Speech Production in Amharic-Speaking Children with Repaired Cleft Palate

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Abstract

Cleft lip/palate is one of the most frequent birth malformations, affecting the structure and function of the upper lip and/or palate. Studies have shown that a history of cleft palate often affects an individual's speech production, and similar patterns of atypical speech production have been reported across a variety of different languages (Henningsson and Willadsen, 2011). Currently, however, no such studies have been undertaken on Amharic, the national language of Ethiopia. Amharic has non-pulmonic (ejective) as well as pulmonic consonants, which is one of the ways in which it differs from other languages reported in the cleft literature. The aim of this study was therefore to describe speech production features of Amharic-speaking individuals with repaired cleft palate and compare and contrast them with cleft-related speech characteristics reported in other languages.

Speech samples were obtained from 20 Amharic-speaking children aged between 5 and 14, with a repaired cleft palate, and a control group of 5 typically-developing children, aged between 4;0 and 6;0, all resident in Ethiopia. Audio and video recordings were made of the participants' speech production in a variety of contexts including single word production, sentence repetition and spontaneous speech, using a version of the GOS.SP.ASS (Great Ormond Street Speech Assessment: Sell, Harding and Grunwell, 1999) modified for Amharic. A descriptive research design, which involved a combination of perceptual and acoustic phonetic analysis, was employed.

The results showed that in addition to the features of speech production associated with cleft palate which are common across languages, there were also language-specific speech production characteristics related to the phonetic and phonological system of Amharic. The atypical speech production patterns identified here suggest that Amharic-speaking children with cleft palate employed various strategies in order to manage the particular speech production challenges posed by the Amharic

phonological system. In particular, in maintaining segmental contrasts, they exhibited a range of unusual airstream mechanisms. In common with children speaking other languages, the children in this study used a range of ingressive articulations (clicks and implosives) in order to avoid nasal escape of air during segmental articulation. Also, however, for ejective versus pulmonic contrasts, they used various atypical realisations (e.g., a preference for glottal realisations of ejectives) and atypical airstream mechanisms (e.g., realisation of ejectives as pulmonics).

Dedication

This thesis is dedicated to my mother, Adanech Birhanu, an astoundingly strong woman, whose advice to work hard at everything I do, to never be afraid to fail, to try and to persevere through difficult times has remained my most important asset! Thanks, Adi! You are the best mom anyone could ever ask for.

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Author's Declaration

I hereby acknowledge that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted to any academic institution for degree purposes.

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Abebayehu Messele Mekonnen

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Chapter 1: Introduction

1.1. Cleft lip and cleft palate

The purpose of this chapter is to give a brief introduction about cleft lip and palate, its aetiology, incidence, classification and effects. The chapter also aims at briefly providing a background regarding cleft care in Ethiopia.

Cleft lip and/or palate (CLP) is a condition in which the tissues that form the upper lip and/or palate fail to align properly during the initial stages of gestation and leave a fissure in the upper lip and/or the palate. In the development of the face, the most important changes occur between the five to nine weeks of pregnancy; and it takes another two weeks for the palate to be completed (Watson, 2001a). It is during this period that most speech articulators including the lips and palate develop and this is the period when CLP and other craniofacial anomalies can develop. CLP is one of the most frequent birth malformations, which may also occur in association with other congenital anomalies such as clubfoot, Pierre Robin Sequence, Spina bifida, etc and as part of an identified syndrome, in which case the clefting is often referred to as *syndromic*.

A cleft occurring in isolation (i.e., not as part of a syndrome) is generally referred to as *non-syndromic*. Various occurrence rates of CLP with associated anomalies have been reported. Shprintzen *et al*. (1985) reported that 40% of all cleft infants have associated anomalies. Some estimates (e.g., Christensen, 1999; Natsume *et al.*, 2001) lower this figure to 25% or less, while others (e.g., Tolarova and Cervenka, 1998; Forrester and Merz, 2004; Altunhan *et al.*, 2011) raise it up to as much as 70%. Such discrepancies might be due to the large number of syndromes associated with CLP and the variability in the rate of their occurrences in different populations. The following section will briefly discuss the possible causes of CLP.

1.2. Aetiology

More than four centuries have passed since the embryological basis of clefting was suggested and more than half a century since a compelling account of how clefting occurs was provided (Bhattacharya *et al.*, 2009). However, even today, no definitive answer as to what causes CLP has been agreed. More than 300 syndromes have already been associated with the condition (Murray, 2002; Mossey and Little, 2002), indicating that a single cause or single etiological model could not describe the occurrence of all types of cleft. However, recent research has been more indicative of the causal factors of clefting than ever before. For example, there has been clear development in identifying genetic and environmental causes for syndromic CLP, although the causes of the non-syndromic cleft is still unknown (Dixon *et al.*, 2011). Stanier and Moore (2004) indicated that there was some evidence that similar genes contribute to both syndromic and non-syndromic clefts, maybe modified or with variable expression. However, in spite of such suggestions, no conclusive answer has yet been provided.

In addition to the significant contributions of the genetic studies, research carried out on the influences of environmental factors has advanced understanding of the causes of cleft palate. These studies (e.g., Friis, 1989; Werler *et al.*, 1990; Romitti *et al.*, 1999; Zeiger *et al.*, 2005; Honein *et al.*, 2007) have reported that various environmental factors such as smoking in parents, maternal epilepsy and alcohol abuse by parents are involved.

Although genetic and environmental factors have repeatedly been investigated in many studies, several circumstances have impeded progress. For example, the complex heterogeneity of the human race has been the greatest challenge hindering the advance of our understanding of the causes of CLP (Melnick, 1992; Nemana *et al.*, 1992). In addition, so many diverse genes have been identified as being important in facial development and may contribute to the condition, by interacting both with each other and with environmental factors.

1.3. Incidence

CLP is a globally attested condition with a worldwide frequency of 1 in 700 (Bernheim *et al.*, 2006; Mossey *et al.*, 2009), although its prevalence rate varies based on ethnic background, sex, the type of cleft and family's socio-economic background (Bender, 2000). For example, Gorlin *et al*. (2001) reported that the highest prevalence is observed among descendants of Asian or Native North American populations, intermediate among the Caucasians and the lowest among Africans. In terms of cleft type, Gorlin (2004) noted that a combination of cleft lip and cleft palate is more common than an isolated occurrence of either. Mossey and Little (2002) reported that Northern Europeans, Asians, Native Americans, and Aboriginal Australians are more commonly affected by unilateral or bilateral cleft lip and palate. In contrast, among Africans and those of African descent cleft lip is more prevalent (Mossey and Little, 2002). Such variations may be due to the congenital variety in the gene pool of a specific race (Westreich, 2000). In terms of gender, cleft lip and cleft lip with cleft palate are more prevalent in men than in women, while isolated cleft palate is seen more in women than in men (Meng *et al.*, 2006; Jagomagi *et al.*, 2010).

There are a number of factors which make it difficult to know the true prevalence of this condition. For example, pregnancy may spontaneously terminate when the foetus has an anomaly. Planned pregnancy termination due to anomalies is also practiced in many countries (Boyd *et al.*, 2008). This being the case, many reports disregard incidents of CLP in stillbirths and only account for those in live births (Hodgkinson *et al.*, 2005). Factors such as source of data, variableness of policies of planned pregnancy termination could also contribute to the inconsistency of prevalence reports (Cooper *et al.*, 2006).

Often epidemiologic data are collected from hospital records, habilitation or surgical records, or birth certificates. The most accurate data are those gathered from hospital records. It is, however, important to note that the number and accessibility of the stated institutions vary from place to place, particularly in developing countries. Several reports attribute the lowest prevalence rate to Africa, where many babies are delivered at home due mainly to lack of accessible and affordable medical institutions. In some tribes, due to superstition or otherwise, infants with clefts would be abandoned or even killed. These and other related factors suggest that the prevalence of CLP in Africa may be under-reported.

1.4. Classification

CLP can be considered as one of a heterogeneous group of anomalies. As children naturally differ in many respects, the condition of the cleft also varies from child to child and can range from a small notch in the lip to an opening running into the palate and nose. As Watson (2001b) noted despite the heterogeneity of CLP, it is important to classify them into groups in order to describe, study and compare the results of their management. Accordingly, several classifications have been proposed over the years (e.g., Davis and Ritchie, 1922; Veau, 1933; Fogh-Andersen, 1942; Kernahan and Stark, 1958; Harkins *et al.*, 1962; Spina, 1973; Tessier, 1976; Albery and Grunwell, 1993; Wenbin, 2007). These classification systems are used for different purposes, and for our purpose the one suggested by Albery and Grunwell (1993), which is a modified version of Kernahan and Stark's (1958) system is presented here.

Table 1.1 Albery and Grunwell's (1993:85) classification based on Kernahan and Stark (1958).

Cleft lip only
- Unilateral
  - complete
  - incomplete
- Bilateral
  - complete
  - incomplete

Cleft lip and palate
- Unilateral
  - complete
  - incomplete
- Bilateral
  - complete
  - incomplete
- Unilateral cleft lip and cleft of the soft palate only
- Bilateral cleft soft palate only

Cleft palate only
- Hard and soft palate (total post-alveolar)
- Soft palate only

Figure 1.1 below illustrates some of the non-syndromic clefts.

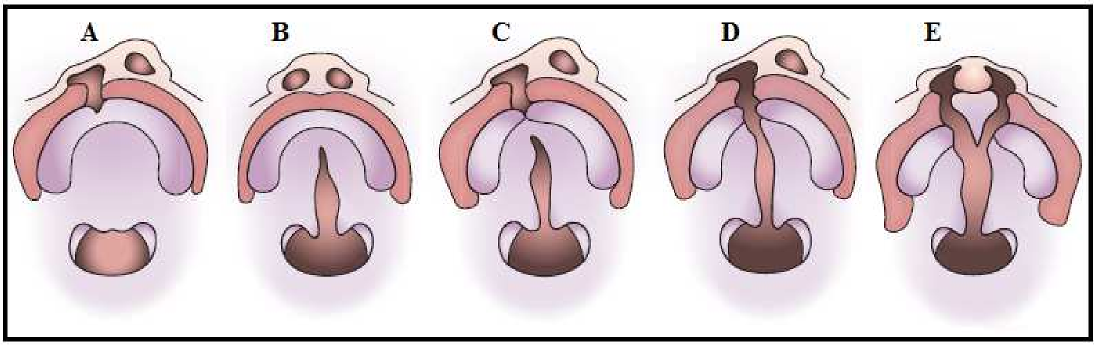


Figure 1.1 Non-syndromic orofacial clefts. (A) Cleft lip and alveolus; (B) Cleft palate; (C) Incomplete unilateral cleft lip and palate; (D) Complete unilateral cleft lip and palate; (E) Complete bilateral cleft lip and palate. Adapted from: Shaw and Semb (1993:235).

1.5. Effects

Structural complications caused by CLP include velopharyngeal insufficiency (VPI), a failure of the velopharyngeal sphincter to adequately separate the oral cavity from the nasal cavity during speech production, feeding, or breathing, atypical mid-face growth, and Eustachian malfunction. These structural atypicalities have functional implications. Systems affected by the cleft condition include feeding, dentition, communication and psychological condition. Speech production is one of the most affected systems. VPI, for example, causes inappropriate air escape through the nasal cavity, which affects speech production at the phonatory, resonatory and articulatory levels. Complications relating to the structure and movement of the lips and teeth growth could also have detrimental effects on speech production. Moreover, children with cleft palate often have difficulty with Eustachian tube function, leading to conductive hearing loss, which could in turn affect speech production. Apart from these physiological challenges, clefting affects the psychological well-being of the individuals with the condition. The sociopsychological challenges may be because of the associated stigma of observable structural and/or speech atypicalities.

1.6. Cleft lip/palate in Ethiopia

Ethiopia is a nation in the horn of Africa (see Figure 1.2) with about 80 million people and more than 80 different languages and ethnic groups. Amharic is the national language. The true prevalence of CLP in Ethiopia is unknown, though different estimations have been reported. For example, Mekonnen *et al*. (2006) reported that, in Addis Ababa, the capital, during 2004-2005, of 17, 242 live births, 30 cleft cases were identified, and the incidence of CLP was 1.74 in1,000 live births.

In Ethiopia, as in many other developing countries, many people cannot get treatment for palate closure due to, among other things, poor socioeconomic conditions, a severe shortage of qualified professionals to undertake surgical treatment, long distances to travel for surgical services, and lack of information regarding the availability of surgical services. Hence, it often happens that clefts are never repaired or only much later in life. For example, Mekonnen *et al*. (2006) stated that, in the whole of Ethiopia, there were only 8 plastic and reconstructive surgeons and 40 dentists, serving about 80 million people; and practically all are based in the capital Addis Ababa.

Figure 1.2 Location of Ethiopia

Cure Ethiopia is a non-governmental hospital in Addis Ababa delivering care to cleft patients aged under 18. Apart from repairing CLP, corrections of other birth anomalies are also done in the hospital. The facility is the best in Ethiopia and the treatment is free of charge. The hospital does not however provide speech therapy services. Charities such as Smile Train have also been providing treatment in the country. There are a number of large hospitals in Addis Ababa with high-quality facilities to carry out different surgical procedures to a high standard, including complex reconstructive operations. However, they remain inaccessible to the greater number of rural inhabitants.

More than 35 years ago, Finseth and Finseth (1975:111-12) wrote: '[a]dults with clefts could be found in villages and rural areas often [and] the people with clefts do not as a general rule come to the hospital. Then senior members of the society passed on the information that a new surgeon was available who repaired clefts'. This situation still prevails in some remote communities. Unlike developed countries, where cases of CLP are usually treated by a multidisciplinary team, in Ethiopia, the first multidisciplinary approach to treatment was not until 2003 when a joint project between Norway and Ethiopia was started which lasted until 2009. The project was funded by the Norwegian government and run by two hospitals in Addis (i.e., Yekatit 12 Hospital and Alert Hospital), and Haukeland University Hospital in Bergen, Norway (Mekonnen *et al*., 2006; Holmefjord and Kvinnsland, 2010).

In addition to introducing a multidisciplinary approach to the management of clefts, the project also aimed to establish Speech Therapy as a new profession in Ethiopia. As part of this, speech therapists have been trained and are providing pre- and post-surgery speech assessment, post-surgery speech therapy, advising parents and cooperating with the team in administering follow up. Moreover, a speech therapy unit, the only one in the whole of Ethiopia, has been established in Yekatit 12 Hospital. The unit is equipped with screening instruments such as audiometry and nasoendoscopy, and assessment and treatment protocols for the two major languages, Amharic and Afan-Oromo.

Studies in other languages have shown that cleft palate may significantly affect speech production. Currently no such studies have been undertaken on Amharic, the national language of Ethiopia. Amharic has non-pulmonic (ejective) as well as pulmonic consonants, which is one of the ways in which it differs from other languages reported in the cleft literature. The aim of this study is therefore to describe the speech production features of Amharic-speaking children with operated cleft lip/palate and compare and contrast them with the speech characteristics that are generally described as being typical of speech production associated with cleft palate as reported for other languages.

The thesis has twelve chapters, the first of which is this introduction. Chapter 2 reviews the relevant literature on speech development in children with cleft palate, while Chapter 3 presents a review of key literature in the assessment of speech production, with particular emphasis on the assessment of cleft palate speech. Chapter 4 provides an outline of the phonetics and phonology of Amharic. Chapter 5 is the methodology chapter and encompasses research aims, the design of the study, the methods of data collection, participants, participant selection criteria, speech sample and methods and materials used to collect data and protocol used for transcription validity and reliability checks. Chapter 6 describes the speech assessment devised for this study, based on a version of the GOS.SP.ASS (Great Ormond Street Speech Assessment: Sell *et al.*, 1999).

Chapter 7 describes patterns of speech production in typically-developing children and provides a summary of speech development in typically-developing Amharic-speaking children. Chapters 8 and 9 present the speech production features demonstrated by the children with cleft palate. The phonetic variations and the phonological consequences of the identified atypical speech production features are examined in Chapter 10. Chapter 11 explores the use of covert contrasts, which could not be perceptually detected. In Chapter 12, the speech production features noted in the children with cleft palate in relation to those reported from other languages are discussed.

In addition, in this chapter, cross-linguistic similarities and differences are examined in relation to various theoretical issues such as universal vs. language-specific aspects of cleft-related speech, the association of timing of surgery to speech output, and the phonetic vs. phonological nature of speech production in individuals with a cleft lip/palate.

As understanding how speech and language develops in the presence of the cleft palate provides important insights into, among other things, the relationship between early and later speech and the nature of cleft-related speech, the next chapter will review the relevant literature on speech development in children with cleft palate in relation to typical speech and language development and examine the similarities and differences across languages.

Chapter 2: Speech development and cross-linguistic differences

2.1. Introduction

Human growth involves cognitive and physical development which follow a predictable sequence. Speech development, involving both cognitive and physical development, also follows specific patterns. However, like other aspects of human development, speech development is characterized by variation. That is, children can markedly vary, within a language and across languages, in terms of the rate at which they reach a given milestone, and in terms of style and sequence of learning different aspects of the phonetics and phonology of their language. Such individual and cross-linguistic differences present challenges for researchers and practitioners to adequately define 'typical' speech and language development, which is essential in order to identify the differences in speech development when a disorder such as cleft palate is present. There is a large body of literature on speech development in typically developing children from different linguistic backgrounds, although the main bulk of this literature is based on English. This line of research has been widened to investigate patterns of speech development in children at risk of, or showing, difficulties in speech development. For example, there is a long history of interest in the study of speech development in children with cleft palate. This chapter reviews the literature on patterns of speech development in children with cleft palate in comparison with those in typically developing children.

The purpose of this chapter is to review some of the relevant literature on speech development in children with cleft palate in relation to typical speech and language development and study cross-linguistic similarities and differences. The reason for studying speech development and the relationship between early speech and later speech is basically to distinguish between atypical speech development unrelated to the cleft palate and atypical speech development related to the cleft palate. The chapter also reviews cleft-related speech production features reported in different languages. So, this chapter serves as a basis for the next chapter, which is on assessment of cleft-related speech, by providing relevant information on how speech and language develops in children with cleft palate, relative to typical speech and language development and reviewing speech production features associated with cleft palate across languages.

The chapter is divided into four main sections. The first part of the review considers the prevalence of speech difficulties that children with cleft palate have after cleft repair; and factors relating to the differences in reports on the prevalence of speech difficulties observed after surgery. In the second section, a discussion of patterns of pre-speech vocalisations in children with cleft palate in comparison with those in typically developing children will be presented. This part of the review also includes the relationship between pre-linguistic vocalisations and early sound patterns and later speech; and the times at which the onset of first word and early expressive vocabulary emerge in children with and without cleft palate. Reviewing the current knowledge regarding how children with cleft palate develop speech compared to typical speech development not only provides information as to how to differentiate atypical speech output and development that are associated with the cleft condition from developmental realisations, it also informs as to why individuals with cleft palate sound the way they do later in life by learning how they develop speech. In the third part of the chapter, the phonetics and phonology of cleft palate speech will be considered. In this section, issues such as whether the potential causes of speech difficulties observed in cleft population are articulatory or phonological will be discussed. This section will also include accounts of patterns of speech production commonly attested in individuals with cleft palate; types of articulatory strategies employed by these individuals; the effects that the articulatory adjustments made in early speech have on the phonological system; patterns of atypical phonological features observed in cleft palate speech; and the implications of the phonological difficulties. The fourth part of the chapter deals with issues pertaining to cross-linguistic studies of speech output in cleft palate. Then a brief summary of the main points will be provided.

2.2. Speech after cleft repair

It is reasonably common for children with cleft palate to have speech difficulties after the cleft palate is surgically closed, though this is not always the case. Differing figures are quoted for the prevalence of speech difficulties resulting from the cleft of the lip and/or palate. For example, Spreistersbach (1973) found that roughly 50% of children with cleft palate develop normal speech after having their cleft palate repaired, 25% need speech and language therapy and 25% require secondary velopharyngeal surgery. Stengelhofen (1989) estimated that about 40% of children born with cleft palate have longstanding problems resulting in speech deficit, and hence they require speech therapy intervention. Still another estimate was reported by Witzel (1991), who stated that after surgery about 75% of children with cleft lip and palate require speech therapy intervention, while the remaining 25% develop speech that does not require therapy intervention. Further, Grunwell and Sell (2001) estimated that, following surgery, around 50% of children develop acceptable speech without requiring speech and language therapy.

Explaining the inconsistency of the reports on the incidence of speech difficulties associated with the cleft, Grunwell and Sell (2001:69) wrote “in part this reflects changes in practice, such as the timing of surgery, but a major drawback has been the many and differing approaches to the measurement of speech”. Even given such discrepancies on the prevalence rate, it is apparent that a considerable number of children with cleft palate have a range of speech impairments, indicating a need for a continuous professional involvement in cleft palate speech assessment and management (Howard, 1993; Sell *et al.*, 2001; Hardin-Jones and Jones, 2005; Harding and Grunwell, 1996; Lohmander and Persson, 2008). Although measures and results have been varied, it has become clear that the speech output of children with cleft palate is often less well developed than those of their non-cleft peers. A number of possible influencing factors, such as frequent hospitalisations and hearing loss associated with middle ear effusion, have been cited for speech development delays noticed in children with cleft palate. But the most significant factors affecting early speech development appear to be the structural anomalies associated with the cleft (McWilliams *et al*., 1990; Chapman, 1991; D’Antonio and Scherer, 1995; Harding and Grunwell, 1996; Kuehn and Moller, 2000; Peterson-Falzone *et al.*, 2001; Priester and Goorhuis-Brouwer, 2008). In the following sections, how the structural and functional constraints associated with the cleft affect speech development and later speech output in children with cleft palate will be considered.

2.3. Pre-speech vocalisations and babbling

Defining vocal behaviours that occur in the process of speech development within the first year is rather complicated and the subject of controversy among scholars. For example, the stage of development that generally comes after that of the production of basic biological sounds such as crying (i.e., roughly after 1.5 to 2.5 months) is referred to by Oller (1980, 1986, 1986) as the ‘GOOing’ stage, and by Stark (1980, 1986) as the ‘cooing’ stage. Further, Koopmans-Van Beinum and Van der Stelt (1986) describe the sounds produced during this stage as involving ‘one articulatory movement’, while Holmgren *et al*., (1996) term this phase an ‘interrupted phonation with no articulation’. In a similar vein, the speech development stage that generally occurs between 6 to 10 months is referred to as ‘canonical babbling’ (Oller, 1980, 1986), ‘reduplicated babbling’ (Stark, 1980, 1986), and ‘babbling’ (Vihman *et al.*, 1985a; Koopmans-van Beinum and Van der Stelt, 1986).

Oller (1980, 1986) defines canonical babbling as a repetitive, rhythmic and well-formed syllable-like output (e.g., *dada* or *baibai*). These are also the defining features of what Stark (1980, 1986) terms ‘reduplicated babbling’. According to Oller and Stark, ‘canonical’ or ‘reduplicated’ babbling (e.g., *dada*) is different from ‘variegated babbling’ or ‘non-reduplicated babbling’ (e.g., *babi*), and they occur in two successive stages. Variegated babbling or non-reduplicated babbling emerges after ‘canonical’ or ‘reduplicated’ babbling (Oller, 1980, 1986; Stark, 1980, 1986). Other authors, however, consider both stages as one and categorise them as ‘canonical babbling’ (Von Hapsburg and Davis, 2009) or as ‘babbling’ (Vihman *et al*. 1985; Koopmans-Van Beinum and Van der Stelt, 1986). A more elaborate and technical definition of what has been referred to as canonical or reduplicated babbling is found in MacNeilage (in press), as cited by MacNeilage (2011):

> … one or more instances of a rhythmic alternation of a closed and open mouth, produced by a mandibular elevation/depression cycle, accompanied by vocal fold vibration, and linguistically meaningless, though giving the perceptual impression of a consonant-vowel (CV) sequence.

Despite the differences in terminologies and categorisation, there is a general agreement that the speech development stage that occurs within six to twelve months is a significant event due to its link to early and later speech development. It is this stage that is referred to as babbling here. Pre-speech vocalisation (also known as pre-linguistic vocalisation) is taken to refer to both vegetative sounds, which are associated with biological function or physical state (e.g., coughing, sneeze, crying) and non-vegetative sounds (e.g., cooing).

The development of pre-speech vocalisations and babbling and the order in which speech sounds emerge, despite the disagreements among researchers, have been well documented (Oller, 1980; Stark, 1980; Vihman *et al*., 1985; Vihman *et al*., 1986; Roug *et al.*, 1989; Mitchell and Kent, 1990; Gogate and Bahrick, 1998; Nathani and Oller, 2001; Stokes and Wong, 2002; Beckman, Kiyoko *et al.*, 2003, Tsurutani, 2004; Tsurutani, 2007). And, over the last 40 years, several studies (Morris, 1962; Richman and Eliason, 1982; Stoel-Gammon, 1985; Grunwell and Russel, 1987; O'Gara and Logemann, 1988; Estrem and Broen, 1989; Chapman, 1991; Chapman and Hardin, 1992; Jocelyn *et al.*, 1996; Hattee *et al.*, 2001; Jones *et al.*, 2003; Chapman, 2004; Persson *et al.*, 2006; Scherer *et al.*, 2008; Priester and Goorhuis-Brouwer, 2008) have studied the linguistic development of children with cleft palate, the vast majority of the studies being on the articulatory aspects. But considerable interest in studying pre-speech vocalisations in children with clefts has been shown since the 1980s, as it became apparent that pre-speech behaviours are essential to later speech. This leads to the question of how the relationship between pre-speech behaviours and early and later speech was viewed in the past as compared to current perspectives.

2.3.1. The relationship between pre-speech and early speech

In the past (e.g., Jakobson, 1941/1968; Lenneberg, 1967) the relationship between pre-speech vocalisations and sound patterns in early speech in typically developing children was viewed as minimal. But further investigations into the matter has led to a recognition that, in typically developing children, universally, there is often a marked similarity between the phonetic inventory of babbling and a child's early phonology (Locke, 1983; Kent and Bauer, 1985; Stoel-Gammon, 1985; Vihman *et al*., 1985; Oller, 2000; Nathani and Oller, 2001;Vihman and Kunnari, 2006). It can be suggested that a similar relationship exists in children with cleft palate as some features of pre-speech vocalisation of children with cleft palate and their later speech have some similarities. For example, several studies of early vocal development in children with cleft palate (e.g., Grunwell and Russell, 1987, O'Gara and Logemann, 1988; O'Gara *et al.*, 1994; Chapman, 2001; Salas-Provance *et al.*, 2003; Morris and Ozanne, 2003; Scherer, *et al.*, 2008) have noted pre-speech difficulties such as retracted articulatory patterns and compensatory articulations, which usually persist into later speech. These findings argue against the view that prevailed for many years that pre-speech productions were not affected by cleft palate and hence later cleft palate speech would not be discernible in the pre-speech productions.

Many of these studies have investigated the early speech development of children with cleft palate in comparison with those in children without cleft palate. Such comparative studies have described differences and similarities of different aspects of early speech production and development in typically developing children and in children with cleft palate. Accordingly, Chapman *et al*. (2001), for example, examined pre-speech development of 30 9-month-old children with unoperated cleft palate compared with 15 age-matched non-cleft children. They found that the cleft group had smaller canonical babbling ratios (i.e., the number of canonical syllables divided by the total number of syllables) than the control group, with only 57% of the babies with cleft palate attaining the canonical babbling stage by 9 months compared to 93% of their non-cleft peers. Similarly, Scherer *et al*. (2008) investigated the early vocalisation skills of 13 babies with cleft lip and palate at 6 and 12 months of age in comparison with 13 age-matched children without cleft. All the babies with cleft lip and palate had their clefts repaired between 10 to 12 months, with the exception of one baby who was 13 months old at the time of cleft repair.

The study found that, at 6 months of age (i.e., before palate repair) the two groups of children exhibited more similarities than differences in pre-speech productions but later at 9 months of age (i.e., again before palate repair), consistent with what Chapman *et al*. (2001) found, for babies with cleft palate, delays in babbling were observed.

The vocal limitations of children with cleft palate before surgery are apparent and several studies (e.g., Russell and Grunwell, 1993; O'Gara *et al*., 1994; Scherer *et al*., 2000; Jones *et al*., 2003) have shown that children with cleft palate start to demonstrate improvements in speech development following palate closure. However, as discussed above, many children with cleft palate do not develop age-appropriate speech immediately or quickly after surgical intervention (O'Gara and Logemann, 1988; Estrem and Broen, 1989; Chapman and Hardin, 1992; Chapman, 1993; Timmons *et al.*, 2001; Koh *et al.*, 2009; Murthy *et al.*, 2010). The study by Scherer *et al*. (2008) also showed that, by 12 months of age (i.e., all except one of the babies with cleft lip and palate their study received surgery), a significant difference in babbling was observed between the babies with cleft palate and their non- cleft peers, with the cleft group using less canonical babbling than the control group.

Qualitative differences in early vocalisations in terms of use or avoidance of specific sounds, between children with cleft palate and typically developing children have also been reported. Chapman *et al*. (2001), for example, have shown that glottals were observed more commonly in the vocalisations of their 9-month-old babies with cleft palate than the control group. They also found that the babies with cleft palate demonstrated fewer stops, glides and velars. Similar results were reported in Jones *et al*. (2003), except, in the latter study, contrary to what Chapman *et al*. (2001) found, more glides were noted in the vocalisations of the children with cleft palate. In addition, in babies with cleft palate, different patterns of preference for some articulatory features from the typical patterns have been noted. For example, O'Gara and Logemann (1988) noted that, in babies with cleft palate, voiceless plosives frequently occur before voiced plosives, a converse pattern compared to typical development. Such differences in the use and avoidance of specific sounds in pre-speech stages apparently result in differences in the order of consonant acquisition.

Regarding the presence of differences in the size of consonant inventories between pre-speech vocalisation of children with cleft palate and their non-cleft peers, differing reports exist in the literature. While some studies (e.g., Scherer, 1999; Chapman *et al*., 2001; Chapman *et al*., 2003) have shown group differences in consonant inventories, others (e.g., Chapman *et al*., 1991; Jones *et al*., 2003; Scherer *et al*., 2008) reported no significant group differences. Perhaps the absence of significant group differences is linked to the inclusion of compensatory sounds in the consonant inventory, as, for example, Chapman *et al*. (2003) stated that group differences appeared when compensatory sounds such as glottals and glides were excluded.

These quantitative and qualitative differences show that children with cleft palate develop pre-speech differently from that which occurs in typical speech development. Such atypical speech development is manifested not only in articulation but also in phonology. In fact, studies on early phonological development of children with cleft palate have noted delayed and disordered phonological processes in the cleft population (Chapman and Hardin, 1992; Chapman, 1993; Harding and Grunwell, 1995) and delays and disorders not linked to the cleft condition. For example, Salas-Provance *et al*. (2003) examined the early vocalisations of four 15-month-old babies with operated cleft palate vis-à-vis four without cleft palate. They found that the syllables produced by the babies with cleft palate had less phonetic diversity than those of the babies without cleft palate.

However, Chapman *et al*. (2001) found no significant differences in the type and length of syllables produced by 9-month-old children with cleft palate and their age-matched peers. In fact, these two studies differ in at least two important variables: age of subjects at the time of study and status of the cleft. Salas-Provance *et al*. (2003) examined 15-month-olds, all of whom had undergone surgery after 12 months of age; while Chapman *et al*. (2001) studied 9-month-olds with unrepaired cleft palate. Differences in these variables might have resulted in the variations in the results of the two studies, though the differences in the age of the babies at the time of study appear to be a more plausible explanation. Because, given Scherer *et al*.'s (2008) finding that, at six months of age (i.e., pre-surgery), no significant differences were noted in vocalisations between the babies with cleft lip and palate and the control group, and given the fact that all children in early infancy generally have an immature vocal tract and intraoral mechanism that impact infant vocal production (Vorperian *et al.*, 2009), it can be suggested that the effects of the cleft condition on speech development start to be more apparent perhaps after ten months of age, as this is the time when typically developing children reach the canonical babbling stage, which is considered as a significant landmark in a child's speech development (Oller, 2000).

Despite such differences in the findings of individual studies, as noted above, generally, there are indeed significant group differences in early sound development; and, it appears that the group differences that are observed in terms of complexity of early vocalisations are larger than those noted in terms of amount of vocalisation. Hence, the differences noted in early sound development of children with cleft palate may not be explained by amount of vocalisations alone; rather complexity of early vocalisations appears to be a variable that distinguishes the two groups of children prior to palate surgery.

2.3.2. Onset of first words and later speech

The early speech development difficulties noted in children with cleft palate, as Scherer *et al*. (2008) note, often persist although the speech mechanism affected by the cleft is normalised by surgery. As stated above, for example, some of the speech production features (e.g., backed articulatory patterns and compensatory articulations) commonly associated with cleft palate find their root in the pre-speech stages of development. Likewise, the findings of the longitudinal studies conducted on the link between pre-speech vocalisation and later speech and language skills in children with cleft palate by Chapman *et al*. (2003) and Chapman (2004) show that children with more consonants and, specifically, more oral stops in babbling have better speech and language performances by the age of 3. It follows that if the pre-speech vocalisations of a child with cleft palate contain those consonants commonly regarded as vulnerable (i.e., oral pressure consonants) or the most frequent sounds in his/her language, he/she is likely to have a well-developed sound system at a later stage. However, often, this is not the case, as the cleft condition impacts on early speech development and hence on later speech performance.

Consistent with the above interpretation, several studies on early language development (e.g., Chapman, 1991; Broen *et al.*, 1998; Scherer *et al*., 1999 Scherer *et al.*, 1999) have reported that children with cleft palate demonstrate a delay in onset of first words and the development of early expressive vocabulary. For example, Broen *et al*. (1998) compared the early linguistic development of young children with cleft palate to that of typically developing children; and found that the children with cleft palate acquired words more slowly than the control group. An examination of lexical choice in young children with cleft palate during acquisition of their first 50 words (Estrem and Broen, 1989) also indicated that babies with cleft lip and palate used more words having sounds in their sound repertoire than outside their repertoire; and, compared to their non-cleft peers, children with cleft palate produced more words starting with plosives; and tended to attempt more words beginning with nasals, glides, approximants and vowels.

In general, since most of the studies carried out on speech and language development in babies and young children with cleft palate are essentially based on comparative data from children with cleft palate and those without cleft palate and their findings represent group results, they often fail to account for individual differences. Nevertheless, they have shown that a cleft generally impacts on pre-speech vocalisations and may also influence early words production and later speech performance. This highlights the relationship and importance of pre-speech vocalisations to later speech and linguistic skills in individuals with cleft.

The heterogeneity of children with clefts often makes it difficult to control variables and thereby determine relative effect of each factor on speech development. This, coupled with the linguistic diversity, in turn, is a constraint in making generalisations regarding patterns of speech development in children with cleft palate as a whole (Howard, 2004).

2.4. Phonetics and phonology

Witzel and Vallino (1992) outlined the speech production difficulties that are attested in cleft population as relating to (1) the structure and function of organs of speech, (2) hearing, and (3) the anatomy and function of the brain. The accuracy of speech production is constrained by the child's perception of what is to be produced and the child's anatomical capability to produce what is perceived. As described in the preceding sections, the literature generally suggests that in early infancy, some children with cleft palate demonstrate a number of linguistic and phonetic deficits, e.g., limited sound inventories, restricted vocabulary, and the emergence of compensatory articulation patterns (Estrem and Broen, 1989; Scherer, 1999; Salas-Provance *et al*., 2003; Chapman *et al*., 2003; Scherer *et al*., 2008). Several studies, most of them based on English, have described the effects of a cleft on speech production both in different individual speakers and in terms of their similarities and differences across languages. Most such descriptions, particularly those carried out before the 1980s, have followed the traditional view of categorising speech production associated with cleft palate as ‘articulation disorders’. However, linguistic development and articulatory constraints are closely related and speech production patterns are the result of a child’s reaction to the cleft interacting with their own phonological development (Chapman and Hardin, 1992; Chapman, 1993; Harding and Grunwell, 1996; Harding-Bell and Howard, 2011). Grundy and Harding (1995:337) classify and define ‘pure articulatory disorder’ and ‘pure phonological disorder’ as follows:

> [A speech production difficulty is considered] pure articulation disorder where a child substitutes non-native speech sounds for one or more of their native phonemes but in one-to-one correspondence their native phonological system and therefore with no disruption to their ability to signal meaning differences. [Whereas] pure phonological disorder [occurs] where the child is physically able to articulate all of their native speech sounds but does not use these sounds appropriately in their speech, resulting in reduced ability to signal meaning differences.

The authors also discuss the notion of an ‘articulatory disorder with phonological consequences’, where the substitution of non-native sounds affects one’s native phonology and hence disrupts their ability to signal meaningful differences.

With the increase of understanding of the relationship between phonological development and articulatory and perceptual constraints, the phonological approach to speech and language development in children with cleft palate has received growing attention. For example, McWilliams *et al*. (1990) note the importance of both phonetic and phonological perspectives. Howard (1993) also suggested the involvement of both phonetic and phonological dimensions in speech difficulties related to cleft palate. However, despite the growing recognition of the phonological perspective, the long-standing tradition of approaching cleft palate speech from a solely phonetic perspective persists (Chapman and Willadsen, 2011). McWilliams *et al*., (1990), for example, highlight that if the speech difficulties in individuals with cleft mainly reflect the structural disorder, the difficulty producing speech sounds should be phonetic in nature. Moreover, Witzel (1995), recognizing the phonological influences on speech production in individuals with cleft palate, reinforced the articulatory approach as more helpful and easier to identify causation than a phonological perspective.

In contrast, Morris and Ozanne (2003) state that many of the ‘cleft’ speech characteristics could be viewed as being more phonological than articulatory in nature, partly because they often affect more than one segment in any given place or manner of sound class; and in part because they can affect segments not considered difficult for individuals with cleft palate (e.g., nasals, liquids). A related but somewhat different view is reflected by Chapman and Hardin (1992) and Harding and Grunwell (1996), who contend that cleft-related speech should not be considered as an articulatory disorder; nor as a phonological disorder, but as an articulatory disorder with phonological implications, which is consistent with Grundy and Harding’s (1995) definition of an ‘articulatory disorder with phonological consequences’. For example, if a child with a cleft produces /p/ and /b/ as [p̃̇], and if such a realisation is a direct result of the cleft condition, then this speech production difficulty is regarded as an articulatory problem with phonological consequences, as the substitution of [p̃̇] for /p/ and /b/ disrupts the child’s ability to signal the differences between the two phonemes (i.e., /p/ and /b/).

The terms used in the cleft literature to refer to aspects of cleft palate speech vary, leading to further confusions. In the literature, it is not uncommon to come across ‘articulatory’ and ‘phonetic’ being used interchangeably; and, in some cases, one subsuming the other (often phonetics/articulation subsuming phonology). McWilliams *et al*. (1984:232), for example, outlining the components of speech difficulties in the cleft population, wrote that ‘the articulatory problems of people with cleft palate may involve phonetics, phonology, or both.’ In contrast, McWilliams *et al*. (1984) and Stengelhofen (1989) commented that some authors use the general term ‘phonology’ to include both articulatory and phonological aspects. Shriberg (1982) suggested that the term ‘phonological disorder’ be used to replace ‘articulation disorder’ for it is more generic. This controversy is perhaps due to the long-standing way of treating phonetics and phonology as separate, largely autonomous, components of linguistics. Contrary to this position, these days, the two levels of speech production have been recognised as highly interdependent and often inseparable (Ohala, 1997, 2005). Nonetheless, Stengelhofen (1989) suggested that if the articulatory level is considered as the principal foundation, as it were the building block for signalling the phonological contrasts essential to meaningful speech, it is crucial that it is studied separately. Howard (2011) also highlights the importance of doing analysis at the phonetic level, as a prerequisite to phonological analysis.

Moreover, several authorities (e.g., Grunwell, 1988; Chapman, 1992; Chapman and Hardin, 1992; Howard, 1993; Grundy and Harding, 1995; Harding and Grunwell, 1996; Russell and Harding, 2001; Chapman and Harding, 2002; Howard, 2004; Harding and Howard, 2011) also stress that, since the inadequacies of a deficient or inefficient articulatory mechanism may impact upon the development of the phonological system, the phonological aspect should not be ignored. In fact, the speech production features observed in individuals with cleft palate can be better explained and predicted and receive better treatment only with the input of both phonetics and phonology. In the following sections, phonetic and phonological characteristics of speech output of individuals with cleft palate will be discussed.

2.4.1. Articulation

Patterns of speech production in individuals with cleft palate have been extensively studied. Such studies described different aspects of cleft palate including articulation, resonance and voice. Individuals with cleft palate are generally at higher risk of atypical articulation; and, as a group, their realisations of speech sounds are different from typical articulation patterns. In general, speech production related to cleft palate is described in terms of nasal emission, nasal resonance and compensatory articulations (Harding and Grunwell, 1998). However, children with cleft differ in various respects such as severity and type of cleft, timing of surgery, absence or presence of syndromic complications; and these differences give rise to speech output differences. For example, the speech production differences often noted in the cleft population arise from the differences in the type of cleft, as a large association exists between the type and extent of articulation difficulties and the type of cleft. Albery and Grunwell (1993) have shown that there are significant differences in patterns of articulation between the different cleft types. For example, in a group of children with a cleft of the soft palate, no atypical realisations were found involving dental, palatal, or velar place of articulation. It is also the case that some speech sounds such as oral pressure consonants are more vulnerable in cleft of the lip and palate than in cleft of the lip only. Albery and Grunwell (1993) suggest that the differences in the effects of dental problems and malocclusion on speech production may account for some of the different patterns of speech difficulties noted in different cleft types. Furthermore, studies have indicated that severity of speech difficulties is often directly related to severity of a cleft (McWilliams *et al*., 1990; and Albery and Grunwell, 1993; Grunwell and Sell, 2001; Chapman *et al*., 2003).

In terms of general characteristics, as stated above, consonants such as oral plosives, fricatives and affricates are particularly susceptible to atypical realisations as a consequence of the cleft palate condition because for these groups of consonants to be correctly produced, the velopharyngeal port/sphincter must be closed in order that the oral airflow does not escape through the nasal cavity, which may not be the case even after surgery (Albery and Grunwell, 1993; Peterson-Falzone *et al*., 2001; Peterson-Falzone *et al*., 2006). While nasals are rarely affected and difficulties with liquids have been reported only occasionally, fricatives, affricates and plosives present the greatest difficulty (Harding and Grunwell, 1996, 1998; Sell *et al*., 1994, 1999; Keuhn and Moller, 2000; Henningsson *et al*., 2008). Obstruents are referred to in the cleft literature as 'pressure consonants'. A summary of the overall findings regarding difficulties of manner of articulation in the cleft population and of the potential range of articulatory atypicalities related to clefts is found in Stengelhofen (1989:26):

- 'changes in breath direction;
- inadequacy of breath support because of air waste;
- weakened fricatives, plosives and affricates;
- audible nasal emission;
- tendency for contacts to be towards the back of the oral cavity;
- preponderance of lamino contacts and imprecise tongue tip movements;
- use of double articulations, e.g., alveolar and glottal;
- secondary articulations such as pharyngealization and velarization;
- frequent use of glottal stop;
- fricatives may be retracted in place to become velar, pharyngeal or glottal.'

The list of cleft type characteristics presented by Harding and Grunwell (1996) includes: dentalization, lateralization/lateral articulation, palatalization/palatal articulation, active nasal fricatives, glottal articulation, absent pressure consonants, and gliding of fricatives/affricates. Most of these atypical speech production features are related to the cleft condition or may be consequences of the other complications resulting from the condition e.g., hearing impairment, poor maxillary growth. For example, Trost-Cardamone and Bernthal (1993) suggest that the development of backed articulatory behaviours may be caused by early hearing loss resulting from chronic otitis media with effusion, although there are other reasons such as the presence of fistulae, (a complication following cleft palate repair leaving an opening) that could give rise to backed articulations. It has also been theorized that the phonation disturbances observed in cleft palate speech are due to laryngeal constriction, caused by excessive laryngeal valve action as a compensatory mechanism for velopharyngeal insufficiency (Witzel, 1991). Moreover, where poor velopharyngeal structure or function or other structural anomalies related to the cleft exist, some sounds (e.g., pharyngeal fricatives and glottal stops) are substituted for other sounds, often for oral pressure consonants in an effort to camouflage or compensate for the effects of the structural and functional anomalies. Such phenomena are referred to as compensatory articulations (Morley, 1970; Trost, 1981a; Persson *et al.*, 2003; Hardin-Jones and Jones, 2005).

One of the defining features of speech segments is the source and direction of airstream used to produce them. Different types of consonants use airstreams differing in terms of source and/or direction. Changes in breath direction will distort target sounds or result in the production of a different sound from the target. In cleft palate speech, due to the cleft condition, the air which is supposed to pass through the oral cavity, for the production of oral consonants, may inappropriately escape into or through the nasal cavity, resulting in inadequacy of breath support and hence weak articulation of most oral pressure consonants. Misdirection of airflow generally does not happen with vowels or approximants as they do not need the build-up of air pressure necessary for pressure consonants and perceptually they are still often acceptable with some degree of nasalisation. Inappropriate air escape during consonant productions may produce audible nasal emission, hypernasality or nasal turbulence, which are defined and discussed in detail in Chapter 6. A conscious or unconscious attempt to avoid or cover up such speech production effects may also lead to compensatory articulation (Hutters and Brøndsted, 1987).

Compensatory articulatory habits include using a soft voice that uses less breath pressure, weakly articulated consonants, retracted articulations, double articulations, lateralized articulations, and fricative gliding (Hutters and Brøndsted, 1987; Harding and Grunwell, 1998, Trost-Cardamone, 1990, 1997; Persson *et al*., 2003; Howard, 2004; Hardin-Jones and Jones, 2005; Russell, 2010). Hutters and Brøndsted (1987) proposed a framework of ‘active’ and ‘passive’ strategies. ‘Active’ strategies are speech production features, such as double articulations and backed realisations, resulting from a compensatory strategy aimed at compensating for the effects of the cleft, and to this end they substitute other sound segments for particular targets. If no compensation is made for the effects of the cleft, atypical speech production features such as hypernasality, hyponasality, audible nasal escape, nasal turbulence and weak articulation of oral pressure consonants may be heard (Grunwell and Sell, 2001). Such articulatory adaptations are referred to as ‘passive’ cleft-type speech characteristics. Passive articulatory strategies use a consonant range restricted to sonorant consonants (i.e., nasals, glides and liquids) and a non-oral glottal fricative [h] (Harding and Grunwell, 1996). The realisation of /b/ as [g] and /d/ as [n] are examples of ‘active’ and ‘passive’ compensatory articulations respectively. Passive compensatory strategies restrict the child’s phonetic inventory, which in turn means that they restrict phonological contrasts essential to intelligibility. Hence, compensatory strategies are generally designed to maximize the range of meaningful consonantal contrasts (Harding and Grunwell, 1998). Studies (e.g., Golding-Kushner, 1995; Harding and Grunwell, 1998; Sell *et al*., 2009) have shown that the active characteristics do not change spontaneously (without speech and language therapy) following surgery and are not always readily amenable to therapy, indicating that active and passive speech behaviours require different speech therapy approaches.

Golding-Kushner (1995) also distinguished between obligatory and compensatory developmental articulatory patterns. Obligatory effects are due to anatomical anomalies and often are not responsive to therapy until the structural anomalies are corrected, while compensatory strategies are employed by individuals with cleft palate to minimize the consequences of the structural anomalies and maximize intelligibility; they include realisations that are the closest approximation to a sound in the presence of structural anomaly (e.g., [ɟ] for /d/), which may or may not resolve when the physiological anomalies are corrected.

Harding and Grunwell (1998) suggest that some aspects of speech production in cleft children might be typical developmental realisations or, alternatively, reflections of atypical speech production processes which are not specifically associated with the cleft condition. It is essential to distinguish such features from those speech production features related to the cleft condition, in order to plan intervention. Developmental realisations are those patterns of speech production regarded as typical relative to a child’s age and stage of development.

Many of the aforementioned phonetic properties and patterns related to cleft palate are generally considered to be universal; however, although less researched, there are also cleft speech characteristics that are language specific (Hutters and Brøndsted, 1987; Brøndsted *et al.*, 1994; Henningsson *et al*., 2008; Chapman and Willadsen, 2011). Moreover, as noted above, while most of the compensatory strategies used by speakers with cleft palate appear to be due to an attempt to facilitate phonological contrast, some others have phonological consequences (Howard, 1993; Grundy and Harding, 1995; Harding and Grunwell, 1996; Harding and Howard, 2011). The following section is devoted to the discussion of the phonological consequences of cleft palate.

2.4.2. Phonology

The potential articulatory effects of cleft palate are fairly well understood; however, the impact of the anatomical and functional limitations on the phonological system is less known and researched (Chapman and Willadsen, 2011). In addition to the realisation of /p/ and /b/ as [p̰̈] discussed earlier, examples of articulatory constraints on phonology could be the consequences of reduced intra-oral pressure and backed articulatory patterns commonly observed in the speech of individuals with cleft palate. Reduced intra-oral pressure and increased nasal resonance may give rise to nasal realization of voiced plosives /b d ɡ/ as [m n ŋ], which can seriously impact on phonological development. Likewise, backing of alveolar consonants may give rise to a loss of contrasts between, for example, /t/ and /k/, and /d/ and /ɡ/. This might be because the child is aware of the importance of the phonemic distinction but is unable to attain the requisite articulatory position for physiological reasons (Hewlett, 1990); or alternatively because he/she is unaware of the phonological differences in the first place, indicating difficulties with the linguistic system, which is therefore not directly related to the cleft condition.

Some authors (e.g., McWilliams *et al*., 1984, Milroy, 1985; Chapman, 1993) note that the phonological difficulties observed in individuals with cleft palate are linguistically based and reflect difficulty with the orderly patterning and representation of the sound system within a language, as phonology straddles the phonetic level and other levels of language. It has further been suggested that phonological difficulties may be part of the overall delays in expressive language often reported for children with cleft palate (Nation and Wetherbee, 1985; Chapman, 1993; D'Antonio and Scherer, 1995; Morris and Ozanne, 2003; D'Antonio and Scherer, 2008). Grunwell and Sell (2001) pointed out the possibility that the characteristics of cleft palate speech are phonetically a natural result of the condition while being developmentally and phonologically atypical.

Atypical phonological features identified in cleft speech include: stopping, backing, deletions of final consonants, syllable reduction, initial consonant deletion, nasalization, velar assimilation, glottal insertion, nasal assimilation, and nasal preference (Powers *et al*., 1990 Powers *et al.*, 1990; Chapman and Hardin, 1992; Chapman, 1993; Grunwell and Harding, 1995; Morris and Ozanne, 2003). Different classifications of cleft-type characteristics have been proposed, such as Morley's (1970) Group A and B speech features; Hutters and Brøndsted's (1987) active and passive strategies; Trost-Cardamone's (1990) Category I and II; and Golding-Kushner's (1995) compensatory, obligatory and developmental speech features. However, none of them is expressed in relation to their potential impact on the development a phonological sysstem. In a longitudinal study of pre-speech and speech development in different groups of children aged between 1;6 to 13;0, Harding and Grunwell (1998) have proposed a phonologically based classification system for the observed cleft palate speech patterns. In this classification, following Hutters and Brondsted's (1987) notion of active and passive strategies, atypical speech realisations were further categorised within a phonologically based framework of cleft-type processes, because most articulatory effects affect groups of consonants.

Accordingly, alternative realisations (including non-English consonant realisations, e.g., /s/ to [x]) that are considered to be actively produced so as to signal phonological contrast were classified as active processes. Thus, a strategy was identified as a cleft-type phonological process, if it systematically affected more than one consonant target and these targets were of related phonological features. In contrast, passive realizations do not change the articulatory pattern for the intended consonant but are accompanied by the effects of the affected intra-oral pressure, which include hyponasality, hypernasality and nasal emission. Hence, realisations of /b d ɡ/ as [m n ŋ] constitute a passive process.

2.5. Cross-linguistic differences

Published studies on patterns of cleft-related speech production for other languages than English include Van Demark (1974) on Danish; Landis and Thi Thu Cuc, (1975) on Vietnamese; Ainoda *et al*. (1985) on Japanese; Hutters and Brøndsted (1987) on Danish; Wu *et al*. (1988) on Mandarin; Sell and Grunwell (1990) on Sinhala; Stokes and Whitehill (1996) and Gibbon *et al*. (1998) on Cantonese; and Shahin (2006) on Arabic. Nevertheless, cross-linguistic data on characteristics of cleft palate speech are still limited. Van Demark (1974), in what was possibly the first comparative study, reported on the relationship between velopharyngeal closure and articulatory abilities in Danish and American children with cleft palate. Other than this study which is on speech characteristics, there are only two studies which are explicitly termed cross-linguistic studies. These are the Eurocleft Speech Project (Brøndsted *et al*., 1994), and the ongoing Scandcleft Speech Project (Lohmander *et al*., 2009). Both are studies of treatment outcome.

