at R3.

Phonetic development - 1;9-2;0

Figures 70 and 71 present the phonetic inventories and distribution for AC at 1;9 (R3i) and 2;0 (R3ii). At 1;9 113 meaningful words occurred in the sample of which 77 were different spontaneous words. At 2;0 there were 148 words of which 121 were different spontaneous words. It is evident that AC had continued to make normal progress with regard to language development. His vocabulary increased steadily and he was using two and three word utterances by 2;0.

At 1;9 (Figure 70) it is apparent that AC is using the full range of English plosive consonants. Velar plosives are established in WI and WW positions and there is one WF [k]. Bilabial and alveolar plosives are established in WI position but each phone occurs once only in WW

position. The alveolar approximant [ɹ] is a marginal phone although the equivalent antero-dorsal contoid occurred in both vocalisation initial and within vocalisation positions in babbling at 1;9. With regard to fricative development there is the early occurrence of [ʃ] in WF position, for example:-

bus: [pʊʃ] *fish:* [wɪʃ]

Examination of the words used in the sample at 1;9 reveals some Backing, for example WI /f/ is realised as [k] (apart from 'fish').

There is also some Backing of WI /d/ but this could be accounted for by Consonant Harmony in this sample. Backing does, however, become more evident at 2;0 when there is Backing of WI plosives /t/ /d/, fricatives /s/ /ʃ/ and affricates /tʃ/ /dʒ/, for example:-

tap: [kæp] *daddy:* [gægi]

seesaw: [kikɔ] *shoe:* [ku]

chair: [kɛə] *jeep:* [gip]

Backing is unusual in normal development but has been reported as a characteristic of the speech patterns of some cleft palate children (Edwards 1980, Albery & Russell 1990). In addition the plosive realisations of fricative and affricate targets which occur in the above examples are evidence of a Stopping process. Stopping of fricatives and affricates occurs in normal development at 2;0 (Grunwell 1985).

From the phonetic inventory and distribution at 2;0 (Figure 71) it is apparent that AC is now using the palatal approximant [j] more frequently although the

lateral approximant [l] remains a marginal phone. AC is also using a bilabial fricative in both WI and WF positions. There are more plosive and fricative consonants occurring in WF position which reflects AC's incresed use of CVC structures. In addition it is noteworthy that there are two polysyllabic words in this sample:-

maltesers: [mɔlkijə] *helicopter:* [ɛ:kɒkə]

At 1;9 and 2;0, therefore, there is evidence of normal phonetic and phonological development but the presence of a Backing process is developmentally unusual. As discussed above Backing is a characteristic associated with cleft palate speech (Edwards 1980).

Phonetic and Phonological development 2;3-4;0

There has been no change in the phonetic inventory at 2;3 (Figure 72) apart from more frequent use of [l] which means that it is now included in the main inventory. Progress has been made, however, with regard to distribution. There is an increase in the range and number of plosives in SIWW and SFWF positions. More fricatives occur in SFWF position and there are two in SIWW position. In addition there is the development of consonant clusters in WF position, in particular nasal+obstruent clusters, and one WI cluster [bl].

At 2;3 there is sufficient data to undertake a phonological analysis and Figure 73 presents AC's phones mapped onto the adult target phones. The developmentally

normal Stopping process is still operating for most fricative and affricate targets in WI and WW but not WF position. It is evident that the Backing process is begining to resolve although there is still Backing of WI /S/ which is also Stopped. There is now variability in the production of other phones which were consistently Backed at 2;0, i.e. /d/ /t/ and /ʧ/. WI /d/, for example, is realised as [d] four times and as [g] five times. WI /t/ is realised as [t] four times, as [k] three times and as [d] once. There are not consistent realisations for particular lexical items and there is often variability in production of the same word, for example:-

two: [du, ku, tu] *door:* [dɔ, gɔ]

jump: [gʌmp, dʌm]

In a small number of cases the Backing could be attributed to Consonant Harmony as in:-

cat: [kæk] *sticky:* [kɪki] *duck:* [gʌk]

The canonical word structure at 2;3 is CVC and it is apparent from Figure 73 that AC is using WF plosive and fricative consonants. The post-alveolar fricative [ʃ] which has been present in WF position since 1;9 is used to realise /S/ and /Z/ in addition to /ʃ/. The phones which do occur in WF position are usually realised correctly in terms of manner, that is plosives are realised by plosives and fricatives by fricatives.

There is, therefore, evidence of further normal phonetic and phonological development at 2;3 and in addition the abnormal Backing process is begining to resolve.

It is evident from the phonetic inventory at 2;6 (Figure 74) that AC has acquired the affricate [ʧ] and also the voiced post-alveolar fricative [ʒ]. There has been further progress with regard to cluster development with obstruent+approximant clusters in WI position. Grunwell (1987a) reports that clusters of this type begin to be evidenced in the speech patterns of some normal children at 2;6-3;0. AC is, therefore, evidencing normal cluster development.

The Contrastive Assessment at 2;6 (Figure 75) reveals that there is still evidence of Backing of alveolar plosive, fricative and affricate targets but this is occurring less frequently. The fricative development that was noted in WF position at 2;3 has now progressed to SIWW position but there is still Stopping of WI targets. The newly acquired affricate [ʧ] is evident in both WI and WF positions. Like the development of [ʃ] at 1;9, this is an early development of the affricate in comparison to patterns of normal development (Grunwell 1987a).

From 2;9-4;0 changes which occur in AC's phonetic inventories are also evident in the Contrastive Assessments. Therefore only the latter are included in the following figures with reference being made to cluster development in the text.

At 2;9 (Figure 76) appropriate stabilisation has occurred in AC's phonological system. There is reduced variability and the Backing process has virtually disappeared. The voiceless bilabial fricative [ɸ] which was present as a

realisation of WF /f/ at 2;6 is now used to realise target /f/ in all word positions which represents a breaking down of the Stopping pattern. AC's development of fricatives has always commenced in WF position before generalising to other positions in word structure and is therefore following a pattern of normal development as described by Ferguson (1978). The realisation of /f/ as a bilabial fricative is, however, unusual and it could be hypothesised that this is associated with the fact that AC had a cleft lip and palate. It can not, however, be accounted for by AC's oral structures at this stage, nor is it something which has been reported as a feature of cleft palate speech. It is feasible, though, that previous transcriptions of cleft palate speech were not at the level of phonetic detail which would allow this characteristic to be observed.

Figure 77 presents the Contrastive Assessment for AC at 3;0. The realisation of /f/ as a bilabial fricative is still evident and the same phone is also used to realise WF /θ/ and one occurrence of WI /θ/. In normal development at 3;0 /θ/ is often realised as [f] (Grunwell 1985) and AC is, therefore using his realisation of target /f/, that is /θ/ → /f/ → [ɸ]. There is, therefore, evidence of a normal developmental pattern in addition to the unusual phonetic realisation. The voiced bilabial fricative is also present in the phonetic inventory at 3;0 and is used to realise target /V/ in WF and once in WW position. It is also apparent from Figure 77 that [S] and [Z] are present in AC's phonetic inventory at 3;0

which is when [S] becomes evident in the inventories of normal children. [Z] does not usually occur until 3;6-4;6 (Grunwell 1985). AC is, therefore, again evidencing early fricative development.

The Stopping process for fricative targets has virtually resolved and fricatives are now used in all word positions. There is, however, considerable variability in the realisations of the alveolar fricatives /S/ and /Z/. In addition there is overlap between /S/ and /ʃ/ as [ʃ] is used to realise both targets. This is also evident in clusters as AC is begining to evidence some /ʃ/+consonant clusters and not /S/+consonant clusters which occur at 3;0-3;6 in normal development (Grunwell 1985). [ʃ] is the most frequent realisation of /S/ in WI and WF positions and also occurs for some /Z/ targets. [ʒ] is the most frequent realisation for /Z/ in WW and WF positions. In addition there are some unusual realisations, for example, alveolo-palatal fricatives. It would appear, therefore, that AC is having some difficulty in establishing the correct articulatory patterns for /S/ and /Z/. A tendency for cleft palate children to 'misarticulate' these phones is reported in the literature (McWilliams et al 1984).

At 3;0, therefore, there is evidence of continuing normal phonetic and phonological development but in addition there are some phonetic features which may be associated with the cleft palate condition.

At 3;6 the range of clusters used by AC has increased further. /s/ + consonant clusters are now present in SFWF

position in addition to some /ʃ/+consonant clusters which are still present. From 2;9 to 3;6 AC continued to develop obstruent+approximant clusters, particularly in WI position, and also nasal+obstruent and obstruent +obstruent clusters in WF position.

Figure 78 presents the Contrastive Assessment for AC at 3;6. A significant change is the accurate realisation of /f/ and /v/ in all word positions with only limited variability. The unusual bilabial fricatives have become marginal phones. With regard to /θ/ and /ð/, however, [f] is used to realise /θ/ in both WI and WF positions which is developmentally normal. /ð/, is Stopped in WI position and is realised as [d] which often occurs in the speech patterns of normal children at 3;6 (Grunwell 1985). In WW position /ð/ is variably realised as [β,b,v]. There is still considerable variability with regard to the realisation of targets /s/ and /z/. The distinction between voiced and voiceless is consistent but each target is realised by alveolo-palatal and post-alveolar phones in addition to the accurate alveolar matches with the adult targets. At 3;6 the overlap between /s/ and /ʃ/ has virtually disappeared except in WF position.

It is evident, therefore, that at 3;6 AC has continued to make normal progress in phonetic and phonological development. The unusual bilabial fricatives have virtually disappeared but there are still unusual realisations of alveolar fricative targets, which could be associated with the cleft palate condition (McWilliams et al 1984).

It should be noted that despite some ear infections AC's hearing tests had been within normal limits and his aural examinations satisfactory until he was 3;10. On that occasion it was reported that he had suffered frequent infections requiring antibiotic treatment during the previous four months. The aural examination and impedance measurements confirmed bilateral OME and in addition AC had a low tone hearing loss. The otolaryngologist decided to treat the OME by chemoprophylaxis using Trimethoprim. This did not, however, produce the desired result and bilateral OME was still in evidence at 4;0. Grommets were inserted when AC was 4;3.

Figure 79 presents the Contrastive Assessment for AC at 4;0. Despite the presence of a conductive hearing loss some minor changes in phonetic and phonological development are evident. The dental fricatives are now present as marginal phones. [ð] is used to realise one WI and one WW /ð/, and there is one occurrence of WI [θ]. Both these phones may not occur in normal development until 4;6. It would appear, therefore, that AC is again evidencing early fricative development. There are still variable fricative realisations of the alveolar fricative targets /S/ and /Z/. The most frequent realisations of these phones in WI position are the alveolo-palatal fricatives [ɕ] and [ʑ], and in WF position the post-alveolar fricatives [ʃ] and [ʒ]. AC occasionally uses accurate realisations of /S/ and /Z/. In addition, at the 4;0 recording it was noted that AC could accurately imitate these phones easily. There has also been further

cluster development with more clusters now occurring in WW position.