The Eurocleft study aimed at devising a research protocol that would provide comparable data on the speech of children from five European language backgrounds, namely Danish, Dutch, English, Norwegian and Swedish. To develop the protocol, the research group set up an analytical framework which took account of the phonetic features of the languages and the potential impacts that the palatal clefting has on the realisation of these phonetic targets. Based on the findings and models stating that certain speech characteristics of cleft palate, particularly active compensatory strategies, are associated with the structural anomalies (Hutters and Brøndsted, 1987; Hewlett, 1990; Trost-Cardamone, 1990) and are universal (Sell and Grunwell, 1993), the study hypothesised that individual speakers of the languages in the study, with consonants in common, may utilise similar articulatory processes to overcome the impacts of the same structural limitation.

The phonetic framework established consisted of a pattern of 21 atypical realisation categories, which were grouped into five clusters: *nasal air flow*, *glottal realizations*, *alveolar deviations*, *sibilant deviations* and *others*. Speech features included under the cluster of nasal air flow are nasal emission, nasalisation, nasal snort, nasal realisation and nasal fricatives. Glottal productions included glottal realizations and glottal reinforcement. Articulatory features such as backing, palatalization, retraction and fronting were categorised as alveolar deviations, while palatalization, retraction, fronting, lateral [s], and [s]-like deviations were classified as sibilant deviations. Atypical realisations which were not phonetically defined in respect to the phonetic features of target consonants were categorised as 'others'. These realisation patterns include labial deviation, palatal fronting of velars, post-velar realizations, silent articulation of [f], and cluster realizations. In addition, the authors stated that the devising and validation of the phonetic framework for the description of cleft palate speech not only has produced further evidence that the phonetic characteristics of cleft palate speech are universal, but also confirmed that they can be identified irrespective of the language of the cleft palate speaker and the language of the analyst.

However, a limitation of a cross-linguistic study limited to Northern European languages is that it lacks data on individuals with cleft palate speaking languages belonging to other language families, which have different phonetic and phonological features. What has been reported for individuals with cleft palate speaking Indo-European languages, in which most speech sounds are produced on a pulmonic egressive airstream, may not hold true for those speaking Khoisan languages of Africa, for example, which are known for their clicks. Given the cleft condition, which affects the aerodynamics of speech production, individuals with cleft palate from the two language families (i.e., Indo-European and Khoisan) would presumably employ different strategies to deal with the speech production difficulties arising from the cleft condition. As a result, unshared and shared speech sounds may be realised differently by individuals with cleft palate from the two language families.

Moreover, individual languages vary in terms of the distributional patterns of their speech sounds, which also determines the realisation of individual sounds in different contexts. Such differences exist even among languages that have a genetic relationship; and hence one would anticipate that the possible impact that a cleft palate may have on speech production would differ from language to language as well. For example, high vowels, requiring tighter velopharyngeal closure, are more vulnerable to hypernasality than are low vowels (Moon *et al.*, 1994; Kuehn and Moon, 1998; Bae *et al.*, 2007; Henningson *et al*., 2008), indicating the need to control a vowel sample for the height feature, which may otherwise compromise comparison between speech features of different languages. Additionally, cross-linguistic differences in the number and frequency of occurrence of nasal vowels, nasal consonants, and contrastive nasalized vowels are also critical variables that need to be considered, as studies of typical speech productions (e.g., Solé, 1992; Leeper *et al.*, 1992) have shown significant cross-linguistic differences in nasalance scores resulting from differences in these variables (Henningsson *et al*., 2008). Moreover, as discussed in Chapter 12, linguistic features such as gemination and distributional pattern of sounds produced using different airstream mechanisms may result in differences in the speech output of individuals with cleft palate with different linguistic backgrounds.

Such linguistic variables are not limited just to vowels and consonants but languages also vary in terms of prosodic features. Studies have shown the influences of suprasegmentals on cleft palate speech. For example, Stokes and Whitehill (1996) reported a rather high rate of initial consonant deletion in the speech of seven Cantonese-speaking children with operated cleft palate, which the authors attributed to the possibility that the children were using tone rather than consonants to signal lexical contrasts.

The languages included in the Eurocleft Speech Project are related and rather similar with regard to their phonetic characteristics. However, as Hutters and Henningsson (2004) remarked, the selection of common consonants across the languages was made on the basis of phonetic criteria in the broad sense of the word and may even have been based on phonological considerations. Another limitation of the study is that it is hypothesised that individuals with cleft palate may employ similar articulatory processes to avoid the effects of the ‘same defect’, while, as noted above, it is an established fact that individuals with cleft palate are heterogeneous (Hutters and Henningsson, 2004).

The Scandcleft speech project (Lohmander *et al*., 2009) involved five different languages, namely Danish, English, Norwegian, Swedish (Germanic languages) and Finnish (a Finno-Ugric language) focusing on the production of pressure consonants and nasal resonance on vowels. The critique by Hutters and Henningsson (2004) indicated that, as was the case in the Eurocleft study, the phonetic and phonological differences of the languages included in the Scandcleft project presented methodological challenges. For example, /b, d, g/ are more or less voiced in all Germanic languages; but they are unvoiced in Danish; and Finnish /p, t, k/, the only stops in the language, are phonetically unvoiced, unaspirated, and fortis in the strong position considered in the speech materials. Such variations in phonetic features across languages clearly limit the amount and type of data to be sampled for cross-linguistic comparative purposes, which in turn impacts on the reliability of the results to be drawn. The speech samples developed for this study, however, attempted to control the effect of vowel height on the velopharyngeal closure force by using one high vowel in the context of a pressure consonant in singleton words (Lohmander *et al*., 2009).

Ideally, to compare speech outcome data from different languages, the influence of language needs to be eliminated, that is, the speech sample should be constructed based on phonetic features shared by all the languages (Hutters and Henningsson, 2004; Henningsson *et al*., 2008; Lohmander *et al*., 2009). While this is a theoretically desirable basis for valid cross-linguistic comparison, sampling of shared phonetic stimuli only may limit the number of possible speech sounds sampled in a given language, since, as discussed above, languages vary in terms of, among other things, the number of sounds and phonetic features. For example, of the twenty-four English consonants, sixteen are pressure consonants as compared to two in Hawaiian (Hutters and Henningsson, 2004), which has only eight contrasting consonants (Ladefoged and Maddieson, 1996). Moreover, Nunggubuyu, an Australian language, has four contrastive variants of the voiceless alveolar stop, namely /t̪/, /t/, /ʈ/ and /t̠ᶴ/ (Ladefoged, 2001), contrasts that do not exist in languages such as English. These cross-linguistic differences in the number and phonetic features of consonants that are vulnerable to the cleft condition result in differences in the speech output of individuals with a cleft speaking different languages, indicating that individuals with cleft palate with different language backgrounds may need to be evaluated differently in order to determine the quality of their speech (Henningsson and Willadsen, 2011). Such linguistic variables, apart from constraining cross-linguistic comparisons, also challenge attempts to develop a universal system for reporting speech outcomes in individuals with cleft palate. Despite the challenges, it has been recognized that it is essential to continue to work with individuals speaking languages other than English and thereby improve techniques of management of speech difficulties related to the cleft condition, as speech assessment and treatment is crucial for this population.

2.6. Summary

This chapter has dealt with the development of the sound system; the relationship between this sound system and later speech in children with cleft palate in comparison with typically developing children; key features of speech production in children with cleft palate, and with issues in cross-linguistic studies of speech output associated with cleft palate. The review has shown that, in typical speech development, there is continuity between infant vocalisations and later speech; and that it has become apparent that early and later speech can be predicted from aspects of pre-speech vocalisation. Similarly, studies have indicated that the 'cleft-type' speech characteristics find their roots in the pre-linguistic sounds produced by infants with cleft palate. The review has also demonstrated that there are quantitative and qualitative differences between speech development in children with cleft palate and typical speech development.

The chapter has considered the phonetic and phonological features commonly observed in individuals with cleft palate. The articulatory features related to cleft palate are essentially attributed to the structural and functional anomalies caused by the cleft condition. These articulatory difficulties have phonological consequences as well. Moreover, the chapter has reviewed cross-linguistic studies which have shown that, despite the challenges, it is not impossible to use data of speakers of different languages and compare speech outcome across languages.

As stated at the beginning of this chapter, its purpose has been to review the literature regarding speech and language development in children with cleft palate in relation to that of typical speech and language development, cleft-related speech and cross linguistic similarities and differences cleft-related speech development and speech features associated with cleft palate. The information reviewed led to the questions of how best to assess cleft-related speech, and what the challenges are associated with the assessment of speech production features related to cleft palate, which are dealt with in the next chapter.

Chapter 3: Assessment of cleft palate speech

3.1. Introduction

This chapter presents a review of key literature in the assessment of speech production, with particular emphasis on the assessment of cleft palate speech. As this study employs perceptual and instrumental analysis, reviewing the approaches used in the analysis of speech production in general and cleft-related speech in particular provides information regarding the advantages and disadvantages of the methods to be used. The chapter is divided into two main parts. The first part is devoted to a discussion of perceptual analysis, which includes an account of perceptual rating scales and phonetic transcription, while the second part summarises relevant issues in instrumental speech analysis, particularly in acoustic analysis.

3.2. Perceptual analysis of speech production

Perceptual analysis is a method of describing speech production solely by listening and looking, that is, using visual and auditory perception. Etter (2010) states that an assessment is regarded as 'perceptual' if it is subjectively based and cannot be calibrated to a constant metric. Perceptual analysis of speech production involves procedures such as judgments of the overall rating of speech production ability, qualitative description of realisations of speech components (e.g., as atypical consonant realisations, hypernasal speech, creaky voice, etc.) and rating intelligibility.

3.2.1. Why perceptual analysis?

Perceptual analysis typically forms the basis of speech assessment in the clinical context (McWilliams *et al.*, 1990; Sell *et al.*, 1999; Lohmander and Olsson, 2004; Sell, 2005; Sell *et al*., 2009; Howard and Heselwood, 2011; Howard, 2011). At a time when objective measurements of different aspects of speech production are possible, one might wonder why researchers and clinicians continue to use perceptual analysis, which is a less objective endeavour than instrumental analysis. The main reason is because in spoken communication what matters most is what we hear, not what an instrument captures; and hence there is no better source of information on how speech sounds to us than our perception (Howard and Heselwood, 2011). As Howard and Heselwood (2002a:47) observe:

> First, [perceptual analysis] completes the bridge between the speaker and hearer in the sense that, without perceptual judgements, we are dealing with phenomena devoid of communicative value. We don't speak palatograms or hear spectrograms….Second, it engages us more fully with the data so we are less likely to miss significant details and more likely to detect possible patterns.

The most important first step in the assessment of atypical speech is to find out which aspects of speech are affected and to what extent the affected speech components impact on how the speech is perceived by others. This implies that, as Kuehn (1982:518) points out, 'in a sense, a speech disorder does not exist until it is perceived by a listener'. The management of speech difficulties begins with the recognition of the extent of the difficulties. In the assessment of cleft palate speech, perceptual analysis is used to examine and describe the type and extent of speech difficulties, determine the need for surgery, the appropriateness and efficacy of speech intervention, and to plan, execute and compare among different therapeutic procedures.

3.2.2. Types of perceptual analysis

The kind of perceptual analysis procedure to be used is mainly determined by the aim of the analysis and the aspect of speech to be assessed. Speech assessment may be done for clinical or research purposes. In either case, the goal of the assessment may be to explore the possible impacts of a structural or functional atypicality that gives rise to a perceived speech production difficulty. This can be done by analysing how speech sounds are realised, or by looking into the relationship between articulatory performance and level of speech intelligibility. Alternatively, the evaluation may aim to explore a specific feature such as level of nasal emission or of any other atypical pattern of nasal resonance and airflow, and of voice qualities. The perceptual assessment of any of these aspects of speech production involves either the use of phonetic transcription or some kind of rating scale (Howard, 2011). In the sections that follow, accounts of perceptual rating scales and phonetic transcription will be given in turn.

3.2.2.1. Perceptual rating scales

Perceptual rating scales, in speech assessment, estimate the degree or severity of specific speech characteristics such as hypernasality or intelligibility. There are several methods available for speech assessment using perceptual rating scales. These include descriptive category judgements such as *mild*, *moderate* and *severe*, equal-appearing interval scaling (EAI), direct magnitude estimation (DME), and visual analogue scaling. EAI scaling is a measure having an arbitrary zero point with further numbers placed at equal appearing intervals (e.g., 0-1-2-3-4-5). In this scaling method, listeners assign a number corresponding to an interval on the scale to the aspect of speech being investigated. Another type of scale is direct magnitude estimation (DME). This procedure can be administered with or without a standard speech sample. When it is used with a standard, the investigator assigns a number to a speech sample that serves as a reference on which other judgements will be based; listeners are asked to rate all subsequent stimuli in relation to the speech sample assigned as a standard. By contrast, when DME is used without a standard speech sample, listeners assign a number themselves to the first speech sample presented to them, and they rate all subsequent speech samples with numbers that are in proportion to the first rated sample. Visual analogue scaling (VAS) is another perceptual procedure, in which listeners place a mark, in proportion to the perceived magnitude of each stimulus (e.g., an attribute of speech), along a straight line with constant and predefined extremes of the attribute being measured (Wewers and Lowe, 1990; Kreiman *et al.*, 1993; Eadie and Doyle, 2002). For example, if the degree of atypical nasal resonance in individuals with cleft palate is to be assessed using VAS, the magnitude ranges along a continuum from *normal* to *severe*.

In the literature, there is a great deal of disagreement as to which of the many rating scales and procedures are best suited to evaluate which aspects of speech production. This is because the choice of a procedure is essentially dictated by the nature of the perceptual dimension to be assessed, or by the type of analysis (e.g., qualitative or quantitative) to be carried out. For example, for quantitative analysis, some authors choose VAS over EAI scales, because the interval size of an EAI scale may not actually be equal in all continua (Maier *et al.*, 2010). In general, in the assessment of cleft-related speech, rating scales are often used to assess parameters such as nasal emission, facial grimace, nasal resonance, phonation and overall articulation performance. However, they do not provide specific information about the realisation of individual target segments, or patterns of speech production, nor do they show how articulatory improvements occur (e.g., after a course of therapy) (Sell and Grunwell, 2001). Such information can be best obtained using phonetic transcription, which will be discussed in the following section.

3.2.2.2. Phonetic transcription

Phonetic transcription, the second commonly used method of perceptual speech assessment in the clinical context, consists of a system of symbols used to represent information regarding speech production and auditory perception. Ordinary orthography is insufficient for this purpose and hence irrelevant for speech analysis (Ball, 2006). It has been recognised that transcription is an essential clinical and research tool forming a vital source of data for analysis, interpretation, decision making, and dissemination of results (Ball and Rahilly, 2002; Lohmander and Olsson, 2004; Sell, 2005; Heselwood and Howard, 2008; Howard, 2011). An important distinction in terms of transcription types is that between systematic versus impressionistic transcriptions (Abercrombie, 1964). Ladefoged (1993) notes that a systematic transcription is one that systematically (e.g., in terms of contrastive and non-contrastive variations) represents different aspects of speech production based on prior information about the language or, in the case of clinical data, the speech production of the individual speaker. In other words it is a ‘phonological’ transcription. In contrast, an impressionistic transcription is one that is made without such prior information about a language or the speech production of the individual speaker—the kind of transcription made by a speech and language therapist, as far as possible without preconceptions, listening to the speech production of an individual speaker prior to carrying out a phonological analysis. Impressionistic transcription is also made when transcribing the speech of a child and is the preferred type of transcription for clinical data (Buckingham and Yule, 1987; Ball and Local, 1996). Impressionistic transcription is necessary in the clinical context because every individual’s speech output is different, even though the overall nature and pattern of different speech difficulties may be predictable to some extent. There are further differences within systematic transcriptions, which will be discussed in the following subsection.

3.2.2.2.1. Types/levels of transcription

The first distinction among systematic transcriptions is that between a simple and a comparative use of particular symbols (Ladefoged, 1993). A transcription that uses the ordinary letters of the roman alphabet such as [a] and [r] is referred to as simple, whereas the one that uses more unusual symbols, such as [ɑ, ɒ, ɐ] [ʀ, ɹ, ɾ], to convey more phonetic detail, is called comparative (Ladefoged, 1993). Once the phonological system of a language and/or an individual speaker is known, depending on the purpose of the analysis, a choice between ‘broad’ and ‘narrow’ transcriptions is made. The most widely used type of broad transcription is a *phonemic* transcription, containing the minimum amount of phonetic detail required to differentiate one phoneme from another. In this transcription system, information about allophonic differences is not accounted for, but is extracted from the rules of phonological systems (Heselwood and Howard, 2008). A narrow transcription, also referred to as *phonetic* transcription, is one that shows as much phonetic detail as one needs for a certain purpose, either just by employing more specific symbols and diacritics or by also representing some allophonic variations (Ladefoged, 2001). Ball and colleagues (Ball *et al.*, 1996; Ball and Kent, 1997; Ball and Müller, 2006) have underlined that a transcription that is restricted to the symbols used to record typical allophonic variations may lead to inaccurate recording of atypical realisations. Therefore, for clinical purposes, a narrow transcription cannot be limited to typical allophonic variations.

3.2.2.2.2. Type and amount of speech sample to be transcribed

Different suggestions have been proposed in relation to the type and amount of speech sample that should be transcribed for clinical analysis. Regarding the type of data, the literature suggests that in order to evaluate frequency and consistency of atypical realisations across different speech situations, a detailed and comprehensive speech sample is needed, but in reality most clinical assessments are based on a single-word sample, often elicited using a picture naming task (Grunwell, 1987; Grunwell, 1993; LeBlanc and Shprintzen, 1996; Sell *et al.*, 1994b, Sell *et al.*, 1999; Kuehn and Moller, 2000; Peterson-Falzone, *et al.*, 2006; Henningsson, *et al.*, 2008). Even though the use of spontaneous connected speech data is supported in research and clinical literature, it has some limitations, for example, when determining the gloss of severely unintelligible speech. For this reason, a single-word confrontation naming sample is often preferred, as it is considered to be the most glossable type of speech sample (Heselwood and Howard, 2008). Besides, analysing sounds in single words can provide information about the speaker's articulatory abilities in less challenging contexts (Howard, 1993). Moreover, using a speech sample gathered through single-word confrontation naming enables us to compare speech performance across individuals or across different time points for an individual speaker.

A connected speech sample taken using a sentence repetition task may also address the issues of glossablity and replicability. In fact, controlling the context as in sentence repetition is a well established, useful and economic method, providing a speech sample to establish whether specific targets can be obtained, and hence to offer information on an individual's phonetic repertoire (Brøndsted, *et al.*, 1994; Sell *et al.*, 1994; Sell *et al.*, 1999; Lohmander and Olsson, 2004; Henningsson *et al.*, 2008). Moreover, Johnson *et al*. (2004) have suggested that sentence repetition tasks can sample continuous speech in a considerably shorter time than a typical conversational approach. However, in a sentence repetition sample, the naturalness of the data will be compromised (Grunwell, 1993; Kuehn and Moller, 2000). Because each type of sample has its individual pitfalls, a combined sample of single words, sentence repetition and spontaneous connected speech will provide a more comprehensive picture of the speaker's overall speech production abilities and difficulties than any single task.

Regarding the amount of speech to be sampled, Crary (1983) suggested that a sample of 50 words was sufficient to display the properties of a child's everyday phonological system. Grunwell (1987) argues that 200-250 words, at a minimum, should be sampled, whereas Lambert and Waters (1989) suggests "75-100 utterances". In fact, Crary's (1983) study focuses on just one approach to speech evaluation, phonological process analysis; and its objective was to evaluate the impact for this approach of increasing sample size from spontaneous speech. Hence, the results may not apply to other sampling formats, or other types of phonological analyses. Grunwell (1987) and Lambert and Waters (1989) suggested that a larger sample than 50 words is needed because it represents a speaker's speech production patterns better and provides more information as to how all target speech sounds and sound combinations are realised in a variety of contexts. In any sample, the major components of speech production that need to be analysed include initiation, phonation, articulation, resonance and prosody. These aspects of speech can be divided into segmental and prosodic elements, which can be transcribed separately or can be represented by combining transcriptions of both segmental and suprasegmental features. The next section deals with the transcription resources that are available to capture and analyse the different facets of speech production just outlined.

3.2.2.2.3. Transcription resources

There are different transcription systems and conventions developed to record segmental and suprasegmental phenomena of speech production. The International Phonetic Alphabet (IPA) and Extensions to the International Phonetic Alphabet

(ExtIPA), latin-alphabet-based systems of phonetic notation, are the most commonly used resources of transcription for research and clinical purposes. The IPA has undergone several developmental changes over the years to include additional speech production features. The latest IPA was revised in 2005. In order to capture and investigate atypical speech production features and processes, ExtIPA was developed and included in *The Handbook of the International Phonetic Association* (IPA, 1999). ExtIPA is a result of several works (Ball, 1988, 1991; Duckworth *et al.*, 1990; Bernhardt and Ball, 1993; Ball *et al.*, 1994). The system was first introduced in Duckworth *et al*. (1990); Bernhardt and Ball (1993) suggested additions and changes. Ball (1991) and Ball *et al*. (1994) provide examples of ExtIPA in use with a variety of atypical segmental and suprasegmental components of speech. The system was last revised in 2002. Another transcription tool is the Voice Quality Symbols (VoQS System; Ball *et al*., 1995), which contains symbols devised to denote specific phonation types such as whisper, creak, ventricular voice, murmur, whispery creak, and for supralaryngeal settings, such as nasalized, palatalized, velarized, which apply to longer stretches of speech than individual segments (Ball *et al.*, 1995; Ball *et al.*, 1999; Ball and Rahilly, 2002).

Heselwood and Howard (2008) provide a detailed discussion of different aspects of speech production and the relevant transcription systems and conventions used to transcribe each aspect of speech production. Moreover, Howard (2011) specifically discusses symbols for the transcription of cleft speech. Prosody is extensively covered both in IPA and ExtIPA. In the section that follows, we will explore the different conditions under which transcription is carried out.

3.2.2.2.4. Mode of presentation and transcription type and condition

The question of how to transcribe involves issues relating to the condition under which a transcription is made, how a transcription is laid out and what level of phonetic detail is required. As to the conditions under which transcriptions are made, they may be carried out live, or from audio or video recordings. Heselwood and Howard (2008) suggest that the first step to phonetic analysis is to make good-quality audio and preferably video recordings from which transcription can be carried out after data collection; or against which live transcription can be checked. In cases where video recording could not be made (e.g., due to ethical reasons, i.e., when subjects are not willing to be videoed), live transcription allows us to capture any articulatory features that may be difficult to detect from an audio recording such as silent co-occurring articulations or slight audible nasal emission as in [p͋], which can be seen but not easily heard (Grunwell, 1993; Harding and Grunwell, 1998b). But, this approach has a number of pitfalls. Firstly, live transcription is unreliable because speech is fast-moving and it is not physically possible to transcribe at the speed of speech (Amorosa *et al.*, 1985). Second, we cannot produce exactly the same speech sound twice, and asking a speaker to repeat an utterance cannot confirm or disconfirm initial perceptions (Ladefoged, 2003, 2005; Heselwood and Howard, 2008). Therefore, making a good-quality recording is necessary.

There has been a long tradition of making audio recordings to analyse, describe and document typical as well as atypical speech production and other levels of language. With the emergence of video recordings, the use of this medium to capture and analyse speech production has been common over the last thirty years. Clearly, making transcriptions from a recording provides the benefit of repeated listening, although the number of times a transcriber should listen to a recording during the transcription has been debated. For example, Amorosa *et al*. (1985) suggested listening as many times as necessary, but Shriberg and Kwiatkowski (1980) and Shriberg *et al*. (1984) recommended not listening to the recording more than three times, because too much sensory exposure can lead to auditory illusions and hence transcriptions resulting from repeated playbacks may be unreliable. Another technique, called analytical listening, proposed by Ashby *et al.*, (1996) allows one to focus on a certain phonetic feature many times. Heselwood and Howard (2008) acknowledge the importance of analytical listening, but also highlight the importance of Shriberg and colleagues' suggestion that the number of listening times needs to be limited.

Transcription layout is another issue that needs to be considered. There are many possible ways to lay out a transcript. Müller *et al*. (2006) note that the way we conventionally write may influence our choice of transforming a text from spoken to graphic medium. That is, for some languages such as English and Amharic, a left-to-right directionality is preferable, while for others such as Arabic and Hebrew, the converse directionality would be a default option. Such somewhat intuitively directed choices of transcription layout are more common in what Ball and Local (1996) refer to as 'working records', which are the initial notes taken during transcription and analysis. Such records contain more detailed information than 'presentation transcriptions', which are particularly made for formal purposes such as publications. Formal transcriptions that are made using IPA, ExtIPA and VoQS conventions follow a left-to-right, top-to-bottom directionality. Even so, there are different ways of presenting transcriptions, depending on several factors, such as visual simplicity, amount and type of data, level of importance. For example, in any layout, certain aspects of the data and the analysis enclosed in the transcript may be given more prominence than others (e.g., presented in bold, underlined, italicised, encircled) such that the reader gives special attention to them (Müller and Damico, 2002; Müller, *et al.*, 2006).

3.2.2.2.5. Limitations of phonetic transcription

The fact that phonetic transcription is subjectively based has over many years made it subject to criticisms. Other potential drawbacks of phonetic transcription relate to the speech processing phenomena called categorical perception and phonemic false evaluation (Buckingham and Yule, 1987). Categorical perception refers to a process whereby listeners assign speech sounds to a particular phonological category or speech sound unit of the target system of their native language, by disregarding those features not required for phonemic categorization. For example, if a native speaker of Assamese, an Indian language, was presented with [e] and [ɛ] vowels, which are contrastive in this language, they would perceive and categorise them as two different vowels. But if an Amharic speaker was presented with the same vowels, they would typically perceive and categorise them as a single vowel, i.e., /e/, as this is the only mid front vowel phoneme that their language has. Such categorical perception leads to a further challenge known as phonemic false evaluation, which is a mistaken placement of speech sounds into one's own internalized phonemic categories, because of the effect of categorical perception. For example, the mid-dorsum palatal stops (Trost, 1981a) commonly noted in the speech of individuals with cleft palate are often misperceived as either /t/, /d/ and /n/ or /k/, /ɡ/ and /ŋ/ by English-speaking listeners due to the constraints of categorical perception imposed by the English language, which only contains alveolar and velar lingual stops.

Phonetic transcription can also be affected by a phenomenon known as the phonemic restoration effect (Warren, 1970), where a speech signal can be synthesized by the brain and clearly perceived as intact even though the acoustic information for a phoneme is replaced by or obliterated by extraneous sound. Such auditory illusions can be influenced by earlier sentential context that offers information about the probability of the missing phoneme (Groppe *et al.*, 2010). For example, if a portion of a recorded utterance is cut from the middle of the recording and presented to us, we tend not to notice the absence of the missing part. Moreover, although hearers perceive speech as a flow of discrete units such as phonemes, syllables, words, and sentences, this linearity is difficult to visually observe in the acoustic form of the speech signal. This implies that, however detailed our transcription can be, we simply cannot capture the complex acoustic information that is derived from acoustic analysis.

Transcribing immature or atypical speech presents further challenges. Sometimes a child succeeds in acquiring immature, inappropriate or atypical contrasts which are not perceptible to adults. These are often termed covert contrasts (Scobbie *et al.*, 1998, 2001; Berti, 2010; Munson *et al.*, 2010). Such sub-phonemic differences are characteristically not noticeable enough to be transcribed using phonetic symbols, but can be captured instrumentally. This phenomenon was first reported by Macken and Barton (1980), who found imperceptible but consistent contrasts in VOT in typically developing children, but has also been widely reported in the literature on atypical speech development and speech production.

Another factor that influences the quality of transcription is the effect of listeners' expectations. Oller and Eilers (1975) argue that knowing the target utterance can have positive or negative effects on the quality of the transcription. Pye *et al*. (1988) suggest that it makes the transcription process easier, while Howard and Heselwood (2002b) indicate that knowing the target form for clinical transcription, where listeners' expectations and actually produced forms may not correspond, has potential drawbacks (e.g., listeners' internal phonetic/phonological representation may bias judgement).

3.2.3. Assessing segmental articulation in cleft palate

The use of perceptual ratings scales of articulatory abilities of individuals with cleft palate were popular, particularly before and during the 1980s (e.g., Van Demark, 1964; Van Demark and Van Demark, 1967; Subtelny *et al.*, 1972; Moller and Starr, 1984; Starr *et al.*, 1984). For example, Van Demark (1964) examined overall articulatory abilities of children with cleft lip and/or palate using direct-magnitude estimation. Van Demark and Van Demark (1967) compared the degree of articulatory difficulties of children with functional articulation disorder (i.e., speech production difficulties whose cause or causes are unknown) and of children with cleft palate using a seven point equal-appearing-intervals scale. Subtelny *et al*. (1972) evaluated articulation in children with cleft palate using categorical descriptions having a six-point scale. In Moller and Starr (1984), articulation of children with cleft palate was rated on an eight point scale; while Starr *et al*. (1984) examined ratings of articulation of children with cleft palate made on a seven-point equal-appearing-interval scale. Turning to more recent research, Lohmander and Olsson (2004), based on a review of 88 articles that appeared in three international journals between 1980 and 2000, reported that 65 of the 88 articles (74%) used interval scales. In nine of them, another method for evaluating articulation was used as well (e.g., percent correct consonants, type and frequency of consonant ‘errors’, or a description of errors). Only 8 articles of the 88 articles (8%) used phonetic transcription. This indicates that, apparently due to the challenges associated with phonetic transcription, there has been a tendency to avoid use of transcription it the assessment and analysis of cleft-related speech. Nevertheless, it is commonly used in the clinical setting, at least by UK cleft speech and language therapists,.

There is a growing acknowledgement of the importance of phonetic transcription in speech assessment in cleft palate (Howard and Heselwood, 2002; Lohmander and

Olsson, 2004; Sell, 2005; Müller, *et al.*, 2006; Henningsson *et al*., 2008; Ball, 2008; Howard, 2011 Howard, 2011; Howard and Heselwood, 2011). Descriptions based on phonetic transcription generally identify and classify typical cleft speech characteristics into sub-categories based on place and manner of articulation: e.g., anterior errors, posterior oral errors, non-oral errors (Harding *et al.*, 1997), or according to speaker strategy: e.g. active and passive (Hutters and Brøndsted, 1987). A detailed account of characteristics of cleft-related speech can be found in Chapter 2.

3.2.4. Assessing resonance and airflow in cleft palate

Resonance refers to the way sound in speech is shaped and propagated as it passes through the pharyngeal, oral and/or nasal cavities. In the assessment of cleft palate speech, a description of the resonance characteristics is important (Kuehn and Moller, 2000 Kuehn and Moller, 2000; Sell, 2005; 1994b, 1999; Henningsson *et al.*, 2008; Lohmander *et al*., 2009), as atypical nasal resonance is one of the primary features that characterise the speech of individuals with cleft palate. Nasal resonance is generally evaluated based on type (hypernasality, hyponasality, mixed hyper- and hyponasality, and cul-de-sac), severity and consistency. Hypernasality refers to a markedly excess amount of perceived nasal cavity resonance during speech. It is particularly noticeable on vowels, glides and sometimes on voiced consonants. Hyponasality refers to decreased or inefficient nasal resonance during speech, particularly during the production of nasal consonants and nasalised vowels (Kummer, 2001; Henningson *et al*., 2008). Mixed resonance is perceived when hyper- and hyponasality co-occur, while cul-de-sac resonance occurs when airflow is obstructed in the pharyngeal or nasal cavity causing a “muffled” speech quality.

For assessing resonance disorders and atypical airflow, rating scales, using descriptive category judgements and EAI scaling, remain the favoured approach (Sell, 2005; Henningsson *et al*., 2008; Lohmander *et al*., 2009). However, there is currently no international standard protocol for rating resonance. For example, for measuring severity of hypernasality, there is a considerable range of scale values used in the literature. Kuehn *et al*. (2001) used a 10-point scale, whereas the assessments and assigned perceptual ratings of hyponasality and hypernasality proposed by Dailey *et al*. (2006) are based on a 6-point scale. Further differences can be found in other assessment protocols and proposals, which include an 8-point scale (McWilliams and Philips, 1979); 5-point scale (Sell *et al*., 2001 Imatomi, 2005); 4-point scale (Henningsson *et al*., 2008); and 3-point (Lohmander *et al*., 2009). Such discrepancies not only limit the ease of comparing speech outputs and outcomes of intervention and comparing different research studies, but also increase the likelihood of poor reliability on the longer scales (Sell, 2005).

Studies have suggested that EAI may not be a suitable technique for the assessment of hypernasality and audible nasal emission, because when listeners attempt to divide a perceptual continuum into equal intervals, there is often a systematic bias to divide the lower end of the continuum into smaller intervals (Berry and Silverman, 1972; Stevens, 1975; Zraick and Liss, 2000; Whitehill, 2002; Baylis *et al*., 2011). These studies recommend the use of direct magnitude estimation (DME) instead of EAI for the evaluation of hypernasality and audible nasal emission. For example, Whitehill *et al*. (2002) compared the validity and reliability of a 7-point interval scale to DME for perceptual judgement of hypernasality in the speech of individuals with cleft palate. They found that DME was more valid and more reliable than EAI. This finding is consistent with the one already reported by Zraick and Liss (2000). Moreover, Baylis *et al*. (2011) compared EAI and DME scaling for rating audible nasal emission and found a higher inter- and intra-rater reliability for the direct magnitude estimation judgments.

Even though DME has repeatedly been shown to be a valid and reliable procedure, only a handful of studies (e.g., Jones *et al.*, 1990; Whitehill *et al.*, 2002) have used it for the evaluation of hypernasality in the cleft population. This is perhaps because as a clinical tool it may be less clear for listeners than EAI and it can be harder to compare data across settings (Whitehill *et al*., 2002; Whitehill and Wong, 2007; Baylis *et al*., 2011). No limitations of DME have been reported other than the perceived complexity of use and the lack of familiarity with this technique among clinicians. It has also been suggested that other techniques, such as paired comparisons and multidimensional scaling may provide more effective alternatives for perceptual ratings of resonance (Whitehill *et al.*, 2002).

Phonetic transcription has also been used to describe atypical patterns of resonance and airflow observed in the speech of individuals with cleft palate. Howard (2011) discusses how these symbols are used to capture these aspects of speech production in cleft speech. The IPA nasal and oral symbols together with the nasal tilde (i.e., [˜]) allow us to distinguish between oral, nasal and nasalised sounds or sounds realised with audible nasal resonance (e.g., /b/ vs. [m] and /a/ vs. [ã] or /b/ vs. [b̃]). Other symbols that are used to transcribe other atypical features of resonance and airflow commonly observed in individuals with cleft palate are found in ExtIPA. For example, [͋] is used to indicate audible nasal escape (e.g., Amharic /səw/ '*man/human*' may be realised by a speaker with a cleft palate as [s͋ə̃w̃]); while [͊] shows a degree of denasalisation of nasal consonants (e.g., Amharic /ajɨn/ '*eye*' may be produced as [ajɨn̄] or [ajɨd]). Moreover, ExtIPA includes symbols for active nasal fricatives [m̥̈ n̥̈ ŋ̥̈], nasal turbulence [s̃], and the velopharyngeal fricative [ʩ].

Despite the controversies outlined earlier about the assessment and analysis procedures, it has become customary to combine perceptual and instrumental procedures for the assessment and analysis of resonance and airflow. Thus, using perceptual assessment along with instrumental techniques, for example, with nasometry, and other instruments that measure aerodynamic data apparently yields a better resonance and airflow analysis (we will return to the discussion of instrumental analysis of resonance and airflow in section 3.3.2).

3.2.5. Assessing voice quality in cleft palate

'Voice quality' has been taken to refer to a wide variety of concepts ranging from those relating to laryngeal settings or a specific phonatory quality such as creaky voice to one that defines the characteristic vocal colour of a speaker, including, for example, pitch and loudness. Abercrombie (1967:91) defines 'voice quality' as 'those characteristics which are present more or less all the time that a person is talking: it is a quasi-permanent quality running through all the sounds that issues from his mouth.' This definition is a basis for Laver's (1980) widely accepted definition of the term, that is, 'the characteristic auditory colouring of an individual speaker's voice' (p. 1).

Voice disorder exists when the characteristic vocal features such as pitch, loudness, and phonation types differs from what is considered to be 'typical' for a given age, gender or cultural group. Voice disorders (including those associated with cleft palate) are assessed using both perceptual and instrumental methods. As is the case with the assessment and analysis of other aspects of speech production, perceptual analysis of voice disorders remains the standard against which instrumental measures of voice are evaluated (Kreiman, *et al.*, 1993; Kent, 1996; Critcher and Pannbacker, 2000; Carding, 2000; Bhuta *et al.*, 2004; Eadie and Baylor, 2006; Stanton *et al.*, 2009). Carding (2000) outlines three types of perceptual assessment of voice quality: auditory perceptual assessment; visual perceptual assessment; and the patients' judgement of their own voice disorder. Auditory perceptual assessment of voice quality involves listening to speech samples and judging the voice quality on various parameters such as overall severity, roughness, breathiness by using different rating scales (as reflected, for example, in The Buffalo III Voice Profile (Wilson, 1987); The Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) scale (Hirano, 1980); and The Vocal Profile Analysis (VPA) (Laver *et al.*, 1991)). Visual perceptual assessment involves the use of instrumental techniques such as indirect laryngoscopy and endoscopy. The third approach to perceptual voice assessment is formalising the patients' opinion of their voice disorder; but there are currently no standardized questionnaires for this purpose (Carding, 2000). Carding and Horsley (1992) note that patients' descriptions of their own voice difficulties can be very valuable to determine how the problems have affected their day-to-day communication.

Phonetic transcription is another approach to perceptual analysis of voice quality. VoQS (Ball, *et al.*, 1995) is a widely recognized tool for the transcription of voice quality. This system was devised based on Laver's (1980) vocal profiling analysis. VoQS offers symbols to indicate airstream types (e.g., [↓] for pulmonic ingressive speech), phonation types (e.g., [W] for whisper), and supralaryngeal settings (e.g., [V^j] for palatalized voice). Clearly, all the stated procedures provide different perspectives on describing vocal function; however, no standardized measure of voice function is currently available (Cavalli, 2011; Kreiman and Gerratt, 2011). Hence, it is unclear as to which of these measures and procedures are best suited to measuring voice quality.

Due to this, it has been difficult for researchers to have a reasonable basis for selecting one or another of the various possible protocols and analysis when designing studies. Kreiman *et al*. (1993) proposed a theoretical framework in order to address the problems of perceptual rating of voice quality. The framework outlines the factors that give rise to the variability in ratings of voice quality, which include, listeners' background and biases and the task used to rate voice. It also addresses the issues of how voice quality can most appropriately be evaluated, the standard for intra- and inter-rater reliability of perceptual ratings and how reliability of judgements and levels of agreement within and among raters might be maximized. Dejonckere (2000) also proposed a protocol meant to lead to better agreement and standardization concerning the methodology for functional assessment of voice disorders, and to make relevant comparisons with the literature possible when presenting or publishing the outcomes of voice assessment and treatment. The protocol involves a multidimensional set of minimal basic measurements suitable for all 'common' voice disorders and includes five different methods: perceptual, videostroboscopy, acoustics, aerodynamics, and subjective rating by the patient. Clearly, such a protocol that utilises a variety of approaches enables us to assess and analyse voice problems more effectively.

In order to devise a valid and reliable protocol, it is important to identify the sources of listener variability in voice quality. Studies have indicated that poor inter-rater agreement is the result of measurement errors related to a variety of factors, e.g., momentary changes in memory, experience with the stimuli, training, rather than true differences in the perception of voice quality (Gerratt and Kreiman, 2001; Kreiman and Gerratt, 2005; Shrivastav *et al.*, 2005; Kreiman *et al.*, 2007; Kreiman and Gerratt, 2011). It is therefore necessary to review the existing methods of voice quality assessment, as these studies have shown that inter-rater reliability is an issue of methodology, not listener unreliability.

3.2.6. Assessing intelligibility in cleft palate speech

Intelligibility has been described as the accuracy with which a listener can decode the acoustic signal of a speaker (Kent *et al.*, 1989; Yorkston *et al.*, 1996; Dagenais *et al.*, 2006; Van Lierde *et al.*, 2011). In the literature, intelligibility often is used interchangeably with understandability (Metz *et al.*, 1985; Hodge and Gotzke, 2007; Henningsson *et al*., 2008) and in contrast with comprehensibility and acceptability. Studies have defined intelligibility in terms of the amount of linguistic units heard correctly (e.g., how many words, phrases, etc), by contrasting it with acceptability which refers to how the listener rates the individual's overall speaking performance; and with comprehensibility, which refers to *contextual intelligibility* or intelligibility when contextual cues such as semantic information, syntactic information, orthographic information, and gestures, and of course speaker and listener shared knowledge of topic are present (Witzel, 1995; Yorkston *et al.*, 1996; Dagenais *et al.*, 1999; Dagenais, *et al.*, 2006).

Beyond this terminological minefield, there are several speaker- and listener-related factors that can affect how well a speech signal is deciphered. Flipsen (1995) and Witt *et al.* (1997) have pointed out that listeners who are more familiar with the speaker may have a better advantage in understanding what is being said. Specifically, parents understand what their children are saying better than a stranger; and siblings may adapt to their brother's and sister's speech more than parents and hence better comprehend it. It is also clear that cues such as the syntactic position of a word and the semantics of other words in the structure maximise the intelligibility of the word. Yorkston and Beukelman (1981) and Sitler *et al.*, (1983) have shown that words are harder to understand in isolation than in a sentence, particularly in atypical speech. Other variables that have been reported to have the potential to impact speech intelligibility significantly include utterance length (Yorkston and

Beukelman, 1981; Wilcox and Morris, 1999), listener experience, listening conditions, speaking rates (Strauss *et al.*, 1988; McWilliams *et al.*, 1990; Tjaden and Liss, 1995; Yorkston, *et al.*, 1996; Witt, *et al.*, 1997; Whitehill, 2002; Walshe *et al.*, 2008), and nonverbal cues such as gestures (Hunter *et al.*, 1991; Munhall *et al.*, 2004; Sueyoshi and Hardison, 2005; Keintz *et al.*, 2007).

As the primary goal of speech is effective communication, speech intelligibility is generally seen as an extremely important measure of oral communication competence. Hence, intelligibility measures provide a reference for how structural and functional impairments of the speech mechanism affect a speaker's ability to communicate effectively (Connolly, 1986; Kent *et al.*, 1989; Sell, 2005). Although the importance of assessing intelligibility in the cleft palate population has well been recognized, the issue as to whether or not it should be reported has been controversial. Dalston *et al*. (1998), for example, suggested that intelligibility should always be reported together with hypernasality, hyponasality, nasal escape, and articulation. This recommendation has, however, been questioned by other authorities (e.g., Witzel, 1991; Sell *et al*., 1994; Sell, 2005), as it is difficult to rate reliably and can be influenced by a number of factors other than the speech features that are being assessed, such as speech difficulties related to problems of hearing, developmental speech immaturities, or the listener's experience of disordered speech. Taking these factors into consideration, Witzel (1991) suggests that intelligibility should be reported only in combination with thorough descriptions of consonant production and nasality. Hirschberg and Van Demark (1997) and Whitehill (2002) recommend that intelligibility needs to be included in a standard speech assessment and intelligibility is one of the parameters included in the Cleft Audit Protocol for Speech-Augmented (CAPS-A) (John *et al.*, 2006a; Sell *et al.*, 2009). Following Whitehill (2002), Henningsson *et al*. (2008) also included *speech understandability* and *speech acceptability* in their recommended list of speech parameters that need to be reported. Understandability is related closely to the notion of intelligibility, while acceptability refers to a different perceptual aspect of speech adequacy (Whitehill, 2002). The speech of an individual may be intelligible or understandable but may not be acceptable.

With respect to the measurement of intelligibility, scaling procedures (such as interval scales) and word identification tasks are the two major methods that are broadly employed (McWilliams *et al*., 1990; Schiavetti, 1992; Whitehill, 2002; Whitehill and Chau, 2004; Hodge and Gotzke, 2007). In scaling methods, the rater estimates the portion of the intended targets that were understood. Despite their limitations in terms of precision and reliability, scaling procedures are used by many intelligibility studies in cleft palate (e.g., Schiavetti, 1992; Flipsen, 2006). Moreover, McWilliams *et al*. (1990) showed that most of the studies reviewed up to that point used EAI scales to measure intelligibility, the majority of them using correlational analysis to examine the relationship between intelligibility and other variables (e.g., articulation). Some of the studies (e.g., Forner, 1983) employed interval scaling to measure intelligibility but examined differences between groups rather than using correlational analysis. Whitehill's (2002) critical review of studies of intelligibility in speakers with cleft palate showed that, of 57 studies reviewed, 27 (47.4%), that is, almost half of the studies, used a rating scale, most commonly an EAI scale.

In terms of word identification tasks, a commonly used approach is a transcription task, whereby listeners are asked to write down orthographically what they understand of the speech stimuli presented to them. The transcribed words are scored as either correct or incorrect relative to the intended words of the speaker and then percentage scores of intelligibility are calculated. Although this approach is considered by some to be valid and reliable (Schiavetti, 1992) and has been used by several intelligibility studies (Whitehill, 2002), its reliability has been questioned by others (e.g., Hustad, 2008). One of its pitfalls is that in order to label a listener's judgement (i.e., transcription of what was said) as 'correct' and 'incorrect', the target utterance needs to be available, which is not always the case in clinical data. Another drawback is that it requires more time than scaling techniques (Hodge and Whitehill, 2010).

A second word identification task often used in intelligibility studies is a multiple-choice task whereby listeners are asked to identify words spoken from a limited set of choices. Using a multiple-choice format, Whitehill and Chau (2004) developed a minimal contrast-based intelligibility test for Cantonese-speaking children with repaired cleft palate. The study was based on phonetic contrasts known to be problematic for individuals with cleft palate. They found that the most problematic contrasts, based on listener choices, were place of articulation of plosives and nasals; and manner of articulation (stop vs. fricative and stop vs. affricate). They also showed that single-word intelligibility could be predicted with 91% accuracy using just three phonetic contrasts (i.e., 'place of initial and final stops and nasals', 'stop vs. fricative', and 'stop vs. affricate'). However, the authors identified two methodological limitations to their study. Firstly, as both anterior and posterior atypical realisations were included into the phonetic contrast of place of plosive and nasal (e.g., stops at both alveolar and velar place of articulation were targeted in the same contrast), the relative contribution of these two atypical articulatory placements to intelligibility could not be determined. Secondly, the error patterns considered were not collected from the subjects, but produced from a literature review. Further, the study could not capture atypical patterns that could not be characterised phonemically (e.g., [p] vs. [p͋]).

Despite the challenges, perceptual speech evaluation is still regarded as the most valuable approach to the evaluation and analysis of speech production of individuals with cleft palate (McWilliams *et al.*, 1990; Sell and Grunwell, 1993b; Sell and Grunwell, 2001; Howard, 2004; Lohmander and Olsson, 2004; Sell, 2005; Peterson-Falzone, *et al.*, 2006; Henningsson, *et al*., 2008; Howard, 2011). It also seems clear that no instrumental technique could effectively replace the use of perceptual judgements. However, several authorities (e.g., Howard and Heselwood, 2002b; Ladefoged, 2003) note that the use of instruments in speech analysis is also of great importance, and this is certainly the case in the analysis of speech production associated with cleft palate (Whitehill *et al.*, 1996; Sell and Grunwell, 2001; Kuehn and Henne, 2003; Gibbon, 2008; Sweeney, 2011; Sell and Pereira, 2011). In the sections that follow, the use of instrumentation in the assessment and analysis of speech production in general and speech production in individuals with cleft palate in particular will be dealt with.

3.3. Instrumental analysis

Instrumental analysis of speech production involves the use of techniques that either allow direct observation of speech production activities or enable us to indirectly infer information about processes of speech production and function of the vocal organs. With advances in speech technology, the efficiency and accuracy of instrumental analysis of speech production has increased. Indeed, although it may sometimes conflict with listeners' perceptions, instrumental analysis provides objective measures of structural and functional dimensions of speech production. Recognizing the importance of instrumental analysis in speech assessment in clinical context, Howard and Heselwood (2011:941) wrote:

> [Instruments] can …tell us what kind of events in the physical world give rise to what we hear, and this information is invaluable for our general understanding of the phonetic structure of speech and also for informing clinical intervention and remediation.

The use of instrumentation has been common practice in the assessment of the speech output of individuals with cleft palate. The study by Lohmander and Olsson (2004) showed that, of the 88 articles, in 52 (59%) of them, instrumental analysis had been employed together with perceptual assessment.

A variety of instruments has been used to study various aspects of speech production of individuals with cleft palate. The following sections will discuss the use of instrumentation in the assessment and analysis of articulation, resonance and voicing/phonation, with particular reference to cleft palate speech. In this review, only acoustic analysis will be treated in detail, as this is the method (in tandem with perceptual analysis) that is used in the present study.

3.3.1. Instrumental analysis of articulation

Techniques used to measure articulatory gestures or movements involve obtaining data regarding timing of the movement of articulators, and the place and manner of articulation. This can be done using direct and/or indirect procedures. A direct method is one that allows a direct visual access to the articulatory anatomy and process.

Direct methods include electropalatography (EPG*)*, nasopharyngoscopy, lateral cephalometric radiography, videofluoroscopy, magnetic resonance imaging (MRI), and ultrasound. Indirect procedures provide inferences through data about the structure and function of the speech production mechanism, and include acoustic analysis, the pressure flow technique, and rhinomanometry. Gibbon (2008) provides detailed explanations of what these techniques are and how they are used in the assessment, analysis and treatment of articulation disorders. For our purpose we will only consider the acoustic analysis, which can be carried out using the audio data recorded for perceptual analysis. Moreover, acoustic techniques require only speech-analyzing software and a computer.

3.3.1.1. Acoustic analysis of articulation

Acoustic analysis measures the physical properties of speech production based on an audio-recorded speech signal using a speech analysis computer program. In other words, it is a computer software based procedure which makes use of a recorded and digitized acoustic speech signal as an input.

Acoustic analysis of consonant articulation essentially involves the examination of the acoustic properties that are associated with place and manner of articulation and voicing. In the case of vowel articulations, the analysis deals with those physical properties which are linked with the horizontal and vertical movements and placements of the tongue and the conditions of the lips.

The acoustic characteristics of vowels are less complex than those of consonants. Kent and Read (2002:105) wrote that '[i]n some respect, the vowels are the simplest sounds to analyse and describe acoustically'. This is the opposite for perceptual analysis, where vowels have been shown to be particularly challenging. Acoustically, vowels are usually characterized in terms of the frequencies of formants.

A formant is a concentration of vocal tract resonances around a particular frequency. In Figure 3.1, formants of the Amharic vowel /a/, as produced by a male adult speaker, are shown as red dots overlaid on the spectrograms.

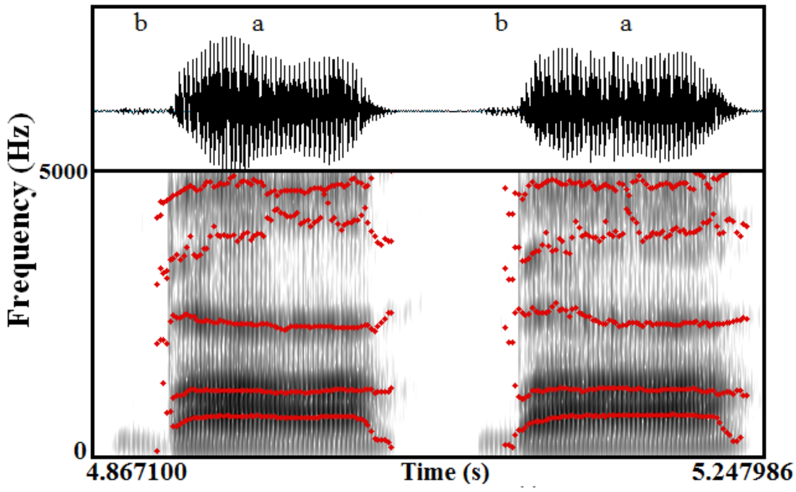


Figure 3.1 Waveforms (upper) and spectrograms (lower) of the syllables /ba ba/ with sustained /a/ vowel, as produced by male adult Amharic speaker. The red dots overlaid on the spectrograms correspond to the formants of the vowel.

It has been recognized that vowel-quality distinctions essentially depend on the first three formants (F1, F2 and F3). F1 corresponds fairly closely to vowel height, and F2 characterises both backness and lip-rounding (Hayward, 2000; Ladefoged, 2003). Figure 3.2 shows F1 vs. F2 vowel plot for seven Amharic vowels. Considering only F1 and F2 may provide a fairly accurate description of vowels of languages such as English and Amharic which do not contrast vowels by lip rounding only. But, in languages such as French, the fact that F2 corresponds to both backness and lip-rounding, makes it difficult to differentiate between, for example, a high front rounded vowel and its unrounded counterpart. Ladefoged (2003) suggests that roundedness can be shown by plotting F1 vs. F3 as well as F1 vs. F2. Another important acoustic parameter used to describe vowels is duration.

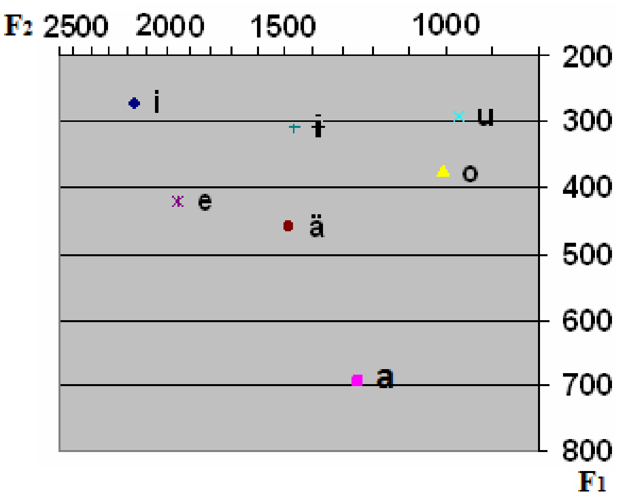


Figure 3.2 A formant chart showing F1 and F2 for seven Amharic vowels. (adapted from Mekonnen, 2007:25). NB: /ä/ was used for /ə/.

The acoustic characteristics of consonants are very varied, and therefore it is difficult to describe all of them with any single set of measures. Although it is sometimes difficult to distinguish between sound classes on the basis of a single set of acoustic measures, it is nevertheless customary and possible to describe the acoustic properties of different consonant classes. A brief account of only the acoustic properties of pulmonic and ejective stops are made here, as one of the chapter of this thesis explores the use of covert contrast in the production of pulmonic and ejective stops.

The articulation of a stop consonant is generally characterised by three successive phases: *closure*, *release*, and *transition*. The acoustic correlate of the closure phase, called the *stop gap* (Kent and Read, 2002), is associated with little or no acoustic energy due to the blocked vocal tract. The stop gap is almost silent for voiceless stops, as the vocal tract is closed up and the vocal folds are not vibrating. For voiced stops, the stop gap often contains a band of very low frequency voiced energy called the *voice bar* (Kent and Read, 2002). In Figure 3.1, this voice energy corresponds to the dark band seen at the beginning of the spectrograms. During the release phase, however, the impounded air escapes, producing a very brief and fast burst. In a spectrogram, the burst corresponds to a friction or a turbulence noise generated as the constriction is released. The release phase may be accompanied by a breathy noise that is generated as air passes through the vocal folds, in which case it is aspirated. Aspiration is one of the articulatory-acoustic features that separate voiceless stops from voiced ones. Of course, they differ in terms of voice onset time (VOT), a temporal acoustic parameter which refers to the time between the release of the stop closure and the onset of the vibration of the vocal folds. While voiced stops have a negative VOT, that is, voicing is initiated before the stop release, the voiceless ones have a positive VOT, that is, the voicing starts after the stop release. Duration of VOT is also a very important acoustic cue for distinction between voiceless oral stops and ejective stops, which is of particular relevance to the present study. During the transition phase, for a prevocalic stop, the vocal tract configuration starts to change from the oral constriction of complete closure to a relatively open shape for the vowel that follows. A syllable-final, postvocalic stop can be released, in which case the acoustic correlate of the release is a brief burst, or unreleased, in which case no burst appears.

Ejective stops share some of the acoustic features (e.g., duration, VOT, release, transition) of voiceless stops. However, since ejectives are produced on a glottalic egressive airstream involving both oral and glottal closure, the sequence of the release of these closures also differentiates one ejective from another. The power of the burst is also another acoustic characteristic of ejectives. As ejectives have high oral pressure, they normally have strong bursts upon release; and compared to plosives, the power of the burst is stronger (Catford, 2001). For example, the waveforms and spectrograms of /t̪/ and /t̪’/, in Figure 3.3, illustrate that /t̪’/ has a stronger acoustic energy and hence a greater release burst amplitude than /t̪/.

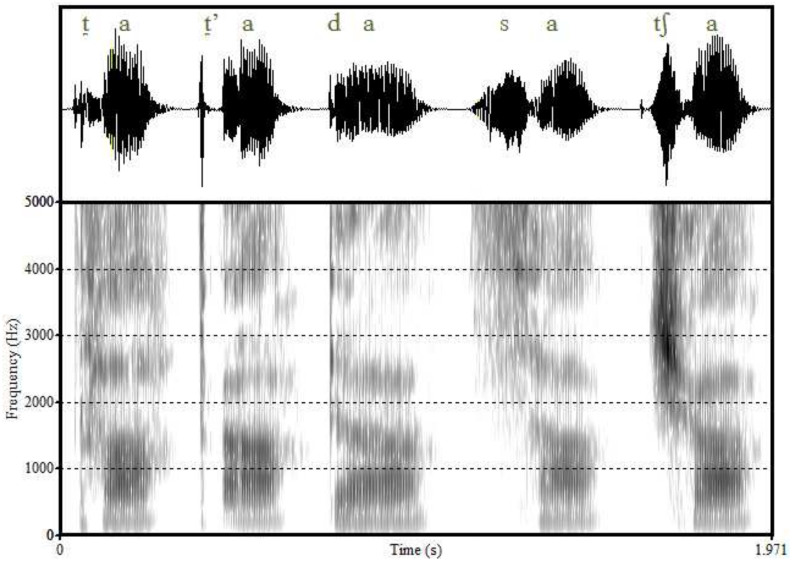


Figure 3.3 Waveforms (upper) and spectrograms (lower) of the syllables /t̪a/, /t̪'a/, /da/, /sa/, and / ʧa/, as produced by male adult Amharic speaker.

Acoustic analysis of articulatory features of cleft palate speech has been used in several studies (e.g., Nord and Ericsson, 1985; Kido *et al.*, 1992; Gibbon and Crampin, 2001, 2002; Casal *et al.*, 2002; Gámiz *et al.*, 2006; Ahlberg *et al.*, 2006). Lohmander and Olsson (2004) showed that, of the 52 studies which used instrumental analysis in their review, 15 used acoustic measurements of various types, spectrography being the mainly used approach to articulatory analysis. For example, Gibbon and Crampin (2001) used acoustic analysis, together with EPG, to investigate place of articulation for /t/ and /k/ targets, which their subject, an English-speaking adult with repaired cleft palate, produced as mid-dorsum palatal stops ([c]). Gibbon *et al*. (2002) also used acoustic analysis combined with EPG analysis to examine the frequency of labial-lingual double articulations occurring for /p/, /b/, and /m/ targets and described the linguapalatal contact patterns involved in these atypical realisations. In another cleft study, Casal *et al*. (2002), acoustic analysis was used to examine vocalic variables such as the first three formant frequencies, duration, and context; obstruent variables, which include burst, VOT, and duration; and nasal variables such as, the first two formant frequencies, and duration in cleft speech.

Gámiz *et al*. (2006) used the method to determine the factors that alter the measures of VOT in children with repaired cleft palate. The study by Ahlberg and colleagues (Ahlberg *et al*., 2006) compared phonetic transcriptions and acoustic analysis of initial sounds in babbling sequences from infants with cleft palate. They found that results of the acoustic analysis were in relatively good agreement with the analysis made using phonetic transcription. However, it is important to note that this is not always the case. Howard and Heselwood (2011) discuss instances where acoustic and perceptual analyses disagree.

3.3.2. Instrumental analysis of resonance and airflow

Instrumentally, resonance and airflow can be measured using direct and indirect procedures. Direct methods involve having direct visual access to the pharynx and the velopharyngeal sphincter and include techniques such as nasopharyngoscopy, lateral cephalometric radiography, videofluoroscopy, magnetic resonance imaging (MRI), and ultrasound. Indirect measures allow us to make inferences about the structure and function of the velopharyngeal mechanism through analysis of acoustic and airflow measures. Sell and Pereira (2011) and Sweeney (2011) provide a detailed discussion on the different instrumental techniques used for evaluating atypical resonance and airflow commonly noted in speakers with cleft palate. For the purposes of the current study, we will focus here on the acoustic techniques.

3.3.2.1. Acoustic analysis of resonance and airflow

Nasometry measures acoustic energy that is emitted from oral and nasal cavities during speech using two microphones, one recording the acoustic output from the oral cavity, while the other captures nasally emitted acoustic energy. It has been employed in many cleft studies to measure the presence and extent of nasality in speech production. Its measures are valuable for supplementing the speech and language therapist's perception of hypernasal resonance in individuals with velopharyngeal insufficiency (Dalston *et al.*, 1991; Watterson *et al.*, 1996). Studies have shown, however, that nasometry scores can be influenced by factors such as language, dialect, age, gender, and the specific speech stimuli used (Seaver *et al.*, 1991; Karnell, 1995), which makes it difficult to compare scores across speakers, dialects and cross-linguistically. Standardized scores are available for many languages such as English (Seaver *et al*., 1991; van Doorn and Purcell, 1998); Flemish (Van Lierde *et al.*, 2001), Thai (Prathanee *et al.*, 2003). However, even where standardised scores are available, nasometric data need to be considered as a supplement to but not a substitute for perceptual judgement. In fact, Sweeney (2011:213) highlights that 'perceptual data must form the basis of all assessment results despite the recognized problems associated with perceptual assessment'.

Resonance and airflow can also be studied using spectrographic analysis. In fact, the acoustic analysis of speech samples recorded by a microphone appears to have an advantage for evaluating atypical resonance and airflow because it analyzes the same signals that are perceived by listeners; and, when using this technique, the use of a tape recorder or a computer and a standard sensitive microphone usually suffice to acquire data (Kataoka *et al.*, 2001; Lee *et al.*, 2009). The essential acoustic cues of hypernasality include, introduction of additional formants, broadening of formant bandwidths, a reduction of the intensity of F1 and F2 (Hawkins and Stevens, 1985; Kataoka *et al*., 2001). Until recently, most acoustic studies of resonance and airflow in speakers with cleft palate involved qualitative descriptions of the presence of aspects of atypical resonance and airflow (Whitehill and Lee, 2008). This is because it is difficult to quantify the degree of atypical resonance and airflow using spectrographic analysis. However, there have been several attempts at quantification. Studies (e.g., Plante *et al.*, 1993; Kataoka *et al.*, 1996; Chen, 1997; Kataoka, *et al.*, 2001; Rah *et al.*, 2001; Lee *et al.*, 2005; Lee, *et al.*, 2009) have used different techniques such as Linear Predictive Coding (LPC) analysis, formant analysis, and spectral analysis to evaluate hypernasality in speakers with cleft palate and other etiologies.

3.3.3. Instrumental analysis of voice quality/phonation types

Behram and Orlikoff (1997) note that instrumental measures of the vocal function are an integral part of, rather than a supplement to, the assessment and treatment of voice problems. Direct phonatory analysis provides information about the actual anatomical and/or functional status of the phonatory system. Such first-hand information can be obtained using laryngoscopic techniques (See Awan, 2008 for a detailed discussion of direct and indirect methods). In contrast, indirect methods allow for inferences about typical and atypical function by analysing by-products of the phonatory function rather than through analysis of the phonatory function itself (Awan, 2008). The main indirect method is acoustic analysis. Once again, our focus is going to be on the acoustic approach, as it is the one used in the present study.

3.3.3.1. Acoustic analysis of voice quality

This approach has long been in use to study speech production in typical as well as in populations with speech difficulties (Hillman *et al.*, 1990; Carding, 2000; Awan, 2008). Acoustic parameters measure, among other things, fundamental frequency (F_0), intensity (amplitude), and dynamic vocal range. A technique that is frequently used to measure voice quality is quantifying the distribution (i.e., perturbations) of acoustic waveform by identifying, for example, where each cycle of vibration starts and ends. Despite its obvious importance, there are two main limitations that are cited in relation to this technique. The first problem is that, since a severely disturbed voice signal is characterised by aperiodic vibration with no cyclic boundaries, it is difficult to accurately measure such a signal using acoustic perturbation measures which depend on the accurate identification of cyclic boundaries. The second one relates to the more general problem of quantifying the multidimensional nature of the speech and therefore of the voice signal. In order to address these issues, multivariate approaches that use a combination of the results of a number of test variables may be employed (Awan, 2008). One of the acoustic techniques used as a part of multivariate analyses is spectral analysis. Basically, spectral analysis extracts the fundamental frequency from the spectrum of a sound wave and has been considered to offer a strong prediction of atypical voice quality (de Krom, 1995; Dejonckere and Lebacq, 1996). Cavalli (2011) discuss the different types of instrumental measures used for the assessment of voice quality in individuals with cleft palate. She suggests that routine voice assessment may include references to different acoustic measures such as fundamental frequency (F_0), which corresponds to the rate of vocal fold vibration, perturbation, which measures cycles of vibration, and intensity, which corresponds to the loudness of speech.

3.3.4. ***General limitations of instrumentation***

Although instrumental analysis of speech production in general provides a different perspective than the one offered by perceptual analysis, some of the instruments are expensive and have high maintenance and operational cost which makes their availability impossible or limited in speech laboratories and clinics. This is particularly likely to be a problem in developing world contexts. The use of some instrumental techniques may also interfere with normal speech production and create discomfort, and hence be difficult for young children to endure. Furthermore, instrumental analysis often involves a large amount of data and can be a technically complex and time-consuming task (Gibbon, 2008). However, none of these limitations apply to the technique used in the present study, acoustic analysis, which through programs such Praat® and Speech Analyzer® is widely available at no cost to the user, as long as they have access to a computer.

3.4. Summary

This chapter has covered a wide variety of issues relating to speech assessment in general and the assessment of speech output in individuals with cleft palate in particular. The chapter started with a detailed account of the major types of perceptual analysis, namely, perceptual rating scales and phonetic transcription. The relative advantages and limitations of these approaches have been dealt with. It has become clear that perceptual analysis, despite its limitations, remains an extremely valuable clinical and research tool. It is important to note, however, that instrumental analysis is also of great value in providing information about the physical properties of speech production and the function of the speech system in atypical speech production. It is also important to remember that both perceptual and instrumental analyses are important and should not be used to validate or invalidate each other, because they provide different perspectives on speech analysis.

In the last two chapters, relevant general issues regarding cleft speech development and speech features associated with cleft palate and the assessment methods used to assess these speech production features were reviewed. As the main aim of this study is to describe the speech production features of Amharic speakers, it is important to provide an overview of the phonetics and phonology of Amharic, which the next chapter will be devoted to.

Chapter 4: Phonetics and phonology of Amharic

4.1. Introduction

The analysis of the phonetics and phonology of Amharic-speaking children with cleft palate requires background knowledge of the phonetics and phonology of Amharic. This chapter is thus allows comparison between adult norms and typical and atypical developmental realisations. Understanding the phonetics and phonology of adult language helps one to distinguish processes occurring in typical speech from those realisations or processes that are atypical. The chapter begins by addressing issues as to which language family Amharic belongs to, how many dialects it has, where and how widely the dialects are spoken and then mentions the linguistic studies done on the language. This is followed by an account of the phonemic system of Amharic. In this section the ongoing controversies regarding the number of Amharic phonemes are discussed, with an explanation of the positions taken for the purposes of the present study. Then, phonetic variation and phonological processes are dealt with, followed by a discussion of Amharic syllable structures and stress patterns.

4.2. Background

Amharic, a Semitic language belonging to the Ethio-Semitic subgroup of the Semitic Family, is the national language of Ethiopia spoken by 32.7% of the total population of Ethiopia as a mother tongue (Central Statistical Authority, 2007). It is also the official or working language of most of the regions within the federal system. Amharic is said to have five dialects: Gondar, Gojjam, Wollo, Menz and the Addis

Ababa ('standard') dialect. The first two varieties are spoken in the northwestern part, the Wollo dialect is spoken in the northeastern part of Ethiopia, the Menz dialect is spoken in northern parts, north of Addis Ababa inside the boundaries of the current Semien Showa Zone of Amhara Region. The Addis Ababa dialect is the one used in and around Addis Ababa and other regional cities and towns. It is also a variety used by the media. Literature on Amharic dates back to the 17th century (Ludolf, 1698; Podolsky, 1991). Linguistic descriptions on the language include Isenberg (1842), Armbruster (1908), Dawkins (1960), Bender (1968), Cohen ([1936] 1970), Taddese (1972), Habtemariam (1973), Podolsky (1991), Hayward (1992), Leslau (1995), Getahun (1997), Mengistu (2000), Baye (1995, 2008), Schluter (2008) and Girma (2009). The existence of these studies and its longstanding use for official purpose makes Amharic the most studied and privileged language in Ethiopia.

4.3. The phonemes of Amharic

The number of Amharic consonant phonemes has been a subject of debate among scholars. Some say Amharic has 35 consonant phonemes (e.g., Hayward and Hayward, 1999); for others it is 30 (e.g., Appleyard, 1995; Baye, 2008); for some others, there are 27 consonant phonemes in the language (e.g., Sumner, 1957); and still others (e.g., Mulugeta, 2001) reduce the number to 21. The major reasons for this discrepancy are the labialised (velarised) consonants, [b^w] [k^w], [g^w], [k'^w], etc. and the infrequent sounds, i.e., the voiceless bilabial stop /p/, bilabial ejective /p'/ and voiced labio-dental /v/, which are confined to words of foreign origin.

For the current study, for the reasons discussed below, the labialised consonants are excluded but the rare sounds are included in the phonemic inventory of the language: see Table 4.1.

Table 4.1 Consonant phonemes of Amharic

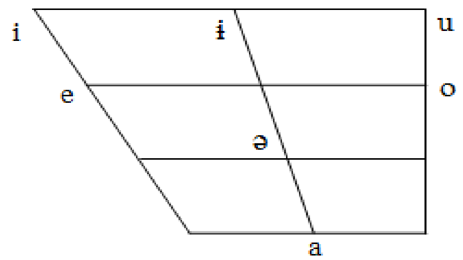
	Bilabial	Labiodental	Dentialv.	Alveolar	Postalveolar	Palatal	Velar	Glottal
Plosive	p b		t̪	d			k g	ʔ
Affricate					ʧ ʤ			
Nasal	m			n		ɲ		
Fricative		f v		s z	ʃ ʒ			h
Trill				r				
Approximant	w					j		
Lateral Approximant				l				
Ejective Stop	p’		t̪’				k’	
Ejective Affricate					ʧ’			
Ejective Fricative				s’				

As briefly stated above, there is a disagreement among scholars regarding the status of /p/, /p’/ and /v/ because the distribution of these sounds is limited to loanwords. Excluding these sounds from the phonemic inventory of Amharic just because of their origin would lead to broader questions as to what is original to Amharic and what is the origin of Amharic itself. In spite of the many philological, historical and comparative researches done to trace the origin of Amharic, no definite answer has been put forward so far. Moreover, though, Amharic generally behaves like the other Semitic languages of Ethiopia, structurally and lexically, it has been massively influenced by other typologically different languages of Ethiopia as a result of language contact (Baye, 2008). If originality is the only variable to consider in order to include or exclude aspects of the language, then not only the sounds in question but the status of the entire language will also be in question. Thus, as /p/, /p’/ and /v/ have already been there in the system of the language for a long time (at least, since the introduction of Orthodox Christianity in the 4th century AD) and hence have been and are still being learned by children with no problem special to them, they can be considered as phonemes of the language. Thus, these sounds are included in the consonant chart because ignoring them just because of their origin and limited distribution would be problematic.

However, the consonant chart excludes the labialised consonants, which is why they are transcribed in phonetic brackets (i.e., [b^w] [k^w], etc). The reason for excluding these consonants from the phonemic inventory is that the labialization is not an inherent feature of the consonants but rather a result of an insertion of /w/ between /ua/ or /oa/ vowel sequence. In Amharic, if the first vowel in a sequence of vowels is /u/ or /o/, [w] is inserted (Hudson, 2000; Mulugeta, 2001). Thus, /t̤'ɨru-at̤/ '*call (you pl.) her*' becomes /t̤'ɨruwat̤/. It is such sequences as /-ruw/ that are referred to as labialized or labiovelar consonants and hence represented as /r^w/, /k^w/, /b^w/ etc. Thus, all consonants in Amharic can potentially be labialised when followed by a sequence of /ua/ or /oa/. For that matter, the Amharic alphabet, the *fidӓl*, itself treats the labialised consonants separately. They are called *diqala fidӓlat* or "bastard letters" as they are extensions of the plain (non-labialised) consonants. It important, however, to recognise the fact that the phonemic/phonetic status of the labialised consonants merits further investigation in relation to phonological theories.

The number and qualities of Amharic vowels are also controversial. Regarding the number, some scholars (e.g., Appleyard, 1995; Mulugeta, 2001; Baye, 1995, 2008) agree that Amharic has seven vowel phonemes but for others (e.g., Cohen, [1936] 1970; Podolsky, 1991) the number ranges from three to nine. In spite of the controversies pertaining to the consonant and vowel phonemes of Amharic, for this study the vowel phonemes presented in the vowel chart in Figure 4.1 have been adopted because they are the ones that function contrastively. This concurs with Appleyard (1995), Mulugeta (2001) and Baye (1995, 2008). Moreover, in the Ethiopian writing system, the *fidӓl*, the basic forms of consonants (the labialised ones excluded) are presented with the seven vowels mentioned above. With regards to diphthongs, as Hayward and Hayward (1999) point out, generally, there are no phonemic diphthongs in the language, and the phonetic diphthongs such as [aɪ], [aʊ], [əɪ] and [əʊ], should be analysed as sequences of /a/ or /ə/ followed by /j/ or /w/.

Figure 4.1 Vowel phonemes of Amharic



4.4. Phonetic variations

Hayward and Hayward (1999) reported that /p, t̪, ʧ, k, kʷ/ are all moderately aspirated. However, all voiceless pulmonic plosives except /ʔ/, all ejectives and affricates are actually moderately aspirated word initially and word medially except for /b/, which is realized as [β] in all places other than word-initially (Derib, 2011). The lenition of /b/ into [β] happens to the singleton /b/, not to the geminate variant. For example, /abəba/ '*flower*' is realised as [aβəβa]; /arb/ '*Friday*' as [aɾβ], /gɨnb/ '*brick wall*' as [gɨnβ]; and /nɨb/ '*bee*' as /nɨβ/; but in such cases as /lɨbb/ '*heart̪*' and /abbat̪/ '*father*' it is realised as geminated [bb].

Alveolar stops, nasals, fricatives, ejectives and the lateral approximant are realised at a post-alveolar or palatal place of articulation when they occur before /i/ or /j/: see Table 4.2. This phenomenon is also attested in many other languages including English. Consider the following examples.

Table 4.2 Examples of palatal and postalveolar allophonic realisations			
/an̪tə/	'*you sg.ms*'	/anʧi/	'*you sg.fem*'
/hid/	'*go imp.2ms*'	/hiʤi/	'*go imp.2fem*'
/at̪'na/	'*study imp.2ms*'	/at̪'ɲɲi/	'*study imp.2fem*'
/rɨsa/	'*forget imp.2ms*'	/rɨʃi/	'*forget imp.2fem*'
/mɨzəz/	'*pull out imp.2ms*'	/mɨzəʒi/	'*pull out imp.2fem*'
/bɨla/	'*eat imp.2ms*'	/bɨji/	'*eat imp.2fem*'
/amt̪'a/	'*bring imp.2ms*'	/amʧ'i /	'*bring imp.2fem*'
/k'ɨrəs'/	'*sharpen, engrave, design imp.2ms*'	/k'ɨrəc'i/	'*sharpen, engrave, design imp.2fem*'

Single /r/ is tap /ɾ/. So, /t̪ɨras/ '*pillow*' is pronounced as [t̪'ɨɾas], /rəʒʒɨm/ '*long, tall*' as [ɾəʒʒɨm]. /r/, which is realised as [ɾ] and geminate /r/ contrast to produce a difference in meaning. For instance, [jibəɾal] '*he/it (will) light(s) up*', [jibərral] '*he/it (will) fly(s)*'. /h/ becomes voiced intervocalic; hence, /məhal/ '*middle, centre*' is pronounced as [məh̬al]. /n/ has different phonetic realizations in different contexts as shown in the examples in Table 4.3 below.

Table 4.3 realisations of /n/ in various contexts		
/anbəssa/	[ambəssa]	'*lion, brave*'
/angət/	[aŋgət̪]	'*neck*'
/kənfər/	[kəɱfər]	'*lip*'
/anʤət /	[aɲʤət]	'*intestine*'
/and/	[and]	'*one*'

All ejectives may be geminated in all phonetic environments. As regards /ɲ/, Hayward and Hayward (1999) stated that it is usually claimed that the geminate variant occurs intervocalically, while the single one occurs elsewhere. However, the geminate variant occurs word-finally as well in words like /nəɲɲ/ '*I am*', /k'əɲɲ/

‘*right (opposite of left)*’, /amaɲɲ/ ‘*believer*’ etc; but the single variant does not contrast phonologically with the geminate one (Baye, 2008). Moreover, /ɲ/ does not occur word-initially (Baye, 2008).

In Amharic, consonant gemination is contrastive, as illustrated in Table 4.4. However, vowel length is not contrastive.

Table 4.4 Consonant germination

/gəna/	‘*yet*’
/gənna/	‘*Ethiopian Christmas*’
/t̪ɨmtʃiɲaləʃ/	‘*you sg. fem. (will) hit me*’
/t̪ɨmmt̪’ʃiɲaləʃ/	‘*you sg.fem. are my favourite*’
/t̪ənəsa/	‘*stand up imp.2ms*’
/t̪ənəssa/	‘*he just stood (woke) up*’

Labialization is the most frequent secondary articulation in Amharic. As discussed above, labialisation in this language is triggered by a sequence of /ua/ or /oa/ vowels. Below are some more examples of labialisation.

Table 4.5 Labialisation

/k’uank’ua/	[k’^{w}ank’^{w}a]	‘*language*’
/fuafuate/	[f^{w}af^{w}ate]	‘*waterfall*’
/kuas/	[k^{w}as]	‘*ball*’
/t̪’uaf/	[t̪’^{w}af]	‘*wax candle*’

In the Wollo dialect of Amharic, in addition to labialization, palatalization is also common, where all stops (affricates included), ejectives, trills, lateral approximants, become palatalized when followed by /ə/ or /e/.

Table 4.6 Palatalization		
/dəhna/	[dʲəhna]	‘*good*’
/ʧ’əw/	[ʧ’ʲəw]	‘*salt*’
/wɨt̪’et/	[wɨt̪ʲet]	‘*result*’
/bəre/	[bəɾʲe]	‘*ox*’
/leba/	[lʲeba]	‘*thief*’

Amharic also uses morphologically conditioned palatalization. Consider the examples below adapted from Hudson (2000:207).

Table 4.7 Morphologically conditioned palatalization

Verb stem	***1st sg.***		***3rd m.sg.***	
/lɨs/	/lɨʃʃ-e/	‘*I licking*’	/lɨs-o/	‘*he licking*’
/jɨz/	/jɨʒ-e/	‘*I holding*’	/jɨz-o/	‘*he holding*’
/kɨd/	/kɨʤʤ-e/	‘*I denying*’	/kɨd-o/	‘*he denying*’

In the above examples, if a verb ends with a coronal (tongue-tip articulated) consonant, this consonant becomes alveo-palatal before /-e/. However, the palatalization is not phonologically conditioned because it does not happen with any /e/ or even with any suffix /e/ (Hudson, 2000). In the examples below there is no palatalization, which evidences the fact that the palatalization observed in the above examples is not phonological.

Table 4.8 Examples showing palatalization is not phonologically conditioned

Verb stem	***1st sg.***		***3rd m.sg.***	
/sɨk’/	/sɨkk’-e/	‘*I laughing*’	/sɨk’-o/	‘*He laughing*’
/dɨh/	/dɨhh-e/	‘*I crawling*’	/dɨh-o/	‘*He crawling*’
/sɨb/	/sɨbbe-e/	‘*I pulling*’	/sɨb-o/	‘*He puling*’

In disyllabic words, when /t̪’/ is followed by /t̪/, there is assimilation of airstream. The ejective (i.e., /t̪’/) becomes pulmonic (i.e., /t̪/). Hence, /sət̪’t̪o/ ‘*he giving*’ becomes [sət̪t̪o]. However, in some dialects (e.g., Gojjam and Wollo), the reverse happens: the pulmonic becomes ejective: [sət̪’t̪’o]. There is no monosyllabic word having /t̪’t̪/ sequence.

Metathesis is a rather rare phonological process in Amharic and not widely employed by most Amharic speakers. Even the individuals who employ metathesis do not transpose sounds for all of the words involving possible metathesis. Moreover, metathesis is not associated with any dialectal variation. Below are some examples of metathesis in Amharic.

Table 4.9 Metathesis

/kɨbrit̪/	/kɨrbit̪/	‘*match*’
/maksəɲo/	/maskəɲo/	‘*Tuesday*’
/kəbəro/	/kərəbo/	‘*drum*’
/ɨrsas/	/ɨsras/	‘*pencil*’

Insertion of glides or semivowels /w/ and /j/ is common in Amharic. As stated above /w/ is inserted between /ua/ and /oa/ vowel sequences; and /j/ is inserted in /ia/ and /ea/ sequences (Hudson, 2000). Consider the following examples.

Table 4.10 Insertion

/nɨgəru-at̪/	[nɨgəruwat̪]	‘*you (pl.) tell her*’
/sərt̪o-al/	[sərt̪uwal]	‘*he (it)has done/worked*’
/wɨsʤi-at̪/	[wɨsʤijat̪]	‘*you (fem.) take her*’
/asɨrre-at̪/	[asɨrrejat̪]	‘*I tying/arresting her*’

Hayward and Hayward (1999) reported that a prothetic /ɨ/ is often inserted before word-initial /r/ in such words as /ɨrəʒʒɨm/ '*long/tall*'. But, forms such as /ɨrəʒʒɨm/, /ɨruk'/ '*far*' etc are 'non-standard' but acceptable; and they are developmental variants. The epenthetic /ɨ/ is actually inserted to avoid impermissible consonant clusters notably word-initially and word-medially as word-final consonant clusters are less strict. Thus, in such borrowed words as *sport* the epenthetic vowel (i.e., /ɨ/) is inserted yielding /ɨsport̤/. In some words, deletion of certain segments is common but not phonologically conditioned. In some cases, this applies to assimilation as well. For example, /adrɨg/ or /adɨrg/ '*do imp.2ms*' becomes [arg], /gədlo/ '*he/it killing*' becomes [gədlo]. This is not the case with all the words with similar pattern. /adrɨk'/ or /adɨrk'/ '*dry imp.2ms*', for example, cannot be *[ark']; likewise, it is unacceptable for /nədlo/ '*h/it making a hole*' to become * [nəllo].

Reference to the length of Amharic vowels is also vague as there has never been systematic experimental study done on the length of the vowels. Gankin, (1969) suggested that some vowels such as /o/ and /e/ are always long, and /ɨ/ and /ə/ are always short, whereas the length of /u/, /i/ and /a/ depends on the stress; Hayward and Hayward (1999) state that vowels in the language are generally short; but they become longer in non-final open syllables and final syllables closed by one consonant. Although the claim made by Hayward and Hayward (1999) appears to be the case, the long variants are not as long as the long vowels in other Ethiopian languages; and vowel length is not contrastive (Derib, 2011).

4.5. Stress and syllable

The issue of stress is also another area which needs to be definitively addressed. Some (e.g., Mulugeta, 2001; Hayward, 1992) say stress in Amharic is indeterminate; whereas others provide different suggestions. Leslau (1995:44-5) for instance noted “Amharic has an almost even distribution of stress on each syllable [...] the syllable preceding a geminated syllable is likely to be stressed.” Tilahun (2002) states that, in general, stress falls equally on each syllable in Amharic. Hayward and Hayward (1999) and Mullen (1986) claim that Amharic has “weak stress”, which is not in accord with all the properties of stress in other languages. Wedekind and Wedekind (1991:749) however state that “Amharic stress is like the Egyptian sphinx: there are many representations, and many things can be said about it - but the first thing to say is that “it” does not really exist.” Furthermore, there are some (e.g., Abraham, 1942) who claim that Amharic is a tone language, a claim not accepted by most scholars. It seems that Amharic falls somewhere between stressed-timed and syllable-timed languages.

The syllable structure of Amharic is represented differently in different works. Getahun (1997), for instance, describes the six possible syllable structures of Amharic as V, VC, VCC, CV, CVC, and CVCC; and Mulugeta (2001) describes only the underlying structure as CV, CVC and CVCC. The structure can be summarized as (C)V(C)(C). Thus, all syllables have nuclei, which are vowels. Unlike in some languages, in Amharic there are no syllabic consonants. CV is the pattern that covers a large portion of the syllable distribution of the language (Sebsibe *et al.*, 2004). As can be observed from the syllable descriptions just discussed, there is a disagreement on whether Amharic has a syllable which starts with vowel. Like Mulugeta (2001), some say that the Amharic phonological system does not contain a syllable starting with a vowel because in the absence of any other initial consonant there is always a glottal stop occurring before the vowel. Accordingly, it is argued that a monosyllabic word /and/ '*one*' is produced as [ʔand]. Whereas other researchers such as Getahun (1997) claim that Amharic does not actually use word-initial glottal stop. This disagreement needs to be addressed by future research.

4.6. Summary

This chapter has provided an overview of the phonetics and phonology of Amharic, covering the essential segmental and suprasegmental aspects of the language. The consonant and vowel phonemes and their phonetic variants together with different phonological processes have been described. The status of /p, p', v/ has also been considered, and it is argued that these sounds should be included as the phonemes of the language. Among the most frequently cited problems are the inclusion or exclusion of the labialised consonants and the status of stress in the language. The issue of stress also remains unsettled, and will require further investigation. The syllable structures and phonotactics of the language have also been reviewed. So far, appraisal of the literature on speech development in children with cleft palate and common speech production features associated with cleft palate across languages, and issues pertaining to the assessment of cleft-related speech and the phonetics and phonology of Amharic has been made. Chapter 2 to 4 provide useful information to shape the research questions and design relevant methodology for the present study, which will be described in the next chapter.

Chapter 5: Research aims and methods

5.1. Introduction

The purpose of this chapter is to outline the research aims and questions of the thesis and describe and explain the methods used to address the research questions. It also reports results of the reliability exercise, carried out to assess the level of reliability of the phonetic transcription made for this study. The first part of the chapter outlines and explains the objectives of the study and presents the research questions that the study aims to address. Then, the research design employed and the methods followed are described and justified. In the last section, the protocol designed for assessing the reliability of transcriptions and perceptual ratings made for this study are discussed.

5.2. Research aims

This study investigates how cleft palate affects speech production in Amharic-speaking children with repaired cleft lip and palate/cleft palate. Studies in other languages have shown that cleft palate may significantly affect speech production. Currently no such studies have been undertaken on Amharic, the national language of Ethiopia. The aim of this project is therefore to describe the speech output of Amharic-speaking children with operated cleft lip/palate in terms of speech sound production. The study addresses the following research questions:

1. What are the main features of typical speech development in Amharic-speaking children?
2. How does cleft lip/palate affect speech production in Amharic-speaking children with repaired cleft lip/palate?

- Are there active cleft-type articulations?
- Are there passive cleft-type realisations?
- Are there non-cleft developmental realisations?
- Are there unusual speech production features?
- Are vowel articulations, resonance, and voice/phonation affected, and if so, in what ways?

3. What are the relationships between the dependent variable speech output and the independent variables: age of participants at assessment, age at surgery and cleft type?
    - Which compensatory articulations are most commonly observed?
    - Which processes are most/least preferred by individual children?
    - How is age of participants related to their speech output?
    - What is the relationship between cleft type and speech output?
    - Which consonants are most/least affected?
    - How are the realisations of ejectives different from those of their pulmonic counterparts?
    - How are the identified speech production features and trends similar to/different from speech behaviours reported for individuals with cleft palate in other languages?
4. Are there variations conditioned by context and/or elicitation mode?
    - What are the phonological consequences of the atypical speech productions observed in the children with cleft palate?
    - Is phonetic variability related to age of assessment and/or cleft type?
    - Is degree of loss of phonemic contrast related to age of assessment and/or cleft type?

5. For the children who did not produce a perceptible contrast between the pulmonic and ejective stops, is there acoustic evidence for covert contrasts?
    - If there is any evidence for covert contrast, which acoustic features did the children use to signal the contrasts?
    - Are there any similarities/difference between the children with cleft palate and their non-cleft peers with respect to VOT, total closure duration and relative burst intensity for pulmonic and ejective stops?
6. Are the speech characteristics of Amharic-speaking children with repaired cleft lip/palate consistent with the speech characteristics that are generally described as being typical of speech production associated with cleft palate as reported for other languages?
    - What were the theoretical, methodological and clinical implications of the identified speech production features?

The first research question is dealt with in Chapter 7, the second in Chapter 8, the third in Chapter 9, the fourth in Chapter 10, the fifth in Chapter 11 and the sixth in Chapter 12.

5.3. Design and method

The study employed a descriptive research design, which involved a combination of perceptual and instrumental (acoustic) phonetic and phonological analysis. The study also compared the speech of children with cleft to the speech of typically-developing children.

5.3.1. Participants

Speech samples were obtained from 20 children aged between 5;0 and 14;0 years, with a repaired cleft palate, and a control group of 5 typically-developing children (aged between 4;0-6;0 years), all resident in Ethiopia. A 13;11 year-old girl was additionally recruited specially for the acoustic analysis part of the study, in order to normalise the age range. Before the recruitment of the participants, departmental ethics approval was obtained (see Appendix 1). Below, how the participants of this project were (i) identified, (ii) approached and (iii) recruited is explained in turn.

i. Identification

The children with cleft palate were identified by a specialist speech and language therapist, from the group of children referred to the speech and language therapy clinic for cleft lip and palate in a hospital in Addis Ababa, Ethiopia. The typically-developing children and their parents were identified by the chief investigator from staff at Addis Ababa University, by a circular email. Parents who were interested in their children participating in the study replied to the email.

ii. Approach

Parents of all of the children with cleft palate meeting the inclusion/exclusion criteria (see Table5.1) were approached initially by their child's speech and language therapist. An information sheet describing the study and what their involvement would entail was provided to each parent and each child who expressed interest in taking part in the study (See Appendix 2 for an example of an information sheet and consent form).

Parents of all of the typically-developing children meeting the inclusion/exclusion criteria and who replied to the initial email were approached by the chief investigator of this study, in the first instance by email with accompanying information sheets (for both child and parent) describing the study and what their involvement would entail.

iii. Recruitment

The chief investigator met with the parents expressed an interest (having read the information sheets) in participating, in either the hospital (the children with cleft palate) or university (the typically-developing children) setting, to discuss the research, answer any questions they may have and to provide them with a consent form. Consents were obtained for use of speech recordings and for the illustrations showing children's faces which are used later in this thesis. Table 5.1 contains the inclusion and exclusion criteria for participant recruitment.

Table 5.1 Participants inclusion and exclusion criteria

Children with cleft palate	
Inclusion criteria	• Age: 5;0 – 14;0 • First language: Amharic. No other language spoken in the home. • Cleft lip and/or palate • Palate surgery within 12 months prior to data collection, but not within three months period prior to data collection
Exclusion criteria	• Severe hearing impairment • Congenital syndrome accompanying the cleft • Other developmental difficulties
Typically-developing children	
Inclusion criteria	• Age: 4;0 – 6;0 • First language: Amharic. No other language spoken in the home.
Exclusion criteria	• Any identified developmental difficulties or medical conditions which could impact on speech/language development

Demographic information about the children is presented in Tables 5.2 and 5.3.

Table 5.2 Demographic data on the five typically-developing children.

Participants	***Gender***	***Age***
Eldana	F	4;2
Abenzer	M	4;8
Dagem	M	5;3
Eyuel	M	5;5
Sunamawit	F	5;7

Table 5.3 Demographic data on the 20 children with cleft palate.

Participants		***Gender***	***Age at assessment***	***Age at surgery***	***Cleft type****
1.	SG	F	5	4;5	ICP
2.	OS	M	5	4;5	ICP
3.	EA	M	5;1	4;6	UCLP
4.	SA	F	5;1	4;6	ICP
5.	TB	M	5;2	4;8	UCLP
6.	YD	M	5;3	4;5	BCLP
7.	NB	M	6;3	4;8	BCLP
8.	BN	F	6;5	5;11	BCLP
9.	EY	M	7	6;6	UCLP
10.	NF	M	7;8	7;2	UCLP
11.	EZ	M	8	7;5	UCLP
12.	WL	F	8	7;6	ICP
13.	ES	M	8;2	7;8	BCLP
14.	BM	M	10;2	9;7	UCLP
15.	AT	M	10;4	9;8	UCLP
16.	EM	F	11	10;5	UCLP
17.	HA	M	12	11;5	BCLP
18.	DS	F	14	13;5	UCLP
19.	FM	M	14	13;5	UCLP
20.	BZ	F	14	13;5	ICP
		mean	***8.4***	***7.8***	

*ICP=isolated cleft palate; UCLP=unilateral cleft lip and palate; BCLP=Bilateral cleft lip and palate

For the purpose of analysis, the children are later categorized into three groups according to their age at assessment ((i) 5-7;11 (early childhood), (ii) 8-10;11 (middle childhood), (iii) 11-14 (early/pre-adolescence)) (Rhodes *et al*., 2011).

Data collection

As noted above, data collection took place in two locations: For the children with cleft palate, in the speech therapy clinic as part of a routine speech therapy session; while for the typically-developing children in the Department of Linguistics at Addis Ababa University. Data for the cleft group were collected by a speech language therapist, in the presence of the chief investigator, while, for the typically-developing children, they were collected by the chief investigator. Audio and video recordings were made of the participants' speech production in a variety of contexts including:

(a) single word production (using picture naming),
(b) sentence repetition, using a version of the GOS.SP.ASS (Great Ormond Street Speech Assessment: Sell, Harding and Grunwell, 1999) modified for Amharic; and
(c) spontaneous connected speech production (using spontaneous/conversational speech where the participant talks with the speech therapist/chief investigator about familiar subjects-school, home, hobbies etc).

The formal assessment material (i.e., the Amharic GOS.SP.ASS) will be described in detail in the next chapter. The assessment material contains the Amharic GOS.SP.ASS sentences and a list of single words (see appendix-3).

5.3.3. Data analysis

The audio/video data of the single word production were phonetically transcribed using symbols from the IPA (IPA, 1999) and ExtIPA (Ball, *et al.*, 1994). The data from connected speech tasks were transcribed orthographically (using Amharic script) in the first instance; subsequently sections of specific interest were transcribed phonetically. Portions of the speech data were also analysed acoustically, using

PRAAT, a software programme for acoustic analysis which is widely used in phonetic research (Boersma and Weenink, 2012). Details of the methods employed for acoustic analysis are presented in Chapter 11.

5.4. Protocol for measuring reliability of phonetic transcription and perceptual rating

This section describes the protocol employed for assessing the reliability of the phonetic transcription and perceptual ratings used for this study. The first part of this section reviews the key literature on the issues that need to be considered in undertaking a phonetic transcription/perpetual ratings reliability exercise. By doing so, it provides the rationale for why specific materials, methods and procedures were chosen for the reliability exercise.

Reliability is generally defined as the extent to which a measurement or procedure of a study produces consistent results over time and an accurate representation of the total population under study. Kirk and Miller (1986) identified three aspects of reliability, namely: (1) equivalence, which refers to the extent of agreement between two or more measurements that are employed at nearly the same point in time; (2) stability, which is thought to occur when the same or similar results are found with repeated testing; (3) internal consistency (homogeneity), which concerns the degree to which individual items of a measurement are correlated with each other, measuring the same thing.

In the study of human communication, most analysis involving the observation of people using spoken language will somehow, at some stage, rely on some form of transcription (Müller, *et al.*, 2006). Phonetic transcription is widely utilized to study different aspects of speech communication in a variety of areas including field linguistics, language acquisition, dialectology, clinical linguistics, language technology. However, Lohmander and Olsson (2004) indicated that only a few studies (8 out of 88 in their review) used phonetic transcription to assess cleft palate speech; but, in recent years, phonetic transcription has been a more commonly used method than rating scales in the assessment of speech outputs of individuals with cleft palate (Chapman and Hardin, 1992; Morris and Ozanne, 2003; Willadsen and Albrechtsen, 2006; Chapman *et al.*, 2008; Lohmander and Persson, 2008; Lohmander *et al.*, 2011; Klintö *et al.*, 2011). However, the accuracy of phonetic transcription has often been questioned, as there are several theoretical and practical factors affecting it. Shriberg and Lof (1991) posited 16 variables that contribute to variance in phonetic transcription reliability. These variables fall into four major categories, namely, those relating to subjects (e.g., level of intelligibility), analysis (e.g., type of system—narrow vs. broad), context (e.g., continuous speech vs. single word), and units (e.g., features—manner, place, height). The negative effects that these variables have on transcription quality have been empirically confirmed (Shriberg and Lof, 1991; Louko and Edwards, 2001; Stoel-Gammon, 2001). Indeed, no transcription is thought to be perfect (Amorosa *et al.*, 1985; Howard and Heselwood, 2002a; Howard, 2011); instead, a set of independently made transcriptions by trained transcribers is assumed to provide an inventory of plausible interpretations (Ramsdell *et al.*, 2007). Variations among transcriptions also suggest inter-transcriber disagreement.

5.4.1. Reliability and validity of phonetic transcription

The fact that phonetic transcriptions are error-prone (Shriberg, *et al.*, 1984) implies the need for checking the quality of transcriptions. The most common way of doing this is by having at least a portion of the data transcribed by an independent transcriber and by measuring the inter-transcriber agreement. Hence, the reliability of phonetic transcription measures the extent of repeatability of judgements generated within a specific transcription system (Shriberg and Lof, 1991; Cucchiarini, 1996). The validity of phonetic transcription mainly centres on the degree of similarity between (a) perceptual data and data from other sources such as physiologic, kinetic, or acoustic; and (b) perceptual decisions made under different transcription conditions (e.g., from recording vs. live) (Riley *et al.*, 1986; Pye, *et al.*, 1988; Shriberg and Lof, 1991; Cucchiarini, 1996). Regarding the similarity or difference between perceptual and instrumental evidences, it has been argued (e.g., Heselwood, 2009; Howard, 2011; Howard and Heselwood, 2011) that just because a transcription disagrees with instrumental evidence that does not mean that it is an invalid record of the listener's perceptual experience. Instrumental and perceptual analyses are in fact complementary and provide qualitatively different information about an utterance, rather than competing to validate or invalidate the other (Heselwood, 2009; Howard, 2011; Howard and Heselwood, 2011).

Reporting estimates of phonetic transcription reliability, when presenting findings based on phonetic transcription, has become common practice among researchers and clinicians. The issues of reliability and validity of phonetic transcription in such a discipline as speech therapy are crucial, as the transcribed data is used as a basis for speech assessment, therapy and the evaluation of the efficacy of therapy (Cucchiarini, 1996; Ramsdell *et al.*, 2007). However, as Ramsdell *et al.* (2007) stated, transcribers' agreement provides no guarantee of transcription accuracy, even with typical mature speech—let alone with clinical data. Two transcriptions can agree and both simply be incorrect, a fact that can be confirmed whenever a gold standard (i.e., an expert's transcription) can be externally validated (Ramsdell *et al.*, 2007). Thus, one may question the need for attempting to transcribe if the aim is not to achieve accuracy, which leads to a question: what is accurate transcription? For Muller *et al.* (2006:10),

> …accuracy means the transcriber's closest possible translation from an auditory to a grapheme medium, executed with the amount of details required for the purpose of the investigation; a close translation is one that leaves the least amount of ambiguity possible.

This question of how accurate an accurate transcription would be relates to the measurement of transcription accuracy.

5.4.2. The reliability of reliability

The process of measuring reliability needs to be reliably carried out. Even though this sounds circular, the logical procedure that dictates the exercise breaks the circularity, as the more rational the procedure is the more self-evident the result becomes. The reliability of the process is thus related to a wide range of issues including deciding the number and status of transcribers, procedures for training the transcribers, the amount and type of data to be sampled, mode of data presentation and method of calculation, "perceptual agreement" versus "symbol agreement" (Cucchiarini, 1996).

5.4.2.1. Transcribers

An important factor relating to transcribers/judges that may affect outcome of the reliability of transcriptions is the level of their knowledge and skills in transcription and amount of experience working on similar speech data. For example, Keuning *et al*. (1999), reported that experienced transcribers performed better than the inexperienced ones. Later studies (e.g., Gooch *et al.*, 2001; Brunnegard and Lohmander, 2007) have shown that the experience and training of transcribers and extent of transcription agreement are directly related. Furthermore, Gooch *et al.* (2001) highlighted the difference between identifying an atypical realisation and transcribing it, which again relates to the level of knowledge and skills of transcribers, particularly of the transcription systems and conventions, namely, IPA, ExtIPA and VoQS. These and other studies (e.g., John *et al.*, 2006a; Sell *et al.*, 2009) indicated the need for training of even experienced professionals in transcribing speech output of individuals with cleft palate. Howard and Heselwood (2002) indicated that the training preferably needs to focus on phonetic properties that are considered particularly problematic.

Another issue that needs to be considered in relation to transcriber's status is the tendency for the more junior transcriber to feel pressured to agree with a more senior, experienced colleague (Shriberg *et al*., 1984). Furthermore, the reliability of transcriptions may also be affected by what Shriberg *et al*. (1987) call 'transcriber drift', a phenomenon that refers to the gradual altering of hearing and notational habits of a transcriber over time, which sometimes happens in long-term projects.

5.4.2.2. Amount and type of data

As discussed in Chapter 3, sampling is also among the major issues that need to be carefully carried out in the process of transcription agreement assessment; and in order to achieve robust, valid and reliable results, generally, a well-defined sampling method that utilises a representative and rigorous frame should be followed. In studies employing phonetic transcription, including studies of cleft palate, the typical amount of speech sample used for transcription reliability estimates is 10-20% of the total speech samples or speech tokens analysed in a study (Shriberg and Lof, 1991; Stokes and To, 2002; Campbell *et al.*, 2003; Salas-Provance *et al.*, 2003; Persson *et al.*, 2006; Edwards and Beckman, 2008; Gozzard *et al.*, 2008; Tyler *et al.*, 2011; Lohmander *et al*., 2011).

Regarding the type of speech material to be used, studies comparing transcription agreement in different types of speech samples in children with phonological impairment or 'speech delay' have reported varying results, although the differences are small. For example, Shriberg and Lof (1991) showed that transcription agreement was slightly better in continuous speech samples than it was in articulation test responses, whereas Masterson *et al.* (2005) found no significant differences in transcription reliability based on single word task and that based on a conversational sample. However, in a recent cleft study, Klintö *et al.* (2011) have shown that there are significant differences in the effects that speech materials have on speech judgment and reliability measures. They report that speech samples gathered using a word naming task form the most reliable speech material if the aim is to evaluate the best speech output of a child with cleft palate; but if the aim is to assess connected speech, the data from a sentence repetition task is a reliable and valid speech material, with good transcription agreement. However, Speake *et al*. (2011) have shown that single word production is likely to miss potentially important aspects of speech production; that even sentence repetition is not the same as real spontaneous speech, and that the very task of sentence repetition has its own problems and pitfalls. For example, they found that, in sentence repetition task, their subject demonstrated unusual speech behaviours characterised by repetitions and repairs, atypical use of open juncture, and unusual word and phrase harmonies. The authors note that the occurrence of such unusual speech production features, in a sentence repetition task, may not be surprising; because sentence repetition task is a controlled context and hence unnatural, requiring verbatim recall of sentences that may contain unfamiliar vocabulary structured unfamiliarly; and not allowing lexical selection and avoidance (Speake *et al*., 2011). Howard (2012) reported similar findings for children with cleft palate. The author suggests that difficulties in connected speech production may be due to the disparity between children's speech production skills and their broader linguistic and conversational abilities. In other words, for children with cleft palate, for example, the articulatory skills are affected by the cleft condition, but the general linguistic and conversational skills continue to develop, putting pressure on the children's ability to deal with the speech production demands in multi-word utterances (Howard, 2012).