Figure 80 charts AC's developmental progress from 1;9 to 4;0 on the PACS Developmental Assessment. At 4;0 AC has reached Stage VI (3;6-4;6). It is evident from this and the results reported above that he has followed a near normal pattern of phonetic and phonological development. There are, however, some unusual features such as the early development of some fricatives and affricates, for example, [ʃ], which is present in the phonetic inventory from 1;9, and [ʧ] which occurs at 2;6. Early development of [ʃ] was also noted for Subject DD in Study 1. In addition AC evidences early development of consonant clusters with some WF clusters occurring at 2;0. Subject AU in Study 1 also evidenced early development of clusters (at 2;3).

Like the three CLP subjects in Study 1, AC uses the unusual process of Backing as opposed to the normal developmental process of Fronting at 1;9 and 2;0. By 2;6 the Backing process has started to resolve and by 2;9 it has virtually disappeared. Backing has been reported as a characteristic of the speech patterns of cleft palate children (Edwards 1980, Albery & Russell 1990).

From 2;9 to 4;0 the fricatives /s/ and /z/ are bracketed because of the variability in the realisation of these target phones as described above. This results in phonetic rather than phonological deviance and intelligibility is usually unaffected. The palatal and alveolo-palatal realisations of these fricative targets

could be related to the cleft palate condition. Palatalisation of fricatives has been reported in the speech of children with complete clefts of the lip and palate (Foster & Greene, 1960; Albery & Hathorn 1985). It has been suggested that palatalisation and lateralisation are associated with dental and occlusal abnormalities but the precise relationship is unclear and as Albery & Hathorn comment there are children with severe degrees of arch collapse, missing teeth and/or Class III malocclusion who manage to produce excelllent speech (Albery & Hathorn op cit). With regard to AC he does not have a crossbite but his upper and lower teeth meet in an edge to edge relationship which is not unusual for normal children in the primary dentition stage. It may be, therefore, that AC's unusual fricative productions are associated with differences in the configuration of the tongue and the shape of the air channel (Catford 1977) rather than structural deviance. There is no lateralisation evident and it would seem that AC is using the middle part of the tongue rather than the tip, and is creating the channel for friction further back in the mouth in order to produce the alveolo-palatal fricatives. In addition AC was able to produce correct alveolar fricative realisations in imitation tasks by modifying his tongue position and using appropriate tongue-tip articulation.

It is noteworthy that the major advances in AC's phonetic and phonological development, as described above, had occurred prior to any significant hearing difficulties. It is evident from these results that AC follows a near

normal pattern of phonetic and phonological development. There is, however, some evidence of characteristics which could be attributed to the cleft palate condition, namely, Backing and unusual realisations of alveolar fricatives. The Backing process had spontaneously resolved by 3;0. The unusual fricative articulations, however, which were first detected at 3;0 are still present at 4;0. It was evident, however, that AC was able to produce accurate realisations of the alveolar targets.

INTER SUBJECT COMPARISON

Pre-speech vocalisations

The results of Study 2 confirm the findings of Study 1 with regard to the phonetic deviance which occurs in the pre-speech vocalisations of all the subjects both pre and post-operatively. As discussed above in Study 1, this finding is in agreement with studies reported for other cleft palate populations (Henningsson 1989, O'Gara & Logemann 1988). The three subjects in Study 2 all evidence restricted contoid phonetic inventories at R1. For Subjects AC and JA pharyngeal and glottal articulations predominate and there are almost no articulations involving the lips and front of the tongue. This is similar to the results for AB and especially SB in Study 1. For PJ, however, 38% of his articulations are

bilabial nasals and 21% are front of tongue nasals. He uses more nasals at R1 than all the subjects in both studies except DD in Study 1.

Post-operatively AC, PJ and JA all evidence an increase in lingual articulations and a decrease in pharyngeal and glottal articulations. This is similar to the post-operative results for the subjects in Study 1. In addition there is an increase in bilabial articulations for both AC and JA. It is noteworthy that in Study 1 at R2 there appeared to be a difference between the subjects who had clefts of the lip and palate (CLP) and those who had clefts of the palate only (CP). The CLP subjects still exhibited a marked lack of plosives using the lips, tip and front of the tongue. In Study 2, however, there is a different picture. AC (CLP) is using bilabial and lingual plosives at R2 but JA (CP) and PJ (CLP) both exhibit a marked lack of plosives and fricatives other than glottal contoids. All the CLP subjects in Study 1 were at least using some postero-dorsal plosives.

At R3 there is a greater difference between the vocalisations of AC and those of JA and PJ. AC has progressed with regard to plosive development although this is delayed in comparison to normal development (Locke 1983). JA and PJ, however, have made no progress with regard to plosive development. For both these subjects, particularly PJ, nasal contoids predominate. In addition PJ uses very few glottal articulations but over 20% of JA's articulations are glottal. These two subjects are, therefore, continuing to evidence very restricted and deviant phonetic development. AC like all the

subjects in Study 1 (except AU who evidenced normal development at R3) is moving towards more normal phonetic patterns but there is still evidence of restricted and deviant phonetic development.

The lack of development for JA and PJ could be related to fluctuating hearing levels as a result of OME. AB in Study 1 also had OME which seemed to have resulted in some regression in phonetic development at R3. This subject, however, evidenced an increase in the percentage of plosives used at R3 and 26% of his total articulations were labial or lingual plosives.

Statistical Analysis

In this type of study the opportunity for statistical analysis is limited. It proved possible, however, to undertake a statistical analysis on some of the pre-speech data. Therefore, in addition to the analyses reported above, a statistical analysis was carried out on the pre-speech data of all eight subjects together, over the three recordings R1, R2 and R3. This analysis considered changes in the frequency of use of the different active articulators and the different manner of articulation categories. With regard to plosive articulations, oral plosives (labial and lingual) were considered separately from glottal plosives.

A Friedman (Friedman 1937) two-way analysis of variance showed a significant difference for front of tongue articulations ($p < 0.002$), for glottal and pharyngeal articulations ($p < 0.030$), for nasal contoids ($p < 0.044$) and

for oral plosives ($p<0.016$). The first two of these results reflect the increase in front of tongue articulations and the decrease in pharyngeal and glottal articulations which occurs post-operatively and is most marked between R1 and R2 for all subjects. Similarly the difference for oral plosives reflects the development of these contoids post-operatively and the marked increase in their frequency of occurrence at R3, for all subjects except JA and PJ.

With regard to nasal articulations, all subjects show an increase in their percentage use of these articulations at R2, except AU who uses the same percentage as at R1. The most marked increases (over 20%) in nasal articulations between R1 and R2 are evidenced for Subjects PJ, JA, AC and FS. Between R2 and R3, Subjects PJ, JA and SB evidence an increase in nasal articulations but for all the other subjects there is a decrease. It is noteworthy that both JA and PJ subsequently evidence very delayed plosive development.

The results of this analysis, therefore, support the interpretations of the non-statistical analyses. The Friedman two-way analysis of variance has detected areas in which significant differences occur and it is noteworthy that these are the areas in which important changes have been observed in the non-statistical analyses. With regard to the active articulators, these areas are front of tongue and glottal/pharyngeal articulations. With regard to manner of articulation, they are nasals and oral plosives.

Some of the characteristics of cleft palate speech patterns which were detected in the data of the subjects in Study 1 are also evidenced in Study 2. These characteristics are nasal and glottal realisations of target obstruents, unusual fricative realisations and a Backing process. In addition for PJ and JA, but not AC, there is evidence of severely delayed phonetic and phonological development. These charactersistics have been reported in the speech patterns of other cleft palate populations (Albery & Russell 1990, Bzoch 1979, Dorf & Curtin 1982, Edwards 1980, McWilliams et al 1984). Backing which was present in the developing phonologies of DD, SB and FS, the three CLP subjects in Study 1, also occurs for AC (CLP). It is first evidenced in the words used by AC at 1;9 but has spontaneously resolved by 3;0. Similarly, Backing had resolved for DD by 3;0 but not until 4;0 for SB and FS. Backing is also evident for PJ but at a much later stage than for the other subjects (from 3;9).

JA and PJ both evidenced nasal realisations of target obstruents. For JA this characteristic seemed to be associated with her physical difficulty in achieving velopharyngeal closure for oral consonants. The nasal realisations gradually disappeared as JA achieved correct articulatory placement for target obstruents and established an oral/nasal contrast. The obstruents, however, were produced with nasal emission. JA was, therefore, able to achieve accurate articulatory

placement but was unable to produce an exclusively oral airstream because of velopharyngeal incompetence (Stengelhofen 1989). Despite this physical restriction on her articulatory ability and phonetic potential, it was apparent by 2;6 that JA was attempting to signal plosive and fricative articulations.

For PJ nasal realisations of target obstruents persisted longer than for JA. They dominated his early speech development, did not begin to diminish until 3;6, and there is still some evidence of them at 4;6. Nasal realisations of target obstruents also occurred for AB and DD in Study 1. For DD they had virtually disappeared at 3;0 but for AB they did not resolve until 4;6. For these two subjects and for PJ the nasal realisations would appear to be a result of abnormal learned neuromotor patterns (Bzoch 1979) as none of these subjects had velopharyngeal insufficiency. Bzoch (op cit) suggests that these atypical patterns are learned prior to primary surgery and 'may be retained indefinitely due to habit.' For these subjects, therefore, it would appear that the abnormal neuromuscular patterns originated in the pre-speech stage of development and became habitual. McWilliams et al (1984) describe children whose speech consists primarily of nasal consonants and vowels. They term the hypernasality associated with this delay in phonetic development 'pseudohypernasality because the speech may improve spontaneously or with therapy'. As described above PJ required regular therapy to facilitate his production of non-nasal consonants. In Study 1

spontaneous improvement occurred for DD but AB required some therapy.

Glottal realisations of target obstruents are evident in the data of JA from 1;9. JA uses the glottal plosive to realise plosive targets and is, therefore, using correct manner but incorrect place of articulation. Her use of glottal realisations gradually decreases as she achieves correct place of articulation and has virtually resolved by 4;0. For JA, her use of glottal realisations could be associated with her difficulty in achieving normal articulatory patterns because of VPI. This pattern is reported in other studies of cleft palate speech (Bzoch 1979, Morris 1979. McWilliams et al 1984). These authors suggest that the speaker uses 'glottal stops' as compensatory articulations in an attempt to produce plosive articulations without nasal escape. As Morris (1979) comments 'the plosive character of the glottal stop does not depend on the velopharyngeal valve...' because the interruption of the airstream occurs at the level of the glottis. In some speakers a glottal pattern of articulation may persist even when they have velopharyngeal competence because it has become a learned pattern of behaviour (Morris, op cit).