5.4.2.3. Mode of presentation and transcription type and condition

In the literature, there are on-going debates on the use of audio versus video recordings and conflicting findings as to how the two types of recordings affect perceptual assessment. McGurk and MacDonald (1976) provided evidence that perception of typical speech is influenced by visual clues. Podol and Salvia (1976) reported that 'seeing' patients with cleft lip and palate impacted ratings. McNutt *et al.* (1991) compared the degrees of phonetic transcription agreement based on transcriptions made using audio and video presentations under two conditions (sound field and headphones), and found that the use of video presentations resulted in higher transcription agreement than the use of audio presentation. In contrast, other studies (Ramig, 1982; Moller and Starr, 1984; Sell *et al.*, 2001) found no differences in the impact of the two media on perceptual assessment. Nevertheless, Stoel-Gammon (2001) and Howard and Heselwood (2002) stressed the importance of visual information in phonetic transcription, which is possible only with live transcription or from video recordings. Visual information is particularly important when attempting to transcribe atypical articulation of dentalization, laminal articulation for alveolar targets, involvement of the lips and position and movement of the mandible (Howard and Heselwood, 2002). Fortunately, this has become more possible than ever before, with current digital technologies which have vastly improved the sound quality of video data, which used to be more of a problem.

Listening conditions constitute another factor affecting the quality of a transcription. For example, transcriptions of the same utterance may show considerable variations, when they are made by the same transcriber, but under different conditions, such as live versus recorded (Amorosa *et al*., 1985; Shriberg and Lof, 1991). In the case of transcription done from recordings, studies use either soundfield or headsets to present speech stimuli. It may be supposed that the use of headphones would increase attention, provide a higher quality sound than soundfield with reduced signal-to-noise ratio; however, the study by McNutt *et al*. (1991) found no significant differences between the two listening conditions (headphone and soundfield) for either audio or video presentations.

Regarding the level of transcription to be used, it is well-recognised that transcriptions of atypical speech are often associated with low reliability, since broad phonetic transcription is more reliable than narrow (Shriberg and Lof 1991; Brøndsted *et al.*, 1994). However, Heselwood and Howard (2008) stated that narrow transcription is currently a preferred tool in clinical contexts. This is because narrow transcription generally contains more information about how an individual realises different speech sounds in different linguistic contexts than broad transcription and therefore is a better source of information for assessment and goal-directed intervention.

Another issue that needs to be considered is the number of times transcribers listen to a recording during the transcription process. As discussed in chapter 3 a number of styles such as repeated-listening and analytical listening have been suggested and the advantages and disadvantages of each technique has been discussed. It has been suggested that (Heselwood and Howard, 2008) the technique of analytical listening is a good method, but the number of listening times needs to be limited.

Another factor to be dealt with is the effect of listeners' expectations on transcription accuracy. Oller and Eilers (1975) argue that knowing the target utterance can have positive or negative effects on the quality of the transcription. Pye *et al.* (1988) suggest that it makes the transcription process easier, while Howard and Heselwood (2002) indicate that knowing the target form for clinical transcription, where listeners' expectations and actually produced forms may not correspond, has potential drawbacks.

5.4.2.4. Calculation

Methods of calculating and the criteria of transcription agreement vary in different studies. The most widely employed measure of transcription agreement, presented in much of the speech therapy and language acquisition literature (e.g., Amorosa *et al*., 1985; Pye *et al*., 1988; Shriberg and Lof, 1991; Ferrier *et al.*, 1991; Otomo and Stoel-Gammon, 1992; Hardin-Jones, 2005; Magnus *et al.*, 2011) is percentage agreement using a point-to-point formula, that is, a percentage of the number of agreements divided by the number of consonants produced in the sample (i.e., agreements plus disagreements). However, Cucchiarini (1996) notes that such percentage agreement scores do not reflect the range of variations that might occur between two transcriptions. She states that the point-to-point comparison has three major pitfalls. First, the approach is based on the presupposition that agreement between transcription symbols is '*all-or-none*', while the extent of (dis)agreement between/among transcriptions may fall somewhere along the continuum between the two. Second, it is influenced by chance agreement, since, in multivalued variables, the probability of agreement depends on the number of categories involved. Third, it does not account for additional or omitted segments, as its assumption is that two transcriptions contain the same number of symbols. For example, if transcriber *x* transcribes /bet/, an Amharic word for '*house*/*home*', as [b̃ẽt̝̃̇], while transcriber *y* transcribes it as [b̃ẽ]; or if *x* transcribes it as [b̃ẽnt̪̃̇], while *y* transcribes it as [b̃ẽt̪̃̇], point-to-point comparison cannot account for the omitted (i.e., /t/, in the first case) or the added (i.e., /n/, in the second case) segment, as there will be misalignment between the two transcriptions due to the deletion or insertion.

Having discussed these drawbacks, Cucchiarini (1996) proposed another approach to measuring transcription reliability, which is carried out by assigning different weights to the various types of (dis)agreements according to the extent of similarity between speech sounds. This technique is called the weighted approach. The importance of this approach has been recognized by several researchers in the areas of infant vocalisations, child phonology, and speech disorders (e.g., Vihman *et al.*, 1985b; Oller and Steffens, 1994; Davis and MacNeilage, 1995; Ingram, 2002; Ramsdell *et al*., 2007). The problem with the weighted approach, however, is that it requires a quantification of the extent of similarity and difference between speech sounds (Cucchiarini, 1996). Given these reservations, recent cleft studies have typically used point-by-point agreement to provide transcription reliability estimates (e.g., Hardin-Jones and Jones, 2005; Persson *et al*., 2006; Hardin-Jones and Chapman, 2008; Chapman *et al*., 2008; Lohmander *et al*., 2011; Magnus *et al*., 2011).

5.4.3. The reliability and validity exercise

One aim of the methodology of the current study was to assess the extent of the reliability of transcriptions and perceptual ratings made for the analysis of the speech output of the children with cleft palate. In the light of the literature, the following protocol was adopted.

5.4.3.1. Training the transcriber

i. The transcriber

A member of the Department of Linguistics at Addis Ababa University, Ethiopia, who is a native speaker of Amharic, and is trained in and experienced in general phonetic transcription, was trained in the transcription of speech production associated with cleft palate, for the purposes of assessing the reliability of the transcriptions carried out by the main investigator in the current study.

ii. The training material

The training was carried out by means of a power-point presentation using extracts from the data collected for this study. The training material was designed to cover all of the 'cleft-type' speech production features identified in the data. The training extracts were then excluded from the material used in the actual reliability study itself.

The transcriptions of the data used in the training material were made by the main investigator; before they were presented to the transcriber, they were checked against transcriptions made by the lead supervisor of this project and agreed by discussion (Shriberg and Lof, 1991).

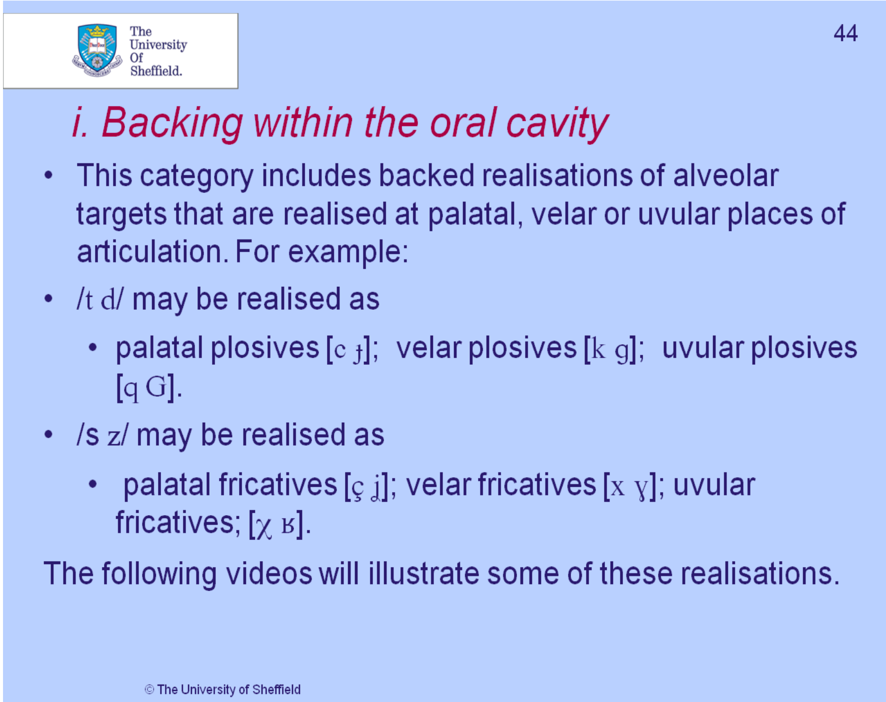


Figure 5.1. An example of the slide of the PowerPoint to be used for the training

After the training material was agreed, it was sent to the transcriber and he was given two weeks to complete his training and was told to listen to the data provided to him as many times as he liked. Figure 5.1 is a screenshot of one of the slides of the power-point used for training the transcriber.

iii. Testing the transcriber

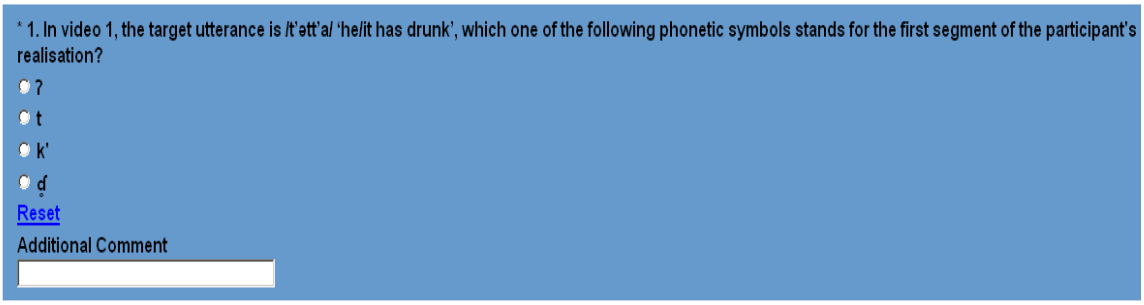
Upon completion of the training phase, the transcriber took an online test to make sure he understood what was expected of him in the reliability exercise proper. The transcriber could take the test repeatedly until he passed it; and he was told that only when he successfully completed the test should he start transcribing the data. He was instructed to start transcribing the data when the chief investigator received an automatic email confirming that the test was successfully completed. The online test consisted of 26 questions; and 23 of his answers were consistent with the transcriptions/ratings that the lead supervisor of the project and the chief investigator had agreed on. Figure 5.2 shows the instructions provided to the transcriber about the test of the training phase:

> ***Instruction***
> *This test is designed to measure your understanding of the training you have received. Please take a few minutes and answer the following questions. There are four choices provided for each question, and there is only one correct answer. Click on the answer you think is correct; and, if you think that you have made the wrong choice, you can amend it by clicking on 'Reset'. However, changes must be done before submitting your answers. If you think that the correct answer is not among the choices provided, then write your own answer in the 'additional comment' box, in which you can also provide any further information (e.g., about articulatory features such as labialisation, voice quality, resonance type, etc.). You can listen to the data as many times as you like and can take the test repeatedly until you pass it. Please note that you must pass the test in order to start the actual transcription task. When you pass the test, the chief investigator will receive an automatic confirmation email; you will then be given the go-ahead to start transcribing the data. Please do not hesitate to contact the chief investigator if you have any questions. Thank you!*

Figure 5.2 Instruction about the test.

iv. The questions

Numbered videos were sent as part of the training material to the transcriber; then the questions were cross-referenced to the numbered videos. The test was designed to cover all 'cleft-type' speech production features. The tokens used in the test were excluded both from the training material and the speech sample used in the actual reliability study itself. Below is an example of the questions set up for the online test:


* 1. In video 1, the target utterance is /t'ətt'a/ 'he/it has drunk', which one of the following phonetic symbols stands for the first segment of the participant's realisation?

- ʔ
- t
- k'
- ɗ̥

Reset

Additional Comment

Figure 5.3. An example of the question set up for testing the transcriber.

5.4.3.2. The data, the transcription process, and the analysis

i. The data

In the reliability exercise proper, 3.5% of the data (for segmental reliability) was randomly selected from the remaining speech data in such a way that the sample covers all the identified speech production features. Data from each participant's speech production were used.

Since the data acquired are of different types, namely: single words, sentence repetition and spontaneous conversational speech, the sample used for the reliability exercise was drawn from the complete range of speech materials.

The proportions of data sampled from each elicitation condition were: 3% from single-word speech samples; 4% from GOS.SP.ASS sentences; and 3% from spontaneous connected speech samples. In addition, 20 additional extracts, 25 seconds long on average, were sampled for resonance and airflow ratings.

The speech material, using both the audio and video signals from the videotapes, was presented to the transcriber over headphones; and he was provided with a gloss of the target utterances, as the chief investigator transcribed the data with this information.

ii. Instructions to the transcriber

During the actual transcription session, the transcriber was instructed to

1. use headphones to listen to the recordings
2. listen to the recordings as many times as he wanted

3. use narrow phonetic transcription, making use of the conventional IPA, extIPA, and VoQS symbols to transcribe specific target phonemes within an utterance (i.e., single word, phrase, sentence).

iii. The analysis

A 5-point categorical scale (0=complete disagreement; 1=little agreement; 2=partial agreement; 3=little disagreement; 4=complete agreement) was created to provide an inter-judge reliability estimate.

Table 5.4 lists the phonetic features that were targeted for the reliability exercise. Table 5.5 shows the criteria used for assigning each level of transcription agreement, i.e., definitions of the above categories.

Table 5.4 Segmental features considered in the rating of degree of agreement

Segments	***Core features***	***Other articulatory features***
Consonants	Place of articulation Manner of articulation Airstream mechanism Voicing Accompanying resonance & airflow	Secondary articulatory features (e.g., palatalization, labialisation, etc.)
Vowels	Height Horizontal tongue position Labial setting Accompanying resonance	Advancement and retraction Others (e.g., laryngeal voice quality)

Table 5.5 Definitions of the categories used for assigning degrees of agreement/disagreement

Consonants	
Scale attributed	***Features to be considered***
Complete agreement	When there is a complete one-to-one match
Little disagreement	When two transcriptions share all the core features but do not share the ‘other articulatory’ features
Partial agreement	When two transcriptions share 4 of the 5 core features and do not share the ‘other articulatory’ features
Little agreement	When two transcriptions share less than 4 of the 5 core features and do not share the ‘other articulatory’ features
Complete disagreement	When two transcriptions share none of the core features
Vowels	
Complete agreement	When there is a complete one-to-one match
Little disagreement	When two transcriptions share all the core features but do not share the ‘other articulatory’ features
Partial agreement	When two transcriptions share 3 of the 4 core features and do not share the ‘other articulatory’ features
Little agreement	When two transcriptions share less than 3 of the 5 core features and do not share the ‘other articulatory’ features
Complete disagreement	When two transcriptions share none of the core features

Hypernasality and nasal emission were rated using a 4-point and a 3-point scale respectively, while hyponasality and nasal turbulence were rated using a binary system (present vs. absent). The rationale for the choice of these scales, as part of the description of the assessment material, was that this reflected the design of the original GOS.SP.ASS, upon which the GOS.SP.ASS for Amharic is based. Further information on the design of the GOS.SP.ASS and Amharic GOS.SP.ASS is provided in Chapter 6. For resonance and airflow ratings, given the number of raters and the type of variables, Cohen’s Kappa coefficient analysis (Cohen, 1960) was performed.

5.4.3.3. Results

Table 5.6 shows the percentage of different levels of transcription agreement achieved. As instructed, the transcriber transcribed specific target phonemes within an utterance (i.e., single word, phrase, and sentence). The total number of consonants transcribed was 245. The table below shows the degree of segmental transcription agreement achieved.

Table 5.6 Degree of transcription agreement

Degree of agreement	*n**	*%*
Complete agreement	187	76.3
Little disagreement	16	6.5
Partial agreement	36	14.7
Little agreement	6	2.4
Total	**245**	

n* reflects the number of consonants

The results of the inter-rater agreement for resonance and airflow are presented in Table 5.7.

Table 5.7 Degree of inter-rater agreement

Parameter	*Kappa and p values*
Hypernasality	Kappa = 0.717 with $p < 0.001$
Hyponasality	Kappa = 0.773 with $p < 0.001$
Nasal Emission	Kappa = 0.744 with $p < 0.001$
Nasal Turbulence	Kappa = 0.828 with $p < 0.001$

For segment transcriptions, 76.3 % complete agreement was achieved. For resonance and airflow ratings, 71.7 %, 77.3%, 74.4% and 82.8 % agreements were achieved for the ratings of hypernasality, hyponasality, nasal emission and nasal turbulence respectively. As can be seen from the p values (i.e., $p < 0.001$), the agreements achieved are all statistically significant. As a rule of thumb values of Kappa from 0.60 to 0.79 are considered substantial (Landis and Koch, 1977). All the agreements achieved are above the lowest threshold (i.e., 70 %) for transcription agreement suggested by Shriberg *et al.* (2010).

5.4.4. Summary

In this chapter, the objectives, design and methods employed for this study are described. The research questions that the study aims to address are outlined and the research design employed and the methods followed are described and justified. Moreover, the protocol designed for assessing the reliability of transcriptions and perceptual ratings made for this study are discussed, and the results of the reliability exercise presented. The results suggest that the transcriptions presented in this study meet the basic standard set in the literature. This is also true for airflow and resonance results reported here. As stated above, for this study, a speech assessment protocol was devised based on the Great Ormond Street Speech Assessment protocol (GOS.SP.ASS '98; Sell *et al.*, 1999). As the assessment material is one of the important contributions of this study, in the next chapter, its content and structure, the procedure followed to devise it and the challenges faced during this process are described.

Chapter 6: Speech Assessment Protocol for Amharic

6.1. Introduction

Obtaining a sample that provides significant information about specific atypical speech characteristics and serves as a basis for planning treatment is crucial in the clinical context. Samples for formal perceptual assessment of atypical speech production are often taken using some kind of protocol. Devising a linguistically and culturally relevant speech assessment tool is an important step towards identifying and managing communication difficulties associated with cleft palate. The purpose of this chapter is therefore to discuss matters relating to the assessment protocol devised for this study.

There are a number of variables that need to be considered when developing such a protocol. These include the language that the protocol is devised for, the speech parameters to be included in the protocol, and measurement methods to be used. As already stated in Chapter 5, currently, there is no standard protocol to be used for the assessment and management of speech difficulties in Amharic-speaking individuals with cleft palate. One of the aims of this study is thus to devise a culturally and linguistically appropriate perceptual speech assessment tool for Amharic, which can be used for clinical and research purposes. As stated above, this chapter describes the assessment protocol developed for this study, which was based on the Great Ormond Street Speech Assessment protocol (GOS.SP.ASS ’98; Sell *et al.*, 1999). Prior to the description of the protocol, there is a consideration of issues relating to the diversity of methods and protocols that exist for evaluating speech production in individuals with cleft palate. Subsequently, the rationale for choosing GOS.SP.ASS ’98 as a basis for developing an assessment protocol for Amharic-speaking individuals with cleft palate will be explained. Then, the speech parameters included in the assessment material will be defined and described. Here, changes and additions made to the original GOS.SP.ASS. ’98 will be explained. This will be followed by a discussion on the methods and procedures followed to devise the present protocol.

6.2. Speech assessment protocols

The methods and protocols used for the assessment of cleft palate speech vary from country to country and among clinics. The lack of an acceptable framework for evaluating speech output in this population has been a fundamental problem for clinicians and researchers. To address this issue, various attempts have been made to standardize the procedures and systems used in the assessment of cleft-related speech. For example, one of the major aims of the 7th Congress on Cleft Palate and Related Craniofacial Anomalies held in 1993 was to develop basic protocols of speech assessment which can be used internationally.

In a similar vein, in 2001, different approaches were proposed at the 9th International Congress on Cleft Palate and Related Craniofacial Anomalies in order to standardise speech assessment procedures and protocols (Lohmander and Olsson, 2004; Sell, 2005). GOS.SP.ASS. was one of the procedures presented at the symposium together with three other assessment protocols, namely, the Japanese system for assessing cleft palate speech, the perceptual system for evaluation of cleft-related speech used in the United States (American Cleft Palate-Craniofacial Association, 1993), and Cross Linguistic Outcome Comparison (CLOC) (Hutters and Henningsson, 2001). In 2006, an assessment tool, Cleft Audit Protocol for Speech-Augmented (CAPS-A), (John *et al.*, 2006), was proposed for use in inter-centre audit studies of cleft speech in UK. This protocol is an improved version of Cleft Audit Protocol for Speech (CAPS; Harding *et al*., 1997), which was developed based on GOS.SP.ASS. ’94 (Sell *et al.*, 1994a). More recently, in 2008, Henningsson and colleagues (Henningsson *et al.*, 2008) published a universal system for reporting speech outcomes in individuals with cleft palate, which is an outcome of a working group that was formed at the 2002 American Cleft Palate-Craniofacial Association annual meeting.

6.3. Why GOS.SP.ASS?

As has been discussed above, several systems are available for evaluating the speech output of individuals with cleft palate. There are a number of reasons why GOS.SP.ASS was chosen to serve as a foundation for the development of the assessment protocol used for this study. First, GOS.SP.ASS is recognized to be comprehensive for clinical and research purposes and provides good levels of inter-judge reliability (Sell *et al*., 1999; John *et al*., 2006). Second, in a UK survey (Razzell and Harding, 1995; as cited in John *et al*., 2006) that was conducted to choose a preferred procedure for clinical and research purposes, six speech assessment protocols were reviewed and compared across four parameters: ease of use, speed of use, comprehensiveness of information and accessibility of information from completed forms. GOS.SP.ASS (Sell *et al*., 1994) was selected as the optimal protocol. It was revised in 1998 (GOS.SP.ASS ’98; Sell *et al*., 1999). The revision aimed to avoid ambiguities, facilitate form completion, and include additional parameters that are useful in caseload management. Third, the protocol uses a common set of sentences, which can be replicated in other languages and used to elicit speech samples that are comparable across individuals or across different time points for an individual speaker. GOS.SP.ASS has been translated into other languages such as German (Bressmann *et al.*, 2002). Fourth, aside from enabling us to assess different aspects of speech production such as articulation, resonance and voice quality, the system makes it possible to describe the visual appearance of speech and offers a systematic approach to an oral examination. The protocol devised for this study not only will serve as a data collection tool for research purposes, but could be used for clinical purposes as well.

6.4. The Structure of GOS.SP.ASS (Amharic)

In this section, the structure of the GOS.SP.ASS, as originally devised for English, is described. It is important to note that the structure of the Amharic- GOS.SP.ASS is similar to that of the original English- GOS.SP.ASS (Sell *et al*., 1999). Specific reference is made to the adaptations that were necessary when devising a version for the Amharic language. The protocol (see Appendex-3) is composed of four parts, namely, (1) patient identification information, (2) resonance and airflow, (3) consonant production, and (4) other sections. The latter includes those used to identify and describe visual appearance, aetiology, oral examination, to record issues relating to treatment, and to describe categories that capture speech parameters such as speech understandability and speech acceptability. Each of these sections will be described in turn.

6.4.1. Patient identification information

This first part of the protocol is designed to record the demographic information of patients. The data include name and age of patient at the time of evaluation, type of cleft, date of surgery, patient's hospital number, date of evaluation, tape number and patient's first language. In addition, Henningsson *et al*. (2008) suggest that it is important to document the name and address of a contact person and gender of the patient. Hence they are included in our system, for optional use. This section of the

English GOS.SP.ASS ’98 contains only name, age, cleft type, hospital number, and tape number.

6.4.2. Resonance and airflow

As indicated in Chapter 3, resonance refers to propagation of sound in the vocal tract, while airflow refers to the amount and direction of air used for the production of speech sounds. Speech parameters that are included in this part of the protocol include: hypernasality, hyponasality, mixed resonance, nasal emission, nasal turbulence and grimace. Each of these parameters will be defined and described below.

i. Hypernasality

As discussed in chapter 3, a range of rating scales have been used to evaluate hypernasality. The English GOS.SP.ASS ’98 uses a 4-point scale. Each point on the scale is defined and described in terms of their corresponding level of severity. Grade 0 corresponds to normal tone; Grade 1 indicates hypernasal resonance perceived on vowels and approximants; Grade 2 shows hypernasal resonance perceived on vowels and approximants, but also involves noticeably weakened consonants with nasalization of voiced consonants; and Grade 3 represents all the above features of hypernasality plus the replacement of voiced plosives /b d ɡ/ by their nasal counterparts [m n ŋ]. Hypernasality can be perceived consistently or inconsistently; and GOS.SP.ASS ’98 offers options to record this. For the GOS.SP.ASS (Amharic) protocol a 4-point scale for hypernasality rating together with the categories to rate consistency is also used. The 4-point scale was not modified, as suggested in the literature (e.g., John *et* al., 2006; Henningsson *et al.*, 2008; Sweeney, 2011).

Grade 0 shows a typical tone. Grade 1 indicates hypernasal resonance perceived on vowels and approximants: [ã ũ õ] [w̃ j̃ l̃ r̃]. Grade 2 represents hypernasal resonance perceived on vowels and approximants, but can also involve markedly weakened consonants with nasalisation of voiced consonants: [ã ũ õ], [w̃ j̃ l̃ r̃], [b̃ d̃ z̃]. Grade 3 indicates when voiced plosives are replaced by their nasal equivalents: /b d g/→[m n ŋ].

ii. Hyponasality

Judgements of hyponasality are made on production of nasal consonants. The English GOS.SP.ASS uses a 3-point scale for rating hyponasality. Following Henningsson *et al.*, (2008) a binary system, i.e., present vs. absent, is used for the GOS.SP.ASS (Amharic) protocol because John *et al.* (2006b) reported an increase in reliability of hyponasality rating when the scale was reduced from a 3-point scale to a binary scale. Cul-de-sac resonance and mixed resonance are also included in the present protocol and a binary system (i.e., *present* vs. *absent*) is used to judge them.

iii. Nasal emission and/or nasal turbulence

Nasal emission, in individuals with cleft palate, is most commonly associated with a relatively large velopharyngeal opening and/or the presence of fistula in the palate (Sweeney, 2011). Hence, nasal emission is divided into three categories: *inaudible nasal emission*, *audible nasal emission* and *nasal turbulence* (McWilliams *et al.*, 1990). Inaudible nasal emission occurs when there is emission of air though the nasal cavity during the production of high pressure consonants (i.e., stops, fricatives and affricates), but it is not perceived by the listener. GOS.SP.ASS. ’98 provides a mirror test to detect inaudible nasal emission. The test, which is also included in the Amharic adaptation, can be carried out by placing a mirror under the nose and looking for misting on the mirror during sound production.

Audible nasal emission occurs when there is audible escape of air though the nasal cavity during the production of high pressure consonants (McWilliams *et al*., 1990). The English GOS.SP.ASS. ’98 employs a 3-point scale for rating nasal emission and nasal turbulence together with additional categories to further specify audibility, consistency, and whether the nasal emission or turbulence is perceived as accompanying or replacing consonants. CAPS-A (John *et al*., 2006) also uses a 3-point scale for these parameters. The same scale (i.e., a 3-point scale) is used for the present protocol, where 0 = absent nasal emission/turbulence, 1 = slight nasal emission/turbulence, 2 = marked nasal emission/turbulence.

iv. Grimace

Nasal grimace refers to the visible consequences of the closing of the nares by constricting of the alae in an attempt to inhibit nasal emission, and in its more severe form, may include the forehead too, resulting in facial grimace (Sweeney *et al*., 1996). GOS.SP.ASS. ’98 uses a 4-point scale for rating grimace. However, John *et al*. (2006) showed an increase in reliability of grimace ratings when the scale was reduced to a 2-point scale. Accordingly, a binary system (*presence* vs. *absence*) for rating of grimace, in tandem with categories (*consistent* vs. *inconsistent*) identifying its consistency is used for GOS.SP.ASS. (Amharic)

6.4.3. Consonant realisations

In this section, the cleft-type consonant realisations (CTCs) that are included in the assessment material will be described. The section is divided into four sub-sections: *anterior oral cleft-type consonant realisations*, *posterior cleft-type consonant realisations*, *passive cleft-type realisations*, and *non-pulmonic realisations*. The later sub-section is added to the original GOS.SP.ASS, partly because it is important to capture realisations produced with non-pulmonic airstream mechanisms (ejectives, clicks and implosives) and partly because the phonological system of Amharic contains ejectives. When completing the form, it is suggested that typical realisations, regardless of syllable/word position, are circled, while atypical realisations are transcribed phonetically in the space below the target consonant. It is also suggested that phonetic variability needs to be recorded. Separate spaces are provided to note differences in syllable/word-initial and syllable/word-final realisations. Further transcription details can be recorded in the space reserved for the transcription of spontaneous speech.

i. Anterior oral cleft-type consonant realisations

Atypical consonant realisations included in this category are misarticulations of tip/blade sounds, lateralization, palatalization/palatal articulation and double articulation.

a) Misarticulations of tip/blade sounds

This category includes dentalization, interdental and linguolabial articulations. Dentalization refers to the articulation of an anterior consonant in which the tongue tip makes contact with the back of the upper front teeth (e.g., [d̪]). Interdental articulation indicates the production of speech sounds by placing the tip of the tongue between the upper and lower front teeth (e.g., [n̪͆]). A linguolabial consonant is made by placing the tongue tip against the upper lip (e.g., [t̼]).

b) Lateralization/lateral articulation

Such articulation occurs when the pulmonic air stream is directed down one or both sides of the oral cavity and the tongue blocks the centre path. For example, in cleft-related speech, /s/ and /ʃ/ may be realised as [ɬ].

c) Palatalization

Sell *et al.*, (1999) made a distinction between palatalization, which is a secondary articulation that modifies correct target realisation (e.g., [dʲ]), and palatal realisation [ç], replacing the target consonant. This distinction is made in the Amharic GOS.SP.ASS as well.

d) Double articulation

Doubly-articulated speech sounds are those which have two simultaneous articulations of the same degree of stricture (Ladefoged and Maddieson, 1996). An example of common double articulations in the cleft population can be: /t d/→ [t͡k, d͡g].

ii. Posterior cleft-type consonant realisations

This category captures patterns of backed articulation and active nasal fricatives.

a) Backing

Backed articulatory patterns commonly observed in individuals with cleft palate fall into two categories: *backing within the oral cavity*; and *backing to post-uvular place*.

i. Backing within the oral cavity

This category identifies pressure consonant targets that are realised at palatal, velar or uvular places. For example, /t d/ may respectively be realised as mid-dorsum palatals [c, ɟ], or as velars [k g] or uvular stops [q ɢ]. Likewise, /s z/ can respectively be realised as palatal [ç ʝ] or as velar [x ɣ] or as uvular fricatives [χ ʁ].

ii. Backing of oral targets to post-uvular place

This category captures both pharyngeal and glottal realisations of target oral pressure consonants. Possible pharyngeal productions include pharyngeal stop /ʡ/, pharyngeal fricatives /ħ ʕ/, and pharyngeal affricates /ʡħ ʡʕ/. Glottal productions include glottal stop /ʔ/ and /h/. Even though /ʡ/ is categorized on the IPA chart as an epiglottal plosive, it is also used here for the pharyngeal stop as it has been shown (e.g., by Esling, 1999) that there is not good evidence that the two articulations, i.e., pharyngeal and epiglottal are distinct.

It is important to note that the GOS.SP.ASS '98 and the IPA only recognise pharyngeal fricatives. Even though pharyngeal stops and affricates have not yet been accepted universally, it is important to record them if they are perceived (Howard and Heselwood, 2011).

b) Active nasal fricatives

The production of active nasal fricatives involves the stopping of airflow in the oral cavity and active direction of the pulmonary air nasally, as an alternative articulation to an oral fricative realization (Harding and Grunwell, 1998a). This category captures fricative targets that are realised by voiceless nasals with additional audible nasal emission (e.g., realisation of /f/ as [m̥͋] or /s/ as [n̥͋]). In cases where a backing pattern is also present, /s ʃ/ are often realised as [ŋ̊͋] (Sell *et al.*, 1999).

iii. Passive cleft-type consonant realisations

As noted in chapter 2, passive realisations occur when no compensation is made for the effects of the cleft. These include weak/nasalised consonants, nasal realizations of fricatives, nasal realisations of plosives, absent pressure consonants and gliding of fricatives/affricates.

a) Weak/nasalized consonants

These are pressure consonants that are weakly articulated due to reduced oral pressure. Weak oral pressure consonants may be associated with nasalised consonant productions such as [ṽ̥ z̥̃ b̥̃ d̥̃].

b) Passive nasal fricatives

Harding and Grunwell (1998) defined a passive nasal fricative as an unreleased /s/, transcribed as [(s)], double-articulated with a voiceless nasal, transcribed as [n̥], i.e., a production of an intended /s/ accompanied by unintended nasal airflow [(s)͡n̥].

c) Nasal consonant for oral pressure consonants

This category captures atypical realisations where the target oral pressure consonant is replaced by a nasal consonant. For example, /b/ may be realised as [m].

c) Nasalised voiced pressure consonants

This involves nasalisation of voiced pressure consonants, which may occur with moderate or severe levels of hypernasality.

d) Absent pressure consonants

This category identifies speech patterns where there is a lack of pressure consonants, and therefore a limited range of consonants, consisting of nasals and approximants.

e) Gliding of fricatives/affricates

This category captures the realisations of fricatives such as /s ʃ/ as [j] or [w]. This characteristic is seen in non-cleft children as an uncommon developmental process (Grunwell, 1987). Sell *et al*. (1999) also suggested that it might be a persistent developmental process which is perpetuated due to the cleft palate. Harding and

Grunwell (1998) considered gliding of fricatives as an active process because in their data the glide [j] was consistently produced as an active alternative to the target fricatives /s z ʃ/.

iii. Non-pulmonic realisations

This is an additional category to the original GOS.SP.ASS, added with particular reference to the phonological system of Amharic, i.e., Amharic has non-pulmonic (ejective) as well as pulmonic consonants (see Chapter 5). The category identifies the use of atypical airstream mechanisms. Individuals with cleft palate may realise pulmonic consonants as clicks and ejectives as plain pulmonic egressive consonants or as implosives. For example, /s/ may be realised as [ǂ$^{\text{ŋ}}$]; /t̪’/ as [t̪] or as [ɗ]. Such realisations can be summarised using the categories in this section of the protocol.

6.4.4. Other sections

i. Transcription of spontaneous speech

This section can be used to record atypical consonant productions observed in spontaneous speech. Other types of realisations such as unusual vowels and consonant harmony can also be recorded in this section.

ii. Developmental realisations

This category includes atypical speech sound realisations that are commonly observed in typical speech development. They may also indicate a coexisting phonological delay or disorder or mask articulatory constraints resulting from the cleft palate (Sell *et al*., 1999). Such developmental ‘errors’ include: fronting, cluster reduction, stopping, gliding of liquids, and consonant omission (Henningsson *et al*., 2008).

iii. Summary of speech patterns

This section is intended to provide an overview of the speech output being assessed. The section has eight categories: normal consonants, no CTCs, anterior CTCs, posterior CTCs**,** non-pulmonic realisations, passive CTCs, developmental realisations, and others.

iv. Speech and language therapy

This is a summary of current state of intervention recommendations, that is, a record of whether a patient requires therapy, is to be placed on a waiting list for regular therapy, is currently receiving therapy, etc.

v. Relevant information from parents

This is to record information relating to intensity, frequency and focus of therapy, child's health, hearing, progress at school, and any parental concerns with speech and appearance.

vi. Voice

GOS.SP.ASS '98 uses a descriptive category measure for evaluating voice quality, that is, *normal*, *dysphonic*, and *reduced volume*. John *et al.*'s (2006) study showed that intra-rater reliability increased when a binary system (*absent* vs. *present*) was used. Henningsson *et al*. (2008) also suggested a binary rating in which, 0=no voice disorder and 1=voice disorder. Following John *et al.*'s (2006) and Henningsson *et al*. (2008), a binary rating is used for this system.

vii. Visual appearance of speech

This category captures any significant appearance and/or movement of the visually accessible speech organs (e.g., lips and tongue tip) and the face.

viii. Oral examination

This section is meant to identify problems relating to the structure and function of the nose, lips, the tongue, teeth, hard and soft palate, and nasopharynx.

ix. Language

Information relating to the expressive and receptive language is recorded here. The section has three categories: *normal, delayed* and *disordered*.

x. Speech understandability and speech acceptability

These categories are added to the original GOS.PA.ASS because the literature recommends the reporting of speech intelligibility (Whitehill, 2002; Sell, 2005; John *et al*., 2006; Henningsson *et al*., 2008; Whitehill *et al.*, 2011). As indicated in chapter 3, speech understandability refers to the magnitude to which the listener understands the speaker's message; and speech acceptability refers to 'the degree to which speech calls attention to itself apart from the content of the spoken message' (Henningsson *et al*., 2008:09). In the protocol outlined in this study, speech understandability is described using four categories: (a) *always easy to understand*; (b) *occasionally hard to understand*; (c) *often hard to understand*; and (d) *mostly or always hard to understand*. Equally, judgement of speech acceptability is made using four categories: (1) *normal*; (2) *deviates from normal to a mild degree*; (3) *deviates from normal to a moderate degree*; and (4) *deviates from normal to a severe degree*. These are the categories used in Henningsson *et al*., (2008) to describe the two parameters.

xi. Aetiology

In the section, syndromes associated with cleft palate are recorded. In addition, relevant information from team members (e.g., orthodontics, audiology, plastic surgery, etc) is noted here.

xii. Management plan

Treatment plans and recommendation for future management are recorded in this section.

xiii. Additional notes section

Supplementary comments can be included in this section. It can also be used to note parental attitudes, and advice and recommendations provided by the speech language therapist.

xiv. Areas requiring further assessment

Issues that need further consideration (e.g., an ENT or orthodontic opinion) are recorded here. It may be valuable to include a full phonetic and phonological assessment together with notes of instrumental assessments (e.g., investigations done using videofluoroscopy, anemometry).

6.5. Development of Speech materials for the Amharic version

The main adaption to the English version was to create a set of sentences for speech elicitation, in Amharic, that met the criteria for the GOPASS protocol. The procedure that was followed when creating these sentences will now be described.

The Amharic sentences were developed following the GOS.SP.ASS guideline. Based on the guidelines, efforts have been made to include one target consonant only in different word positions, to control the potential effects of assimilation; and to exclude other influencing ‘vulnerable’ consonants in the sentences. Moreover, attempts were made to make the sentences ‘short, imagable, meaningful, and relevant’. Finally, each sentence was constructed in such a way that they can be short but containing the maximum number of each target consonant. Then, the sentences were pre-tested on two typically-developing children (aged 4;8 and 5;0); and revisions were made based on the observations on the children's productions. The revisions were mainly in terms of sentence length, that is, some of the sentences were made shorter, which sometimes led to changes in the structure and content of the sentences. For example, the sentence which was initially devised to elicit realisations of target /f/ was /wəfu zaf laj t̪əkk'əmət̪t̪'o fɨrafɨre bəlla/, '*The bird sitting on the tree ate seeds (fruit)*'. However, as the children found the sentence rather difficult to produce, the sentence was modified: /wəfu fɨəlu laj t̪əkk'əmət̪t̪'ə/ '*The bird sat on the goat*', which was shorter and easier to produce.

It is important to consider some of the linguistic issues involved in devising a protocol for Amharic compared with English. One of the challenges was avoiding other vulnerable consonants than the targets, as they might interfere with production or perception of target consonants. A word may be short, imagable, contain word/syllable-initial and -final pulmonic target, but may have a word-medial ejective consonant. For example, the word /t̪əʧ'awət̪/ '*play imp.2ms*', can be used in a sentence /ajat̪u t̪at̪in t̪əʧ'awət̪ alut̪/ '*Tati's grandmother/father told him to play*', to elicit target /t̪/; however, the fact that the word /t̪əʧ'awət̪/ has word-medial /ʧ'/, which may disturb production or perception of /t̪/, makes the word less favourable.

A word may be acceptable in terms of imagability and its content, but its position in the sentence or its syntactic feature may necessitate the attachment of certain grammatical or structural markers to some of the words. For example, the sentence, /lilli wələlu laj t̪əɲɲa-ʧ/ '*Lilli slept on the floor*', is generally acceptable, in terms of imagability, distribution of the target sound (i.e., /l/), etc. However, as the subject /lilli/ '*person's name*' is of a feminine gender, the gender marker {-ʧ}, which is a vulnerable sound, is suffixed to the verb. Besides, one may wonder why the verb/phrase /t̪əɲɲa-ʧ/, '*she slept*', which contains another vulnerable consonant (i.e., /t̪/), was chosen. The reason was, given the prepositional phrase is /wələlu laj/, '*on the floor*', which is made of words containing only the target sound (/l/), vowels and approximants, that the other possible main verbs which go in harmony with the prepositional phrase are /t̪əkk'mət̪'ə-ʧ/ '*she sat*', /k'omə-ʧ/ '*she stood*', etc, which contain more pressure consonants than /t̪əɲɲa-ʧ/. Verbs such as /ajjə-ʧ/ '*she saw*' may have less vulnerable consonants, but could not meet the grammatical requirements. For example, if the verb/phrase /ajjə-ʧ/ '*she saw*' was used in the sentence, the resulting structure would be * /lilli wələlu laj ajjə-ʧ/ * '*Lilli saw on the floor*.', which is unacceptable unless a noun or noun phrase (i.e., what Lilli saw) is embedded, which makes the sentence longer and more difficult for the children to say.

Another issue is that, in Amharic, some sounds (e.g., /p/, /v/, /ʒ/, /p'/) are found only in borrowed words and their occurrences in words are limited, making it difficult to come up with words which are imagable, contain only the target sounds and can allow a sentence construction which is short. Moreover, some sounds have limited distribution in terms of word/syllable position. For example, as noted in chapter 4, in Amharic, /ɲ/ does not occur word-initially. Gemination, which is a common and contrastive phonological feature in Amharic also posed another challenge. A word might be a perfect candidate in terms of its imagability and sound distribution, but contain a geminated target segment, which children may produce differently from its singleton cognate.

The issue of imagability is also present another challenge. A word may meet the phonological and morpho-syntactic criteria, but may be difficult for the children to conceptualize. For example, even though the /s’əhaj s’əs’ət̪u s’ənnabat̪/ ‘*Tsehay’s guilty conscience has got worse*’ is generally fine in terms of containing the possible number of the target consonant (i.e., /s’/) in a relatively short sentence; however, in terms of imagability, it would be difficult for young children to conceptualise what the sentence is actually about. Furthermore, using pictures that demonstrate the sentences may facilitate conceptualisation, be enjoyable and engaging and hence assist the elicitation process. However, some sentences may meet all the relevant criteria (i.e., imagability, sound distribution, length, etc) discussed above, but may be difficult to demonstrate in pictures. For example, the sentence /as’ew s’oməw s’ələju/ ‘*The emperor fasted and prayed*’ generally meets most of the criteria discussed above. However, depicting, the concepts of *fasting* and *praying*, in a picture is not an easy task to do.

6.6. Summary

This chapter has provided an overview of the perceptual speech assessment protocol developed for the assessment of speech production in Amharic-speaking individuals with cleft palate. The chapter started with explaining the importance of speech protocol in the assessment and management of communication difficulties and the need for a separate protocol for the Amharic language. Then, the rationale for selecting GOS.SP.ASS to serve as a foundation for the current protocol has been explained.

Moreover, the speech parameters and categories included in the protocol have also been defined and described. The changes made to the original GOS.SP.ASS have also been explained. Details regarding the sub-categories of the parameters can be found in GOS.SP.ASS ’94 and GOS.SP.ASS ’98 (Sell *et al.*, 1994; 1999). An account of how the Amharic sentences were developed, piloted and the challenges faced during the development of the sentences have also been provided.

This chapter has presented an account of the challenges encountered in devising the assessment tool. These included keeping the sentences short without significantly decreasing the number of target consonants, and making the vocabulary imagable. Also, avoiding the interference of unwanted phonemes/morphemes with the target phoneme due to the morpho-syntactic requirements of the words used in the sentences, and the effects of gemination was not an easy task. Moreover, the limited distribution of some phonemes and depicting the sentences in pictures which the children are shown when they are asked to repeat the sentences also presented a challenge. Given the ways in which the challenges were dealt with, together with the remaining limitation which could not be overcome, the devised assessment material appears to be effective for collecting data for a study such as this one. It is important, however, to note that, in the future, the protocol should be tested for reliability and validity; and its efficacy should also be evaluated.

Chapter 7 to 11 present discuss the results of the present study in relation to previous reports. So, the next chapter provides an overview of developmental speech production features in Amharic, which can serve as a basis for the descriptions of cleft speech production features presented in chapter 8.

Chapter 7: Speech development in typically-developing Amharic-speaking children

7.1. Introduction

This chapter describes patterns of speech production in typically-developing children and provides a summary of speech development in typically-developing Amharic-speaking children. The main reason for providing an account of a small-scale study designed to provide data on speech development in Amharic is because there is very little previous literature to draw on for comparative purposes for the main study. The chapter has two main parts. The first part reports results from the perceptual phonetic and phonological analyses of the speech of five typically-developing children. These children form the control group of this study. The point of having the control group is not to demonstrate speech development per se in Amharic but to provide control data for the children with cleft palate. Thus the children reported here are relatively old in terms of speech development generally. Many of the developmental immaturities which might have been present at an earlier age are likely to have disappeared by the time these children were studied.

Details of the children are provided in Table 7.1. Because analysis of the speech of the two oldest children showed that their speech output closely resembled that of adult Amharic speakers, their speech is not described in detail. The second part of the chapter summarises the general trends observed here, together with other developmental realisations noted in an earlier study (Mekonnen, 2008). The chapter addresses the following questions.

Research questions addressed in this chapter:

- What are the main developmental speech characteristics of typically-developing Amharic-speaking children?
- How do these characteristics compare with patterns reported for other languages?

Table 7.1 Demographic data on the five typically-developing children.

Participants	***Gender***	***Age***
Eldana	F	4;2
Abenzer	M	4;8
Dagem	M	5;3
Eyuel	M	5;5
Sunamawit	F	5;7

7.2. Phonetics and phonology of the typically-developing children

This section aims to provide an overview of typical speech development in Amharic-speaking children. First, the speech output of the typically-developing children of this study will be described. Then, the general trends observed and other developmental realisation noted in Mekonnen (2008) will be summarised.

As the first step, the consonant repertoire of each of the three younger children is presented individually (Tables 7.2-7.7). SIWI stands for syllable-initial-word-initial; while SFWF represents syllable-final-word-final. The shaded boxes denote that the target segment does not occur in that position in Amharic. For all children (including the children with cleft palate), an example for SFWF /v/ could not be collected because, as pointed out in chapter four, in Amharic, the distribution of /v/ is restricted to words of foreign origin (e.g., television, virus, nerve, etc.), and hence its frequency is limited. The bold font in the tables signifies a realisation different from the target. The data presented do not include processes such as cluster reduction involving more than one segment.

7.2.1. Eldana

A number of non-adult, presumably developmental realisations were identified in Eldana's speech, shown in bold on Table 7.2.

Table 7.2 Eldana's consonant realisations.

Pulmonic consonants																					
Place	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	ʧ	ʤ	ɲ	k	g	ʔ	h
SIWI	m	p	b	f	**b**	n	l	t̪	d	**ʃ**	**ʃ**	**l**	ʃ	**ʃ**	ʧ	**ʧ**	ɲ	k	**k**	ʔ	h
SFWF	m	p	b	f		n	l	t̪	**t**	**ʃ**	**ʃ**	**l**	ʃ	**ʃ**	ʧ	**ʧ**	ɲ	k	**k**		h

Ejectives					
Place	***Bilabial***	***(Denti)alveolar***		***Post-alveolar***	***Velar***
Target	p'	t̪'	s'	ʧ'	k'
SIWI	p'	t̪'	s'	ʧ'	k'
SFWF		t̪'	s'	ʧ'	k'

In Table 7.3 these realisations are classified and described in terms of a set of phonological processes, which includes stopping (i.e., substitution of a stop for a fricative), gliding, backing, word-final devoicing, and substitution of [l] for /r/. Examples of each developmental process are given in the table, which also includes instances of cluster reduction, not shown in Table 7.2.

Table 7.3 Eldana's developmental realisations

Process	***Pattern***	***Target***	***Realisation***	***Gloss***	***Source of example***
Stopping	/v/→[b]	/t̪ivi/	[t̪ibi]	'*television*'	GO.SP.ASS.
Backing	/s/→[ʃ]	/sisaj/	[ʃiʃaj]	'*person's name*'	GO.SP.ASS.
Cluster reduction	/s/→ø	/sost̪/	[sot̪]	'*three*'	counting
	/n/→ø	/sɨmɨnt̪/	[ʃɨmɨt̪]	'*eight*'	counting
Devoicing	/ʒ/→[ʃ]	/məjaʒa/	[məjaʃa]	'*handle/case*'	GO.SP.ASS.
	/g/→[k]	/gabi/	[kabi]	'*a cotton shawl*'	single-word
	/ʤ/→[ʧ]	/ʤəbəna/	[ʧəbəna]	'*coffee pot*'	single-word
Backing & devoicing	/z/→[ʃ]	/azzəzə/	[aʃʃəʃə]	'*he/it ordered*'	GO.SP.ASS.
Word-final devoicing	/d/→[t]	/wənd/	[wənt]	'*male*'	spont. speech
Substitution of /r/	/r/→[l]	/arat/	[alat]	'*four*'	counting

7.2.1.1. Variations conditioned by context and/or elicitation mode

The realisation of /v/ as [b] was limited to the word /tivi/ '*tivi*', which is a short form of '*television*'. This is the only word included in the assessment materials (i.e., GOS.SP.ASS) and no other word containing this sound was collected. This is because, as already noted, /v/ is lexically restricted. The cluster reductions, i.e., reduction of the number of consonants that appear together in a syllable without a vowel between them, were observed in all word positions and in all speech sampling conditions. Regarding variations conditioned by mode of elicitation, the production of /s/ as [ʃ] was noted in the sentence repetition task but not in single words. The devoicing of /ʒ/, /g/ and /ʤ/ was not context-dependent. It occurred in all word positions and across all elicitation modes. Also, the productions [ʃ] for /z/ and [l] for /r/ were noted in all word positions and across all elicitation modes. Devoicing of word final /d/ was also observed in all elicitation modes.

The fricatives /s/ and /ʃ/ were realised as [ʃ] in all contexts; and both affricates were realised as [ʧ]. Also, the contrasts between /b/ and /v/ and between /l/ and /r/ are lost in her speech. Word-final devoicing of [d] also affects Eldana's ability to signal the contrast between the following words, for example /wɨsəd/ '*take (masc. imp.)*' vs. /wɨsət̪/ '*borrowing*'.

7.2.2. Abenzer

Table 7.4 Abenzer's consonant realisations.

Pulmonic consonants																					
Place	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	ʧ	ʤ	ɲ	k	g	ʔ	h
SIWI	m	p	b	f	b	n	l	t̪	d	ʃ ø	ʒ	l	ʃ	ʒ	ʧ	ʤ	ɲ	k	g	ʔ	h
SFWF	m	p	b	f		n	l	t̪	t	ʃ	ʒ	l	ʃ	ʒ	ʧ	ʤ	ɲ	k	g		h

Ejectives					
Place	***Bilabial***	***(Denti)alveolar***		***Post-alveolar***	***Velar***
Target	p'	t̪'	s'	ʧ'	k'
SIWI	p'	t̪'	s'	ʧ'	k'
SFWF		t̪'	s'	ʧ'	k'

Abenezer also exhibited some of the developmental realisations seen in Eldana's speech. The phonological processes identified in Abenzer's speech include stopping, backing, cluster reduction, devoicing of the final voiced consonant /d/, and substitution of [l] for /r/. Below are examples of each of these processes.

Table 7.5 Abenzer's developmental realisations

Process	***Pattern***	***Target***	***Realisation***	***Gloss***	***Source of Example***
Stopping	/v/→[b]	/t̪ivi/	[tibi]	'*television*'	GOS.SP.ASS.
Backing	/s/→[ʃ]	/ammɨst̪/	[ammɨʃt̪]	'*five*'	spont. speech
Cluster reduction	/s/→ø	/ammɨst̪/	[ammɨt̪]	'*five*'	spont. speech
Word-final devoicing	/d/→[t]	/and/	[ant]	'*one*'	spont. speech
Substitution of /r/	/r/→[l]	/fərəs/	[fələʃ]	'*horse*'	single-word

7.2.2.1. *Variations conditioned by context and/or elicitation mode*

As was the case with Eldan’s speech, the realisation of /b/ as [v] was limited to one word; so no variation conditioned by context could be found. The production of [ʃ] for /s/ was noted in all speech samples both word-initially and word-finally. The devoicing of /d/ was also noted in the spontaneous conversational speech sample, but not in other samples. For example, as indicated in Table 7.5, the example given (i.e., /and/ ‘*one*’) was taken from the spontaneous speech sample.