For PJ a few glottal realisations of target obstruents occur in WF position from 2;0. At 3;6 PJ's use of glottal realisations has increased and these occur in all word positions as some of his variable realisations of obstruent targets. From 3;9 there is a decrease in PJ's use of glottal realisations and they no longer occur in WI position. There are still some glottal realisations as

part of the variability at 4;0 and 4;6. AB and SB in Study 1 also evidenced glottal realisations. For AB they had disappeared by 3;6 and for SB by 4;6.

Unlike JA and PJ, AC does not evidence nasal or glottal realisations and follows a more normal pattern of phonetic development. However, although AC evidences early development of fricatives, unusual fricative realisations of alveolar fricatives are evident from 3;0. JA uses a palatal fricative to realise some fricative and affricate targets from 2;6 but this has resolved and she is using correct articulatory placement at 4;0. Both JA and AC evidence normal fricative development but there is some phonetic deviance related to the cleft palate condition (Albery & Russell 1990). There is, therefore, normal phonological development overlaid with phonetic deviance.

When PJ first evidences fricatives at 4;0, there is a range of variable fricatives in WF position. These variable realisations include palatal fricatives, nasalisation and lateralisation of alveolar fricatives. Considerable variability in fricative production and unusual fricative realisations still persist for PJ at 4;6. Palatal realisations of fricative targets were also evidenced for all the subjects in Study 1, with the exception of AB. For these subjects the palatal realisations had disappeared by 4;0. At 4;0, however, SB was using some lateralisation of alveolar fricatives in addition to accurate matches with these fricative targets. Unusual fricative realisations, in particular lateralisation and palatalisation of alveolar fricative

targets, have been reported in other studies of the speech patterns of cleft palate children (Foster & Greene 1960, Dorf & Curtin 1982, Albery & Hathorn 1985).

With regard to comparison between the pre-speech and speech results for each subject some interesting observations can be made. Both JA and PJ evidenced very restricted and deviant phonetic development in their pre-speech contoid phonetic inventories at 1;6. In particular there was a marked lack of plosive and fricative articulations. Both these subjects subsequently evidenced considerable difficulty and delay in establishing plosives and fricatives in their phonological systems. In Study 1, subject AB also evidenced a marked delay in development, particularly with regard to the development of plosive and fricative articulations. This delay had largely resolved by 4;6 but there was some remaining evidence of developmentally normal delay. A further similarity between PJ, JA and AB is that these subjects all suffered from intermittent conductive hearing losses at what may have been critical periods in their phonetic and phonological development. In addition it was determined that JA had velopharyngeal insufficiency which made it more difficult for her to achieve intra-oral pressure for normal plosives and fricatives.

At 1;6 AC's contoid phonetic inventory exhibited a more normal pattern than those of JA and PJ but there continued to be evidence of restricted and deviant phonetic development. In particular there was a lack of plosives involving the front of the tongue. This subject subsequently evidenced a Backing process in his early

phonological development although this was beginning to resolve by 2;3. The results for this subject, therefore, like those for AU, DD and FS in Study 1, indicate that there is the possibility of spontaneous recovery from phonetic deviance and of relatively normal phonological development once the palatal surgery has provided an intact intra-oral mechanism. PJ, like subjects AB and SB in Study 1 demonstrates that there can be persisting phonetic influence on phonological development. JA, however, evidences a different pattern of development. For this subject there is evidence of normal phonological development overlaid with phonetic deviance caused by VPI. The results for JA, therefore, indicate that there is the possibility of an incipient phonological system underlying a phonetic disorder.

It can, therefore, be concluded that although there are some common tendencies, each child has his/her own route for phonetic and phonological development. These results, like those of Study 1, are in agreement with the observations of McWilliams et al (1984) regarding the individual variability between the speech patterns of cleft palate children and the fact that they are a heterogeneous population in this respect. In addition McWilliams et al (op cit) comment on the occurrence of improvement with age, especially with regard to the articulation of plosives and fricatives. The results of both Study 1 and Study 2 support this.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

As outlined in Chapter 1 and discussed in Chapter 3, the purpose of this study is to investigate the relationship between physical, phonetic and phonological factors in the speech development of cleft palate children. The aims of the study are to determine the extent and nature of any deviance or delay and whether these result primarily from phonetic or phonological bases (Crystal 1981,1987). A further aim is to consider whether there are possible natural explanations (Harris & Cottam 1985) in order to begin to address the issue of why some cleft palate children develop normal speech patterns whilst others experience considerable difficulty.

In Chapter 3 it was hypothesised that there will be phonetic deviance in the pre-surgical vocalisations of cleft palate children as a result of the structural abnormality. This hypothesis is confirmed by the results of this study. Prior to the operation to repair the palate all the subjects evidence restricted and deviant contoid phonetic inventories. There is a general lack of articulations involving the lips and front of the tongue and a predominance of glottal and pharyngeal articulations. This phonetic deviance is, undoubtedly, physically based and results from the structural inadequacy of the intra-oral mechanism. Post-operatively, in the context of an improved intra-oral mechanism, there is the opportunity for a greater range of articulatory

possibilities and all the subjects demonstrate this to some extent. There is an increase in lingual articulations and a corresponding decrease in glottal and pharyngeal articulations for all the subjects. Phonetic deviance, however, is still evident. It is noteworthy that at this stage individual differences are begining to emerge with regard to the production of plosives. These differences are more apparent at the third pre-speech recording (R3) when the children are aged between 1;6 and 1;9.

The second hypothesis suggested that the link between the phonetic repertoire of babbling and the basic sound system of a child's language, which has been established in studies of normal children (Oller et al 1975, Locke 1983), would also exist in the cleft palate population. This is supported by the results of this investigation. Much of the phonetic deviance which was present in the pre-speech vocalisations of these subjects at R3 can be detected in their early speech patterns. For four of the subjects in Study 1, for example, antero-dorsal fricatives in their pre-speech phonetic inventories are still evident as palatal fricatives in later phonetic inventories which are based on meaningful speech. In addition, for subject SB the range of posterior fricatives present in her pre-speech inventory at R3 (1;9) is still evident as an abnormal range of back fricatives in her speech at R4 (2;6). With regard to Study 2, the lack of plosives and the predominance of nasal articulations for both PJ and JA in their pre-speech patterns at 1;9 are subsequently evidenced in

their early speech development. Furthermore, for these two subjects the phonetic deviance persists and is similar to that reported for older cleft palate children's speech patterns (Bzoch 1979, Morris 1979, McWilliams et al 1984). This evidence supports the hypothesis that later speech patterns can be predicted from pre-speech vocalisations. The management implications of this finding are discussed below.

The hypotheses concerning the relationship between phonetic and phonological development in cleft palate children are confirmed by the results of this study. It was suggested in Chapter 3 that progressively more normal phonetic development would lead to normal phonological development but that a delay in phonetic development could also cause a further delay in the establishment of the child's phonological system. Both these developmental routes can be observed in the results of this investigation. AU in Study 1, for example, has a developmentally normal phonetic inventory at R3 (1;7) and subsequently evidences normal phonetic and phonological development. For other subjects, however, there is evidence to suggest that the phonetic deviance influences early phonological development. Pre-speech delay in the development of oral plosives, for example, leads to a delay in the establishment of this type of consonant in the children's contrastive systems. DD, SB and FS in Study 1 all evidence delay in the establishment of bilabial plosives. Paradoxically one bilabial plosive was evident in SB's pre-speech phonetic inventory though there were none in the inventories of FS and DD. For AB

in Study 1, there is a delay in establishing voiceless plosives in his contrastive system although voiced plosives are established sooner. This corresponds with his pre-speech pattern in which voiced but not voiceless plosives were present. Delay in plosive development is particularly marked for JA and PJ in Study 2. It is noteworthy that for some subjects (DD, SB and JA) who evidenced delay in establishing bilabial plosives in their phonological systems, there is also a delay in establishing labio-dental fricatives. There is a persistent Stopping process operating for these target phones; they are usually realised as bilabial plosives. This is a developmentally normal process (Grunwell 1987). It would appear, therefore, that for these subjects a delay in one aspect of phonological development has lead to a delay in another related area.

It is evident that abnormal phonetic patterns may also give rise to unusual phonological processes. Backing, for example, occurs to different extents for all the CLP subjects. For these CLP subjects, the lack of plosives and fricatives involving the lips and front of the tongue in the pre-speech stage of development seems to have predisposed them towards using a Backing process in their early speech patterns. This occurs even when the child is able to use the correct target consonant. For example, AC's phonetic inventory at 2;0 contains the full range of English plosive consonants but in his speech pattern there is Backing of word-initial plosive targets. In these subjects, therefore, Backing is an example of a

secondary phonological disorder arising from a primary phonetic deviance.

From the results of both studies, in particular from Study 2, (which investigates the period from 1;6 to 3;0 in greater detail), the relationship between phonetic and phonological development in children with cleft palate can be observed. It should be noted that, even when the children begin to evidence more normal phonetic inventories, there are abnormal and variable matches with the adult target system. It would appear, therefore, that the cleft palate condition predisposes children in the early stages of phonetic development pre-verbally to use a developmentally abnormal phonetic inventory. Subsequently, when they begin to talk, like other children, they use the phonetic repertoire which was at their disposal during the pre-speech stage of development. The patterns of their first words are, therefore, abnormal because of the predisposition resulting from the structural abnormality. The deviant phonetic patterns become established as developmentally unusual phonological patterns. As the children begin to be able to overcome the phonetic deviance and expand their phonetic repertoire, more normal phonetic inventories result. There is then evidence that the cleft palate condition is affecting phonological development because the children appear to experience more difficulties with some types of matches than would be expected from their more normal phonetic inventories (see, for example, Backing as described above). Mismatches with the adult target system have, therefore,

become established as a result of the cleft palate condition. This indicates that the cleft palate condition may not only have clear phonetic consequences but that these may also be evident in phonological development. There is, therefore, the possibility of an interaction between early phonetic development and later phonological learning.

Some children, for example AC and DD, overcome the consequences arising from the predisposition to abnormal patterns sooner than others. They have, therefore, applied new phonetic and phonological knowledge to establish more normal speech patterns. Other children, for example, AB, PJ, and SB, experience more difficulty in overcoming the phonetic and phonological consequences of the cleft palate condition. For these children the inability to learn and apply new phonological rules results in delayed and disordered phonological development. It is apparent, therefore, 'that in the developmental process the inadequacies of a deficient or inefficient phonetic mechanism may impact upon phonological learning' (Grunwell 1988). There appears to be a developmentally different pattern of phonological learning that, it could be argued, is a result of the cleft palate condition. Such a finding is not compatible with the proposal of Hewlett (1985) that speech disorders associated with cleft palate are primarily articulatory and that the remainder of the speech production mechanism, that is the phonological system, is unimpaired.