In fact, in Amharic, as is in many other languages (e.g., English, Harris, 1994; German, Brockhaus, 1995; Luo (Dholuo), Tucker, 1994), it is typical for adults to at least partially devoice word-final /d/, so the child’s realisation might not be considered ‘developmental’ or ‘inappropriate’. The realisation of [l] for /r/ is consistent in all word positions and across all elicitation modes.

7.2.3. Dagem

Table 7.6 Dagem’s consonant realisations.

Pulmonic consonants																					
Place	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	ʧ	ʤ	ɲ	k	g	ʔ	h
SIWI	m	p	b	f	b	n	l	t̪	d	s	z	l	ʃ	ʒ	ʧ ʃ	ʤ	ɲ	k	g	ʔ	h
SFWF	m	p	b	f		n	l	t̪	d	s	z	l	ʃ	ʒ	ʧ	ʤ	ɲ	k	g		h

Ejectives					
Place	***Bilabial***	***(Denti)alveolar***		***Post-alveolar***	***Velar***
Target	p’	t̪’	s’	ʧ’	k’
SIWI	p’	t̪’	s’	ʧ’	k’
SFWF		t̪’	s’	ʧ’	k’

Dagem's sound system appears to be quite mature, in relation to the other two children. Developmental realisations noted in his speech include the substitution of [l] for /r/, realisation of /v/ as [b] and /ʧ/ as [ʃ]. Below are some examples showing his realisations of /r/ as [l].

Table 7.7 Dagem's realisation of the alveolar trill /r/.

Target	***Realisation***	***Gloss***	***Source of example***
/fɨre/	[fɨle]	*'seed'*	GOS.SP.ASS.
/ɨrrəɲɲa/	[ɨlləɲɲa]	'*shepherd*'	GOS.SP.ASS.
/fərəs/	[fələs]	'*horse*'	single-word
/nəbɨr/	[nəbɨl]	*'tiger'*	spont. speech
/rəsahu/	[ləsahu]	*'I have forgotten'*	spont. speech

7.2.3.1. Variations conditioned by context and/or elicitation mode

Dagem realised /r/ as [l] consistently, and no difference conditioned either by elicitation mode or context was found. The realisation of /v/ as [b] was seen in the word /t̪ivi/ '*television*', which he realised as [t̪ibi]. In addition, in the conversational speech sample, there were repeated instances where he spontaneously realised /ʧ/ as [ʃ], and then became aware of his misarticulation and corrected himself. For example, he realised /ʧaʧi/ '*person's name*' as [ʃaʃi]; and /ʧɨbbo/ '*bonfire*' as [ʃɨbbo]; but he immediately corrected himself.

7.3. Summary

This section summarizes the developmental realisations identified in the speech of the three typically-developing children together with other productions reported in Mekonnen (2008). That study described variants of the alveolar trill /r/ and other developmental realisations in twenty-four typically-developing Amharic-speaking children, aged between 2;0 to 4;11.

a. Stopping

Following Edwards and Shriberg (1983), stopping is taken here to refer to fricatives, affricates, liquids, and glides being replaced by stops. The only stopping pattern observed in the control group of this study was the realisation of /v/ as [b], which was also reported in Mekonnen (2008). Such stopping patterns (i.e., /v/→[b]) have also been reported for other languages such as English (e.g., Smith, 1973; Ingram, 1976; Grunwell, 1985), Hindi (Srivastava, 1974); and Czech (Pačesova, 1968). However, stopping of alveolar fricatives, and post-alveolar fricatives and affricates have not been observed in the speech of the control group of this study; nor have they been reported in Mekonnen (2008), which included children as young as 2;0.. Whether stopping of /s z/ does not occur at all in Amharic, or it has been suppressed by age 2;0 is a matter that needs to be further investigated.

b. Assimilation/consonant harmony

Mekonnen (2008) found assimilation/consonant harmony in the speech of a boy, aged 2;8. This boy occasionally realised /f/ as [t̪], which can be illustrated by such words as /fant̪a/ '*a brand of soft drink*' or '*share*' and /fit̪/ '*face*' which he consistently realised them as [t̪at̪a] and [t̪it̪], respectively. The stopping of /f/ is a regressive non-contiguous assimilation, triggered by the /t̪/. The boy also stopped /f/ in other positions. For example, he realised /t̪'əffa/ '*lost*' as [t̪ət̪t̪a]; /t̪'ɨffi/ '*slap*' as [t̪ɨt̪t̪i] and /kənfər/ '*lip*' as [t̪ət̪əj]. The boy demonstrated that he could produce /f/ in words such as /fɨre/ '*seed*' and /wəf/ '*bird*', which he produced as [fɨje] and [wəf] respectively. The stopping of /f/ appears to occur when /f/ occurs in words which contain stops and ejective stops. Moreover, Mekonnen (2008) reported that two children (aged 2; 9 and 3;6) realised /t̪/ as [p] and /d/ as [b] in such words as /t̪ep/ '*tape player*' and /dabbo/, which were respectively realised as [pep] and [babbo]. These realisations also appear to be a result of a regressive non-contiguous assimilation.

c. Fronting

Fronting refers here to the substitution of a consonant for one produced further back in the oral cavity. This is another phonological process rarely attested in the speech of young Amharic-speaking children. None of the children in the control group demonstrated a fronted articulatory pattern. Mekonnen (2008) observed some fronting patterns in the speech of a 2;8-year-old boy who realised /k/ as [t̪]. As indicated above, this child realised /kənfər/ '*lip*' as [t̪ət̪əj], in which /k/ was produced as [t̪]. Other examples of fronting noted in his speech include /koka/ '*a brand of soft drink*'; /ɨkul/ '*equal*'; and /kis/ '*pocket*', which he respectively realised as [t̪ot̪a] [ɨt̪uj] and [t̪iʃ]. The boy also demonstrated a similar pattern of fronting where her realised /g/ as [d]. This production was noted to be common in the speech of 2;0 to 3;11 year olds. Words illustrating this realisation include /gəbəja/ '*market*'; /alga/ '*bed*'; and /harəg/ '*ivy*', which were respectively realised as [dəbəja], [alda] and [harəd].

The fronting of the (denti) alveolar consonants to bilabial place is rather uncommon across languages, but fronting of velars and post-alveolars have been reported for children acquiring other languages. Examples of fronting reported for children acquiring English can be found in Ingram (1974). In this study, Philip, 1;9, one of the two children studied, produced [t] for /k/ and [d] for /g/.

d. Backing

Backing refers here to the substitution of a consonant for one produced further forward in the vocal tract. Backing of alveolar fricatives to post-alveolar place seems to be one of the most common phonological processes that young Amharic-speaking children exhibit. As has been shown, in the speech of the children in the control group, the alveolar fricatives /s z/ are backed to the post-alveolar place and realised as [ʃ]. In the case of /z/, apart from backing, devoicing was also involved (e.g., in Eldana's speech). Mekonnen (2008) also noted that backing of the alveolar fricatives was one of the most frequent processes observed in the children from the age of 2;00 up to 3;4 years. It appears that in the speech of two- to four-year-old Amharic-speaking children, the alveolar fricatives /s z/ are commonly backed and realised as [ʃ]. A similar pattern has been observed in Japanese-acquiring children, who substitute the more posterior [ɕ] for target /s/ (Nakanishi *et al.*, 1972; Beckman *et al.*,2003; Li *et al.*, 2009; Li *et al.*, 2011). However, a converse process is common in children acquiring English, where /ʃ ʒ/ are fronted to alveolar place and realised as [s z], respectively (Weiner, 1979). Mekonnen (2008) observed another pattern of backing in the speech of the 2;8-year-old boy who realised /f/ as [t̪]. As indicated above, this child realised /kənfər/ '*lip*' as [t̪ət̪əj], in which /k/ was produced as [t̪]. Dean *et al.*, (1990) label backing as an 'unusual' or 'atypical' process. Other authorities (e.g., Weiner, 1979; Shriberg and Kwiatkowski, 1980; Ingram, 1981; Grunwell, 1985) have not included backing in their classifications of typical phonological processes in child speech.

e. Word-final devoicing

This is a process that describes the devoicing of final consonants. Two of the five children in the control group of this study devoiced word-final /d/. Mekonnen (2008) also noted the devoicing of word-final /d/ in monosyllabic words. Devoicing of /g/ was noted less frequently (i.e., in just one child, Eldana) Furthermore, devoicing of the alveolar and post-alveolar fricatives /z ʒ/ was identified. It is therefore reasonable to state that in the speech of 2;0- to 4;11-year-old Amharic-speaking children, devoicing /z ʒ/ is common regardless of context. Devoicing of word-final /d/ is common. However, devoicing of /g/ is rather infrequent. Other than these consonants, devoicing of other voiced consonants has not been observed both in the speech of the children studied here and in Mekonnen (2008).

f. Cluster reduction

A cluster is a sequence of consonants that occupy a single position in syllable structure. Cluster reduction involves the deletion of one or more members of a consonant cluster. Cluster reduction is a process commonly observed in Amharic-speaking children who are as old as four years of age. As exemplified in Table 7.3 and Table 7.5, often /s/ and /n/ are deleted as a means of cluster reduction. As shown in the tables, the word-final (/-st̪/ and /-nt̪/) consonant cluster are commonly reduced to /t̪/. McLeod *et* al (2001) identify different types of reduction. Ingram (1976) pointed out that, typically, in English, the marked member of the cluster is deleted, which also supported by more recent study by McLeod *et* al (2001). Thus, in /s/ plus a stop, the /s/ is deleted; in stop + liquid, the liquid is deleted, in fricative + glide/liquid, the glide/liquid is deleted; and in nasal + obstruent, the obstruent is deleted (Ingram, 1976). The cluster reductions identified in Amharic-speaking children are consistent with Ingram’s (1976) framework.

g. Gliding

Gliding refers to the substitution of a liquid by a glide, such as /l/→ [j] or /r/→ [w] or [j]. In the speech of young Amharic-speaking children, it is common to hear /l/ and

/r/ being realised as [j]. Examples showing /r/ being realised as [j] are given in the next section. Although gliding of these sounds was not observed in the speech of the children in the control group in the present study, Mekonnen (2008) frequently observed it in children as old as 4;0 years of age. Ingram (1976) identifies gliding as a common process. The most common type of gliding in English is the replacement of /r/ by [w] (Smit, 1993). However, in Amharic it is uncommon to hear children realising /r/ as [w]

h. Substitution of /r/

Generally, Amharic-speaking children as old as five years of age have difficulty realising the alveolar trill /r/. This is also true in other languages such as Hindi (Srivastava, 1974); Igbo (Nwokah, 1986); Quiche (Pye *et al.*, 1987); Portuguese (Yavas and Lamprechrt, 1988); Italian (Bernthal and Bankson, 1988); Spanish (Carballo and Mendoza, 2000) and Polish (Łobacz, 2000). In English, too, in which the /r/ is an approximant, it is acquired rather late (Jakobson, 1968; Smith, 1973; Hayward, 2000; Howard and Heselwood, 2002a). In Amharic, developmental substitutes for /r/ are [l], [j], [ɰ] and less often [ʀ], the latter particularly in older children with delayed development of this sound (Mekonnen, 2008). Below are examples for each realisation taken from Mekonnen (2008):

Table 7.8 Developmental substitutions of the alveolar trill /r/.

Target	***Realisation***	***Gloss***
/fɨre/	[fɨle]	'*seed*'
/bərərə/	[bəjəjə]	'*he/it flew*'
/t̪ərara/	[t̪əɰaɰa]	'*mountain*'
/rəʤɨm/	[ʀəʧɨm]	'*long/tall*'

i. De-ejectivisation

In the speech of Amharic-speaking children who are younger than four years, it is quite common to hear pulmonic consonants replacing their ejective counterparts

(Mekonnen, 2008). That is, the children *de-ejectivise* ejective consonants. No ejectivisation of pulmonic targets was noted in the speech of any of the five children in the control group. Mekonnen (2008) also noted that four-year-olds can produce ejectives. Below are examples of *de-ejectivisation* noted in the speech of two- to three-year-olds taken from taken from Mekonnen (2008).

Table 7.9 Developmental substitutions of ejectives by their pulmonic counterparts.

Pattern	***Target***	***Realisation***	***Gloss***
/p'/→[p]	/p'app'as/	[pappas]	'*bishop*'
/t̪'/→[t̪]	/t̪'ət̪'ər/	[t̪ət̪əl]	'*a small rock*'
/s'/→[s]	/s'əhaj/	[səhaj]	'*sun*'
/ʧ'/→[ʧ]	/ʧ'əw/	[ʧəw]	'*salt*'
/k'/→[k]	/k'arja/	/kalja/	'*pepper*'

This chapter has provided an overview of patterns of typical speech development in Amharic. The next chapter will describe the speech output of the children with cleft palate.

The main developmental speech characteristics attested in the speech of the control group of this study are: stopping, backing, cluster reduction, (word-final) devoicing, and substitution. In addition to these processes, Mekonnen (2008) reported other developmental realisations noted in the speech of typically-developing Amharic-speaking children, aged between 2;0 to 4;11, which are: assimilation/consonant harmony, fronting, gliding and de-ejectivisation. Most of the developmental speech characteristics presented here are similar to patterns reported for other languages. However, some differences were also observed. For example, stopping of alveolar fricatives, and post-alveolar fricatives and affricates, which is a common developmental process in many languages, were not found in the speech of the control group of this study; nor have they been reported in Mekonnen (2008). Also, in the speech of two- to four-year-old Amharic-speaking children, the alveolar fricatives (/s, z/) are commonly backed and realised as [ʃ]; however, in children acquiring English, a converse process is common (/ʃ ʒ/→ [s z]). The results presented in this chapter serve as an input for the following chapter, which, among other things, attempts to distinguish between developmental speech production features unrelated to the cleft and speech characteristics associated with cleft lip and palate.

Chapter 8: Perceptual phonetic and phonological analysis

8.1. Introduction

As stated in Chapter 5, the main purpose of this study is to describe the speech production features attested in Amharic-speaking children with cleft palate. This chapter presents the results from the perceptual phonetic analysis of the speech output of these children. Details of the children are provided in Table 8.1. The chapter is structured in five parts. The first describes the consonantal realisations of the children with cleft palate which includes accounts of active cleft-type, passive cleft-type and developmental realisations. In the second part, a description of vowel productions in terms of the horizontal and vertical positions and movement of the tongue, lip settings, and duration are made. The third part deals with resonance and airflow where the degree and effects of hypernasality, hyponasality, nasal emission and nasal turbulence are discussed. The fourth part provides an account of phonation and laryngeal voice quality and the fifth part summarises the main points.

The analysis of the speech production features of children with cleft palate was carried out based on general speech production principles; and by comparing their productions with patterns of speech production features exhibited by typically-developing children and with typical adult realisations. By doing so, the following research questions are addressed:

Research questions addressed in this chapter:

What are the speech production characteristics found in Amharic-speaking children with cleft palate?

- Are there active cleft-type articulations?
- Are there passive cleft-type realisations?
- Are there non-cleft developmental realisations?
- Are there unusual speech production features?
- Are vowel articulations, resonance, and voice/phonation affected, and if so, in what ways?

Table 8.1 Demographic data on the 20 children with cleft palate.

Participants		*Gender*	*Age at assessment*	*Age at surgery*	*Difference**	*Cleft type*
21.	SG	F	5	4;5	7	ICP
22.	OS	M	5	4;5	7	ICP
23.	EA	M	5;1	4;6	7	UCLP
24.	SA	F	5;1	4;6	7	ICP
25.	TB	M	5;2	4;8	6	UCLP
26.	YD	M	5;3	4;5	9	BCLP
27.	NB	M	6;3	4;8	7	BCLP
28.	BN	F	6;5	5;11	6	BCLP
29.	EY	M	7	6;6	6	UCLP
30.	NF	M	7;8	7;2	6	UCLP
31.	EZ	M	8	7;5	7	UCLP
32.	WL	F	8	7;6	6	ICP
33.	ES	M	8;2	7;8	6	BCLP
34.	BM	M	10;2	9;7	7	UCLP
35.	AT	M	10;4	9;8	8	UCLP
36.	EM	F	11	10;5	7	UCLP
37.	HA	M	12	11;5	7	BCLP
38.	DS	F	14	13;5	7	UCLP
39.	FM	M	14	13;5	7	UCLP
40.	BZ	F	14	13;5	7	ICP
		mean	***8.4***	***7.8***	**7**	

*Difference refers to the age gap (in months) between the time of assessment and that of surgery.

8.2. Consonants

As noted above, the descriptions of the consonant realisations are structured in such a way that they reflect the GOS.SP.ASS categories, that is, active cleft-type realisations, passive cleft-type realisations, non-cleft developmental realisations. Accordingly, in the following sections, each of these speech production types will be discussed in relation to the speech output of the children with cleft palate. Variations conditioned by context and/or elicitation modes together with phonological implications of the identified atypical speech production features will be dealt with in Chapter 10. The consonant repertoire of all the children with cleft palate can be found in Appendix 4.

8.2.1. Active cleft-type realisations

In this section, consonants that are produced as a result of compensatory strategies aiming at substituting for the effects of the cleft are discussed. Active cleft-type realisations observed in the children are categorised as *anterior* and *posterior* articulations. Anterior articulations include linguolabial realisations, interdental realisations, lateralization, and palatalization.

Posterior or backed articulations are categorised into two as backing within the oral cavity and backing to post-uvular place (glottal). Patterns of double articulation and nasal fricatives are also categorised under posterior articulation. In the following sections, each of these sub-categories will be described consecutively.

8.2.1.1. Anterior articulations

The articulatory behaviours that fall into this category and which were observed in the children are linguolabial realisations of alveolar targets and interdental realisations of alveolar and palatal consonants.

8.2.1.1.1. Linguolabial articulations

Linguolabial articulation occurs when the tongue tip or blade is placed against the upper lip, which is drawn downward to meet the tongue. Such realisations were noted in the speech of three of the twenty participants, BM (10;2) EY (7;0) and SG (5;0). BM realised the denti/alveolar consonants /t̪, t̪’, d, n, l/ as linguolabials [t̼̃, t̼̃’, d̼̃, n̼, n̼]. EY also demonstrated linguolabial articulations. The consonants that he realised linguolabially are /l/ and /n/. SG demonstrated consistent realisation of /r/ as [n̼] pattern. Table 8.2 and Figure 8.1 illustrate some examples of their linguolabial productions.

Table 8.2 Patterns of linguolabial articulations and words exemplifying them.

Participant	***Pattern***	***Target***	***Realisation***	***Gloss***	***Source of example***
BM	/t̪/→[t̼̃]	/t̪ep/	[t̼̃ẽp̃]	‘*tape player*’	single-word
	/t̪’/→[t̼̃’]	/t̪’ut̪/	[t̼̃’ũt̼̃]	‘*breast*’	single-word
	/d/→[d̼̃]	/dɨmmət̪/	[d̼̃ɨ̃mmə̃t̼̃]	‘*cat*’	single-word
	/n/→[n̼]	/nəw/	[n̼ə̃w̃]	‘*is* (*to be verb*)’	spont. speech
	/l/→[n̼]	/wələl/	[wə̃n̼ə̃n̼]	‘*floor*’	GOS.SP.ASS.
EY	/l/→[n̼]	/lɨbs/	[n̼ɨb̥ç]	‘*cloth*’	single-word
	/l/→[n̼]	/aləw/	[an̼n̼əw]	‘*he(it) said to him/it*’	spont. speech
	/l/→[n̼]	/p’aulos-ɨn/	[p’aun̼oç-ɨn̼]	‘*Paul+object marker*’	GOS.SP.ASS.
SG	/r/→[n̼]	/arat̪/	[an̼at̪]	‘*four*’	counting
	/r/→[n̼]	/ɨrrəɲɲa/	[ɨ̃n̼n̼ə̃ɲɲã]	‘*shepherd*’	GOS.SP.ASS.

(a) (b)

Figure 8.1 Realisation of /l/ as [n̼] as articulated by BM (a) and EY (b).

8.2.1.1.2. Interdental articulation

Interdental articulation involves the production of speech sounds by placing the tip of the tongue between the upper and lower front teeth. Interdental realisations of alveolar and palatal consonants were recorded in the speech of seven children with cleft palate. Patterns and examples of such articulations can be found in Table 8.3 below. Figure 8.2 shows interdental realisations of some of the children.

Table 8.3 Words illustrating interdental articulations.

Participant	***Pattern***	***Target***	***Realisation***	***Gloss***	***Source of example***
BM	/s/→[s̪̻]	/sisaj/	[s̪̻̃ĩs̪̻̃ãj̃]	*'personal name'*	GOS.SP.ASS.
	/t̪/→[t̪̻']	/s'əhaj/	[s̪̻̃'ə̃h̃ãj̃]	*'the sun'*	single-word
	/d/→[d̪̻̃]	/ɨrrəɲɲa/	[ɨ̃n̪̻n̪̻ə̃ɲɲã]	*'shepherd'*	GOS.SP.ASS.
EY	/r/→[n̪̻]	/fərəs/	[fən̪̻əç]	*'horse'*	single-word
		/ɨrrəɲɲa/	[ɨn̪̻n̪̻əɲɲa]	*'shepherd '*	GOS.SP.ASS.
		/ɨrat/	[ɨn̪̻ac]	*'dinner '*	spont. speech
TB	/r/→[n̪̻]	/ɨrrəɲɲa/	[ɨ̃n̪̻n̪̻ə̃ɲɲã]	*'shepherd'*	GOS.SP.ASS.
		/waɲɲə/	[wãn̪̻n̪̻ə̃]	*'he/it swam'*	spont. speech

WL	/ɲ/→[ṅ̪]	/ɨrrəɲɲa/	[ĩυυə̃ṅ̪ṅ̪a]	‘*shepherd* ’	GOS.SP.ASS.
		/moɲɲ/	[mõṅ̪ṅ̪]	‘*foolish*’	spont. speech
		/wət̪ət̪/	[wə̃ṫ̪̃ə̃ṫ̪̃]	‘*milk* ’	GOS.SP.ASS.
EA	/t̪/→[ṫ̪]	/wət̪ət̪/	[wə̃ṫ̪̃ə̃t̪]	‘*milk* ’	GOS.SP.ASS.
		/t̪’ut̪/	[ṫ̪̃ũṫ̪̃]	‘*breast* ’	Single-word
BZ	/r/→[ṅ̪]	/ɨrrəɲɲa/	[ĩṅ̪ṅ̪ə̃ɲɲã]	‘*shepherd*’	GOS.SP.ASS.
	/t̪/→[ṫ̪]	/t̪it̪t̪i/	[ṫ̪̃ĩṫ̪̃ṫ̪̃ĩ]	‘*personal name*’	GOS.SP.ASS.
FM	/d/→[ḋ̪]	/dɨmmət̪/	[ḋ̪ĩmmə̃ṫ̪̃]	‘*cat*’	Single-word
	/ɲ/→[ṅ̪]	/ɨrrəɲɲa/	[ĩṅ̪ṅ̪ə̃ɲɲã]	‘*shepherd*’	GOS.SP.ASS.

(a) (b) (c)

Figure 8.2 TB’s realisation of /r/ as [ṅ̪] (a); WL’s realisation of /ɲ/ as [ṅ̪] (b); EA’s realisation of /t̪/ as [ṫ̪] (c)

8.2.1.1.3. Lateralization/lateral articulation

Lateral articulation occurs when the pulmonic air stream is directed down one or both sides of the oral cavity and the tongue blocks the centre path. Such articulations were noted in four of the children with cleft palate (aged between 5;2-10;2). Two of the children (TB (5;2) and WL (8)) lateralized the alveolar fricatives /s/ and /z/. BM (10;2) lateralized all the sibilants, while EY (7) lateralized postalveolar affricates /ʧ/ and /ʤ/. The patterns and words exemplifying the lateral articulations are presented in Table 8.4 below.

Table 8.4 Lateral articulations and words illustrating them.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/s/→[ɬ̃] (TB)	/pasṯa/	[paɬ̃ṯ̃a]	'*pasta*'	single-word
/z/→[ɬ̃] (WL)	/zəṯ'əɲ/	[ɬ̃əʔəñ̪]	'*nine*'	counting
/ʃ/→[ɬ̃] (BM)	/ʃaj/	[ɬ̃ãj]	'*tea*'	GOS.SP.ASS
/ʧ/→[t̃ɬ̃] (BM)	/ʧaʧi/	[t̃ɬ̃ãt̃ɬ̃ĩ]	'*person's name*'	GOS.SP.ASS
/ʤ/→[d̃ʒ̃] (BM)	/ʤiʤʤi/	[d̃ʒ̃ĩd̃ʒ̃d̃ʒ̃ĩ]	'*person's name*'	GOS.SP.ASS
/ʤ/→[t̃ɬ̃] (EY)	/ʤiʤʤi/	[t̃ɬ̃ɨt̃ɬ̃ɨ]	'*person's name*'	GOS.SP.ASS

Lateralizations are referred to as 'minor errors' by Harding and Grunwell (1996) because they are cleft-type speech features that may occur "within the range of normal non-cleft speech" and do not require intervention. However, Albery and Grunwell (1993) noted that lateralization could not be attributed to developmental factors, rather it is attributable to the cleft condition. The authors also stated that lateralization (and other secondary articulations such as palatalization) does not spontaneously remediate, and is even resistant to speech therapy.

8.2.1.1.4. Palatalization

It is important to make a distinction between palatalization, which is a secondary articulation that modifies the realisation of a primary articulation (e.g., [dʲ]), and palatal realisation (e.g., [ç]), replacing the target consonant (e.g., /s/). Palatal articulations will be discussed later in relation to backing. Here, only palatalization is discussed. Of all the children with cleft palate, only NF exhibited palatalization. He sometimes realised /ʒ/ and /ʤ/ as [ʤʲ]. Words illustrating these realisations include /ʒant'ɨla/ '*umbrella*', and /ʤəb̥əna/ '*coffee pot*', which he realised them as [ʤʲãnʔĩnã] and [ʤʲə̃bə̃nã], respectively. As noted in Chapter 4, in the Wollo dialect of Amharic, it is common to palatalize stops (affricates included), ejectives, trills, lateral approximants when they occur before /ə/ or /e/. However, as NF spoke only the Addis Ababa dialect, his realisation is considered to be atypical, as it is not typical for his dialect.

8.2.1.1.5. Other anterior realisations

In addition to the aforementioned anterior articulatory patterns, other atypical articulatory placements which can fall into this general category were also noted. For example, atypical labial articulation was observed in NF's production of the voiceless labiodental fricative /f/, which he often realised it as bilabial fricative [ɸ]. This realisation can be illustrated by such words as /wəfu/ 'the bird' and /fɨjjelu/ 'the goat', which he respectively realised as [ʔoɸu] and [ɸəjenu].

Another anterior articulation was found in WL's speech. She realised the alveolar trill /r/ as [ʋ] and [b]. For example, she realised the word /ɨrrəɲɲa/ 'he/it swam' as [ɨ̃ʋʋə̃n̪̊n̪̊ã]; and /tərət-tərət/ 'tale-tale' as [n̪̊ə̃bə̃n̪̊ə̃bə̃n̪̊]. NF also demonstrated a fronted articulatory pattern, where he realised /g/ as [ɲ] word-initially. For example, he realised the word /gabi/ 'a cotton shawl' as [ɲaɓ̥i]. Moreover, realisation of /p/ for /t̪/ was noted in the speech of EY and BN. For example, they repeatedly realised the word /t̪ep/ 'tape player' as [pep], but they immediately corrected themselves. As noted in the previous chapter this could be an assimilation/consonant harmony. Moreover, as noted in the previous chapter, this realisation is common among young typically developing Amharic-speaking children. Thus, the realisation seen in the speech of EY and BN is likely to be a persisting immaturity which emerged as a typical developmental pattern. Such realisation was also noted in the speech of EA, which will be discussed in the section which deals with non-cleft developmental realisations. Thus far, the anterior articulatory patterns observed in the children with cleft palate have been discussed. The next section deals with posterior ones.

8.2.1.2. Posterior oral articulations

Backed articulations commonly observed in the speech of individuals with cleft palate have generally been categorised into two types (Henningsson, et al., 2008), as backing of oral targets within the oral cavity; and backing of oral targets to post-uvular place. The discussion of double-articulations is also included in this section as the identified double-articulations involved backing. Each of these articulatory patterns is discussed below in relation to the speech production features identified in the children with cleft palate.

8.2.1.2.1. Backing within the oral cavity

This category includes consonants realised at places further back than their typical place of articulation, but still within the oral cavity. Such backed realisations were observed in 14 children.

The articulatory patterns noted are: backing of (denti)alveolar targets to palatal place, alveolar targets to velar, post-alveolar to palatal and to velar, and velar to uvular. Table 8.5 below summarises these backing patterns observed in the children.

Table 8.5 Backing of oral targets within oral cavity.

Stops	***Fricatives***	***Affricates***	***Liquids***	***Ejectives***
/b/→[g] (EM)	/f/→[k] (BM)	/ʧ/→[c] (BN)	/l/→[ʄ] (EY)	/t̪’/→[k’] (EY,BN)
/p/→[k] (EM)	/s/→[ç] (BN, EY,NF)	/ʧ/→[ɲ] (NF)		/t̪’/→[q’] (WL)
/t̪/→[c] (EY, BN)	/z/→[j̰] (BN, EY, NF)	/ʤ/→[ɟ] (EY)		/t̪’/→[ǂ^ŋ] (WL)
/d/→[Ɉ] (EY, BN)	/z/→[ɣ] (BN)	/ʤ/→[g̃] (BN)		/s’/→[ç’] (EY)
/d/→[ɲ] (NF)	/ʃ/→[ç] (BN, EY)			/ʧ’/→[c’] (EY)
/k/→[q] (NB, BZ, FM)	/ʒ/→[j̰] (EY,NF)			/k’/→[q’] (WL, NB, BZ, FM)
/g/→[ɢ] (NB)	/ʒ/→[ɣ] (BN)			
	/ʒ/→[ɲ] (NF)			
	/z/→[ŋ] (YD)			
	/ʒ/→[ŋ] (YD)			

i. Stops

EM consistently realised /p/ as [k]. EY, BN and NF demonstrated backed articulations of the (denti)alveolar consonants /t̪/ and /d/ to palatal place. NF realised /d/ as [ɲ] in word-initial position. This realisation involved not only backing of the alveolar target to the palatal place, but a substitution of an oral consonant with a completely nasal one. This is an example showing the presence of more than one process affecting the realisation of a segment simultaneously. Backed articulations of the stop consonants were also noted in the speech of NB, BZ, and FM. Below are some examples of the identified backed patterns.

Table 8.6 Words illustrating backed articulations of stops.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/t̪/→[c]	/t̪ep/ (BN)	[cẽp]	‘*tape player*’	single-word
/d/→[Ɉ]	/dɨmmət/ (BN)	[Ɉɨmməc]	‘*he/it’s gone*’	single-word
/d/→[ɲ]	/dagɨm/ (NF)	[ɲaʔɨm]	‘*personal name*’	spont. speech
/k/→[q]	/kəkka/ (FM)	[qə̃qqã]	‘*he grounded*’	GOS.SP.ASS
/g/→[ɢ]	/ãgã/ (NB)	[ãɢã]	‘*person’s name*’	GOS.SP.ASS

ii. Fricatives

Five of the children backed one or more fricatives. Backing of the alveolar fricatives /s/ and /z/ was the most common backed articulatory patterns observed in the fricative sound class. They were respectively realised as [ç] and [ʝ̞] by three (BN, EY, and NF) of the five children who backed fricatives. Various realisations of the post-alveolar fricatives /ʃ/ and /ʒ/ were recorded. An unusual backed articulation sporadically observed in BM's speech was the realisation of /f/ as [k]. Below are patterns and examples of the fricatives backed within the oral cavity.

Table 8.7 Words illustrating backed articulations of fricatives.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/f/→[k]	/salf/ (BM)	[s̃ãn̪k̃]	'*when I pass*'	spont. speech
/s/→[ç]	/sisaj/ (EY)	[çiççaj]	'*personal name*'	GOS.SP.ASS.
/z/→[ʝ̞]	/zɨnab/ (NF)	[ʝ̞ɨ̃nãb̥]	'*rain*'	single-word
/z/→[ɣ]	/zɨnab/ (BN)	[ɣɨ̃nãb̥]	'*rain*'	single-word
/ʃ/→[ç]	/ʃaj/ (EY)	[çaj]	'*tea*'	GOS.SP.ASS.
/ʒ/→[ʝ̞]	/ʒant'ɨla/ (NF)	[ʝ̞ãnʔɨ̃nã]	'*umbrella*'	GOS.SP.ASS
/ʒ/→[ɣ]	/ʒant'ɨla/ (BN)	[ɣãnk'ɨ̃nã]	'*umbrella*'	single-word
/ʒ/→[ɲ]	/məjaʒa/ (NF)	[mə̃jɲã]	'*handle/case*'	GOS.SP.ASS
/z//→[ŋ]	/awaze/ (YD)	[ãwãŋẽ]	'*hot pepper paste*'	GOS.SP.ASS
/ʒ/→[ŋ]	/ʒant'ɨla/ (YD)	[ŋãnʔɨ̃nã]	'*umbrella*'	single-word

iii. Affricates

Backed realisations of the post-alveolar affricates /ʧ/ and /ʤ/ were recorded in three of the children, EY, BN and NF. EY and BN realised /ʧ/ as [c], but NF realised it as [ɲ]. BN consistently realised /ʤ/ as [g̃], while EY realised it often as [ɟ]. NF sometimes realised /ʤ/ as [ɟʲ] and often as [ʔ]. An example of each backed realisation of the affricates is given below.

Table 8.8 Words illustrating backed articulations of affricates.

Target	***Realisation***	***Gloss***	***Source of example***
/alətʃ/ (BN)	[anəç]	'*she said*'	GOSSPAS
/ʤəbəna/ (EY)	[ɟəbəna]	'*coffee pot*'	single-word
/ʤɨbu/ (BN)	[ɠ̃ɨ̃bũ]	'*the hyena*'	spont. speech

iv. Liquids

The consonants considered here are /l/ and /r/. Backed articulations of these consonants were noted in the speech of six of the children with cleft palate: EY, YD, NF, TB, AT and WL. EY realised /l/ as [ʛ], which was noted in one word only, that is, /lilli/ '*person's name*', which he realised it as [ʛɨ̃ñ̪ñ̪i]. NF and TB consistently realised /r/ as [ɰ]. NF's realisation of the word /ɨrrəɲɲa/ '*shepherd*', which he realised as [ɨɰɰəɲɲa]; and TB's realisation of the word /surri/ '*trousers*', which was realised as [ñ̥ũɰɰĩ] are examples of the realisation of /r/ as [ɰ]. As pointed out in the previous chapter, the realisation of /r/ as [ɰ] is one of the developmental realisations commonly observed in Amharic-speaking children. However, these realisations are not age-appropriate for NF and TB, so they are considered to be atypical (at least for NF, who was 7;8 year old). As pointed out in the previous chapter, two of the children (age: 5;5 and 5;7) from the control group produced /r/ typically.

v. Ejectives

Backing of ejectives within the oral cavity was observed in the speech of six children (EY, BN, WL, NB, BZ and FM). EY consistently realised /t̪'/ as [k'], and /tʃ'/ as [c']. BN also realised /t̪'/ as [k']. WL often realised /t̪'/ as [q'], (as well as [ʔ] and sometimes as [ǂ^ŋ]). She also realised /k'/ as [q'], a realisation noted in the speech of NB, BZ and FM as well. The examples below illustrate each of these realisations.

Table 8.9 Words illustrating backed articulations of ejectives.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/t̪’/→[k’] (EY,BN)	/t̪’ət̪’t̪’a/	[k’əkk’a] (EY)	‘*he(it) drunk*’	GOS.SP.ASS
/t̪’/→[q’] (WL)	/t̪’ara/	[q’ãbã]	‘*roof*’	spont. speech
/t̪’/→[ɟ̶ᵑ] (WL)	/t̪’ut̪/	[ɟ̶ᵑũŋ̥̃]	‘*breast*’	single-word
/s’/→[ç’] (EY)	/s’ələju/	[ç’əɲ̟əju]	‘*he (honorific) prayed*’	GOS.SP.ASS
/ʧ’/→[c’] (EY)	/ʧ’əw/	[c’əw]	‘*salt*’	GOS.SP.ASS
/k’/→[q’] (WL NB, BZ,FM)	/k’ən/	[q’ən] (WL)	‘*day(time)*’	spont. speech

8.2.1.2.2. Backing to post-uvular place (glottal articulations)

In this category, consonants which are normally produced within the oral cavity but backed in the current data to post-uvular places are discussed. The glottal stop [ʔ] was found to be used by 14 children as a replacement for target stops, fricatives, affricates, ejectives and trill. Other than the glottal stop, the use of [h] for /k/ and for [t̪] was recorded in five of the 14 children who demonstrated glottal articulation. Table 8.10 below summarises these backing patterns identified in the children’s speech samples.

Table 8.10 Backing of oral targets to post-uvular place.

Stops	***Fricatives***	***Affricates***	***Trill***	***Ejectives***
/p/→[ʔ]	/v/→[ʔ]	/ʧ/→[ʔ]	/r/→[ʔ]	/p’/→[ʔ]
/b/→[ʔ]	/s/→[ʔ]	/ʤ/→[ʔ]		/t̪’/→[ʔ]
/t̪/→[ʔ]	/z/→[ʔ]			/s’/→[ʔ]
/k/→[ʔ]	/ʒ/→[ʔ]			/ʧ’/→[ʔ]
/t̪/→[h]				/k’/→[ʔ]
/k/→[h]				
/d/→[ʔ]				
/g/→[ʔ]				

EZ’s oral consonants were predominantly replaced by the glottal stop. As can be seen from his phonetic inventory (appendix 4), he realised 15 consonants (out of the 28 consonants of Amharic) as a glottal stop either exclusively in all contexts or in certain contexts. He used the glottal stop for all of the ejectives almost in all contexts. The use of the glottal stop for oral pressure consonants was commonly noted in the speech of NF and ES as well. Below are examples showing backing of oral targets to post-uvular places. For convenience, pulmonic and ejective consonants are presented in the table separately.

Table 8.11 Words illustrating backing of oral targets to post-uvular places.

		Pulmonic consonants		
Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/p/→[ʔ]	/pappaja/(EY)	[ʔãʔãj̃ã]	*‘papaya’*	GOS.SP.ASS
/t̪/→[ʔ]	/t̪it̪t̪i/ (NF)	[ʔĩʔĩ]	*‘personal name’*	GOS.SP.ASS
/d/→[ʔ]	/dɨmmət/ (EZ)	[ʔɨ̃nnə̃]	*‘cat’*	single-word
/k/→[h]	/kəsɨra/ (WL)	[hə̃ñ̥ɨ̃bã]	*‘from work’*	spont. speech
/k/→[ʔ]	/kɨk/ (AT)	[ʔɨ̃ʔ]	*‘split peas’*	GOS.SP.ASS
/g/→[ʔ]	/gabi/ (TB)	[ʔab̥i]	*‘a cotton shawl’*	single-word
/ʒ/→[ʔ]	/ʒant̪’ɨla/ (ES)	[ʔãʔɨ̃nã]	*‘umbrella’*	GOS.SP.ASS
/ʧ/→[ʔ]	/ʧɨbbo/ (EZ)	[ʔɨ̃b͡ʔõ]	*‘bonfire’*	single-word
/ʤ/→[ʔ]	/ʤiʤʤi/ (ES)	[ʔɨ̃ʔʔɨ̃]	*‘person’s name’*	GOS.SP.ASS
		Ejectives		
/p’/→[ʔ]	/p’app’as/ (EM)	[ʔãʔʔãñ̥]	*‘bishop’*	GOS.SP.ASS
/t̪’/→[ʔ]	/t̪’ut̪/ (YD)	[ʔũʔ]	*‘breast’*	single-word
/s’/→[ʔ]	/s’əhaj/ (NF)	[ʔə̃hãj]	*‘the sun’*	single-word
/ʧ’/→[ʔ]	/ʧ’əw/ (EM)	[ʔə̃w]	*‘salt’*	GOS.SP.ASS
/k’/→[ʔ]	/k’əmis/ (EZ)	[ʔə̃mĩñ̥]	*‘skirt’*	single-word

8.2.1.2.3. Double articulations

Double articulations are those realisations which have two simultaneous articulations of the same degree of stricture. Here, the concept of double articulation is taken to include glottally reinforced consonants as well. Patterns of double articulations have been noted in eight of the children.

Table 8.12 Double articulations and words illustrating them.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/b/→[b͡ʔ] (EZ)	/ʧɨbbo/	[ʔɨ̃b͡ʔõ]	‘*bonfire*’	single-word
/p/→[p̰͡ʔ] (HA)	/pappi/	[p̰͡ʔãp̰͡ʔp̰͡ʔĩ]	‘*person’s name*’	GOS.SP.ASS
/b/→[b̃͡ʔ] (HA)	/bajje/	[b̃͡ʔãjj̃ẽ]	‘*person’s name*’	GOS.SP.ASS
/p’/→[p̰͡!] (HA)	/pappi/	[p̰͡!ãp̰͡!p̰͡!ĩ]	‘*person’s name*’	GOS.SP.ASS
/l/→[n͡ʔ] (ES)	/lilli/	[n͡ʔĩn͡ʔi]	‘*person’s name*’	GOS.SP.ASS
/d/→[ɲ͡ʔ] (NF)	/dɨmət̪/	[ɲ͡ʔɨ̃mə̃t̪̃]	‘*cat*’	single-word
/d/→[d͡g] (BN)	/dɨmmət̪/	[d͡gɨ̃mmə̃c]	‘*cat*’	single-word
/d/→[d͡ʔ] (AT)	/jɨwoddal/	[jɨ̃wõd͡ʔãn]	‘*he/it likes*’	GOS.SP.ASS
/ʒ/→[ɲ͡ʔ] (NB)	/ʒant’ɨla/ (NB)	[ɲ͡ʔãnʔɨ̃nã]	‘*tea*’	GOS.SP.ASS.
/ʧ’/→[ǀ͡ʔ] (BN, WL)	/ʧ’amma/ (WL)	[ǀ͡ʔãmmã]	‘*shoe*’	single-word

8.2.1.2.4. Nasal fricative

This is a nasal production that replaces pressure consonants and may be produced as a voiceless nasal fricative with additional audible nasal emission, for example: [m̥̈ n̥̈ ŋ̥̈]. The nasal fricative may be produced with or without turbulence; passively or actively, and/or could be phoneme-specific.

Regarding turbulent and non-turbulent nasal fricatives, Sweeney (2000), as cited in Henningsson, *et al.* (2008), found improved reliability when experienced, trained listeners rated turbulent and non-turbulent nasal fricatives as one category, compared to when they rated them separately. Following this, Henningsson *et al.* (2008) suggested that the two parameters be categorised into one category, an approach followed by this study as well.

Table 8.13 below summarises the substitutions of the fricatives /f s z ʃ/ by the nasal fricatives [ɱ̥̈ m̥̈ n̥̈ ŋ̥̈] identified in the speech of the children with cleft palate.

Table 8.13 Nasal fricatives for pressure consonants.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/f/→[m̥̃]	/fərəs/(WL)	[m̥̃əʋəñ̥]	‘*horse*’	single-word
/f/→[m̥̃]	/fɨjəl/ (WL)	[m̥̃ɨjən]	‘*goat*’	GOS.SP.ASS
/s/→[ñ̥]	/surri/ (EZ)	[ñ̥unni]	‘*trousers*’	single-word
/z/→[ñ̥]	/zɨnab/ (EY)	[ñ̥ɨnab̥]	‘*rain*’	single-word
/ʃ/→[ñ̥]	/ʃɨŋkurt/ (EY)	[ñ̥unʔuʔ̥]	‘*onion*’	single-word
/ʃ/→[ñ̥]	/ʃɨŋkurt/ (WL)	[ñ̥ɨ̃ŋk͂ũrc]	‘*onion*’	single-word

The twelve children who actively produced the nasal fricatives did not make placement distinctions between alveolar and post-alveolar places; they used an alveolar nasal fricative for all alveolar and post-alveolar fricatives. However, WL used [m̥̃] for /f/ in the single word production and she realised it as [m̥̃] word-initially and word-medially in the sentence repetition task. In addition, she produced nasal fricatives not only for fricative consonants but also for the plosive /t̪/, and affricates /ʧ/ and /ʤ/. Below are some examples showing the use active nasal fricatives by WL.

Table 8.14 Nasal fricatives for pressure consonants (by WL).

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/t̪/→[ñ̥]	/wət̪ət̪/	[wə̃ñ̥ə̃ñ̥]	‘*milk*’	GOS.SP.ASS
/ʧ/→[ñ̥ʔ]	/ʧɨbbo/	[ñ̥ʔɨ̃ɓ̃ɓ̃õ]	‘*bonfire*’	single-word
/ʧ/→[ñ̥]	/jaʧʧi/	[jãñ̥ñ̥ĩ]	‘*that (fem.)*’	spont. speech
/ʤ/→[ñ̥]	/ʤiʤʤi/	[ñ̥ĩñ̥ñ̥ĩ]	‘*proper’s name*’	GOS.SP.ASS

8.2.1.3. Atypical usage of airstream mechanisms

Airstream mechanism refers to the source and direction of the air used in the production of speech sounds. Airstream mechanism is one of the parameters that distinguish one consonant or class of consonants from the other. The use of atypical airstream mechanism was noted in all of the children. This includes the use of glottal stop for ejective consonants, which has been discussed in section 8.2.1.2.2.

Other than the glottal substitutions for ejective consonants, the use of pulmonic consonants for ejectives, ejectives for pulmonics, nasal clicks for pulmonics and ejectives, clicks for pulmonics and ejectives, implosives for ejectives, and implosives for pulmonics, were identified.

One or more of these realisations were noted in the speech of all of the children with cleft palate. These realisations are shown in Table 8.15 below together with words illustrating their occurrences.

Table 8.15 Atypical usage of airstream mechanism.

Realisation of ejective as pulmonic consonant				
Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/p’/→[p]	/p’app’s/	[p̃̇ãp̃̇p̃̇ãñ̥̇] (TB)	*‘bishop’*	single-word
/t̪’/→[t̪]	/t̪’ətt’a/	[t̪ətta] (OS)	*‘he/it drank’*	GOS.SP.ASS
/s’/→[s]	/s’om/	[sõm] (SA)	*‘fasting’*	GOS.SP.ASS
/ʧ’/→[ʧ]	/ʧ’amma/	[ʧãmmã] (EA)	*‘shoe’*	single-word
/k’/→[k]	/k’əj/	[k̃̇ə̃j̃] (DS)	*‘red’*	GOS.SP.ASS
Realisation of pulmonic cons. as ejective				
/p/→[p’]	/papaja/	[p’ap’aja] (AT)	*‘papaya’*	GOS.SP.ASS
	/pappi/	[p’app’i] (OS)	*‘person’s name’*	GOS.SP.ASS
	/pasta/	[p’aç?a] (NF)	*‘pasta’*	single-word
	/t̪ep/	[ñ̥̇ẽp’] (WL)	*‘tape player’*	single-word
Realisation of pulmonic and ejective cons. as nasal click				
/s/→[ǂᵑ]	/ɨnnəsu/	[ɨ̃nnə̃ǂᵑũ] (WL)	*‘they’*	spont. speech
/t̪’/→[ǂᵑ]	/t̪’ut̪/	[ǂᵑuñ̥̇] (WL)	*‘breast’*	single-word
/r/→[!]	/ɨrrəɲɲa/	[ɨ̃!ə̃ɲɲã] (HA)	*‘shepherd ’*	GOS.SP.ASS.
Realisation of pulmonic and ejective cons. as oral clicks				
/p/→[ʘ]	/papaja/	[ʘãʘãj̃ã] (WL)	*‘papaya’*	GOS.SP.ASS
	/pasta/	[ʘãŋ̥̃̇ɬ̃̇ã] (WL)	*‘pasta’*	single-word
	/polis/	[ʘõnĩñ̥̇] (WL)	*‘policeman’*	spont. speech
/-mt̪’-/→[ʘ]	/amt̪’u/	[aʘu] (NF)	*‘bring (imp. pl.)’*	spont. speech

Realisation of ejective as implosive				
/p'/→[ɓ̥]	/p'app'as/	[ɓ̥ãɓ̥ɓ̥ãñ̥] (WL)	*'bishop'*	single-word
	/p'awlos /	[ɓ̥ãw̃nõñ̥] (WL)	*'person's name'*	GOS.SP.ASS
/t̪'/→[ɗ]	/t̪'ef /	[ɗef] (NF)	*'a food grain'*	spont. speech
	/t̪'ut̪/	[ɗ̥ũt̪̃] (FM)	*'breast'*	single-word
Realisation of pulmonic cons. as implosive				
/b/→[ɓ̥]	/gəbba/	[ŋ͡gə̃ɓ̥ɓ̥ã] (WL)	*'he/it has entered'*	GOS.SP.ASS
	/bəmɨn /	[ɓ̥ə̃mɨ̃n] (WL)	*'with what'*	spont. speech
	/nəbbəru/	[nə̃ɓ̥ɓ̥ə̃ɰũ] (NF)	*'there/they were'*	spont. speech
	/bɨlt'u/	[ɓ̥ɨ̃nɨ̃ʔũ] (NF)	*'the wise'*	spont. speech
/d/→[ɗ]	/sɨdɨst/	[ʔɨɗɨ̃ñ̥] (NF)	*'six'*	counting
	/jɨwoddan/	[jɨwoɗɗan] (NF)	*'he/it likes'*	GOS.SP.ASS
	/hedu/	[heɗu] (NF)	*'they have gone'*	spont. speech
/l/→[ʄ]	/lilli/	[ʄɨn̪n̪i] (EY)	*' person's name'*	GOS.SP.ASS

8.2.2. Passive cleft-type realisations

This section will focus on cleft-type realizations that are considered to be passive products of either structural anomaly or dysfunction. The passive cleft-type realisations identified in the speech of the children with cleft palate include weak oral pressure consonants, nasal realisations of oral consonants and nasalised voiced pressure consonants.

8.2.2.1. Weak oral pressure consonants

Weak realisations of oral pressure consonants were observed to some extent in the speech of all of the children with cleft palate. Some of these realisations are exemplified in Table 8.16 below.

Table 8.16 Weak pressure consonants and words illustrating them.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/p/→[p̪]	/papaja/	[p̪ãp̪ãjã] (BN)	'*papaya*'	GOS.SP.ASS
/p'/→[p̪̃']	/p'app'as/	[p̪̃'ãp̪̃p̪̃'ãs̪̃] (BM)	'*bishop*'	single-word
/b/→[b̪]	/bet̪/	[b̪ẽt̪̃] (BZ)	'*house/home*'	single-word
/t̪/→[t̪]	/wət̪ət̪/	[wə̃t̪ə̃t̪] (TB)	'*milk*'	GOS.SP.ASS
/d/→[d̪]	/hedə/	[hẽd̪̃ə] (DS)	'*milk*'	spont. speech
/k/→[k̪]	/kɨkk/	[k̪ɨ̃k̪k̪] (EY)	'*split peas*'	GOS.SP.ASS
/k'/→[k̪̃']	/k'əmis/	[k̪̃'əmis̪̃] (YD)	'*skirt*'	Single-words
/g/→[g̪]	/gəzza/	[g̪ə̃z̪̃z̪̃ã] (BM)	'*he/it has bought*'	GOS.SP.ASS

8.2.2.2. Nasal consonants for oral pressure consonants

Atypical realisations in this category often involve plosive consonants where the target plosive is substituted by a homorganic nasal consonant (Hutters and Brøndsted, 1987; Harding and Grunwell, 1998b). Again, realisations of nasal consonants for target oral pressure consonants were noted in the speech of all of the children with cleft palate. The identified atypical nasal realisations are: replacement of [m] for targets /p b/, [n] for targets /z, l, r/, [ŋ] for /ʒ/ and [ɲ] for /g/. One or more of these nasal realisations were found in the speech of all of children with cleft palate. Table 8.17 below presents which child nasally realised which oral pressure consonants and the examples illustrating each realisation.

Table 8.17 Replacement of nasal consonants for oral targets.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/p/→[m]	/past̪a/	[mãñ̥nã] (EY)	'*pasta*'	single-word
/b/→[m]	/bet̪/	[mẽc] (BN)	'*house/home*'	GOS.SP.ASS
/z/→[n]	/zɨnab/	[nɨ̃nãb̃] (HA)	'*rain*'	single-word
/l/→[n]	/wələl/	[wə̃nə̃n] (DS)	'*floor*'	GOS.SP.ASS
/r/→[n]	/arat̪/	[ãnãk̃] (EM)	'*four*'	Spont. speech
/ʒ/→[ŋ]	/məjaʒa/	[mə̃jãŋã] (YD)	'*handle/case*'	Spont. speech
/g/→[ɲ]	/gabi/	[ɲãb̃ĩ] (NF)	'*a cotton shawl*'	Spont. speech

8.2.2.3. Nasalised voiced pressure consonants

Nasalised realisations of one or more voiced obstruents were identified in the speech samples of all of the children. Table 8.18 below contains examples of the identified nasalised voice pressure consonants.