The situation is different, however, for children like JA who have VPI resulting from a structural inadequacy. The results for this subject demonstrate that there may be an incipient phonological system underlying the phonetic disorder. Hewlett's proposal is therefore particularly applicable to subjects who have a structurally inadequate mechanism and conform to the classical descriptions of cleft palate speech. These are the subjects who evidence a high frequency of compensatory articulations. For these subjects speech disorders occur at the lowest level of Hewlett's model of speech production, the Vocal Tract Shape/Movements level (Hewlett 1990). These may result in compensatory strategies at a higher level because the child is physically unable to produce the required sounds. A child who cannot achieve intra-oral pressure as a result of VPI, for example, may use the glottal plosive to signal plosive targets. The child is, therefore, indicating an awareness that plosive realisations are required and the glottal plosive is the result of the 'Motor Programmer...determining and adjusting the parameters of motor plans' (Hewlett, op cit) in order to achieve the correct manner of articulation. A compensation strategy at the higher Motor Programmer level, therefore, results in an adjustment at the lower Vocal Tract level.

Hewlett's model is also applicable when compensatory articulations persist, especially when there is a unique one-to-one relationship with the target consonants. He uses the example of a pharyngeal fricative for which 'the basic motor plan, and therefore the specification of the

sound in the Output Lexicon, would be different.' Hewlett, therefore, is claiming that the pharyngeal fricative has full phonological status. Alternatively, he suggests that the pharyngeal fricative may result from the Motor Programmer seeking out the most efficient way of implementing a sound corresponding, for example, to /s/. When this is achieved 'the resulting strategy would be "phonologised" by means of an entry in the Output Lexicon.' It would only change if the speaker sought to access /s/ again from the Input Lexicon and devise a new motor plan (Hewlett 1990). This explanation is applicable to the speech pattern of JB in Albery & Russell (1990). JB realised the fricatives /ʃ/ and /ʒ/ as [$\widehat{tʃ}$] and [$\widehat{dʒ}$] indicating lateralisation and palatalisation. Similarly subject LS, also in Albery & Russell (1990) used a nasal fricative to realise alveolar and post-alveolar fricative and affricate targets. This pattern of phoneme-specific nasality has phonological consequences but its origin is articulatory and therefore at Hewlett's Vocal Tract Shape/Movements level. With regard to the subjects in the studies presented here, there is no evidence of persisting compensatory articulations occurring in a one-to-one relationship with target consonants. Some compensatory articulations do exist in the children's early speech patterns but these diminish as phonetic proficiency improves and the children increase their phonological knowledge.

Although the results of both Study 1 and Study 2 evidence some common tendencies in the speech development of these cleft palate subjects it is evident that there is

considerable individual variation. This occurs with regard to the rate of development and also the different route for phonetic and phonological development adopted by each child. It is interesting to note that the range of different types of development in this group of cleft palate children mirrors the spectrum observed in the normal population. Both Ingram (1976,1989) and Grunwell (1987a) comment on the individual variation which occurs in the phonetic and phonological development of normal children. Grunwell (op cit) stresses that profiles of phonological development must be interpreted flexibly because of this variation in the 'process and progress of phonological development.' Ingram (1976,1989) states that 'children may differ by as much as 3 years in attaining correct pronunciation of specific English sounds.' He also emphasises the gradual nature of children's acquisition of new sounds 'with extended periods where the sound is both correctly and incorrectly produced.' This pattern of development is observed in the speech patterns of these cleft palate subjects. Several subjects evidence variability in their realisations of the same target consonant. Within this variability there may be developmentally normal realisations, unusual realisations and also accurate matches with the adult target. FS at 2;4, for example, realises word-final /z/ as [d, ç, ʃ, z] Ingram (1987) addresses the issue of individual variation in normal and deviant phonological development with reference to his own and other studies and reaches the 'tentative conclusion.....that the variation of phonological deviance for children with phonological

disorders is that it is no greater than that for normal children.' The results of the studies reported here lead to a similar tentative conclusion with regard to the variation in phonological development of cleft palate children.

In seeking explanations for the different patterns of speech development observed in these studies, the question of possible natural explanations needs to be addressed (Harris & Cottam 1985). In particular it is important to explore why some children spontaneously recover from phonetic deviance and evidence more normal phonological development while others demonstrate more severe difficulties. For JA, a structurally inadequate velopharyngeal mechanism would account for her difficulties in achieving obstruent consonants and a nasal/oral contrast. Once this had been surgically corrected it was evident that JA's phonetic and phonological development was virtually normal for her age. With regard to subject SB, the abnormal structure of the posterior part of her palate could have been a factor in the range of unusual posterior fricatives evident in her speech at 2;6. In addition, at 3;6 when SB was using glottal plosives exclusively to realise target velars, it could be argued that this was related to the surgery which was carried out to repair the posterior part of the palate.

Dental and occlusal abnormalities may influence speech production (Albery & Russell 1990). However, as Bzoch (1979) comments 'the presence of cause-effect relationships between dental and occlusal hazards and

speech production is not predictable'. SB at 4;0 evidenced some lateralisation of alveolar fricatives which might have been related to dental and occlusal abnormalities. SB had some collapse of the lesser segment resulting in misalignment of the dental arch and a small anterior fistula just behind the alveolus. The lateralisation did not persist and had resolved by 4;6. For the subjects who evidenced palatal fricatives in their early speech patterns this appears to have been related to their pre-speech phonetic inventories and not to dental or occlusal problems. These unusual fricatives may, therefore, have been the result of abnormal learned neuromotor patterns (Bzoch 1979, see below). AC was using alveolo-palatal fricatives at 3;6 and 4;0 but there were no obvious dental or occlusal abnormalities which could have accounted for these unusual realisations. They occurred alongside accurate realisations of the target consonants and appeared to result from differences in tongue shape and movement rather than structural factors. There is evidence of these unusual fricatives earlier in AC's phonological development and it seems likely that they are also the result of abnormal learned neuromotor patterns.