Table 8.18 Nasalised voice pressure consonants.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/b/→[b̃]	/bet/	[b̥̃ẽʔ] (EZ)	‘*house/home*’	GOS.SP.ASS
/d/→[d̃]	/dɨmmət/	[d̃ɨ̃mmə̃t̃̇] (TB)	‘*cat*’	single-word
/g/→[g̃]	/gab̥i/	[g̃ãβ̞ĩ] (BM)	‘*A cotton shawl*’	single-word
/v/→[ṽ]	/tivi/	[cɨṽɨ] (EY)	‘*television* (*TV*)’	GOS.SP.ASS
/z/→[z̃]	/azəzzə/	[az̃əz̃z̃ə] (EY)	‘*he/it has ordered*’	GOS.SP.ASS
/ʒ/→[ʒ̃]	/məjaʒa/	[məj̃aʒ̃a] (BM)	‘*case/handle*’	GOS.SP.ASS
/ʤ/→[ʤ̃]	/ʤəb̥əna/	[ʤ̃ə̃b̥ə̃nã] (DS)	‘*coffee pot*’	single-word

8.2.2.4. Pre-nasalised consonants (NC Sequences)

Pre-nasalised consonants (also known as NC sequences) are articulatory sequences of a homorganic nasal and an obstruent. Patterns of NC sequences have been noted in three of the children with cleft palate, namely, EY, WL and NF. EY realised /d/ as [ŋ͡g] when it is geminated and occurs at the beginning of a syllable whose coda is /l/. Elsewhere, he realised it as [n̪̰]; and as [ɟ]. He also inconsistently articulated /ʒ/ as [ŋ͡g]. For example, he realised /jɨwoddal/ ‘*he likes*’ as [jɨwoŋ͡gan̪̰]. Realisation of [ŋ͡g] for /ʒ/ was also recorded in EY’s speech. For example, he produced /məjaʒa/ ‘*a case/handle*’ as [məjaŋ͡ga].

WL consistently produced [ŋ͡g] for /g/, /ʒ/ and geminated /d/, regardless of context and elicitation mode. She also demonstrated an inconsistent use of [ŋ̊͡ʔ] for /ʧ/. Examples are given in Table 8.19.

Table 8.19 Words illustrating WL's pre-nasalised articulations.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/d/→[ŋ͡g]	/jɨwəddal/	[jɨ̃wõŋ͡gãn]	'*he/it likes*'	GOS.SP.ASS
/g/→[ŋ͡g]	/gəbba/	[ŋ͡gə̃ɓ̥ɓ̥ã]	'*he/it has entered*'	GOS.SP.ASS
/ʒ/→[ŋ͡g]	/ʒant̪'ɨla/	[ŋ͡gãnʔɨnã]	'*umbrella*'	single-word
/ʧ/→[ŋ̊͡ʔ]	/ʧɨbbo/	[ŋ̊͡ʔɨ̃ɓ̥ɓ̥õ]	'*bonfire*'	single-word

8.2.3. Non-cleft developmental realisations/processes

Developmental realisations are those productions normally noted in typically-developing children. Such realisations were observed in three children: EA, OS and SA. For these children, the realisations are considered to be atypical because they are not age-appropriate realisations, meaning the realisations are not typical for the ages of these children. The identified non-cleft developmental realisations are presented in Table 8.20 below.

Table 8.20 Non-cleft developmental realisations

	Processes	***Realisations***
Structural simplifications	***cluster reduction***	/sr/→[s] (EA)
		/st̪/→[t̪] (OS)
	anterior realisation	/f/→[ɸ̃̇] (EA)
		/t̪/→[p̃̇] (EA)
	stopping	/f/→[p̃̇] (EA)
		/v/→[b] (SA)
	fronting	/g/→[d] (SA)
	backing	/s/→[ʃ] (OS, SA)
		/z/→[ʃ] (OS, SA)

		/ʒ/→[ʃ] (SA)
	***substitution of* [l] *&* [ɰ˞] *for* /r/**	/r/→[l] (EA, SA) /r/→[ɰ˞] (NF, TB,AT)
Systematic simplifications	***de-affrication***	/ʧ/→[t̪̃̇] (EA) /ʧ/→[t̪] (OS) /ʧ/→[ʃ] (EA,OS) /ʤ/→[d̪̃̇] (EA) /ʤ/→[d] (OS)
	word-final devoicing	/d/→[t̪̃̇] (EA) /d/→[t̪] (OS)
	syllable-initial voicing	/p/→[b̃] (EA) /p'/→[b̃] (OS)
	word-initial devoicing	/g/→[k] (EA)
	context-free devoicing	/ʤ/→[ʧ] (SA)

Except /r/→[l], which is sometimes seen in typically developing children as old as five years of age, these non-cleft developmental realisations presented above are all considered as atypical realisation because they are not typical for the ages of the children who realised them. It could be the case that these children are exhibiting signs of a non-cleft speech delay. Table 8.21 below presents the patterns and examples of the non-cleft realisations attested in the speech of the children.

Table 8.21 Non-cleft developmental realisations.

Pattern	***Target***	***Realisation***	***Gloss***	***Source of example***
/st̪/→[t̪]	/sost̪/	[ʃot̪] (OS)	'*three*'	spont. speech
/t̪/→[p]	/t̪ep/	[p̪̃̇ẽp̪̃̇] (EA)	'*tape player*'	single-word
/v/→[b]	/t̪ivi/	[t̪ibi] (SA)	'*television* (*TV*)'	single-word
/s/→[ʃ]	/səw/	[ʃəw] (OS)	'*man/human*'	spont. speech
/r/→[l]	/ɨrrəɲɲa/	[ɨ̃llə̃ɲɲã] (EA)	'*shepherd*'	GOS.SP.ASS.
/r/→[ɰ˞]	/surri/	[ñ̪̥̇ũɰ˞ɰ˞ĩ] (TB)	'*trousers*'	single-word
/ʧ/→[t̪]	/ʧaʧi/	[t̪at̪i] (OS)	'*person's name*'	GOS.SP.ASS.
/ʤ/→[d̪̃̇]	/ʤɨbu/	[d̪̃̇ɨ̃b̃] (EA)	'*hyena*'	spont. speech
/d/→[t̪̃̇]	/and/	[ant̪] (OS)	'*one*'	spont. speech

/p/→[b̃]	/pappi/	[b̃ãp͋p͋ĩ] (EA)	‘*person’s name*’	GOS.SP.ASS.
/g/→[k]	/gabi/	[k͋ãbĩ] (EA)	‘*a cotton shawl*’	single-word
/ʤ/→[ʧ]	/ʤəbəna/	[ʧəbəna]	‘*coffee pot*’	single-word
/s’/→[s]	/s’əhaj/	[s͋ə̃h͋ãj̃] (TB)	‘*the sun*’	single-word

8.3. Vowels

The major atypicality in vowel production attested in the speech of the children with cleft palate was hypernasality, which made the vowels nasalised. Other atypical vowel qualities could not be identified perceptually with one exception, that is, retracted vowel articulation identified in the speech of EY. EY consistently realised the high front vowel /i/ as the high central vowel [ɨ]; and mid front vowel /e/ as *schwa* [ə]. This resulted in the neutralisation of contrasts between the vowels (i.e., /i/ and /ɨ/ and /e/). For example: the words /biləw/ ‘*if he/it said to him/it*’ would be confused with /bɨləw/ ‘*if I said to him*’; and /resa/ ‘*dead body*’ with /rəsa/ ‘*he/it forgot*’.

8.4. Resonance and airflow

8.4.1. Nasal resonance

This reflects the relative proportions of resonance in the nasal and oral cavities and modifies the vocal tone. It includes hypernasality, hyponasality and mixed resonance. Using the GOS.SP.ASS categories, grade 1 and grade 2 hypernasal resonance patterns were noted in the speech of 18 children. A mild and inconsistent hyponasality was observed in one child’s speech. Other than in his speech, no significant hyponasality was noted in the rest of the speech samples. Table 8.22 demonstrates the extent of nasal resonance and nasal turbulence.

Table 8.22 Number of children demonstrating different levels of atypical nasal resonance.

Consistency and severity	***Hypernasality***			***Hyponasality***	
	Normal tone	*Grade 1*	*Grade 2*	*Present*	*Absent*
	2	4	14	1	19
Consistent		4	14	0	0
Inconsistent		0	0	1	0
Accompanying/ Replacing		4	14	1	0

8.4.2. Audible nasal emission and/or turbulence

In all of the children's speech, nasal emission was frequently heard accompanying consonants. Table 8.23 presents the degree of nasal emission and turbulence perceived in each of the children with cleft palate.

Table 8.23 Number of children with different levels of nasal emission and turbulence.

Consistency and severity	***Nasal emission***			***Nasal turbulence***		
	Normal	*Mild*	*Severe*	*Normal*	*Mild*	*Severe*
	2	6	12	18	2	0
Consistent		0	12		0	
Inconsistent		6	0		2	
Accompanying/ Replacing		6	12		2	

Vowel height plays a role in presence and perception of nasal resonance and airflow. For example, BM's /k/ becomes [ŋ̊̃] when followed by high front vowel but he realised it appropriately as /k/ elsewhere.

8.5. Phonation and laryngeal voice quality

8.5.1. Voiced vs. voiceless

One frequently noticed atypicality of phonation was the devoicing of voiced consonants; and substitution of voiced consonants with voiceless. Devoicing was mostly context dependant (syllable-initial/word-final devoicing noted in the speech of EA and OS), while replacement of voiced consonants with their voiceless counterparts was more context free. The replacement of voiced consonants with their voiceless counterpart was seen only in the speech of EY, who, for example, realised /ʒant̪’ɨla/ ‘*umbrella*’ as [çank’ɨn̪a]. The devoicing of voiced consonants and replacement of voiced consonants by voiceless consonants can be explained by the fact that, given the suspected velopharyngeal insufficiency in these children, voiceless consonants have a higher intraoral pressure than voiced ones (Malécot, 1968; Stevens, 1998). Realisations of /z/ and /ʒ/ as [ʃ] were also noted in the speech of SA.

8.5.2. Laryngeal voice quality

EY’s entire speech was of hoarse voice quality, which might have made it difficult at times to judge the voiced/voiceless nature of individual segments and to make judgements on resonance. Mild and infrequent creaky voice quality was heard in WL’s speech. Other than these, no significant atypical voice qualities have been perceived.

8.6. Summary

Perceptual analysis of the speech of the children with cleft palate showed that articulation of consonants, and voicing as well as resonance were considerably affected. Active and passive cleft-type realizations and non-cleft developmental articulations were identified. In addition, retracted vowel productions and nasalized vowels were recorded. Unusual uses of airstream mechanism and voicing patterns were also observed in some of the children. Furthermore, atypical nasal airflow and nasal resonance were perceived in all of the children with cleft palate. Some of these atypical segmental realizations were conditioned by context and/or elicitation mode, while others were attested across different contexts and in all sampling conditions. Variations conditioned by elicitation conditions and the phonological implications of the identified atypical speech production features will be treated in Chapter 10. In the next chapter, the identified speech production features will be examined in relation to cleft type and age at surgery.

Chapter 9: Speech output in relation to cleft type, age at assessment and surgery

9.1. Introduction

This chapter discusses the observed relationship between the dependent variable speech output and the independent variables: age of participants at assessment, age at surgery and cleft type. A considerable amount of research has documented the influence of age at time of palatal surgery on speech production (e.g., Dorf and Curtin, 1982; O'Gara and Logemann, 1988; Copeland, 1990; O'Gara, *et al.*, 1994; Rohrich *et al.*, 1996; Ysunza *et al.*, 1998; Sandberg *et al.*, 2002; Hardin-Jones and Jones, 2005; Chapman, *et al.*, 2008). These studies suggested that, generally, earlier surgery was associated with better articulation and more typical resonance.

Another factor that has been identified as influencing speech production in individuals with cleft palate is cleft type (e.g., Riski and DeLong, 1984; 1985; Peterson-Falzone, 1990; Dalston, 1992; Albery and Grunwell, 1993; Karling *et al.*, 1993; Hardin-Jones *et al.*, 2003).

Most of these studies suggest that the more severe the cleft, the greater its impact on speech becomes. More specifically, it has been reported that children with a cleft lip and palate (CLP) produce more atypical articulations (Riski and DeLong, 1984; Peterson-Falzone, 1990), and require speech therapy more often (Albery and Grunwell, 1993) than those with an isolated cleft palate (ICP). Moreover, children with a bilateral cleft lip and palate (BCLP) demonstrate poorer speech, more compensatory articulations, and need more speech therapy than those with a unilateral cleft lip and palate (UCLP) (e.g., Van Demark and Hardin, 1985; Peterson-Falzone, 1990; Dalston, 1992; Karling *et al*., 1993).

In addition to presenting the results of the current study, this chapter therefore discusses these results in relation to previous reports in the literature for other languages. The main reason why speech output is examined in relation to cleft type and age at surgery is because there are not many studies conducted on late-operated individuals, so these data present a valuable opportunity to expand the literature on speech production associated with late repair. Furthermore the present chapter adds to the existing literature by analysing these variables in a language which has consonants that use pulmonic and non-pulmonic airstream mechanisms.

The chapter has eight sections. The first describes the realisations that are most preferred by the children and those least observed. In the second section, comparisons of processes used by individual children are presented. In the third, comparisons of speech output in relation to the chronological age of the children at assessment are made.

In the fourth section, the children's speech output is compared as a function of cleft type. In the fifth, the children's speech output is categorised into: (a) active cleft-type, (b) passive cleft-type and (c) non-cleft developmental realisations and the children were compared based on these groups. The sixth section compares the consonants that are most affected by the identified cleft-type speech characteristics and by the non-cleft developmental realisations. The seventh compares realisations of ejectives and their pulmonic counterparts in relation to age at assessment and cleft type. In the final part, the main points are summarised, the patterns and trends are discussed and compared with previous reports. The chapter addresses the following research questions.

Research questions addressed in this chapter:

- Which compensatory articulations are most commonly observed?
- Which processes are most/least preferred by individual children?
- How is age of participants related to their speech output?
- What is the relationship between cleft type and speech output?
- Which consonants are most/least affected?
- How are the realisations of ejectives different from those of their pulmonic counterparts?
- How are the identified speech production features and trends similar to/different from speech behaviours reported for individuals with cleft palate in other languages?

9.2. Comparison of individual realisations

Table 9.1 shows the number and percentage of participants who demonstrated cleft-type and non-cleft developmental realisations. Both figures are presented because the percentages often represent small numbers of actual participants.

Table 9.1 Percentage of children who produced different types of atypical realisations.

Active cleft-type processes	***n***	***%***
Bilabial realisations of non-bilabial consonants	2	10
Linguolabial	3	15
Interdental	7	35
Lateralization	4	20
Palatalization	1	5
Double articulation	8	40
Backing within oral cavity	14	70
Backing to post-uvular (glottal) place	16	80
Prenasalised consonants	3	15
Active nasal fricative	12	60
Atypical use of airstream mechanism	20	100
Passive cleft-type processes		
Weak oral pressure consonants	20	100
Nasal consonants for oral consonants	10	50
Nasalised voiced pressure consonants	20	100
Non-cleft developmental realisations	4	20

It is interesting that usage of atypical airstream mechanism, weak oral pressure consonants and nasalised voiced pressure consonants were noted in in the speech of all of the children. Developmental realisations were noted in 20% (n = 4) of the total group. As indicated in the previous chapter, the identified developmental realisations were not age-appropriate.

9.3. Comparison of processes used by each individual child

Table 9.2 demonstrates the speech production features used by each individual child. One child (WL, who is female, aged 8;0, with an ICP) demonstrated 12 of the 14 cleft-type realisations, i.e., all the cleft-type realisations, except linguolabial articulation and palatalization, were noted in her speech. The children who demonstrated developmental realisations (i.e., the youngest ones) were the ones that showed the least cleft-type realisations. All the children who demonstrated lateralization also showed interdental realisation. All the children who demonstrated prenasalised consonants also demonstrated backing within the oral cavity and backing to the glottal place. All the children who showed double articulations also used backing to the glottal place and nasal fricatives.

As can be seen from Table 9.3, atypical usage of airstream mechanisms was observed in all the children. As noted in the previous chapter, this includes the use of pulmonic consonants for ejectives, ejectives for pulmonics, nasal clicks for pulmonics and ejectives, clicks for pulmonics and ejectives, implosives for ejectives and pulmonics. One or more of these realisations were noted in the speech of all of the children. As shown in Table 9.3, those children who demonstrated realisations of pulmonic and ejective consonants as clicks also showed realisations of ejectives as a glottal stop, pulmonics as ejectives, ejectives as implosives and realisations of pulmonic consonants as implosives.

Table 9.2 Speech production features used by each individual child.

	Active cleft-type processes											***Passive cleft-type processes***			***Dev.***	
Par.	Bil.	Linguo lab	Inter den.	Later	Palat	Doub. art.	Back [1]	Back [2]	Prenas.	Nasal Fric.	Atyp. Airstre.	Weak oral pres. con	Nasals for oral cons.	Nas. voic. pre. cons.	Dev. Realis.	Total
BM		✔	✔	✔			✔	✔			✔	✔	✔	✔		**9**
EY		✔	✔	✔			✔	✔	✔		✔	✔	✔			**9**
BN						✔	✔	✔		✔	✔	✔	✔			**7**
EZ						✔		✔		✔	✔	✔	✔			**6**
WL	✔		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔		**12**
TB			✔	✔			✔	✔			✔	✔	✔	✔	✔	**9**
NF	✔				✔		✔	✔	✔		✔	✔	✔			**8**
EA			✔								✔	✔	✔	✔	✔	**6**
EM								✔		✔	✔	✔	✔			**5**
ES						✔		✔		✔	✔	✔	✔			**6**
SG		✔					✔	✔			✔	✔	✔			**6**
YG							✔	✔		✔	✔	✔	✔			**6**
HA						✔		✔		✔	✔	✔	✔	✔		**7**
OS							✔				✔	✔	✔		✔	**5**
SA							✔				✔	✔	✔		✔	**5**
NB						✔	✔	✔		✔	✔	✔	✔	✔		**8**
AT						✔	✔	✔		✔	✔	✔	✔	✔		**8**
BZ			✔				✔	✔		✔	✔	✔	✔	✔		**8**
FM			✔				✔			✔	✔	✔	✔	✔		**7**
DS						✔		✔		✔	✔	✔	✔	✔		**7**
Tot.	**2**	**3**	**7**	**4**	**1**	**8**	**14**	**16**	**3**	**12**	**20**	**20**	**20**	**10**	**4**	***x* = 7**

NB: The features presented in this table are in the same order as in Table 1. Back[1] = backing within the oral cavity; Back[2] = Backing to post-uvular (glottal) place.

Table 9.3 Atypical airstream mechanism used by each individual child.

Partic.	Realisation of ejectives as pulmonics	Realisation of ejectives as glottal stop	Realisation of pulmonics as ejectives	Realisation of pulmonic and ejective consonants as nasal clicks	Realisation of pulmonic and ejective consonants as clicks	Realisation of ejective as implosive	Realisation of pulmonics as implosive
1. BM		✔					
2. EY		✔					✔
3. BN		✔					
4. EZ		✔					
5. WL		✔	✔	✔	✔	✔	✔
6. TB	✔						
7. NF		✔	✔		✔	✔	✔
8. EA	✔						
9. EM		✔					
10. ES		✔					
11. SG							
12. YG		✔					
13. HA		✔		✔			
14. OS	✔		✔				
15. SA	✔						
16. NB		✔					
17. AT		✔	✔				
18. BZ		✔					
19. FM						✔	
20. DS	✔						
Total	**5**	**13**	**4**	**2**	**2**	**3**	**3**

The most frequent atypical usage of airstream mechanism was realisation of ejectives as a glottal stop, followed by realisation of ejectives as pulmonics and realisation of pulmonics as ejectives.

9.4. Comparison of age at assessment

As stated in chapter five, the children are categorized into three groups according to their age at assessment: (i) 5-7;11; (ii) 8-10;11, (iii) 11-14). Since all of the children underwent palate surgery at around the same time (i.e., 5-6 months before data collection (assessment)), the speech output of the children examined in relation to age at assessment is not significantly different from their speech output observed in relation to age at surgery. So, in order to avoid redundancy, those speech production features examined in relation to age at assessment will be discussed. As the sample size of the study is small (i.e., 20 children), no statistical analysis could be performed. Hence, quantitative analysis using descriptive statistics was employed. As can be seen in Table 9.4, the children are grouped according to their chronological age (age at assessment). Table 9.4 presents the analysis for segmental realisations. Similar analysis is presented for resonance and airflow in Table 9.5.

In this section, the relationship between speech output and age at assessment will be dealt with. Each process is discussed in terms of age related differences. In terms of chronological age, only one child from the first group (i.e., those aged between 5-7;11) and one child from the second group (i.e., those aged between 8-10;11) demonstrated bilabial realisations of consonants that are typically produced at other places. However, no child from the third group (i.e., those aged between 11-14) was recorded with bilabial realisations of non-bilabial consonants. Similar results were noted in the use of linguolabial articulations. While two children from the first group and one child from the second exhibited linguolabial realisations, no child from the third group showed this articulatory behaviour. Moreover, lateralization/lateral articulations were noted in the first two groups but not in the third one. Interdental realisations were seen in all the three groups. Only one child (in the first group) demonstrated palatalization. Although double articulation (including glottal reinforcement) was noted in all age groups, the second group produced the largest proportion.

Table 9.4 Percentage of children who produced different types of atypical realisations, grouped according to age at assessment

Active cleft-type realisations						
	Age at assessment					
	5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***	
Realisations	***n***	***%***	***n***	***%***	***n***	***%***
Bilabial	1	10	1	17	-	-
Linguolabial	2	20	1	17	-	-
Interdental	3	30	2	33	2	50
Lateralization	2	20	2	33	-	-
Palatalization	1	10	-	-	-	-
Double articulation	2	20	5	83	1	25
Backing within the oral cavity	9	90	3	50	2	50
Backing to glottal place	7	70	6	100	3	75
Prenasalised consonants	2	20	1	17	-	-
Active nasal fricative	3	30	5	83	4	100
Atypical use of airstream mechanism	10	100	6	100	4	100
Passive cleft-type realisations						
Weak oral pressure consonants	10	100	5	100	4	100
Nasal cons. for oral pres. cons.	10	100	5	100	4	100
Nasalised voiced pres. cons.	3	30	4	67	3	75
Developmental realisations						
Developmental realisations	4	40	-	-	-	-

All or the majority of the children in all groups demonstrated backing to glottal place of articulation. Instances of pre-nasal consonants were observed only in the first two groups. The use of active nasal fricatives was seen in all the three groups; and there seems to be a positive correlation between use of active nasal fricatives and age at assessment, i.e. the older the child, the more likely that there will be nasal fricatives. This appears to be because the children in the second and third groups had established their speech more with an unrepaired palate than those in the first group, meaning that, for the older children, even after palate repair, carryover of articulation improvements is limited by persistent habit factors established in the presence of an unrepaired palate. It is important to consider that all of the children in this study have had very late repair in comparison with clinical guidelines and surgical practice in developed countries, so for all of them their pre-surgical speech patterns are comparitively well-established; and the 'older'/'younger' categories in this study are different from much of the cleft literature.

Weakly realised oral pressure consonants and replacement of nasal consonants for oral pressure consonants were perceived in the speech of all of the children. Realisations of nasalised voiced pressure consonants appeared to increase with age at assessment Developmental realisations were noted only in the first group, which consisted of the youngest children.

Overall, even though it is difficult to make conclusive statements based on a relatively small sample size, the following general trends could be drawn from the data. The older children (those in the second and third groups) showed more cleft-type speech realisations than those in the first group. The children in the third group showed the least anterior cleft-type realisations. Developmental realisations were confined to the first group.

Regarding resonance and airflow (Table 9.5), the extent of hypernasal resonance perceived in the children ranged from normal resonance to moderate hypernasal resonance. Hyponasal resonance was perceived in only two children.

The majority of the children from the youngest group exhibited mild or moderate resonance. Typical resonance was also recorded in two children in this group. No child from the second group showed normal resonance. Most of the children from this group (second group) had a moderate hypernasal resonance. The speech of all of the children in the third group had a moderate hypernasal resonance. So, there seems to be a positive correlation between age at assessment and severity of hypernasal resonance, meaning that as age at assessment increased the severity of the hypernasal resonance also increases. Again this may be attributable to the timing of palate repair.

The degree of nasal emission perceived in the children followed a similar pattern to that of hypernasality. No nasal emission was perceived in two children from the first group, while the majority of the children from this group showed mild or moderate nasal emission. All the children in the second group displayed nasal emission, with the majority of them demonstrating mild nasal emission. All the children in the third group demonstrated moderate nasal emission.

Table 9.5 Percentage of children who produced different types of atypical realisations, grouped according to age at assessment

Hypernasality						
	Age at assessment					
	5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***	
Realisations	***n***	***%***	***n***	***%***	***n***	***%***
Normal	2	20	-	-	-	-
Mild	4	40	2	33	-	-
Moderate	4	40	4	67	4	100
Hyponasality						
Present	1	10	1	20	-	-
Nasal Emission						
Normal	2	20	-	-	-	-
Mild	4	40	4	67	-	-
Moderate	4	40	2	33	4	100
Nasal Turbulence						
Present	2	20	-	-	1	25

Once more, a positive correlation was evident between age at assessment and severity of nasal emission: severity of nasal emission increased with the increase of age at assessment. Nasal turbulence was not noted in many of the children. For example, no child in the second group exhibited nasal turbulence, and, only two children from the first group and one child from the third group exhibited nasal turbulence.

9.5. Cleft type comparisons

In this section, each cleft type will be discussed in relation to the data presented in Table 9.6. All the identified atypical realisations, except palatalization, occurred in at least one child with ICP. All the children in this group demonstrated baking within the oral cavity, atypical use of airstream mechanism and use of weak oral pressure consonants and nasal consonants for oral pressure consonants.

Table 9.6 Percentage of children who produced different types of atypical realisations, grouped according to cleft type*

Active cleft-type realisations						
	Cleft Type					
	ICP n = 5		***UCLP n = 10***		***BCLP n = 5***	
Realisations	***n***	***n***	***n***	***%***	***n***	***n***
Bilabial	1	20	1	10	-	-
Linguolabial	1	20	2	20	-	-
Interdental	2	40	5	50	-	-
Lateralization	1	20	3	30	-	-
Palatalization	-	-	1	10	-	-
Double articulation	1	20	3	30	4	80
Backing within the oral cavity	5	100	6	60	3	60
Backing to glottal place	3	60	8	80	5	100
Prenasalised consonants	1	20	2	20	-	-
Active nasal fricative	2	40	5	50	5	100
Atypical use of airstream mechanism	5	100	10	100	5	100
Passive cleft-type realisations						
Weak oral pressure consonants	5	100	10	100	5	100
Nasal cons. for oral pres. cons.	5	100	10	100	5	100
Nasalised voiced pres. cons.	2	40	6	60	2	40
Developmental realisations						
Developmental realisations	2	40	2	20	-	-

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

All the identified atypical realisations occurred in at least one child with UCLP. All of the children from this group showed atypical use of airstream mechanism and use of weak oral pressure consonants and nasal consonants for oral pressure consonants. The majority of them also exhibited backing to glottal place. All of the children with a BCLP showed backing to glottal place, active nasal fricatives, atypical use of airstream mechanism and weak oral pressure consonants and nasal consonants for oral pressure consonants. No child with a BCLP produced bilabial, linguolabial, lateral or palatalized articulations. In addition, the children with a BCLP did not produce prenasalised consonants and developmental realisations. However, all of them used glottal replacement. It is interesting to note that the children in this group showed no anterior cleft-type realisations. This could be because the effects of a bilateral cleft lips and palate on the anterior parts (i.e., particularly, the lips and alveolar ridge) of the oral cavity is particularly severe.

The three groups behaved similarly in respect to use of atypical airstream mechanism and use of weak oral pressure consonants and nasal consonants for oral pressure consonants. Moreover, the majority of the children from all cleft type groups showed backing within the oral cavity and glottal replacement.

Table 9.7 Percentage of children who produced different types of atypical realisations, grouped according to cleft type*

Hypernasality						
	Cleft Type					
	ICP n = 5		***UCLP n = 10***		***BCLP n = 5***	
Severity	***n***	***%***	***n***	***%***	***n***	***%***
Normal	2	40	-	-	-	-
Mild	-	-	5	50	1	20
Moderate	3	60	5	50	4	80
Hyponasality						
Present	-	-	1	10	1	20
Nasal Emission						
Normal	2	40	-	-	-	-
Mild	1	20	5	50	2	40
Moderate	2	40	5	50	3	60
Nasal Turbulence						
Present	-	-	2	20	1	20

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

With regards to resonance and airflow, no child from the ICP group showed hyponasality or nasal turbulence. The majority of the children in this group demonstrated a moderate hypernasality. Half of the children in the UCLP group demonstrated mild hypernasality and nasal emission, the other half showed a moderate hypernasality and nasal emission. The majority of the children with a BCLP showed a moderate hypernasal resonance and a mild or moderate nasal emission. No nasal emission was perceived in the speech of the children who demonstrated normal nasal resonance. No child from the UCLP and BCLP groups was recorded with normal nasal resonance. Hyponasality was noted in the speech of two children: one from the UCLP group and the other from the BCLP group. Nasal turbulence was noted only in children with a UCLP and a BCLP.

9.6. Comparison of active, passive and developmental realisations

Table 9.8 shows frequencies of active, passive, and developmental realisations identified in the speech of the children with cleft palate, in relation to age group and type of cleft. The median of the numbers of active, passive and developmental realisations for the whole group were 65, 40 and 24, respectively. The active realisations were grouped into two groups according to the median for the whole group, as it is the mid-point, i.e., 65 (see Table 9.8): (a) <65 and (b) >65. The passive ones were also categorised into two according to the median, i.e., 40: (i) <40 and (ii) >40. The numbers correspond to the frequency of realisations observed in the speech of the children.

Table 9.8 Descriptive statistics for active and passive realisations

	Active	Passive
N	20	20
Mean	56.45	0
Median	65.00	37.15
Std. Deviation	26.307	39.50
Range	84	17.783

Results from the descriptive statistics show that there seems to be a positive correlation between age at assessment and the number of active realisations. 60% (n = 6) of the children from the first group (i.e., those aged between 5-7;11) produced fewer active realisations than the median for the whole group (i.e., 65). To the contrary, 67% (n = 4) of the children from the second group (i.e., those aged between 8-10;11) produced more active realisations than the median for the whole group (i.e., 65). The number of active realisations identified in half of the children from the third group (i.e., those aged between 11-14) was also above the median.

Table 9.9 Frequency of active, passive and developmental realisations, grouped according to age and cleft type*

Active cleft-type realisations												
	Age at assessment						***Cleft type***					
	5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
No. of realisations	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
<65	6	60	2	33	2	50	3	60	3	30	3	60
>65	4	40	4	67	2	50	2	40	7	70	2	40
Passive cleft-type realisations												
<40	6	60	3	50	1	25	4	80	3	30	2	40
>40	4	40	3	50	3	75	1	20	7	70	3	60
Non-cleft developmental realisations												
<24	2	20	-	-	-	-	-	-	2	20	-	-
>24	2	20	-	-	-	-	2	40	-	-	-	-

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

Spearman's correlation coefficient tests were performed to check if similar patterns to the ones drawn from descriptive statistics could be obtained. As already discussed, studies have generally shown that the earlier the surgery the better articulation and the more typical resonance. In other words, the younger the children the fewer the cleft-related speech features (i.e., active and passive). So, even though all the children studied were late-operated, it was hypothesised that cleft-related speech features (active and passive realisations) tend to increase with age, which is a one-tailed hypothesis.

The results of the Spearman's test (see Table 9.10 for correlation matrix) showed similar patterns to those revealed by descriptive statistics. A weak positive correlation between age at assessment and number of active realisations was noted, which was statistically significant ($r_s(18) = 0.37$, $P = 0.05$), meaning that the number of active realisations increased as age at assessment increased. This seems to be because, as already noted, the older children (i.e., those who had surgery at later ages) had an open palate for a longer time, which means that the compensatory strategies that they used in order to compensate the structural deficient established more than they did in the younger children, who had their palate repaired relatively earlier. So, it appears that the longer the cleft is unrepaired the more these compensatory strategies establish so much that they become persistent and affect the speech improvement after surgery.

Table 9.10 Correlation matrix for age in months vs. active realisations

			Age in months	Active
Spearman's rho	Age in months	Correlation Coefficient	1.000	.370
		Sig. (1-tailed)	.	.05
		N	20	20
	Active	Correlation Coefficient	.370	1.000
		Sig. (1-tailed)	.05	.
		N	20	20

In terms of age at assessment *vis-à-vis* number of passive realisations, the majority of the children from the first group (i.e., those aged between 5-7;11) produced fewer passive realisations than the median for the whole group (i.e., 40, See: Table 8), half of the children from the second group and the majority of the children from the third group produced more passive realisations than the median.

Spearman's test (see Table 9.11 for correlation matrix) showed a weak positive correlation between age and that number of passive realisations ($r_s(18) = 0.279$, $P = 0.1$), that is, passive realisations increased with age of participants. However, as can be seen from the p value, the correlation was not statistically significant, which could mean either passive realisations were not affected by age or the two variables might have been positively correlated, but the relationship was too weak to be seen in a sample size of 20.

*Table 9.11*Correlation matrix for age in months vs. passive realisations

			Age in months	Passive
Spearman's rho	Age in months	Correlation Coefficient	1.000	.279
		Sig. (1-tailed)	.	.117
		N	20	20
	Passive	Correlation Coefficient	.279	1.000
		Sig. (1-tailed)	.117	.
		N	20	20

Regarding speech output in relation to cleft type, Table 9.9 shows that the children with an ICP produced less cleft-type (active and passive) realisations than the median number of active and passive realisations identified for the whole group, while the children with a UCLP and a BCLP produced more active and passive realisations than median.

The children with a UCLP produced more active realisations than those with a BCLP. Whereas, although not substantial, the children with a BCLP produced more passive realisations than those with a UCLP. In other words, the BCLP group produced the most passive realisations, while the ICP group realised the least passive realisations.

Overall, there seems to be no significant differences between the three groups with respect to active cleft-type realisations based on cleft type. However, in terms of passive cleft-type realisations, the children with a UCLP and BCLP realised more passive realisations than those with an ICP.

9.7. Comparison of affected consonants

In this section, comparison of consonants that are most/least affected by the identified realisations is presented. Table 9.12 shows the number of children who used different types of realisations for the target consonants.

Table 9.12 Number of participants with active and developmental realisations*.

Realisations/Processes	s	t̪’	ʤ	d	ʧ’	ʒ	t̪	k’	z	ʧ	s’	p’	ʃ	r	g	k	p	b	l	v	n	f	ɲ	**Total**†
Bilabial realisation of non-bilabials														1								1		2
Linguolabial		1		1			1												1		2			6
Interdental	2	2	1	2	1		3		2	2	1		1	4					2		1		1	25
Lateralization	2		2			1			2	2			1											10
Palatalization			1			1																		2
Double artic./glottal reinfor.				3	3	1						2					1	2	1					13
Prenasalised consonants				2		1				1					1									5
Backed within oral cavity	3	3	2	3	1	4	2	4	4	2	1		2	3	1	3	1	1	1			1		42
Backed to post-uvular	2	14	6	5	10	4	9	12	2	4	12	4	2	1	8	9	1	2		4		1		112
Active nasal fricative	12		5		1	5	1		6	5	1		9											45
Atypical use of airstream mechan.		2		1	2	1						7		1			3	2			1			20
Developmental realisations	3	1	3	3	1	1	2	2	2	2	2	3		4	2		1		2	2		1		37
Total‡	24	23	20	20	19	19	18	18	18	18	17	16	15	14	12	12	7	7	7	6	4	4	1	

*Passive cleft-type speech features are not included in the above table because one or more passive cleft-type speech features affected all of the consonants in all of the children.

†Count reflects the total number of consonants affected by each realisation. Note that a certain process may affect a consonant in the speech of more than one child.

‡ Total represents the number of children who used different realisations for each consonant. Note that one child may demonstrate more than one process.

As can be seen from Table 9.12, /s/ was the most affected oral consonant, while /f/ was the least affected one. In terms of consonant classes, /s/, /t̪'/, /ʤ/ and /d/ were the most affected fricative, ejective, affricate and stop consonants, respectively. Backing to post-uvular place (glottal) affected the most number of consonants, affecting 20 consonants, followed by 'backing within the oral cavity', which affected 19 consonants. Bilabial realisations of non-bilabial consonants affected the least number of consonants: only two consonants.

In terms of atypical usage of airstream mechanism, /p'/ was the most affected consonant, with seven children realising it with atypical airstream mechanisms. /p/ was the second most affected consonant, with three children realising it with non-pulmonic airstream mechanisms. /d, ʒ, r, n/ are the least affected with one child each realising them with atypical airstream mechanisms.

The most affected consonant by non-cleft developmental realisations was /r/. Two or more children substituted 13 consonants (of the 18 consonants) with developmental realisations. The remaining five consonants were substituted by developmental realisations by one child each.

9.8. Ejectives

In this section, the realisations of Amharic ejectives (/p', t̪', s', ʧ', k'/) observed in the speech of the children with cleft palate are further analysed. Table 9.13 displays realisations of ejectives and their pulmonic counterparts noted in the speech of each individual child. Although this section focuses on ejectives, productions of pulmonics are also presented for comparative purposes.

9.8.1. The bilabial ejective stop /p'/

Table 9.14 shows number and percentage of children using different realisations for the bilabial ejective /p'/ and its pulmonic counterpart /p/. The majority of the children from the first and third age groups realised /p'/ as an ejective or pulmonic oral consonant (most of them being pulmonic oral plosives), while the majority of the children from the second group realised it as a glottal stop, click or implosive. Similarly, while the majority of the children from the first and third groups realised /p/ as a pulmonic oral consonant, the majority of the children from the second group realised it as a glottal stop, ejective, click and/or nasal fricative. So, more children from the second group appeared to use atypical airstream mechanisms for /p'/ (and for /p/) than those in the other groups.

Hence, the results also suggest that no apparent pattern emerged between age at assessment and realisations of /p'/. In terms of cleft type, while the majority of the children with an ICP and UCLP realised /p'/ as an ejective or pulmonic oral consonant, the majority of the children with a BCLP realised it as a glottal stop or click.

For /p/, even though the majority of the children with an ICP used pulmonic oral consonants, they also exhibited ejective and click realisations of /p/, which were not noted in the other two groups. Almost all of the children (9 out of 10) from the first group (i.e., those aged between 5-7;11 years) and the majority of the children (3 out of 4) from the third group realised /p/ with a pulmonic airstream mechanism. In contrast, only one child from the second group realised /p/ with a pulmonic airstream mechanism. So, as was the case with /p'/, more children from the second group used atypical airstream mechanisms for /p/ than those in the other two groups.

Table 9.13 Realisations of ejectives and their pulmonic counterparts.

Participant	/p/	/p’/	/t̪/	/t̪’/	/s/	/s’/	/tʃ/	/tʃ’/	/k/	/k’/
1. BM	[p̃̇] [p̢]	[p̃̇’]	[t̪̃̇]	[t̪̃̇’] [ʔ]	[s̪̃̇]	[s̪̃̇’]	[tʃ̃̇] [t̃̇ɬ̃̇]	[tʃ̃̇’]	[k̃̇] [k̢]	[k̃̇’] [ʔ]
2. EY	[p]	[p’]	[c] [p]	[k’] [ʔ]	[ç] [ñ̥̇]	[ç’]	[c]	[c’]	[k]	[k’]
3. BN	[p̃̇] [p̢]	[p̃̇’]	[c] [p̃̇]	[k’] [ʔ]	[ñ̥̇] [ç]	[ʔ]	[c]	[͡ǀʔ]	[k̃̇]	[k’]
4. EZ	[m̃̋]	[ʔ]	[ʔ] [t̪̃̇]	[ʔ] [ñ̥̇]	[ñ̥̇]	[ʔ] [ñ̥̇]	[ʔ]	[ʔ]	[ʔ]	[ʔ]
5. WL	[ʘ], [p̃̇’]	[ɓ̥]	[ñ̥̇]	[ʔ] [q̃̇’] [ǂᵑ]	[ɬ̃̇] [ñ̥̇] [ǂᵑ]	[s̃̃]	[͡ŋ̥̃̇ʔ] [ŋ̥̃̇] [ʔ]	[͡ǀʔ] [q̃̇’]	[k̃̇] [h̃̇]	[q̃̇’]
6. TB	[p̃̇]	[p̃̇]	[t̪̃̇]	[t̪̃̇]	[s̃̇]	[s̃̇]	[tʃ̃̇]	[tʃ̃̇]	[k̃̇]	[k̃̇]
7. NF	[p̃̇’]	[p̃̇’]	[ʔ]	[ʔ] [ɖ]	[ñ̥̇]	[ʔ]	[ɲ] [͡ɲʔ]	[ʔ]	[ʔ]	[ʔ]
8. EA	[p̃̇]	[p̃̇]	[t̪̃̇]	[t̪̃̇]	[s̪̃̇]	[s̪̃̇]	[tʃ̃̇]	[tʃ̃̇]	[k̃̇]	[k̃̇]
9. EM	[k̃̇]	[ʔ]	[k̃̇]	[p̃̇’]	[ñ̥̇]	[ʔ]	[k̃̇]	[ʔ]	[x̃̇]	[q̃̇]
10. ES	[m̢̥]	[ʔ]	[m̥] [t̪]	[ʔ]	[ñ̥̇] [ʔ]	[ʔ]	[tʃ̢̃̇] [ʔ]	[ʔ]	[ʔ]	[ʔ]
11. SG	[p̃̇]	[p̃̇]	[ʔ][t̪̃̇]	[ʔ]	[n] [ñ̥̇] [ʔ]	[ʔ]	[ʔ][tʃ̢̃̇]	[ʔ]	[ʔ]	[ʔ]
12. YD	[p̃̇]	[ʔ]	[ʔ] [h̃̇] [t̪]	[ʔ]	[ñ̥̇]	[ʔ]	[ñ̥̇] [tʃ̢̃̇]	[ʔ]	[k̃̇]	[ʔ][k̃̇’]
13. HA	[͡p̃̇ʔ]	[͡p̃̇ʔ]	[t̪]	[ʔ]	[ñ̥̇]	[ʔ]	[tʃ̢̃̇]	[ʔ]	[ʔ]	[ʔ]
14. OS	[p] [p’]	[b]	[t̪]	[t̪]	[ʃ]	[k’]	[ʃ]	[k’]	[k]	[k’] [t̪’]
15. SA	[p]	[p]	[t̪]	[t̪]	[s]	[s]	[tʃ]	[tʃ]	[k]	[k]
16. NB	[p̃̇]	[p̃̇’]	[t̪̃̇]	[ʔ]	[ñ̥̇]	[ʔ]	[t̪̃̇]	[ʔ]	[q̃̇]	[q̃̇]
17. AT	[p̃̇’]	[p̃̇’]	[ʔ]	[ʔ]	[ñ̥̇]	[ʔ]	[ñ̥̇]	[ʔ]	[ʔ]	[ʔ]
18. BZ	[p̃̇]	[p̃̇’]	[t̪] [ʔ]	[ʔ] [t̪]	[ñ̥̇]	[ñ̥̇]	[ñ̥̇]	[ñ̥̇]	[q̃̇]	[ʔ]
19. FM	[p̃̇]	[p̃̇’]	[t̪̃̃] [t̪̃̇]	[ɖ̥]	[s̃̇] [ñ̥̇]	[s̃̃]	[tʃ̃̇]	[tʃ̃̇’]	[q̃̇]	[q̃̇’]
20. DS	[p̃̇]	[p̃̇]	[t̪̃̇]	[t̪̃̇]	[s̃̇]	[s̃̇]	[tʃ̃̇]	[tʃ̃̇]	[k̃̇]	[k̃̇]

Table 9.14 Percentage of children who produced different realisations for /p'/ and /p/

		Active cleft-type realisations											
		Age at assessment						***Cleft type***					
		5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
	Target Realisations	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
/p'/	Ejective	4	40	2	33	2	50	1	20	5	50	2	40
	Pulmonic oral cons.§	5	50	-	-	1	25	3	30	3	30	-	-
	Backed within oral c.	-	-	-	-	-	-	-	-	-	-	-	-
	Glottal realisation*	1	10	2	33	1	25	-	-	2	20	2	40
	Click	-	-	1	17	-	-	-	-	-	-	1	20
	Implosive	-	-	1	17	-	-	1	20	-	-	-	-
	Nasal fricative	-	-	-	-	-	-	-	-	-	-	-	-
/p/	Pulmonic oral consonants	9	90	1	17	3	74	4	80	6	60	3	60
	Ejective	2	20	2	33	-	-	2	40	2	20	-	-
	Backed within oral consonants	-	-	-	-	1	25	-	-	1	10	-	-
	Glottal realisation	-	-	2	33	-	-	-	-	1	10	1	20
	Click	-	-	1	17	-	-	1	20	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	-	-	2	33	-	-	-	-	1	10	1	20

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

*The category *glottal realisation* includes glottal stop and the rarely used glottal fricative [h].

With regards to cleft type, no significant differences were noted in the realisation of /p/ between the groups. More children from the second group (i.e., those aged between 8-10;11 years) used atypical airstream mechanisms for /p'/ and /p/ than those in the other groups. Equally, more children with an ICP realised /p'/ with atypical airstream mechanisms than those in other groups. Overall, more typical use of airstream mechanisms was noted in the production of /p/ than in /p'/.

9.8.2. The denti-alveolar ejective stop /t̪'/

Table 9.15 displays the number and percentages of children who used different realisations for the denti-alveolar ejective stop /t̪'/ and its pulmonic counterpart /t̪/. The majority of the children in all age and cleft type groups used atypical airstream mechanisms for /t̪'/, with no observable differences among the groups. It is interesting, however, to note that the use of a glottal stop for /t̪'/ was noted in all of the children in the second group (i.e., those aged between 8-10;11 years). In comparison, all the children from all age and cleft type groups realised /t̪/ with a pulmonic airstream mechanism. In other words, no child showed usage of ejective, click or implosive realisations for /t̪/.

It is interesting to note that the children generally employed more backed realisations for /t̪'/ than for /t̪/. Moreover, in terms of usage of airstream mechanism, generally, more children from all groups employed typical airstream mechanism for /t̪/ than for /t̪'/.

9.8.3. Alveolar ejective fricative /s’/

Numbers and percentages of children who used different realisations for /s’/ and /s/ are given in Table 9.16. Most of the children from all age and cleft type groups used atypical airstream mechanisms for /s’/. Half of the children from the first and third groups and five of the six children from the second group realised /s’/ as a glottal stop.

In comparison, the majority of the children from all age and cleft type groups realised /s/ as a nasal fricative. In terms of cleft type, most children with a UCLP and a BCLP demonstrated a glottal realisation of /s’/. So, while the children generally preferred glottal realisations, particularly a glottal stop, for /s’/, they predominantly realised its pulmonic counterpart, /s/, as nasal fricative. This seems to be a result of an attempt to maintain the contrast between the two fricatives.

9.8.4. Post-alveolar ejective affricate /ʧ’/

Table 9.17 displays the numbers and percentages of children who used different realisations for the post alveolar ejective affricate /ʧ’/ and its pulmonic counterpart /ʧ/. Regarding age at assessment, several children (4 out of 10) from the first group and the majority of the children from the second group (4 out of 6) used a glottal stop for /ʧ’/, while only one child from the third group showed glottal realisations of this ejective. For /ʧ/, the majority of the children from the first and third groups realised it with the pulmonic airstream mechanism. Even though half of the children from the second group also used a pulmonic airstream mechanism for /ʧ/, the remaining half realised it as a glottal stop.

Table 9.15 Percentage of children who produced different realisations for /t̪'/ and //t̪/

Active cleft-type realisations													
		Age at assessment						***Cleft type***					
		5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
Target	***Realisations***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
/t̪'/	Ejective	2	20	1	17	1	25	-	-	3	30	1	20
	Pulmonic oral cons.	4	40	-	-	2	50	3	60	3	30	-	-
	Backed within oral c.	3	30	1	17	-	-	1	20	2	20	1	20
	Glottal realisation*	5	50	6	100	1	25	1	20	5	50	3	60
	Click	-	-	1	17	-	-	1	20	-	-	-	-
	Implosive	1	10	-	-	1	25	-	-	2	20	-	-
	Nasal fricative	-	-	1	17	-	-	-	-	1	10	-	-
/t̪/	Pulmonic oral cons.	9	90	4	67	4	100	4	80	8	80	5	100
	Ejective	-	-	-	-	-	-	-	-	-	-	-	-
	Backed within oral c.	2	20	-	-	1	25	-	-	2	20	1	20
	Glottal realisation	3	2	1	17	1	25	2	40	3	30	1	20
	Click	-	-	-	-	-	-	-	-	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	-	-	2	50	-	-	1	20	-	-	1	20

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

*The category *glottal realisation* includes glottal stop and the rarely used glottal fricative [h].

Table 9.16 Percentage of children who produced different realisations for /s'/ and /s/

		Active cleft-type realisations											
		Age at assessment						***Cleft type***					
		5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
Target	***Realisations***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
/s'/	Ejective	1	10	1	17	-	-	-	-	2	20	-	-
	Pulmonic oral cons.	3	30	-	-	-	-	2	40	2	20	-	-
	Backed within oral c.	2	20	1	17	1	25	1	20	2	20	1	20
	Glottal realisation*	5	50	5	83	2	50	1	20	7	70	4	80
	Click	-	-	-	-	-	-	-	-	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	-	-	1	17	1	25	1	20	1	10	-	-
/s/	Pulmonic oral cons.	3	30	2	33	2	50	2	40	5	50	-	-
	Ejective	-	-	-	-	-	-	-	-	-	-	-	-
	Backed within oral c.	3	30	-	-	-	-	1	20	1	10	1	20
	Glottal realisation	1	10	1	17	-	-	1	20	-	-	1	20
	Click	-	-	1	17	-	-	1	20	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	6	60	5	83	3	75	3	60	6	60	5	100

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

*The category *glottal realisation* includes glottal stop and the rarely used glottal fricative [h].

Table 9.17 Percentage of children who produced different realisations for /ʧ’/ and /ʧ/

		Active cleft-type realisations											
		Age at assessment						***Cleft type***					
		5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
Target	***Realisations***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
/ ʧ’/	Ejective	2	20	2	33	1	25	2	40	3	30	-	-
	Pulmonic oral cons.	3	30	-	-	1	25	1	20	3	30	-	-
	Backed within oral c.	1	10	1	17	-	-	1	20	1	10	-	-
	Glottal realisation*	4	40	4	67	1	25	1	20	4	40	4	80
	Click	1	10	1	17	-	-	1	20	-	-	1	20
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	-	-	-	-	1	25	1	20	-	-	-	-
/ʧ/	Pulmonic oral cons.	7	70	3	50	3	75	3	60	6	60	4	80
	Ejective	-	-	-	-	-	-	-	-	-	-	-	-
	Backed within oral c.	3	30	-	-	-	-	-	-	2	20	1	20
	Glottal realisation	1	10	3	50	-	-	2	40	1	10	1	20
	Click	-	-	1	17	-	-	1	20	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	1	10	2	33	1	25	2	40	1	10	1	-

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

*The category *glottal realisation* includes glottal stop and the rarely used glottal fricative [h].

Table 9.18 Percentage of children who produced different realisations for /k'/ and /k/

Active cleft-type realisations													
		Age at assessment						***Cleft type***					
		5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
Target	***Realisations***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
/k'/	Ejective	4	40	2	33	1	25	2	40	3	30	-	-
	Pulmonic oral cons.	3	30	-	-	1	25	1	20	3	30	-	-
	Backed within oral c.	1	10	1	17	2	50	1	20	2	20	1	20
	Glottal realisation*	5	50	5	83	1	25	3	60	4	40	4	80
	Click	-	-	-	-	-	-	-	-	-	-	1	20
	Implosive	-	-	-	-	-	-	1	20	-	-	-	-
	Nasal fricative	-	-	-	-	-	-	-	-	-	-	-	-
/k/	Pulmonic oral cons.	8	80	1	17	4	100	3	60	7	70	3	60
	Ejective	-	-	-	-	-	-	2	40	-	-	-	-
	Backed within oral c.	1	10	1	17	2	50	2	40	1	10	1	20
	Glottal realisation	2	20	5	83	-	-	2	40	3	30	2	40
	Click	-	-	-	-	-	-	-	-	-	-	-	-
	Implosive	-	-	-	-	-	-	-	-	-	-	-	-
	Nasal fricative	-	-	-	-	-	-	-	-	1	10	1	20

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.

*The category *glottal realisation* includes glottal stop and the rarely used glottal fricative [h].

Regarding cleft type, while two children (40%) with an ICP and three children (30%) with a UCLP realised /ʧ'/ as an ejective, no child with a BCLP used an ejective realisation. Four of the five children in the latter group used a glottal stop for this ejective.

For /ʧ/, the majority of the children from all cleft types used a pulmonic airstream mechanism. Generally, more children from all groups used a typical airstream mechanism for /ʧ/ than for /ʧ'/; and a glottal realisation was preferred by the children more for the ejective affricate than for the pulmonic one.

9.8.5. Velar ejective stop /k'/

As can be seen from Table 9.18, again the majority of the children from all age and cleft type groups did not realise /k'/ with the typical glottalic egressive airstream mechanism. It is interesting to note that half of the children (n = 5) in the first group and five of the six children from the second group realised this ejective as a glottal stop, and only one child from the third group demonstrated a glottal realisation of /k'/.

The majority of the children from the first and third group realised /k/ as pulmonic oral consonants, while the majority of the children from the second group produced it as a glottal stop. Again, a glottal realisation was preferred more for /k'/ than for /k/. With regards to cleft type, while two children with an ICP and three children with a UCLP realised /k'/ as an ejective, no child from the BCLP group showed ejective realisation of /k'/. The majority of the children from all cleft type groups showed glottal realisations for /k'/. For /k/, a pulmonic airstream mechanism was employed by the majority of the children from all cleft type groups. The children generally used more atypical airstream mechanisms for /k'/ than for /k/.

9.9. Discussion

In this chapter, a number of questions have been addressed. The results relating to each question will now be discussed in turn. Below are the questions outlined in the introductory section of this chapter and the previous chapter. The second question will discussed together with the first one, as they are related. Also, since cross-linguistic issues will be thoroughly discussed in Chapter 12, the last question will be dealt with alongside the discussions of each of the other research questions.

- Which compensatory articulations are most commonly observed?
- Which processes are most/least preferred by individual children?
- How is age of participants related to their speech output?
- What is the relationship between cleft type and speech output?
- Which consonants are most/least affected?
- How are the realisations of ejectives different from those of their pulmonic counterparts?
- How are the identified speech production features and trends similar to/different from speech behaviours reported for individuals with cleft palate in other languages?

i. General trends

- *Which compensatory articulations are most commonly observed?*

The results presented in this chapter suggest that Amharic-speaking children with cleft lip/palate demonstrated a number of atypical speech production features, most of which are similar to those reported for children with cleft palate in other languages. Of the identified atypical speech behaviours, backing appears to be the most common compensatory strategy employed by the children in the present study. More specifically, backing to the glottal place was the most common compensatory strategy used. Backing is one of the common and most dominant cleft-type speech characteristics, regardless of language (e.g., McWilliams, Morris, and Shelton, 1990; Grunwell *et al.*, 1993; Harding and Grunwell, 1996; Peterson-Falzone *et al.*, 2006), and a number of other studies have already reported similar findings for other languages (e.g., Howard, 1993; 2004; Chapman and Hardin, 1992; Chapman, 1993; Stokes and Whitehill, 1996; Hutters *et al.*, 2001; Hardin-Jones and Jones, 2005; Shahin, 2006; Al-Tamimi *et al.*, 2011). In English, for example, Hardin-Jones and Jones (2005) noted that glottal stops were produced by more of the children than any other compensatory articulation pattern. Al-Tamimi *et al.* (2011) reported that backing was the most productive process in the speech of Jordanian-Arabic-speaking children with cleft palate. Shahin (2006) also stated that all the three Arabic-speaking children she studied showed backing patterns. Backed articulations (backed oral and glottal productions) are commonly preferred by children with cleft palate because before the palate is repaired, pressure consonants may be difficult for these children to produce due to the diffusion of air into the nasal cavity leading to lack of intraoral pressure. Hence, the child may attempt to create compensatory pressure areas by humping the back of the tongue or constricting the glottis (Warren, 1986; Peterson-Falzone *et al*., 2006). When the children are doing this, their sensorimotor system will learn this behaviour and it is hard to change even though they are physically able to produce the target phonemes after palate repair because, as Smith (1981:15) argues, “neural connections established through maturation are thought to be more difficult to alter than those established through learning”. Moreover, as the children used backing in an attempt to compensate for an inadequate speech mechanism before surgery, the rule seems to have become included in the developing phonological system and persisted following palatal repair.

It is interesting to note that all the children exhibited weak oral pressure consonants and nasalised voiced pressure consonants. These speech production features are common in individuals with cleft palate irrespective of language and occur due to the pressure leak at the velopharyngeal port compromising intraoral pressure (Trost, 1981b). Half of the children in this study used nasal consonants for oral targets. A similar finding has already been reported for children with cleft palate who speak other languages. For example, Hardin-Jones and Jones (2005:10) noted that in their study ‘a surprisingly large percentage of patients produced nasal substitutions’. Although the persistence of nasal substitutions may be associated with velopharyngeal insufficiency (VPI) for some children, it is important to recognize that such atypical realisations can persist as learned behaviours following palatal surgery for some children who have an adequate mechanism.

Another interesting finding is that one or more of the identified atypical usage of airstream mechanism was noted in all of the children. A few studies have reported atypical usages of airstream mechanism for children with cleft palate. Howard (1993) reported realisations of a bilabial click for target /p/ noted in a 6-year-old English-speaking girl with cleft palate. Moreover, Shahin (2006) found that all of the three children studied realised /k/ as a voiceless velar implosive [ƙ], which she attributed to a result of an intended glottal reinforcement of /k/. Furthermore, Al-Awaji (2008) reported consistent realisations of /r/ as [k’] by one of her four Saudi-Arabian-Arabic-speaking children. In the present study, in addition to realisations of clicks and implosives for pulmonic constants, which have already been reported for English and Arabic, realisations of ejectives as pulmonics (including ejectives as a glottal stop), pulmonics as ejectives, ejectives as nasal clicks, ejectives as clicks, and pulmonics and ejective as implosives have been recorded.

The least favoured realisation in the current study was palatalization, which is opposite to what has been reported for Cantonese-speaking children, who demonstrated palatalization as their most favoured atypical realisation (Stokes and Whitehill, 1996). Sell *et al.* (2001) also reported that palatalization was the second most frequent atypical speech production feature noted in their English-speaking children with cleft palate. It has been suggested that palatalization may be a compensatory articulation involving raising of the tongue to assist in the realisation of pressure consonants (Eurocleft Speech Group, 1993).

- *Which consonants are most/least affected?*

Comparison of consonants affected by the identified speech production features (i.e., the number of children using non-adult realisations) has shown that /s/ was the most affected consonant, which was also the case in a number of previous studies on other languages (e.g., Spriestersbach *et al.*, 1956; Subtelny, 1959; Morley, 1970; Van Demark, 1979; Albery, 1991; Brøndsted, *et al.*, 1994; Harding and Grunwell, 1993). It is well known that, in contrast to other consonants, production of /s/ requires precise shape and positioning of the tongue (Kent, 1992), which makes it difficult for children with cleft palate to produce. /t̪’, ʤ, d, ʧ’/ were the next most affected consonants. Moreover, Fletcher (1985) suggested that as the production of /s/ lasts a relatively long time (200-300 ms) the volume of air required is greater than for most other sounds. It is surprising that the ejective fricative /s’/ was not among the most affected consonants. Because this sound involves an aerodynamic dilemma, in that, in common with other ejectives, it requires an increased intraoral air pressure and a complete oral closure for the ejectivity to be realised; yet during the production of a fricative the air continuously passes through a narrow constriction. Given this and the aerodynamic challenges posed by the cleft condition, one would expect /s’/ to be among the most affected consonants, but it was not. A possible explanation for this could be the fact that /s’/ is less frequent in Amharic, and therefore in the present data, than the consonants which were found to be most affected.

ii. Age at assessment

How is age of participants related to their speech output?

In terms of the relationship between age of participants/age at surgery and their speech output, all the identified speech production features (i.e., active cleft-type, passive-cleft type and non-cleft developmental realisations) were demonstrated by at least one child in the first group (i.e., those aged between 5-7;11). The second group (i.e., those aged between 8-10;11) demonstrated all the realisations except palatalization and developmental realisations. The third group (i.e., those aged between 11-14) did not exhibit bilabial articulations of non-bilabial sounds, linguolabial articulations, interdental articulations, lateralizations, palatalizations, articulations of prenasalised consonants and developmental realisations. The atypical realisations observed in the speech of the children in the third age group appear to be less varied than they were in the other groups. The results suggest that the number of active-cleft type realisations increased as age at assessment increased. As already noted, all the participants with cleft palate in the present study are 'late' operated children. Similar patterns were noted in previous studies that compared children who had surgery at much younger ages than the time at which the children in present study had surgery. For example, Hardin-Jones and Jones (2005), reported that compensatory articulations were produced by more children in their older surgery group than the early surgery group. Moreover, Sell and Grunwell (1993a:141) noted that 'late repair, i.e., after 8;0, in [the] Sinhala-speaking population, did not lead to spontaneous improvement of speech'. This appears to be because, as already noted, as age at time of palatal surgery increases, there is more opportunity for compensatory articulations to have stabilized in the developing phonology.

In terms of resonance and airflow, the children in the third group are the most affected ones. All the children in this group were perceived to have a moderate hypernasal resonance, while some of the children in the first two groups demonstrated typical resonance (20% from the first group) or mild hypernasality (40% from the first and 33% from the second group). Chapman *et al*. (2008) reported similar findings, where their older children exhibited more hypernasality than the younger children. Similarly, in the present study, it seems that degree of hypernasality and nasal emission increased with age of participant. Hyponasality was not perceived in the children in the third group, while nasal turbulence was evident both in the first and third group. Overall, the finding of this study support previous research, that looked at children who have surgery at earlier ages than the children in this study, showing that a better speech outcome was associated with earlier surgery.

iii. Cleft type

- *What is the relationship between cleft type and speech output?*

The groups were also compared on speech output as a function of cleft type. The children with an ICP produced all the identified speech production features except palatalization, while those with a UCLP exhibited them all. Those with a BCLP did not realise the anterior realisations (i.e., bilabial articulations of non-bilabial consonants, linguolabial articulations, interdental articulations, lateralizations, palatalizations). As already noted, this could be because the effects of a bilateral cleft lips and palate on the anterior parts (i.e., particularly, the lips and alveolar ridge) of the oral cavity is particularly severe.

They did not produce prenasalised consonants and developmental realisations either. The atypical realisations observed in the speech of the children with a BCLP are less varied than in those with an ICP and a UCLP. However, the findings of the present study suggested that, in general, there were no major differences between the three groups with respect to active realisations. Similar results have been reported in previous studies (e.g., Hardin-Jones and Jones, 2005; Chapman, *et al.*, 2008). For example, Hardin-Jones and Jones (2005) stated that no significant relationship was evident between cleft type and the number of children producing compensatory articulations.

However, in terms of passive realisations, the children with a UCLP and BCLP exhibited more passive cleft-type realisations than those with an ICP. No significant differences between the UCLP and BCLP were found with respect to both active and passive realisations. This is in consistent with Chapman *et al*. (2008), who compared the speech characteristics of children with BCLP versus UCLP and found no significant differences between the two groups with respect to speech output based on cleft type. In the present study, the fact that the number of children in each group was relatively small and not comparable (i.e., 5 children with an ICP, 10 with a UCLP and 5 with a BCLP) made the comparison of speech productions based on cleft type difficult. Differences in speech output that have been observed across cleft type groups have generally been attributed to structural deficits (e.g., dental/occlusal problems) associated with the cleft (Peterson-Falzone *et al.*, 2001). It has been stated that children with a UCLP and a BCLP are often considered to be at greater risk for atypical articulation than children with an ICP because the cleft extends through the alveolus and thus predisposes the child to a number of dental/occlusal problems, which in turn could cause typical articulations (e.g., maxillary collapse, missing teeth, etc.) (Jones, *et al.*, 2003; Peterson-Falzone *et al.*, 2001).

iv. Ejectives

- *How are the realisations of ejectives different from those of their pulmonic counterparts?*

As shown above, the children demonstrated more atypical realisations in the production of ejectives than for the pulmonic stops. This appears to be due to the fact that, for individuals with cleft palate, both ejectives and pulmonic stops, being high pressure consonants, are challenging to produce, and the Amharic speaker has the added challenge of maintaining a perceptible difference between them for phonological purposes. Eight children managed to achieve ejectivity for /p'/ and seven children for

/k’/, making these two sounds the least difficult ejectives for the children with cleft palate to produce. These could be a reflection of the established preference of individuals with cleft palate for ‘front’ and ‘back’ articulations (Grunwell and Russell, 1988). From an aerodynamic point of view, the fact that a considerable number of children managed to produce /k’/ with the appropriate airstream mechanism is not surprising because higher intraoral air pressure can be achieved during posterior ejectives than during ejectives with anterior places of articulation (Maddieson, 1998; Ohala, 1996; Ladefoged and Maddieson, 1996; Ladefoged, 2005; Johnson, 2012). It is surprising, however, that a significant number of children also managed to achieve ejectivity for /p’/, despite the fact that the intraoral air pressure for this sound is assumed to be less than it is for ejectives produced further back in the oral cavity.

Only two children produced /s’/ with the appropriate airstream mechanism, making it the most difficult ejective to produce for the children with cleft palate. As already discussed above, /s’/ is a particularly complex ejective in terms of its aerodynamics, because it requires two competing demands (i.e., ejectivity and friction) to be satisfied for its production. Typically, this aerodynamic challenge may be managed by reducing the size of the constriction between oral articulators which increases intraoral air pressure such that friction can be achieved using the outflow of air trapped above the larynx (Maddieson, 1998). However, this may not be easy for children with late palate repair and who may also have VPI which has not been remediated by surgery. Owing to this, most of the children produced /s’/ as a glottal stop, which does not require a build-up of intraoral air pressure or friction.

It is important to note that, as can be seen from Table 9.12, the affected consonants were compared based on how many realizations/processes a consonant was affected by. The total number of each consonant affected by each realization in the speech of each child was considered in order to compare the least and most affected consonants. Note that a certain process may affect a consonant in the speech of more than one child. So, even though /s'/ is a difficult sound in terms of its articulatory and aerodynamic properties, it did happen to be among the most affected consonants because of its low frequency in the language and therefore in the data. A consonant would have more chance to be affected by many realizations when it has more frequency and wider distribution.

Regarding realisations of ejectives in relation to age at assessment and cleft type, one of the recurring findings was that the children with BCLP generally behaved consistently differently from those with the other cleft types. These children were recorded using more atypical airstream mechanisms than the children with ICP and UCLP. They also used more glottal realisations, particularly for ejectives, than the children in the other two groups. This could be because in addition to the known preference of individuals with cleft palate for glottal articulations, ejectives typically involve constriction of the glottis, which might have made the glottal substitutions more prevalent for ejectives than for their pulmonic counterparts. However, the fact that the children with BCLP generally showed consistent speech production patterns in a different fashion from those with ICLP appears to be related to the severity of the cleft (Jones, *et al.*, 2003; Peterson-Falzone *et al.*, 2001).

It is also interesting to note that half of the children (n = 5) in the first group and almost all of the children from the second group realised /k'/ as a glottal stop, and only one child from the third group demonstrated a glottal realisation of /k'/. This appears to be linked to developmental factors, but needs further investigation.

In summary, more children demonstrated glottal realisations for ejectives than for the pulmonics. Overall, the children generally preferred backed articulations, particularly glottal realisations, for ejectives. All the implosive productions noted were used to realise target ejectives. The use of implosives for ejectives may be because implosives are perceptually different from pulmonic consonants and are produced mainly on an ingressive airstream, which therefore circumvents the problem of airflow being lost at the velopharyngeal port. Also, more click realisations were used by the children for ejectives than for pulmonics. This appears to be because clicks require a very small air pressure trapped in the oral cavity so that a relatively small movement of the tongue produces a very large change in intraoral air pressure, and makes it possible to produce a loud release burst (Ladefoged and Maddieson, 1996). Moreover, the production of clicks (at least the closure phase) may not be significantly affected by VPI, as the build-up of air pressure is created within the oral cavity, anterior to the velopharyngeal port. It is important to note that even though, from aerodynamics of speech view point, other non-pulmonic sounds (particularly clicks and implosives) seem to be relatively easier than ejectives for the children with cleft palate to produce, they were not commonly used by more children. This could be attributed to several factors. One of the reasons might be that it is simply impossible or very difficult to produce clicks with an unrepaired palate, and after surgery the children tend to continue using the articulatory behaviours established before surgery. It could also be because clicks are very salient perceptually, but so rare cross-linguistically, so using them in languages in which these sounds are not part of their phonemic inventories would make the children's speech difficulty more pronounced. Furthermore, using non-clicks and implosives in a language which already has pulmonic and ejective consonants would present an additional challenge to the children with cleft palate.

The results described and discussed in this chapter provide relevant information about the relationship between speech output and age at surgery and cleft type in late-operated individuals speaking a language which has consonants using pulmonic and non-pulmonic airstream mechanisms. The chapter also compares and contrast the least and most affected consonants in relation to reports in other languages. Moreover, it contributes data on how ejectives are produced by individuals with cleft palate, which has not been reported before. As already indicated, some of the speech production features were consistently attested regardless of word context or elicitation mode, while other realisations were observed in certain word contexts and/or elicitation modes. The next chapter addresses this issue of contextual variation by examining the phonetic variation identified in the speech of the children with cleft palate and reflecting on the phonological consequences this phonetic variation has.

Chapter 10: Causes of phonetic variability and phonological implications

10.1. Introduction

This chapter describes the phonetic variations that appear to be conditioned by contexts and modes of elicitation. It also discusses the implications that the identified atypical realisations have for the children's phonological systems. The phonological analysis demonstrates the degree to which meaningful contrasts are constrained by limitations of the children's systematic and distributional use of speech sounds. This is relevant to the entire study because it shows which children have significant phonological difficulties and hence intelligibility issues. The chapter has six sections. The first discusses the phonetic variations observed in anterior articulations and the phonological implications of the variations. The anterior cleft-type speech characteristics dealt with in this section are linguolabial articulations, interdental articulations and double articulations. In the second part of the chapter, backed articulatory patterns in relation to causes of phonetic variations and phonological implications will be treated. This section has two sub-sections. The first subsection discusses variations observed in 'within the oral cavity' backed articulations. In the second, variations noted in consonants backed to glottal place are described. In the third part of the chapter, the phonetic variants of the consonants that were affected by atypical airstream mechanisms and their phonological implications are discussed. In the fourth part, comparisons of phonetic variations as a function of age at assessment/surgery and cleft type are made. The fifth part compares the children on degree of lost phonemic contrasts as a function of the independent variables (age at assessment/surgery and cleft type). The final section of the chapter summarises the main points. The chapter aims to address the following research questions:

- **Research questions addressed in this chapter:**
  - Are there variations conditioned by context and/or elicitation mode?
    - What are the phonological consequences of the atypical speech productions observed in the children with cleft palate?
    - Is phonetic variability related to age of assessment and/or cleft type?
    - Is degree of loss of phonemic contrast related to age of assessment and/or cleft type?

10.2. Anterior articulations

In this section, ‘anterior cleft-type’ realisations, their phonetic variants and the impact that the realisations have on the phonological systems of the children who realised them are discussed. Accordingly, in the sub-sections that follow, causes of variability and phonological implications noted in linguolabial articulations, interdental articulations and double articulation are analysed consecutively.

10.2.1. Phonetic variations and phonological consequences of linguolabial articulations

Three children (BM, EY, SG) realised linguolabial articulations. As already discussed in section 8.2.1.1.1., BM realised /t̪, t̪’, d, n, l/ as linguolabials [t̼̃̇, t̼̃̇’, d̼̃, n̼, n̼], EY realised /l/ and /n/ as [n̼]; and SG realised /r/ as [n̼]. SG’s realisation of /r/ as [n̼] was consistent across word contexts and elicitation modes. However, variations conditioned by contexts were observed in the speech of BM and EY.

BM realised /t̺, d, n, l/ linguolabially in all word positions and all sampling conditions, however, in a cluster in which /t̺'/ occurs after /n/, he realised /t̺'/ as [ʔ] (n = 5). For example, he realised the word /ʒant̺'ɨla/ '*umbrella*' as [ʒ̃ãn̼ʔɨ̃n̼ã]. Elsewhere, he realised /t̺'/ as [t̼̆'] (n = 41). It appears that BM was aware of the fact that, in this particular case, realising the two neighbouring consonants (/n/ and /t̺'/) linguolabially would result in one geminated linguolabial consonant (as he realised /n/ as [n̼]) rather than two different consonants, which could significantly affect the intelligibility of the word. Moreover, as he routinely produces the target consonant in the last syllable, /l/, as [n̼], producing /t̺'/ linguolabially would result in the neutralisation of the phonemic contrasts of three consonants (/n, t̺', l/) in a single word. So, BM's realisation of /t̺'/ as [ʔ] in this particular instance suggests his knowledge of the phonological contrasts existing between these consonants.

EY consistently realised word-medial and word-final /l/ as [n̼]. Even word-initially, he often realised /l/ as [n̼]; however, there was an instance where he realised it as [ʄ]. The latter realisation (i.e., /l/→[ʄ]) was noted only in one word (i.e., /lilli/→[ʄɨn̼n̼i] '*person's name*'), but repeatedly. It is not clear why he realised this sound (/l/) as an implosive in this particular word, which occurred only in the sentence repetition task. The name /lilli/ is not uncommon in Amharic-speaking communities and has no special phonetic or pragmatic feature. However, in the case of /n/, he often realised it as [n] (n = 72) but sometimes as [n̼] (n = 24), with no consistent pattern. It appears that the two forms ([n] vs. [n̪]) are in free variation in his speech. No variation conditioned by mode of elicitation was found.

Table 10.1 summarises the inconsistencies noted in linguolabial articulations and their distributions. The tick symbol indicates that the realisation always occurred in the corresponding word-context or elicitation mode, while the cross symbol shows that the realisation was not observed in the corresponding word-context or elicitation mode.

Table 10.1 Inconsistencies noted in linguolabial articulations.

Par.	***Pattern***	***SIWI***	***SFWF***	***SGW****	***GOS***	***Spont***	***Additional information***
BM	/t̪’/→[t̪̃’]	often	often	often	often	often	/t̪’/→[ʔ] occurred only after /n/
EY	/l/→[n̪]	often	✔	✔	often	✔	With one exception (/l/→[ɠ])
	/l/→[ɠ]	once	✘	✘	once	✘	Occurred only in one word
	/n/→[n] /n/→[n̪]	often sometimes	often sometimes	often sometimes	often sometimes	often sometimes	These two realisations had no consistent pattern
SG	/r/→[n̪]	✔	✔	✔	✔	✔	consistent

*SGW=single word; GOS=GOS.SP.ASS; Spont=spontaneous speech

Regarding the phonological implications of these realisations, BM attempted to maintain phonemic contrasts between /t̪/ and /t̪’/ and between /t̪/ and /d/; but not between /n/ and /l/, which is a common phenomenon in individuals with cleft palate (Sell, *et al.*, 1994b; Henningsson, *et al.*, 2008). In the first case (i.e., /t̪/ vs. /t̪’/), BM maintained the pulmonic/ejective contrast which normally distinguishes the two sounds. It is important to note however that his ejectives were considerably weaker than typical, due to reduced intraoral air pressure resulting from considerable nasal emission. In the second case (i.e., /t̪/ vs. /d/), he managed to signal the voiced/voiceless contrast. But, typically, in Amharic, these two sounds are differentiated not just by a voiced/voiceless contrast. As the diacritic [̪] shows in /t̪/, they are also differentiated by the place of articulation: /t̪/ is a denti-alveolar stop whereas /d/ is an alveolar one. Hence, although the voice/voiceless contrast is maintained, their difference in terms place of articulation is neutralised. The two sounds remained perceptually different. With regards to /n/ and /l/, no contrast was maintained and the two consonants sounded the same, as [n̪̰]. The neutralisation of the phonemic contrast between these two sounds can be illustrated by his production of the personal names /lilli/ and /ninni/, which he realised as [n̪̰ĩn̪̰n̪̰ĩ].

An overlapping usage of [n̪̰] for both /l/ and /n/ was evident in EY's speech. Although his realisation of /n/ as [n̪̰] (n = 24) was limited, compared to the occurrence of [n] (n = 72), it may have considerable phonological (intelligibility) consequences.

10.2.2. Phonetic variations and phonological consequences of interdental articulations

Seven children (aged between 2;5 and 14;0) demonstrated interdental realisations (see section 8.2.1.1.2. for details). One of these children was BM, who consistently realised /s, s', z, r/ as [s̪̃͆, s̪̃͆', z̪̃͆, n̪̊]. No variation conditioned either by elicitation mode or context was recorded in his realisations of these sounds. He also managed to signal the contrasts between /s/ and /s'/ and between /s/ and /z/. Again the ejectivity in /s'/ was not as strong as it typically is, due to the reduced intra-oral air pressure caused by nasal emission. The contrast between /s/ and /z/ was also maintained in his speech by the proper use of voice/voiceless contrast.

EY was also recorded using interdental articulations. He consistently realised the alveolar trill /r/ as [n̪̊]. This articulatory pattern was consistently noticed in the singleton as well as geminated variants of /r/. No variation conditioned either by mode of elicitation or context was noted. Phonologically, although EY realised /r/ slightly differently from the way he produced /l/ and /n/, i.e. [n̪̺], perceptually, his /r/ sounded very similar. Despite his attempt to maintain the phonemic difference between /r/ and /n/ by using different places of articulation, the contrast between the two sounds appears to be lost, as they sounded very much alike. The slight articulatory differences might also not be visible to his interlocutor in face to face interaction.

TB also exhibited an interdental production of the alveolar trill /r/. This production, however, was restricted to only the word /ɨrrəɲɲa/ '*shepherd*' which he realised it as [ɨn̪͆whiəɲɲa]. This production was noted in the sentence repetition sampling condition. Elsewhere, he realised it as [n], regardless of elicitation mode. For example, in the single-word sampling condition, he realised the words /fərəs/ '*horse*' and /surri/ '*trousers*' as [fə̃nə̃n̪͆̊̇] and [n̪͆̊̇ũnnĩ] respectively. One may wonder why TB realised /r/ as [n̪͆] only in one word, and as [n] elsewhere. It seems that the use of [n] for /r/ in /ɨrrəɲɲa/ affects his ability to signal the contrast between, for example, /ɨrrəɲɲa/ '*shepherd*' and /ɨnnəɲɲa/ '*those*'. Given this, the realisation of /r/ as [n̪͆] in this particular word (/ɨrrəɲɲa/), but not as [n], might have been aimed at maximizing the contrast between the [n] that he realised for /r/ and the actual /n/. If this was the case, it implies that he was aware of the fact that he was realising /r/ as [n] and of the contrast between /r/ and /n/ but unable to maintain the contrast due to the cleft condition.

WL was another child who demonstrated interdental realisations. She consistently realised /ɲ/ as [n̪͆]; and no variation conditioned either by elicitation condition or by context was noted. However, the contrast between /n/ and /ɲ/ was compromised. For example, perceptually, her productions of /ɨnna/ ‘*and*’ and /ɨɲɲa/ ‘*we*’ sounded very much alike.

A number of interdental realisations were seen in EA’s speech as well. He realised /t̪, d, s, z, l, n, ʃ, ʧ, ʤ/ as [t̪͆, d̪͆, s̪͆, z̪͆, n̪͆, n̪͆, s̪͆, t̪͆, d̪͆]. It is interesting to note that for this child all denti/alveolar consonants are affected, whereas for most other children it is only selected sounds. This could be due to his atypical dental condition. As can be seen from figure 10.1, although he seemed to have a typical bite, he had missing and rotated teeth at the alveolar cleft site, which might have caused or contributed to his significant interdental realisations (Hutters and Brøndsted, 1987).

Figure 10.1 EA’s dental condition.

Most of these realisations were consistent. However, there were some variations observed in some of the realisations. For example, he realised /t̪/ as [p͆̇] only in the word /t̪ep/ ‘*tape player*’, which he realised it as [p͆̇ẽp͆̇]. As noted in Chapter 7, this appears to be a result of a regressive non-contiguous assimilation/consonant harmony, which is a developmental realisation in Amharic. Although this realisation was reported to occur in the speech of typically-developing children who are as old as 3;6 years of age

(Mekonnen, 2008), its occurrence at age 5;1 is not age-appropriate. Elsewhere, he realised /t̪/ interdentally as [t̪̆]. /n/→[n̪̆] (n = 3) was noted only when the target was geminated (as in /ninni/ '*person's name*', which he realised as [nĩn̪̆n̪̆ĩ]). Otherwise, it was realised as [n]. He often realised /s/ as [s̪̆̃] (n = 40), less often as [t̪̆̃] (n = 7) and as [n] (n = 5), with no consistent pattern. For example, in the sentence repetition sampling condition, he realised the word /ɨjjasu/ '*person's name*', as [ɨ̃jjãt̪̆̃ũ]. In the same elicitation mode, he produced the word /p'app'asu/ '*the bishop*' as [b̃ãb̃ãnũ]. /z/→[z̪̆] (n = 20) and /z/→[z̪̃] (n = 6) were used inconsistently in his speech. These realisations have significant phonological implications. For example, the use of [t̪̆] for /t̪/ and /ʧ/; [s̪̆̃] for /s/ and /ʃ/; [n̪̆] for /l/ and /n/ resulted in the loss of phonemic contrast between the target consonants.

BZ also showed interdental articulatory behaviour. She consistently realised /r/ (both geminated and singleton) as [n̪̆] in all word contexts and in all elicitation conditions. As there was no other consonant that she realised interdentally, her realisation of /r/ as [n̪̆] affected only the contrast between /r/ and /n/, as her [n̪̆] was perceptually similar to /n/.

Of the seven children who demonstrated interdental realisations, four (BM, EY, TB, EZ) showed interdental nasal realisations of /r/. As discussed in chapter 7, in typical consonant acquisition, the trill is the most difficult consonant to learn, irrespective of language. It has been stated (e.g., Recasens, 1991; Ladefoged and Maddieson, 1996; Solé, 2002) that the alveolar trill requires very precise control of aperture and airflow with minimal deviation, which could be the reason why it is often acquired rather late. The articulatory and aerodynamic precision required to produce /r/ also explains why a considerable number (7 out of 20) of the children with cleft palate substituted it with interdental and alveolar nasal consonants. The interdental realisations observed in four of the children could be attributed to atypical bite and/or dental condition.

The seventh child who showed interdental realisations was FM. He realised /t̪/ and /d/ as [t̪̃̇] and [d̪͆] respectively. /t̪/→[t̪̃̇] (n = 15) and /t̪/→[t̪̃̇] (n = 4) were used inconsistently. For instance, in the sentence repetition sampling condition, /t̪it̪t̪i/ ‘*person’s name*’ was realised as [t̪̃̇ĩt̪̃̇t̪̃̇ĩ] and in the same sampling condition, /t̪əddəfa/ ‘*spilled*’ was realised as [t̪̃̇ə̃d̪͆d̪͆ə̃f̃̇ã]. In the single-word sample, /t̪ep/ ‘*tape player*’ was realised as [t̪̃̇ẽp̃̇]. These variations may not have significant phonological implications, as there are no other consonants that he realised interdentally.

10.2.3. Phonetic variations and phonological consequences of lateral articulations

The children who demonstrated lateral articulations were TB, WL, EY, and BM. Lateral realisations of /s/ and /z/ in the speech of TB and WL were so inconsistent that no clear pattern could be identified. TB sometimes realised /s/ as [ɬ] (n = 4); but most often as [ñ̪̥̇] (n = 24). WL infrequently realised /s/ as [ɬ̃] (n = 4); but most often as [ñ̪̥̇] (n = 51); she often realised /z/ as [ñ̪̥̇] (n= 16) and less often as [ɬ̃] (n = 2). In the speech of EY and BM, it appears that the fricative portion of the affricates /ʧ/ and /ʤ/ were laterally realised when they appeared before a high front vowel /i/. Elsewhere, EY realised /ʧ/ and /ʤ/ as [c̃̇] and [ɟ] respectively, while BM realised them as [ʧ̃̇] and [ʤ̃] respectively. The lateralization observed in these children may not have a detrimental effect on the contrastivity of the segments affected. Only BM used lateralized realisations [ɬ̃̇] and [ɮ̃] for postalveolar fricatives /ʃ/ and /ʒ/ respectively, when they appeared before a high front vowel /i/. Elsewhere, he realised them as [ʃ̰̃] and [ʒ̃], respectively.

10.2.4. Phonetic variations and phonological consequences of double articulation

Eight children demonstrated double articulations (including glottal reinforcements). One of these children was EZ. Inconsistent realisation of the geminated /b/ target as [b͡ʔ] (n = 2) was observed in his speech. For example, he realised /ʧɨbbo/ ‘*bonfire*’ as [ʔɨ̃b͡ʔõ]. Elsewhere, he inconsistently realised /b/ as [ʔ] (n = 6) and as [m̥] (n = 6). Realisation of /b/as [b͡ʔ] was also noted in the speech of HA. This realisation was observed only once, word-initially in the sentence repetition task. Elsewhere, he realised it as [b̃] (n = 26).

BN also demonstrated an instance of double articulation. She was recorded realising /d/ as [d͡g] (n = 1) word-initially, in the word /dɨmməṯ/ ‘*cat*’, which she produced as [d͡gɨ̃mmə̃c]. BN’s realisation of /d/ as [d͡g] was observed only in the single-word sampling condition, only in one word. BN and WL realised the ejective affricate /ʧ’/ as [ǀ͡ʔ]. BN used this realisation (n = 7) consistently in all elicitation modes, while WL used it inconsistently (n = 11). WL had more target /ʧ’/ (n=16) than BN (n= 7) in spontaneous speech. The other realisation that WL used for /ʧ’/ was [q’] (n = 5).

Another child who demonstrated double articulation/glottal reinforcement was ES. He realised /l/ as [n͡ʔ] (n = 1), which was noted in the sentence repetition sampling condition and only in the word /lilli/ '*person's name*', which he realised as [n͡ʔin͡ʔi]. This might be triggered by the fact that the second /l/ is geminated, which needed more pressure and force than the singleton one. Elsewhere, he realised it as [n] (n = 23).

/d/→[d͡ʔ] (n = 4) was noted in AT's speech, which he realised only when the target was geminated. NF produced [ɲ͡ʔ] for /d/ (n = 9) and /g/ (n = 2) inconsistently. DS realised /p/ as [p͡ʔ] (n = 6) consistently in all sampling conditions.

With regards to the phonological consequences of double articulation, in some of the children (i.e., EZ, AT, DS) the occurrence of this articulatory behaviour was limited to or triggered by geminated consonants and was thus predictable. In others, it occurred inconsistently, and with a very limited frequency. This suggests that the distribution of double articulation was generally limited. So, it is reasonable to say that, generally, double articulation had limited phonological implications for the speech of the children.

10.3. Posterior articulations

Here backed articulations, their phonetic variants and their phonological consequences are discussed. In the first sub-section, realisations that are backed within the oral cavity are considered, while in the second those backed to the glottal place are discussed.

10.3.1. Phonetic variations of backed oral realisations and their phonological consequences

As already noted, 14 children exhibited backing of oral targets to places further back than their typical place of articulation, but still within the oral cavity. For convenience, the realisations are grouped according to consonant classes. Accordingly, in what follows, backing of plosives and their phonetic variants coupled with their phonological implications are described followed by sections on fricatives, affricates and ejectives.

i. Stops

EM consistently realised /p/ as [k̟̃] in all elicitation contexts. This realisation involves a shift from the lips to the tongue. This realisation overlapped with her realisation of /t̪/ and /ʧ/, which was also [k̟̃]. Moreover, /b/→[g̃] (n = 4) was noted in her speech when the target was geminated, for example, in such words as /t̪əkk'əbba/ '*has been painted*', which she realised as [h̟̃ə̃ʔʔə̃g̃ã]. Elsewhere, i.e., when the target was singleton, it was realised as [b̃] (n = 31). She realised /k'/ as [q̟̃] (n = 3) only word-initially; elsewhere, it was realised as [ʔ] (n = 18).

EY and BN realised /t̪/ as [c]. EY's realisation of [c] for /t̪/ was consistent. However, word-initially, he produced /t̪/ as [p] just in one word, /t̪ep/ '*tape player*', but he 'corrected' himself and realised it as [c]. Other than this, no variation conditioned by mode of elicitation was noted. BN consistently realised /t̪/ as [c] (n = 68), in all contexts, regardless of elicitation mode. However, as was the case with EY, she realised /t̪/ as [p] (n = 1) just in one word (/t̪ep/); and, as EY did, she 'corrected' herself immediately and produced it as [c]. EY often realised /d/ as [ɟ] (n = 41), but realisations of [ŋ͡g] (n = 9) were noted when the target was geminated. BN often realised /d/ as [ɟ] (n = 68); but word-initially and only in the single-word sampling condition, she was recorded realising it as [d͡g].

EY and BN attempted to maintain the phonemic contrast between /t̪/ vs. /k/ and /d/ vs. /g/. EY realised /t̪/ as [c] and /d/ as [ɟ], and /k/ as [k] and /g/ as [ŋ͡g]. Likewise, BN realised /t̪/ as [c] and /d/ as [ɟ], and /k/ as [k̃] and /g/ as [ɣ]. It appears that they attempted to signal the contrasts between the alveolar and velar consonants. However, for /t̪/ and /k/, as Amharic does not have palatal stops, due to categorical perception, an ordinary native Amharic-speaker may perceive their realisations of these sounds (/t̪/ and /k/) as /k/. In other words, even though, the children made an effort to differentiate /t̪/ and /k/, the contrast is not significant enough for native speakers to perceive and categorise them differently. Regarding /d/ and /g/, it seems that they managed to signal the alveolar-velar contrast.

NF's realisation of /d/ as [ɲ] was restricted to word-initial position, but was seen in all sampling conditions. It does not overlap with /ɲ/ because, in Amharic, /ɲ/ does not occur word-initially.

Elsewhere, he realised /d/ as [ɗ] and [ɲ͡ʔ]. As noted above, the latter realisation was also seen in his production of /g/, which implies that there was a potential loss of contrast between /d/ and /g/ in his speech.,

ii. Fricatives

Similar to the velar realisation of a bilabial target already noted in EM's speech, a velar realisation of a labiodental target was identified in BM's speech. He produced /f/ as [k͋], but the realisation was restricted to a context where /f/ occurs after /l/, which he realised linguolabially as [n̼]. For example, he realised /sa**lf**/ '*when I passed*' as [s͋ã**n̼k͋**]. Elsewhere, he realised /f/ as [m̥]. The realisation of [k͋] for /f/ did not have an impact on the phonemic contrast of the two sounds (/f/ and /k͋/), as the number of times it occurred in the data was limited (n = 2).

/s/→[ç] and /z/→[ʝ] were noted in the speech of EY, BN and NF. No variation either conditioned by context or elicitation mode was observed in EY's realisation of /s/. BN realised /s/ word-initially and word-medially as [ç] (n = 58) and word-finally as [n̥͋] (n = 8). She was consistent in all elicitation modes. NF produced /s/ as [ç] (n = 9) word-initially; elsewhere, he realised it as [n̥͋] (n = 23). Phonologically, even though Amharic does not have [ç] and [ʝ] as part of its phonemic inventory, /s/→[ç] and /z/→[ʝ] will result in a loss of ability to signal phonological contrasts between /s/ and /ʃ/ and between /z/ and /ʒ/, as the children also realised /ʃ/ as [ç] and /ʒ/ as [ʝ].

EY often realised /z/ as [ʝ] (n = 16) and, sometimes as [z̃] (n = 8) and [n̥͋] (n = 11), but with no consistent pattern. Similarly, BN often realised /z/ as [ʝ] (n = 69) and sometimes, word-initially, as [ɣ] (n = 6). As indicated above, EY realised /ʃ/ as [ç] word-initially, and as [ç] and [n̥͋] elsewhere, with no apparent pattern. This was true in all elicitation modes. He realised /ʒ/ as [j̥] (n = 18) in word-medial and word-final positions. Word-initially, he realised it as [d͡g] (n = 10). BN consistently realised /ʃ/ and /ʒ/ as [ç] and [ɣ], respectively.

NF produced word-initial /z/ as [j̥] (n = 5) and elsewhere he realised it as [z̃] (n = 11). No variation conditioned by context or mode of elicitation was recorded. He consistently substituted [ñ̥] for /ʃ/. He realised /ʒ/ as a palatalized [ʤʲ] in word-initial position, and as [ɲ] elsewhere. Nasal realisation of the fricatives /z/ and /ʒ/ was also noted in YD's speech. He used [ŋ] for /z/ and /ʒ/. While /z/→[ŋ] was inconsistently realised with no apparent pattern, /ʒ/→[ŋ] was seen consistently in all contexts and elicitation conditions.

Phonologically, the use of [ç] for /s/ and /ʃ/ by EY, BN and NF and the realisation of /z/ as [j̥] by EY and NF appear to affect the contrast between /s/ and /ʃ/ and between /z/ and /ʒ/. YD's realisation of [ŋ] for both /z/ and /ʒ/ compromised the phonemic contrast between these targets.

iii. Affricates

BN realised /ʧ/ as [c] and /ʤ/ as [g̃] consistently, meaning that the voiceless target was always realised as a palatal and the voiced cognate as a velar. This child realised /t̪/ and /d/ as [c] and [ɟ̥], respectively, thus maintaining a phonemic contrast for the voiced targets but not for the voiceless targets. It is not clear why BN realised the voiceless affricate as palatal but the voiced one as velar. One possibility is that the production of

/ʤ/ was retracted to the velar place due to a result of an attempt to maintain voicing. Cavity enlargement, not cavity size reduction, is typically employed to maintain voicing during the production of obstruents, by shifting the place of closure or constriction further to the front. However, given the air leak through the nasal cavity noted in her speech, the velar place might have been the right place for the child to build sufficient intraoral pressure in such a way that the transglottal pressure difference necessary for voicing (i.e., higher subglottal pressure than the pressure in the oral cavity) can be maintained.

EY was also consistent in his realisation of /ʧ/ as [c]. He often realised /ʤ/ as [ɟ]; but when /ʤ/ occurred before the high front vowel /i/, he realised it as [d̃ʒ̃]. NF also demonstrated backing of affricates. He often realised /ʧ/ as [ɲ] and sometimes as [ʔ] and as [ɲ͡ʔ] with no consistent pattern. His realisation of /ʤ/ as [ʤʲ] was restricted to word-initial positions in single-word sampling condition. Elsewhere, he realised it as [ʔ].

BN attempted to maintain the phonemic contrast between /ʧ/ and /ʤ/ but the realisation of /ʤ/ as [g̃] overlapped with /g/, affecting her ability to signal the contrasts between such words as /ʤɨbu/ '*the hyena*' and /gɨbu/ '*come in (plur. imp)*', which she realised them as [g̃ɨ̃b̃ũ] and [ɣɨ̃b̃ũ]. However, she tried to maintain the contrast between /ʤ/ and /g/ by consistently realising the latter as [ɣ], which coincides with her realisations of /z/ and /ʒ/, which in turn affects the phonemic contrasts between /z/, /ʒ/ and /g/. BN's and EY's realisations of /ʧ/ as [c] and /ʤ/ as [ɟ] also neutralised the contrasts between /t̪/ and /ʧ/ and /d/ and /ʤ/ respectively, as they both realised /t̪/ as [c] and /d/ as [ɟ]. NF's realisation of /ʧ/ as [ɲ] affected the contrasts between /ʧ/ and /ɲ/ and between /ʧ/ and other consonants that he realised as [ɲ] (i.e., /d/, /ʒ/ and /g/). His realisation of /ʤ/ as [ʤʲ] also neutralised the contrast between /ʤ/ and /ʒ/, which he sometimes realised as [ʤʲ].

iv. Ejectives

BN realised /t̪'/ as [k'] consistently. WL often realised the singleton /t̪'/ as [q'] and sometimes as [ɟᵑ], but when geminated she realised it as [ʔ]. For example, she realised /t'ara/ '*roof*' as [q'ãbã]; /t'ut/ '*breast*' as [ɟᵑũñ̥]; but /att'u/ '*they lost/didn't find*' as [ãʔʔũ]. EY consistently articulated /s'/ as [ç']. No variation conditioned either by context or elicitation mode was observed. He often realised /ʧ'/ as [c'], but the use of [ʔ͡ʔ] for the same target was sometimes noted in his single-word speech sample. BN and WL consistently realised /ʧ'/ as [ʔ͡ʔ]. WL often realised /k'/ as [q'] and sometimes as [ɟᵑ] in word-initial position.

EY's and BN's realisations of /t̪'/ as [k'] coincided with their productions of /k'/ as [k'], compromising the phonological contrast between /t̪'/ and /k'/. The contrast between /t̪/ and /t̪'/ appeared to be maintained in EY's and BN's speech, as they often realised /t̪/ as [c] and /t̪'/ as [k']. EY and BN also managed to signal the phonemic contrast between /ʧ/ and /ʧ'/ as they both realised /ʧ/ as [c]; and EY realised /ʧ'/as [c'], while BN realised it as [ɟ͡ʔ]. The contrast between /t̪’/ and /k’/ in WL’s speech was compromised because of her use of [q’] and [ǂᵑ] for both /t̪’/ and /k’/.

10.3.2. Phonetic variations and phonological consequences of glottal articulations

Backing of oral target to the glottal place of articulation was noted in the speech of 16 children. Below is a table containing the number of consonants that were realised as a glottal stop by each child.

Table 10.2 The number of target consonants for which the glottal stop was used, by child.

Child	ES	EZ	SG	NF	HA	AT	EM	YD	DS	BZ	TB	NB	BN	BM	EY	WL
n	17	13	12	8	8	8	7	7	4	4	3	3	2	2	1	1

Most of the children used the glottal realisation consistently and in all sampling conditions. However, some children demonstrated contextual variations and variations conditioned by elicitation mode. EZ was one of the most polific users of glottal realisations. Although the majority of his realisations were consistent, some variations were also noted. For example, he often realised /t̪/ as [ʔ] and sometimes, word-finally, as [t̪̃̇]. Although he sometimes used [ʔ] for /d/, too this was not commonly observed in his speech, and it didn’t have consistent pattern. Moreover, EZ realised /ʒ/ as [ʔ] word-initially; and as [ñ̥̇] elsewhere. He also realised /s’/ often as [ʔ], but, sometimes, word-finally, he realised it as [ñ̥̇], with no consistent pattern. Furthermore, he was the only child who realised /p/ as [ʔ]; and he did it in all contexts regardless of elicitation mode.

Of the 12 consonants which SG realised with a glottal stop, alternative realisations were noted in three of them (i.e., /t̪’/, /s/ and /ʃ/). For example, /t̪’/→[ʔ] was noted in her speech, word-initially and word-medially, but not word-finally, where /t̪’/→[t̪̃] occurred. Likewise, /d/→[ʔ] was observed in other word positions than word-finally, where it was realised as [n] (e.g., /dawd/ ‘*person’s name*’ was realised as [ʔãw̃n]). /s/→[ʔ] was inconsistently produced in her speech. For example, she realised such words as /səʔat̪/ ‘*watch/time*’ and /sost̪/ ‘*three*’ as [ʔə̃ʔãt̪̃] and [ʃõʃt̪̃], respectively, with no consistent pattern. /ʃ/→[ʔ] was also inconsistent: although it was noted in such words as /aʃʃəʧ/ ‘*she rubbed,*’ which she realised it as [ʔãʔẽʧ̃] in the sentence repetition sample, In the same type of sample, however, she realised the word /ʃaʃe/ as [j̃ãjẽ].

NF realised eight target consonants with a glottal stop. He consistently used a glottal stop for five of them (i.e., /t̪, k, s’, ʧ’, k’/) in all word positions and elicitation modes. Inconsistent uses of a glottal stop were noted in his realisations of the remaining three consonants (i.e., /d, ʤ, t̪’/).

Two children (HA and AT) realised the glottal stop for eight consonants (/t̪, d, k, g, t̪’, s’, ʧ’, k’/). HA consistently realised the glottal stop for six of them (k, g, t̪’, s’, ʧ’, k’/). He realised /t̪/ as [h̃] word-initially, as in /t̪əkk’əmət̪’ə/ ‘*he/it sat*’, which was realised as [ɦ̃ə̃ʔʔə̃məʔã]; and /t̪it̪t̪i/ ‘*person’s name*’ realised as [h̃ĩʔʔĩ]. /t̪/→[t̪] occurred word-finally in all elicitation modes. Elsewhere, he realised /t̪/ as [ʔ]. /d/→[d̃] was noted word-initially, but inconsistently. Elsewhere, he realised /d/ as [ʔ].

AT used a glottal stop for eight consonants (/t̪, d, k, g, t̪’, s’, ʧ’, k’/). He realised seven of them as a glottal stop in all word positions and in all elicitation modes. He realised /d/ as [ʔ], and as [d͡ʔ] only when the target was geminated.

Significant glottal realisations were also noted in the speech of EM and YD. EM consistently realised seven consonants (/v, ʒ, ʤ, p’, t̪’, s’, ʧ’/) as a glottal stop. She also used a glottal stop for /k’/ in word medial and word-final positions. Word-initially, she realised it as [q̃]. YD also consistently used a glottal stop for six consonants (/v, ʒ, ʤ, p’, t̪’, s’, ʧ’/). Moreover, he realised /t̪/ as [ʔ] (e.g., he realised the word /t̪ep/ ‘*tape player*’ as [ʔep̃]), except in word-initial position, in the sentence repetition task, where he realised it as [h̃], e.g. /t̪əddəfa/ ‘*was spilled*’, which was realised as [h̃ə̃d̃d̃ə̃m̥ã]. Furthermore, for /k’/, YD used [ʔ] and [k̡’] with no consistent pattern, though [ʔ] was more common For example, in the sentence repetition task, the sentence /k’akk’o k’əj k’ələm t̪əkk’ba/ ‘*Kakko painted himself red*’ was realised as [ʔãʔʔõ k̡’ə̃j ʔə̃nə̃m h̃ə̃k̡’k̡’ə̃b̃b̃ã]. In the single-word sampling condition, he realised the target /k’/ as [ʔ] (e.g., /k’əmis/ ‘*skirt*’ was realised as [ʔə̃mĩñ̥]). Except for these variations, YD consistently realised the remaining six consonants as a glottal stop.

Inconsistent realisations of /t̪/→[ʔ] were observed in BZ’s speech in such words as /t̪ək’əmmət̪’ə/ ‘*he/it sat*’ which she realised as [ʔə̃ʔə̃mmə̃ʔə̃]. She often realised /g/ as [ʔ] and sometimes as [g̃] with no consistent pattern. She often realised /t̪’/ as [t̪̃]; but sometimes (as in /t̪ək’əmmət̪’ə/→[ʔəʔəmməʔə] example cited above), she was recorded using the glottal stop for /t̪’/. Similarly, she sometimes used [ʔ] for /k’/, but often realised it as [q̃’], with no consistent pattern.

BN was sometimes perceived realising /t̪’/ as [ʔ]; but often she articulated it as [k’]. She also consistently realised /s’/ as [ʔ]. As already noted, BM realised /t̪’/ as [ʔ] when the target occurred after /n/, where he realised it as linguolabial [n̼]. He also sometimes realised /k’/as [ʔ]. WL and EY also exhibited glottal realisations. WL realised /t̪’/ as [ʔ] when it was geminated. The realisation of /k/ as [h] was also noted in her spontaneous speech, in word-initial position.

The glottal stop is not a frequent consonant in Amharic, however, it is contrastive (e.g., /səbat/ ‘*seven*’ vs. /səʔat/ ‘*watch*/*time*’). So, using it for another phoneme clearly interferes with the children’s ability to signal phonemic contrasts, which is detrimental to speech intelligibility. It appears that the significant collapse of phonological contrastivity caused by the use of the glottal realisations for a range of consonantal targets in several of the children’s speech could adversely affect their intelligibility.

10.4. Atypical airstream mechanisms

This section discusses the phonetic variations noted in relation to atypical usages of airstream mechanism discussed in previous chapters. The phonological implications of the realisations are also discussed. The use of a glottal stop for ejective consonants (thus using a pulmonic airstream for a target consonant produced with a glottal airstream) has been discussed in the above section. Phonetic variants and phonological implications of other atypical usages of airstream mechanism than the glottal substitutions for ejective consonants are described here.