Bzoch (1979) considers that some of the speech patterns associated with cleft palate are attributable to abnormal learned neuromotor patterns. He suggests that 'auditory decoding and neuromotor encoding skills are learned when the vast majority of infants with a palate defect have an abnormal mechanism' resulting in compensatory neuromuscular patterns which may become habitual. It is

possible that abnormal feeding patterns may also play a part in this process. The infant with a cleft of the palate is unable to form the 'closed box' or the required subatmospheric pressure in the oral cavity, which are two of the four essential factors for normal bottle feeding proposed by Selley, Ellis, Flack & Brooks (1990). In normal feeding it is generally understood that the intra-oral cavity is sealed by the lips around the teat anteriorly and by the tongue contacting the soft palate posteriorly. Reduced intra-oral pressure is then achieved by a combination of jaw and tongue movements in particular. Selley et al (op cit) comment that 'it seems that the ability to produce and maintain a fluctuating subatmospheric pressure within the mouth is an essential factor for facilitating milk transfer during bottle feeding.' The authors demonstrate how an active depression in the dorsum of the tongue, which is accompanied by tip elevation, plays an important part in this process. They consider that 'Proper operation of this tongue depression could be a factor in the development of normal tongue function.' It is possible that the abnormal physical structures and the different feeding strategies which are used to feed cleft palate babies (Campbell & Watson 1980, Gornall, Bryan-Jones & Russell 1990) result in abnormal tongue movements during feeding and that these subsequently influence articulatory development. In some methods, for example, a larger hole is made in the teat and milk is directed towards the back of the tongue (Gornall et al, op cit). In addition the infant is unable to achieve a posterior

seal because of the cleft palate, nor an anterior seal if there is also a cleft of the lip and primary palate. The infant does not, therefore, need to use the tongue to create a reduced intra-oral pressure and is more likely to use the back rather than the tip and front of the tongue during feeding. These abnormal feeding movements may contribute to the pattern of back articulations observed in the pre-operative vocalisations of cleft palate children.

The speech characteristics associated with habitual learned neuromotor patterns include glottal stop and pharyngeal fricative articulation and delayed speech development (Bzoch 1979) Such an explanation could be applicable to the speech patterns of some of the subjects in these studies. With regard to subjects SB, AB and PJ, it could be argued that the persisting phonetic influence on phonological development results from habitual learned neuromotor patterns. For PJ especially this could be traced back to his pre-speech vocalisations when he used predominantly nasal articulations. Subsequently nasal realisations dominated his early speech development and did not begin to diminish until 3;6, with the help of speech therapy intervention. Nasal realisations of target obstruents also persist for AB although this subject evidenced voiced plosives from the pre-speech stage of development.

Another influencing factor for AB, PJ and JA is the fact that these three subjects suffered from frequent episodes of conductive hearing loss resulting from recurrent OME, at what may have been critical periods in their phonetic

and phonological development. Although, as discussed in Chapter 2, the exact nature of the relationship between OME and speech development remains unclear, those children who suffer early and frequent episodes of OME seem to be at greater risk for speech and language problems. With regard to cleft palate it is difficult to separate conductive hearing loss from other possible etiological factors. For these three subjects, however, it would appear that an intermittent fluctuating hearing loss combined with other factors might have contributed to more severe patterns of deviant and delayed speech development. For JA the combination was auditory in addition to structural factors. For AB and PJ the combination of an auditory factor with abnormal learned neuromotor patterns would seem to have resulted in deviant and delayed phonetic and phonological development. It might be argued that the additional influencing factor of hearing problems distinguishes these two subjects from those who evidenced spontaneous recovery from phonetic deviance and relatively normal phonological development.

Despite the small population in this study there are undoubtedly clinical implications for the management of cleft palate children. It does seem possible to predict some of the more severe speech problems during the pre-speech stage of development. An absence of normal plosives such as that evidenced in the data of PJ and JA indicates that there may be a severe delay in the establishment of plosive articulations in the child's

future speech development. It is not possible to determine at the pre-speech stage whether the lack of plosives is due to VPI or other factors but it is important to identify children who are "at risk" for deviant and delayed phonetic and phonological development. These children can, therefore, be closely monitored and indirect intervention can be initiated (Russell 1989). This is in agreement with Mousset & Trichet (1985) who recommend treatment for those children who are not producing any of the voiceless plosives /p/, /t/ and /k/ at fifteen months. Although this work is based on a French population, it is also applicable to English speakers. Children like FS, SB and AB who evidenced a predominance of glottal articulations in their pre-speech data should also be closely monitored in order to determine whether deviant patterns persist or if there is evidence of spontaneous recovery.

It has been demonstrated that frequent episodes of OME resulting in a conductive hearing loss may have contributed to the severity of deviant and delayed speech development for some of the children in this study. This confirms the recommendations made by Paradise (1980) and McWilliams et al (1984) for early intervention and aggressive management of ear problems in children with cleft palate. It is essential, therefore, that the otological status and hearing of all children with cleft palate should be regularly assessed.

The results of this longitudinal investigation into the phonetic and phonological development of a small population of cleft palate children have revealed a

diversity of developmental patterns. This is not unexpected and confirms that children with cleft palate are a heterogeneous population with regard to their speech development (McWilliams et al 1984). It is anticipated that the patterns of development observed in this study would be confirmed by a larger population of cleft palate children. This investigation has also emphasised the importance of longitudinal monitoring with careful and detailed phonetic and phonological analyses of speech development in cleft palate children. It has been demonstrated that such an approach produces information that is highly relevant to the clinical management of these children.

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