De-ejectivisation (i.e., the use of pulmonic consonants for their ejective counterparts) is one atypical usage of airstream mechanism identified in the children with cleft palate. Four children (TB, SA, EA and DS) demonstrated this articulatory behaviour. All of them realised all the ejectives as pulmonic consonants in all contexts and elicitation modes, which had massive phonological consequences.

Realisations of pulmonic consonants as their ejective counterparts were also discussed in chapter 8. Phonetic variability was noted in the speech of four children (AT, OS, NF, WL). AT, for example, realised /p/ as [p’] only in the sentence repetition sampling condition, and as [p] in other elicitation modes, in all word contexts. OS also realised word/syllable-initial /p/ as [p’] in all elicitation modes; elsewhere in the word, he realised it as [p]. For example, he realised the words /pappi/ ‘*person’s name*’ and /t̪ep/ ‘*tape player*’, as [p’app’i] and [t̪ep], respectively. NF consistently demonstrated a /p/→[p’] pattern in all contexts and all elicitation modes. WL’s realisation of /p/ as [p’] was noted only in word-final position in the single-word elicitation mode.

Realisations of pulmonic and ejective consonants as a click were noted in three children (WL, HA, NF). WL’s realisation of /s/ as a nasal click [ǂᵑ] was noted inconsistently only in spontaneous speech. She realised /t̪’/ as [ǂᵑ] only in the single-word sampling condition, and only in word-initial position. WL demonstrated /p/→[ʘ] as well. This realisation was noted in word-initial and word-medial positions (e.g., /papaja/ ‘*papaya*’ realised as [ʘãʘãj̃ã]). In Amharic, /p/ does not frequently occur word-finally. Words having /p/, in all contexts, are of foreign origin. In order to capture realisations of word-final /p/ the only word included in the assessment was /t̪ep/ '*tape player*', which she realised as [ŋ̊̃ẽp']. HA realised both the singleton and geminated /r/ as [!], in all sampling conditions. NF also exhibited a click realisation, where he reduced the consonant cluster /-mt̪'-/ and realised it as [ʘ]. This realisation was noted only in one word in the spontaneous speech sample, but not in other sampling conditions. It is interesting to note that NF's use of [ʘ] for /-mt̪'-/ does not seem to be accidental. /ʘ/ shares aspects of the articulatory features of /m/ and /t̪'/, i.e., like /m/ its place of articulation is bilabial and like /t̪'/ its manner of articulation is stop. The phonetic features shared by the targets and the realization seem to suggest that the target was a result of the child's, conscious or unconscious, attempt to deal with the apparent articulatory precision/typical perceptual output trade-off presented by the cleft condition. In other words, it appears that both articulatory and perceptual goals might have triggered the realisation of [ʘ] for /-mt̪'-/.

Realisations of pulmonic and ejective consonants as implosives were noted in the speech of three children (WL, NF, EY). /b/→[ɓ̥] was noted in WL's speech; however, no consistent pattern was evident. In fact, this realisation was consistently noted when the target was geminated. However, she was also recorded using this realisation ([ɓ̥]) for the singleton /b/ in word-initial position. The variations were not conditioned by elicitation mode. Similarly, NF's realisations of /b/ as [ɓ̥], /d/ as [ɗ] and /t̪'/as [ɗ] did not have any consistent pattern. The latter was noted only in spontaneous speech sample. As already noted, EY's realisation of /l/ as [ɠ] was noted only in only one word, but repeatedly.

NF’s realisation of [ɗ] for /d/ and /t̪’/ affected the phonemic contrast that normally exists between these two targets. As the distributions of /s/→[ǂ^{ŋ}] and /t̪’/→[ǂ^{ŋ}] in WL’s speech were limited, their phonological implications were also limited. She attempted to differentiate /p/ and /p’/ by realising the former as a click and the latter as an implosive [ɓ̥]. However, her realisation of /p’/ sometimes overlapped with her production of /b/, which she realised as [ɓ̥]. The occurrence of /-mt̪’-/→[ʘ], noted in NF’s speech, was limited, and its phonological implication was also limited.

10.5. Comparison of phonetic variability/consistency

The Error Consistency Index (ECI) (Tyler, 2002; Tyler *et al.*, 2003) was used to compare the children on degree of variability/consistency of realisations as a function of age at assessment and cleft type. ECI is a measure of variability/consistency of realisations across a child’s entire phonological system. The measure does not have a developmental norm, mainly because it was developed to quantify the range of consistency/variability in individuals with confirmed speech difficulties and examine the existence of subgroups defined by consistency/variability within these individuals. Tyler *et al.* (2003), for example, reported that in a sample of 40 children, aged between 3;0-5;11 years, with speech and language difficulties, ECI ranged from 12 to 70.

The ECI for each child was obtained by counting the realisations that each child produced for each target consonant in different word contexts and in all elicitation modes and by summing up the total number of realisations that a child produced for each target consonant.

For example, a child realises /s/ three times word/syllable-initially (WISI) and three times word/syllable-finally (WFSF). In WISI position, it is realised one time as [ç̇̃] and one time as [ṫ̃] and one time as [z̃]. In WFSF position, it is produced one time as [ṫ̃] and twice as [ṅ̥̃]. The following entries would then be made on the table below in the row for the /s/ sound:

Table 10.3 Calculation of the Consistency Index

	Realisations		
Target	***WISI***	***WFSF***	***Total***
/s/	[ç̇̃] [ṫ̃] [z̃]	[ṫ̃] [ṅ̥̃]	4

In computing the total, each different realisation is counted as one. So, [ç̇̃], [ṫ̃], [z̃], and [ṅ̥̃] each count as one atypical realisation for a total of 4. A realisation is not counted twice. For example, even although [ṫ̃] was produced both in WISI and WFSF positions, it is counted only one time. The same procedure is then completed for each consonant. The index is the total number of sounds that are realised for the 28 Amharic consonants. A low consistency index score reflects fewer errors per consonant; a high score reflects a lack of consistency in the child’s production. The number of phonetic variabilities are categorised into two categories, according to the median (i.e., the median for the whole group being 33, see Table 10.4): (a) <33 and (b) >33.

Table 10.4 Descriptive statistics for phonetic variability and degree of lost contrast

	Active	Passive
N	20	20
Mean	34.25	37.15
Median	32.50	39.50
Std. Deviation	5.129	17.783
Range	17	62

Table 10.5 demonstrates the correlation matrix for age in months vs. phonetic variability. As can be seen from Table 10.6, in terms of age at assessment, no difference was noted among the three age groups in the number of phonetic variability.

A Spearman correlation test was run by correlating age in months against ECI score. The test showed that there was a weak negative correlation between age and degree of phonetic variability ($r_s(18) = -0.9$, $P = 0.71$), meaning that consistency index decreases as age increases. In other words, as age increases the amount of variability in consonant realisations decreases. However, as can be seen from the *p* value, the correlation was not statistically significant, which could mean either the relationship exists but was too weak to be seen in a small sample size of 20, or the two variables were not actually related.

Table 10.5 Correlation matrix for age in months vs. phonetic variability

			Age in months	Phonetic variability
Spearman's rho	Age in months	Correlation Coefficient	1.000	-.090
		Sig. (2-tailed)	.	.707
		N	20	20
	Phonetic variability	Correlation Coefficient	-.090	1.000
		Sig. (2-tailed)	.707	.
		N	20	20

With respect to cleft type, while all the children with an ICP and half of the children with a UCLP demonstrated more phonetic variability than the median (i.e., 33), all the children with a BCLP showed less phonetic variability than the median. The children with BCLP were the most consistent, followed by those with a UCLP; and those with an ICP were the least consistent. Table 10.6 shows group results of degree of phonetic variability in the children with cleft palate.

Table 10.6 Error Consistency Index (ECI)/degree of phonetic variability, grouped according to age and cleft type*

	variation											
	Age at assessment						***Cleft type***					
	5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
No. of variabilities †	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
<33	5	50	3	50	2	50	-	-	5	50	5	100
>33	5	50	3	50	2	50	5	100	5	50	-	-

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.
† Count reflects the total number of phonetic variations realised for all target consonant (median= 33).

10.6. Comparison of loss of phonemic contrasts

Loss of phonemic contrast was calculated by counting and totalling the number of lost phonemic contrasts in the child's phonological system due to the use of a single realisation for two or more target consonants.

So, for example, the use of a glottal stop [ʔ] for four target consonants would result in the loss of contrasts between the glottal stop and the four consonants (n = 4) plus the contrasts among the four consonants (n = 6), making the total number of lost phonemic contrasts 10 (i.e., 4+6). If the glottal stop was used for three consonants, then the total number of lost contrasts would be 6, that is, the sum of the lost contrasts between the glottal stop and the three consonants (n = 3) and the contrast among the three consonants (n = 3). In cases where a child sometimes used atypical realisations and sometimes achieved targets, the number of occurrence of the realisations (the typical and atypical) determined whether the contrast was lost or not. For example, a child may sometimes realise /t̪/ as [c] (n=15) and sometimes as [t̪] (n=2), with no consistent pattern; and the same child may sometimes realise [ʧ] as [c] (n=21) and sometimes as [ʧ] (n=1). In this case, even though this child demonstrated his ability to achieve the targets (/t̪/ and /ʧ/), the occurrences of his atypical realisations ([c]) exceed the occurrence of his typical realisations, which may suggest a potential loss of contrast between /t̪/ and /ʧ/. In this case, the contrast is counted as 'lost'.

The number of lost contrasts are categorised into two categories, according to the median (i.e., 44, see Table 10.4): (a) <44 and (b) >44. In terms of age at assessment, the majority (70%, n = 7) of the children from the youngest group (i.e., those aged between 5-7;11), two of the children (out of six) from the second group (i.e., those aged between 8-10;11) and one child from the third group (i.e., aged between 11-14) showed less number of contrast losses than the median (x = 44). Again median refers to the mid number of lost phonemic contrasts for the whole group. Table 10.7 shows group results of percentage of loss of phonemic contrasts in the children with cleft palate.

Table 10.7 Percentage of loss of phonemic contrasts, grouped according to age and cleft type*

variation												
	Age at assessment						***Cleft type***					
	5-7;11 n =10		***8-10;11 n = 6***		***11-14 n = 4***		***ICP n = 5***		***UCLP n = 10***		***BCLP n = 5***	
No. of loss of cont.†	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
<44	7	70	2	33	1	25	3	60	6	60	1	20
>44	3	30	4	67	3	75	2	40	4	40	4	80

*ICP = isolated cleft palate; UCLP = unilateral cleft lip and palate; BCLP = bilateral cleft lip and palate.
† Count reflects the total number lost phonemic contrasts noted in the speech of each child (median = 44).

Table 10.8 demonstrates the correlation matrix for age in months vs. phonetic variability. A Spearman correlation test, though not statistically significant, showed that there was a weak positive correlation between age (in months) and number of lost contrasts ($r_s(18) = 0.63$, $P = 0.79$), that is, number lost phonemic contrasts increased as age increased. However, as already noted, the fact that the correlation was not statistically significant could mean either the relationship exists but was too weak to be seen in a small sample size of 20, or the two variables were not actually related.

Table 10.8 Correlation matrix for age in months vs. loss of contrast

			Age in months	Loss of contrast
Spearman's rho	Age in months	Correlation Coefficient	1.000	.063
		Sig. (2-tailed)	.	.790
		N	20	20
	Loss of contrast	Correlation Coefficient	.063	1.000
		Sig. (2-tailed)	.790	.
		N	20	20

In terms of cleft type, while the majority of the children from ICP and UCLP group showed less number of lost contrasts than the median, the majority of the children with a BCLP showed more lost contrasts than the median. This together with the fact that all in the latter group demonstrated less phonetic variability than the median suggests that they had a small phonetic repertoire.

10.7. Discussion

The main research question dealt with in this chapter is:

- *Are there variations conditioned by context and/or elicitation mode?*

There following sub questions are also addressed along with the main research question.

- *What are the phonological consequences of the atypical speech productions observed in the children with cleft palate?*
- *Is phonetic variability related to age of assessment and/or cleft type?*
- *Is degree of loss of phonemic contrast related to age of assessment and/or cleft type?*

In this chapter, some of the active cleft-type speech characteristics, their phonetic variations and phonological consequences are discussed. The findings of the present study suggest that while some of the phonetic variations were systematic and followed certain patterns, some others were so inconsistent that no pattern could be inferred. Variability in speech production is not unusual for individuals with cleft palate (e.g., McWilliams, 1958; Spriestersbach *et al.*, 1961; Van Demark, 1969; Kuehn and Moller, 2000; Klintö, *et al.*, 2011; Howard, 2012). In the present study, comparisons of phonetic variations as a function of age at assessment showed that the children in the third group (aged between 11-14) were the most consistent. This is not because these children had a more typical speech output than the children in the first two groups but rather because the range of speech sounds they had was smaller than that of the younger children. This claim is supported by the fact that the majority of the children in this age group (aged between 11-14) demonstrated more lost contrasts than the median, while the converse was the case for the younger group.

Moreover, from a developmental speech motor perspective, it has been suggested that increased variability may be associated with the emergence of new behaviours (Tyler and Saxman, 1991; Tyler and Edwards, 1993; Forrest *et al.*, 1994) and decreasing speech variability over time reflects a maturing speech motor system (Kent and Forner, 1979; Sharkey and Folkins, 1985). The lower degree of variability in the older children could be due to the fact that they had a more established speech motor system, which could not readily allow new speech production behaviours to develop after surgery.

Concerning cleft type, the children with a BCLP were the most consistent, followed by those with a UCLP; and those with an ICP were the least consistent. This could be due to the fact that the children with a BCLP and a UCLP used a limited range of speech sounds, predominantly glottal realisations. It is important to note that a low consistency index score (i.e., fewer realisations per consonant) does not necessarily reflect a more typical speech output, as children with a small phonetic repertoire could show a low consistency index. Variability may result from modes of elicitation and contextual factors such as word position, adjacent phonetic context, and allophonic variations (Kenney and Prather, 1986; Healy and Madison, 1987; Speake *et al.*, 2011; Klintö *et al.*, 2011; Howard, 2012) and from attempts to maximize phonological contrastivity .

Inconsistent realisations present challenges when describing and analyzing atypical speech production in terms of error pattern and deciding what to target in intervention (Dodd and Bradford, 2000). Forrest *et al.* (2000) note that intervening with children who make inconsistent atypical realisations is problematic because “one may not know the appropriate sound to use in contrast to the error” (pp. 529). This relates particularly to speech difficulties that are phonological in nature. However, it has been argued that cleft palate speech is essentially an articulatory difficulty with phonological consequences (Grunwell and Russell, 1988; Chapman, 1993; Russell and Grunwell, 1993; Howard, 1993; Grundy and Harding, 1995; Harding and Grunwell, 1996; Bzoch, 1997; Harding and Howard, 2011). If the speech production difficulties associated with cleft palate are primarily phonetic in nature, one may wonder therefore why some of the children, discussed in this chapter, sometimes used atypical realisations and sometimes achieved the targets, since the atypical realisations noted in these children could not simply derive from an articulatory difficulty, as evidenced by the fact that the children had demonstrated the ability to produce the sounds appropriately elsewhere.

McWilliams *et al*. (1990) observed a similar situation in some individuals with cleft palate who continued to use atypical realisations even after treatment yet were sometimes able to produce the target consonants appropriately. The authors noted that such continued atypical realisations may suggest some combination of sensorimotor and linguistic factors. Kent (1984), recognising the importance of musculoskeletal and neural development, hypothesised that children actively discover or problem-solve while they develop and interact with the physical and biosocial environments. Hence, children with cleft palate may habituate their atypical realizations but at the same time, they learn from the environment, which appears to be the reason why, even though they continue to use atypical realisations (due to learnt neural behaviour), they are able to achieve targets sometimes.

Klinto *et al.* (2011) note that it is as important to know whether a child can produce a certain phoneme as it is to know the conditions (i.e., elicitation modes) in which the phoneme can be best realised. The authors make the distinction between "best speech performance" and "habitual speech", the former being consciously planned and executed realisations, while the latter are subconsciously realised productions that are routinely used. The authors found that children with cleft palate demonstrated their best speech performances in the single-word and sentence repetition elicitation conditions, while habitual speech was found in spontaneous connected speech. A similar finding was reported by Howard (2012), whereby one of the children studied exhibited his best speech performance in the single-word elicitation condition, while his habitual speech appeared in the sentence repetition and spontaneous connected speech sampling conditions.

Regarding phonological consequences, statistical analysis showed a weak (non-significant) positive correlation between age at assessment and number of lost phonemic contrasts, that is, as age at assessment increased loss of contrasts also seemed to increase. As already stated, the majority of the children (at least 7 out of 10) from the youngest group exhibited fewer lost contrasts than the median. For most of the older children, due mainly to the limited range of speech sounds that they were able to produce, loss of phonemic contrasts was unavoidable.

Auditory difficulty associated with the cleft condition is often cited as a possible reason for loss of phonemic contrasts noted in the speech of individuals with cleft palate. This is because phonemic categorization requires both intact processing of primary acoustic cues and stable representation of contrasts in phonological representation (Cutting and

Pisoni, 1978). However, no severe hearing difficulty was reported for any of the children studied here, Although they could have had a fluctuating conductive loss particularly in their early years which would have been enough to impact on phonological development. It is also important to consider what Menn (1983:11) referred to as “the biasing of perception by expectation”, which explains a phenomenon where a child keeps producing atypical realisations while s/he is capable of improving it.

Menn theorised that children stop attempting to produce the adult target, assuming that their own realisation is typical: “It seems that [they have] replaced [their] original input representation with a new one which is based on [their] own output” (Menn, 1983:11). This appears to be a plausible explanation as to why some children with cleft palate maintain atypical realisations.

In conclusion, the phonetic and phonological analysis revealed that phonetic variability in the speech of the children with cleft palate was common. While some of the variability was conditioned by word contexts and elicitation modes, there was also unsystematic inconsistency. The findings of the present study may be interpreted as supporting the view that atypical speech production features that are originally articulatory in nature, as a result of structural abnormality, may lead to phonological atypicalities (e.g., Grunwell and Russell, 1988; Chapman, 1993; Russell and Grunwell, 1993; Howard, 1993; Grundy and Harding, 1995; Harding and Grunwell, 1996; Bzoch, 1997; Harding and Howard, 2011).

Finally, it is important to note that the some of the contrasts (e.g., voicing, pulmonic vs. ejective) which were deemed to be lost based on perceptual analysis might be too subtle to be detected perceptually but may therefore not be actually absent and may be identifiable using instrumental analysis. The implication is that it is essential to check whether these contrasts are actually there and can be detected using instrumentation. Hence, the next chapter uses acoustic analysis to explore for the presence of pulmonic plosive vs. ejective contrasts, which were judged, from perceptual analysis, to be lost in the speech of four of the children with cleft palate.

Chapter 11: An exploratory study of covert contrasts

11.1. Introduction

The purpose of this chapter is to examine the neutralised pulmonic-ejective contrasts discussed in Chapter 10 using acoustic phonetic techniques in order to determine whether there was any systematic use of covert contrasts which could not be perceptually detected. The chapter takes a group of children with cleft palate who could not signal the pulmonic-ejective contrasts and compares their realisations of pulmonic plosives and ejectives with those of typically-developing children and a group of typical adult speakers on three acoustic parameters: voice onset time (hereafter, VOT), total closure duration and relative intensity.

The chapter is organized as follows. In the first part of the chapter, some of the acoustic characteristic of Amharic stops will be briefly reviewed. In the second, the need for examining covert contrasts will be explained. In the third, the objectives of the present study will be outlined. In the fourth, the methods used in this study will be discussed. In the fifth, the results will be presented. In the final section, a summary of key points will be made. The chapter addresses the following research questions.

Research questions addressed in this chapter:

- For the children who did not produce a perceptible contrast between the pulmonic and ejective stops, is there acoustic evidence for covert contrasts?
- If there is any evidence for covert contrasts, which acoustic features did the children use to signal the contrasts?
- Are there any similarities/differences between the children with cleft palate and their non-cleft peers with respect to VOT, closure duration and relative intensity for pulmonic and ejective stops?

11.2. Amharic pulmonic and ejective stops

The production of ejective stops differs in important ways from the production of pulmonic oral stops (plosives). Ejectives are articulated using simultaneous constrictions in the oral cavity and at the glottis, and they are often associated with loud bursts (in comparison with pulmonic stops), caused by increased oral air pressure due to raising of the glottis during constriction (Ladefoged and Maddieson, 1996). A considerable amount of research has been done on the acoustic characteristics of ejectives, such as the relative timing of the closure and release phases of the two strictures, (e.g., Demolin, 2001; Gordon and Appelbaum, 2006), VOT (e.g., Lindau, 1984; Sands *et al.*, 1993; McDonough and Ladefoged, 1993; Maddieson *et al.*, 2001; Wright *et al.*, 2002, Vicenik, 2010), closure duration (e.g., Lindau, 1984; McDonough and Ladefoged, 1993; Gordon and Appelbaum, 2006), F0 and intensity measures, such as the intensity of the burst and the intensity of the rise time of the following vowel (e.g., Wright *et al.*, 2002; Vicenik, 2010).

Amharic has three stop series: voiceless, voiced and ejectives, as shown in Table 11.1. Previous acoustic studies on Amharic (Hayward, 2000; Demolin, 2001; Nadew, 2008; Mekonnen, 2009), tend to be rather sketchy and do not provide a complete description of the acoustic characteristics of Amharic consonants and vowels.

Table 11.1 Amharic oral stops

	Bilabial	***Denti/alveolar***	***Velar***
Voiceless	p	t̪	k
Ejectives	p’	t̪’	k’
Voiced	b	d	g

Recently, however, Derib (2011) has provided a relatively complete account of the Amharic stops. He compared the voiced, voiceless and ejective stops on duration measures (i.e., total duration, closure duration, burst duration, VOT, voicing lag and rise time), and intensity measurements (i.e., absolute and relative burst intensity). Results showed that:

- Denti-alveolar and velar ejective stops (i.e., /t̪’/ and /k’/) have longer VOT than their pulmonic counterparts (i.e., /t̪/ and /k/). The bilabial stops behave differently from the denti-alveolar and velar stops, i.e., /p/ has a longer VOT than /p’/. In Amharic, the distributions of /p/ and /p’/ are limited to words of foreign origin and biblical terms, so they occur relatively infrequently and in a relatively small number of words.
- Ejective stops have louder bursts than the pulmonic voiceless stops, as also shown by Demolin (2001).
- Ejective stops have lower relative burst intensity than voiceless pulmonic stops.
- Total duration does not distinguish between pulmonic voiceless and ejective stops; nor does closure duration.

11.3. Covert contrast

As explained in chapter 3, acoustic descriptions provide information about the physical properties of speech that the articulatory gestures and movements give rise to. Instrumental examination of the physical correlates of the different articulatory, resonance and vocal features allows objective identification and measurement of speech behaviours which are not apparent from visual or auditory analysis. Several studies over the years have shown that during typical speech development (e.g., Macken and Barton, 1980; Maxwell and Weismer, 1982; Forrest *et al.*, 1990; Tyler *et al.*, 1993; Scobbie *et al.*, 2001; Li *et al.*, 2009; Berti, 2010; Munson *et al.*, 2010), in atypical speech production including speech associated with cleft palate (e.g., Howard, 1993; Whitehill and Lee, 2008; Gibbon, 1995; Gibbon and Crampin, 2001), and even in typical adult speech (Scobbie *et al.*, 2001), there are contrasts (e.g., voicing, place of articulation) which may not be perceptually apparent but can be detected using different instrumental techniques such as electropalatography (EPG) and acoustic analysis.

One may wonder whether it is worth studying such fine-grained speech-sound variations, if they are not big enough to be perceived by the listener and hence not big enough to affect communication. It is important to note, however, that, although covert contrasts may not be consciously perceived, such that they could be incorporated into a segmental transcription, it could still be that, at a subconscious level, listeners still make use, somehow, of this information to aid intelligibility. From a clinical point of view, it is certainly important to make a distinction between a contrast that is simply absent from an individual's phonological system and a contrast which is perceivable through instrumental analysis, because such differences have significant clinical implications, as individuals' atypical phonological systems are assessed and managed based on perceived lack of contrast in their speech (Scobbie *et al.*, 2001). For example, a child who knows the phonemic contrasts between /p/ and /b/ but cannot signal the contrasts to the hearer due to the structural anomalies of the vocal tract associated with cleft palate, might be considered as having phonological difficulties, from the listener perspective, at least.

When phonemic contrasts are not perceptually apparent, checking the presence or absence of covert contrasts may be an important part of speech assessment, as it may dictate the type of treatment to be used which in turn may affect treatment outcomes. A study by Tyler *et al.* (1993), for example, has shown that individuals demonstrating a covert contrast responded to management faster than those who exhibited no contrast at all. In some cases, it may be valuable, therefore, for the purposes of selecting appropriate intervention to check for the presence of covert contrasts particularly if phonological contrasts are claimed to have been neutralised.

11.4. Current study

This study investigates the neutralised pulmonic-ejective contrasts discussed in the previous chapter in order to determine whether there was any systematic use of covert contrasts by any of the children for whom contrasts could not be perceptually detected. More particularly, the similarities and differences between pairs of pulmonic and ejective stops i.e., /t̪, t̪'/ and /k, k'/, are examined with respect to three acoustic measures: VOT, closure duration, and relative burst intensity. The bilabial voiceless stop and bilabial ejective stop (/p/ and /p'/) are not included in this study partly because, as already noted, their distributions are limited to words of foreign origin, and partly because, acoustically, in Amharic, they behave differently from the lingual stops (e.g., in terms of VOT values). The three acoustic parameters of VOT, closure duration, and relative intensity were chosen because it has been shown (Derib, 2011; Demolin, 2001) that they are important acoustic cues that distinguish these pulmonic plosives and ejectives in adult Amharic speech.

11.5. Methodology

11.5.1. Procedure

Speech samples were taken from eight children, with gender balanced across each group: four typically-developing and four children with cleft lip/palate: three with a unilateral cleft lip and palate and one with an isolated cleft palate. Each child with cleft lip/palate was matched for gender and as far as possible, for age, with a typically developing child. Table 11.2 contains demographic information on the eight children studied. The selected children with cleft palate used perceptually indistinguishable pulmonic stops for both pulmonic and ejective stops. However, all the typically-developing children consistently produced perceptually identifiable contrasts between ejectives and pulmonic stops.

Table 11.2 Demographic data on the children participating in the acoustic study

Participant		***Gender***	***Age***	***Cleft type***
Children with cleft	C1*	M	5;1	UCLP
	C2	M	5;2	UCLP
	C3	F	5;1	ICP
	C4	F	14;0	UCLP
Typically-developing children	T1	M	5;3	
	T2	M	5;5	
	T3	F	5;7	
	T4	F	13;11	

* '**C**' stands for cleft, while '**T**' designates typically-developing children.

Data were taken from the recordings made for the main study, as described in Chapter 5. Recordings were made in a quiet room at a clinic (for the children with cleft palate) and in a university phonetics laboratory (for the typically-developing children) using a Sony® ICD-PX820 voice recorder at a sample rate of 44.1 kHz and 16-bit. Audio signals were segmented, using a waveform display supplemented by a wideband spectrogram, and analysed using Praat (Boersma and Weenink, 2012).

11.5.2. Materials

For each child, tokens of target singleton pulmonic denti-alveolar and velar voiceless and ejective stops (/t̪/ /t̪'/ and /k/ /k'/), were chosen from the single word samples and the GOS.SP.ASS sentences data. Either word-initial (e.g., /t̪ep/ '*tape player*') or syllable-initial within-word (e.g., /t̪it̪i/, /kiki/, '*person's names*') targets were selected. Three tokens (one from the single words sample and two from the GOS.SP.ASS sentences) were selected for each target stop. Hence, the total number of tokens sampled for analysis was 96: 3 tokens x 4 target stops x 8 children. Table 11.3 contains the tokens extracted for analysis.

Table 11.3 Token extracted from the single words and GOS.SP.ASS sentences

Targeted sounds	***Target word***	***Gloss***
/t̪/	/t̪it̪i/	'*person's name*'
	/wət̪ət̪/	'*milk*'
	/t̪ep/	'*tape player'*
/t̪'/	/t̪'ət̪'a/	'*he/it drunk*'
	/t̪'ut̪/	'*breast*'
	/ʒant'ɨlaw/	'*umbrella*'
/k/	/kiki/	'*person's name*'
	/kɨk/	'*split peas*'
	/kəbəro/	'*drum*'
/k'/	/k'əj/	'*red*'
	/tək'əbba/	'*is painted*'
	/k'əmis/	'*skirt*'

11.5.3. Analysis

As already stated, three acoustic measures were made for each target consonant: VOT, total closure duration and relative burst intensity. Descriptive statistics (i.e., mean and standard deviation) were used to analyse the data. Values were averaged prior to statistical analysis for the whole group results, and individual profiles were also examined.

11.5.3.1. Voice onset time

For the target voiceless pulmonic stops /t̪/ and /k/, VOT (in ms) was taken as an interval from the burst release to the onset of the following vowel (Ladefoged, 2001). For the ejectives, Derib (2011) found that, in Amharic, for typical adult speakers, the oral and glottal release rarely happen simultaneously: the glottal release typically happens after the oral release. For this reason, it was deemed appropriate to measure VOT for /t̪'/ and /k'/ as the duration between the oral release and the onset of the following vowel.

11.5.3.2. Total closure duration

Total closure duration refers to the duration of voicing into closure plus closure duration, where voicing into closure is the voicing that still takes place after closure onset (Ladefoged and Maddieson 1996). Total closure duration was measured, because, as can be seen from Figure 11.2 for the children with cleft palate, the 'voicing into closure' portion could not always be reliably distinguished (either on the waveform or on spectrogram) from the 'closure with no voicing' portion. Attempts were made to 'trim off' the accompanying nasal emission using noise reduction techniques so that the closure could be better seen.

As can be seen from Figure 11.2, this was helpful particularly for carrying out duration measurements. Total closure duration (in ms) was taken to be the duration between the offset of the preceding vowel and the onset of the burst. Figure 11.1 and 11.2 illustrate the portions of the stop segmented for analysis. In Figure 11.1, the portion of the closure that showed voicing and the portion without voicing (labelled as ‘closure’) combine to give the total closure duration. Voicing lag (i.e., VOT, for voiceless stops), burst and partial duration of the preceding and following vowels are also labelled.

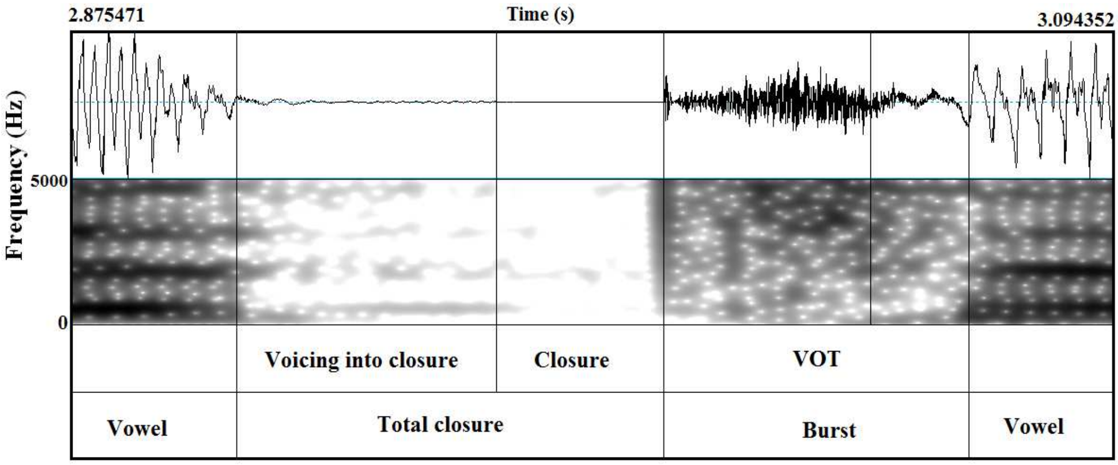


Figure 11.1 A token of word-medial /t̪/, from the word /wət̪ət̪/, [wət̪ət̪] ‘*milk*’, as produced by one of the typically-developing children.

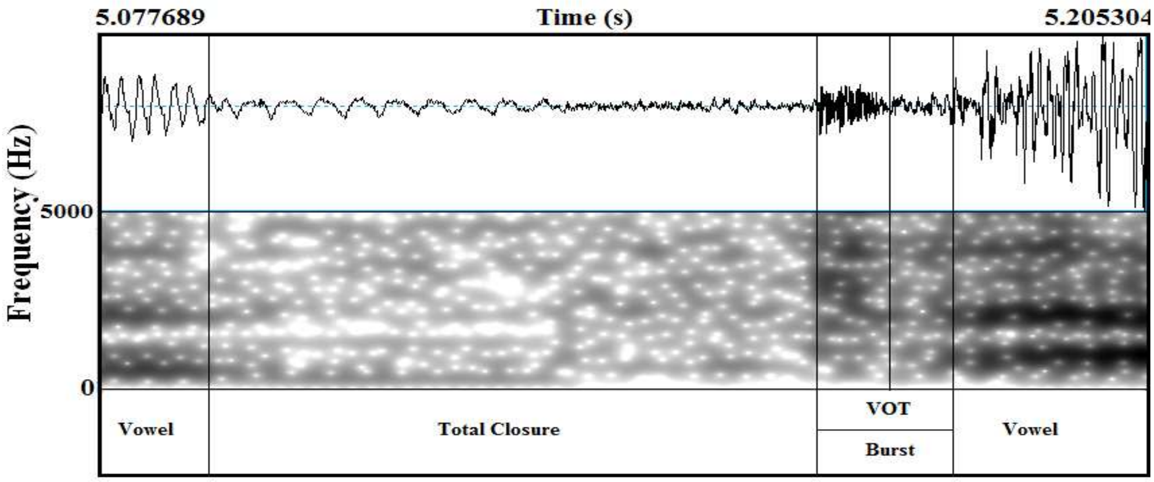


Figure 11.2 A token of word-medial /k’/, from the word /t̪ək’əbba/, [t̪ə̃k̃ə̃b̃b̃ã] ‘*is painted*’, as produced by one of the children with cleft palate. The spectrographic data shows that there was voicing and/or nasal emission through the period of total closure.

11.5.3.3. *Relative burst intensity*

Relative burst intensity was defined as the burst intensity relative to the intensity of the following vowel, so as to normalise inherent intensity differences among individual speakers. The maximum intensity of the burst (in dB) was subtracted from the maximum intensity of the following vowel (in dB) to obtain this measure (Stoel-Gammon *et al.*, 1994). A value of 0 indicates that the burst and the vowel have equal maximum intensity values. Often, the louder the burst the less the relative intensity becomes. Figure 11.3 illustrates how relative burst intensity was measured.

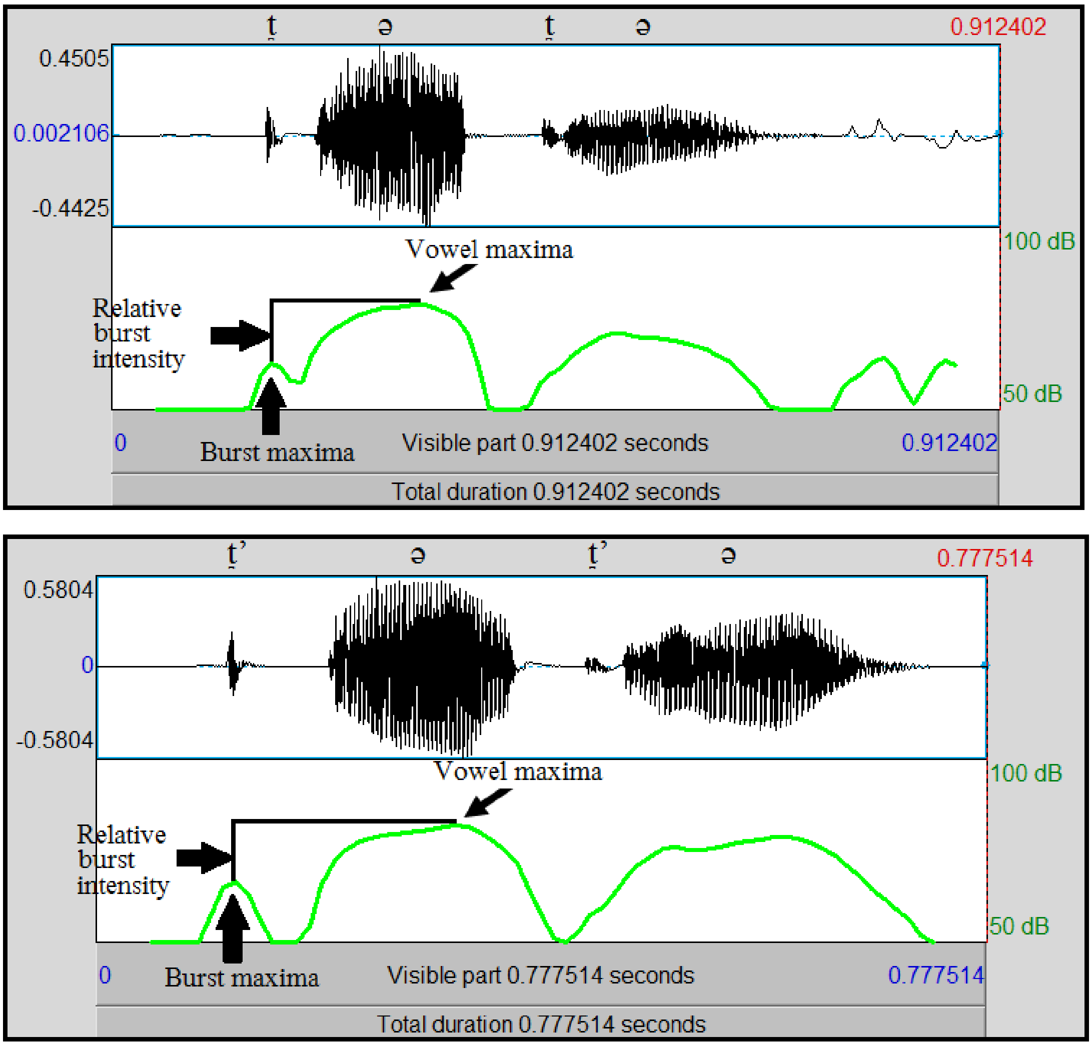


Figure 11.3 Syllables /t̪ət̪ə/ (above) and /t̪’ət̪’ə/ (below), as produced by an adult female Amharic speaker, showing how relative burst intensity was calculated.

11.6. Results

11.6.1. Voice onset time

11.6.1.1. Group results

Table 11.4 and Figure 11.4 show mean VOTs together with standard deviation values for typical adults (from Derib, 2011), typically-developing children and the children with cleft palate. Comparisons of mean VOTs showed that all three groups had longer VOTs for /t̪’/ than for /t̪/. The mean difference in VOT values for the typically-developing children is larger (11 ms) than it is for either the children with cleft palate (4.3 ms) or the typical adults (8.5 ms).

For the velar stops, all three groups had longer mean VOT values for /k’/ that for /k/. The differences in mean VOT values for typically-developing children and for the children with cleft palate are very similar: 29.5 ms (75-45.5) for the typically-developing children and 28.7 ms (70.5-41.8) for the cleft group, both of which are substantially greater than the differences in mean value for the typical adults (6.4 ms, i.e., 66-59.6).

Table 11.4 Voice onset time [mean (SD)] Values in milliseconds.

Group	/t̪/	/t̪’/	/k/	/k’/
Typical adults	42.1 (18)	50.6 (26.6)	59.6 (14.4)	66 (22.3)
Typical children	48.8 (7.4)	59.8 (7.1)	45.5 (17.3)	75 (11.7)
Children with cleft	52 (15.4)	56.3 (12.4)	41.8 (12.4)	70.5 (23.3)

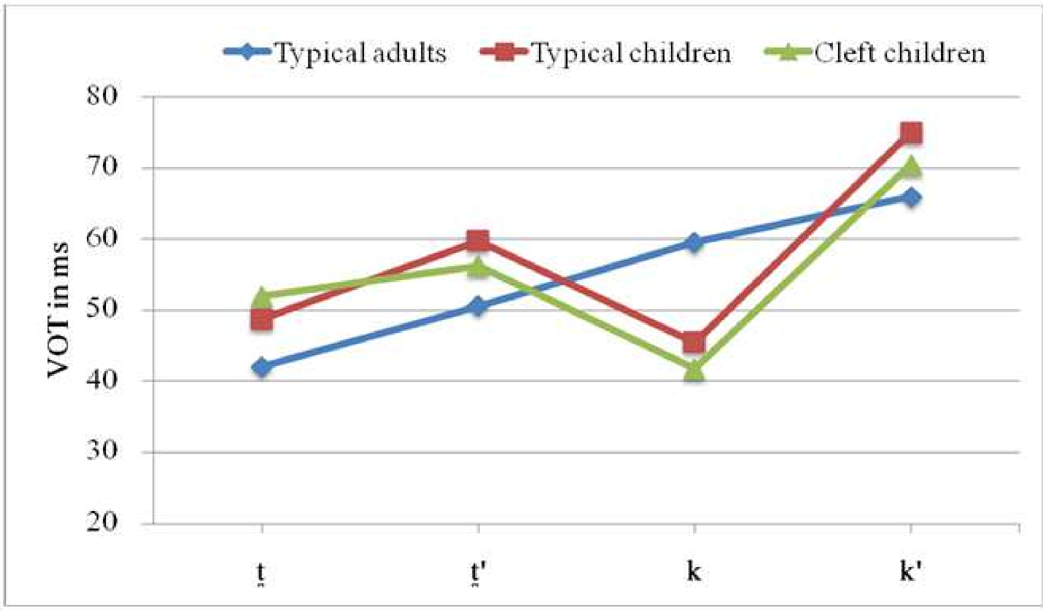
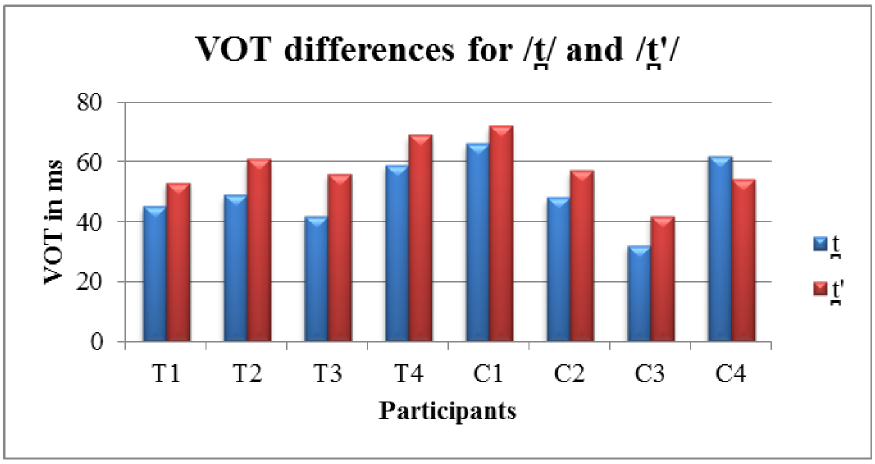


Figure 11.3 Mean VOTs for the two pairs of stops produced by the three groups.

11.6.1.2. Individual results

Figure 11.5 displays mean VOT values for each participant for each group. All the children from both groups (with the exception of C4) had longer VOTs for the ejectives (/t̪'/ and /k'/) than for the pulmonic stops (/t̪/ and /k/). C4 (14;0; with UCLP) showed an opposite pattern, i.e., she had longer VOTs for the pulmonic stops than for the ejectives.



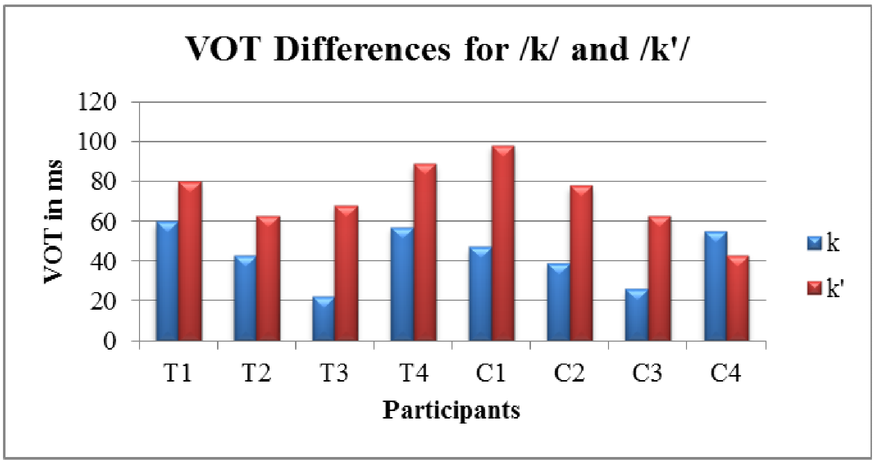


Figure 11.5 Individual VOTs for /t̪/and /t̪’/ (upper) and /k/ and /k’/ (lower). ‘T’ stands for ‘typically-developing’, while ‘C’ stands for ‘cleft’.

The remaining three children with cleft palate had considerably longer VOTs for /k’/ than for /k/. The VOT patterns demonstrated by both groups are consistent with what has been reported for typical adults (Derib, 2011). However, both the children with cleft and typically-developing children had longer VOTs for both pulmonic and ejective stops than the adult VOTs.

11.6.1.3. Consistency across tokens

It is important to examine individual VOTs (in relation to mean VOTs) for each participant so as to make sure that the mean differences accurately reflect all tokens, and are not just an artefact of the mean calculations. Table 11.5 shows individual and mean VOTs and standard deviation values for each participant from both groups. The individual VOTs of the typically-developing children show that all of them consistently exhibited longer VOTs for the ejectives than for the pulmonic stops, across all tokens, although for the cleft participants some of the differences are pretty small in milliseconds.

Table 11.5 Individual and mean VOTs (in ms) of each participant.

Typical					Cleft				
	/t̪/	/t̪'/	/k/	/k'/		/t̪/	/t̪'/	/k/	/k'/
	43	51	58	84		71	73	42	98
T1	47	55	63	80	**C1**	63	68	53	98
	45	52	59	77		64	75	45	99
Mean	**45**	**53**	**60**	**80**	**Mean**	**66**	**72**	**47**	**98**
	47	56	41	58		49	51	39	82
T2	50	60	43	64	**C2**	48	60	33	76
	51	66	45	68		47	61	44	75
Mean	**49**	**61**	**43**	**63**	**Mean**	**48**	**57**	**39**	**78**
	40	54	24	66		36	46	22	58
T3	42	61	19	72	**C3**	31	43	26	63
	45	52	24	65		30	38	30	68
Mean	**42**	**56**	**22**	**68**	**Mean**	**32**	**42**	**26**	**63**
	61	74	52	84		63	58	58	47
T4	58	71	58	89	**C4**	64	54	55	41
	57	63	60	93		60	49	52	42
Mean	**59**	**69**	**57**	**89**	**Mean**	**62**	**54**	**55**	**43**

'T' stands for 'typically-developing', while 'C' stands for 'cleft'.

Likewise, the individual VOTs of three of the children with cleft palate were consistent with the mean VOTs. However, for one of the children with cleft palate, C1, even though the mean VOTs showed that he had longer VOTs for ejectives than for pulmonic stops, a closer examination of the individual VOTs showed that what the mean values revealed was not always the case. The VOT recorded for the first token of /t̪/ was 71 ms, which was longer than the VOT of the second token of /t̪'/, i.e., 68 ms. Apart from this, no inconsistency was seen.

11.6.2. Closure duration

11.6.2.1. Group results

Table 11.6 and Figure 11.6 display mean and standard deviation values for total closure duration (i.e., duration of voicing into closure plus closure duration) for /t̪, t̪'/ and /k, k'/. The typically-developing children had longer closure durations than the children with cleft palate and typical adults for /t̪/ and /t̪'/. The differences in mean closure duration for the typically-developing children and children with cleft palate for /t̪/ and /t̪'/ were 9.5 ms and 9 ms respectively.

For /k/, the cleft group had a longer mean closure duration than the typically-developing children, the difference being 3.7 ms. For /k'/, however, the typically-developing children had a longer mean closure duration than the cleft group, with a mean difference 16.3 ms. For /k/, the typical adults had a shorter mean closure duration than the cleft group, but slightly longer than the values of the typically developing children. For /k'/, both the typically-developing children and the children with cleft palate had a longer mean closure duration than the value of the typical adults.

Table 11.6 Total closure duration [mean (SD)] Values in milliseconds.

Group	/t̪/	/t̪'/	/k/	/k'/
Typical adults	52.3 (14.6)	55.8 (12.4)	64.6 (13.5)	59.1 (13.5)
Typical children	65.5 (12.9)	78.8 (6.8)	63.8 (6.5)	78.8 (15.3)
Children with cleft	56 (14.8)	69.8 (13.5)	67.5 (18.4)	62.5 (23.4)

In general, while the typically-developing children had longer closure durations for the ejective stops than for the pulmonic ones, the typical adults and the children with cleft palate did not show such a pattern

11.6.2.2. Individual Results

Figure 11.7 shows that all children from both groups had longer mean closure duration for /t̪'/ than for /t̪/. All the typically developing children except T4, had a longer mean closure duration for /k'/ than for /k/. T4 had an equal mean closure duration for both /k/ and /k'/. Two of the children with cleft palate (C1 and C3) had longer and the remaining two (C2 and C4) had shorter mean closure duration for /k'/ than for /k/.

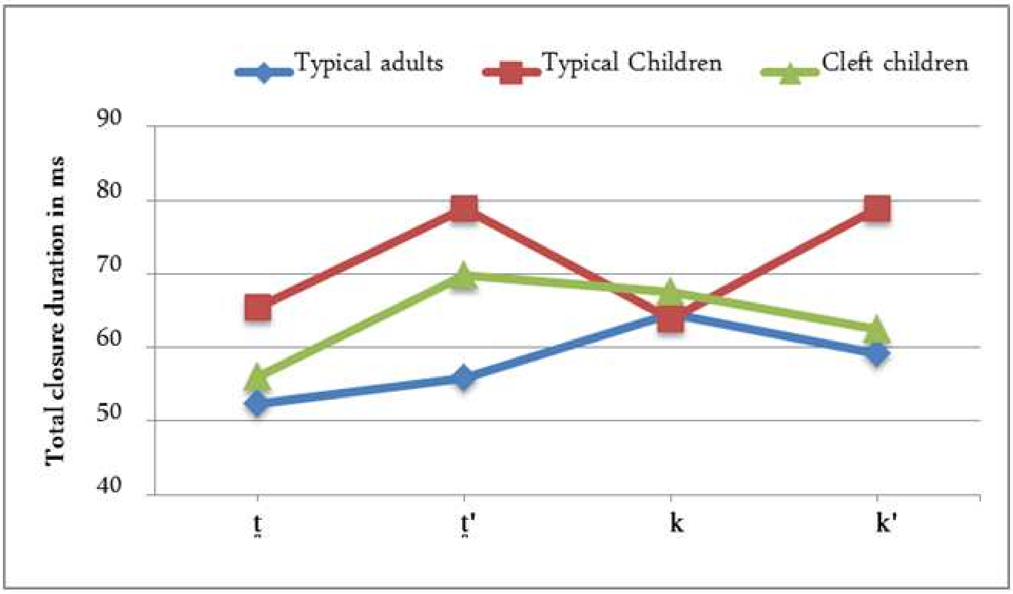
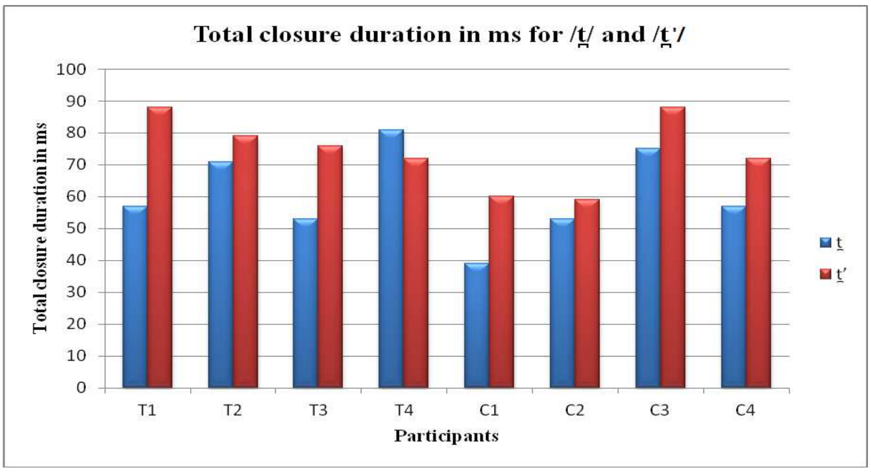


Figure 11.6 Mean total closure duration for the two groups of stops produced by three groups.



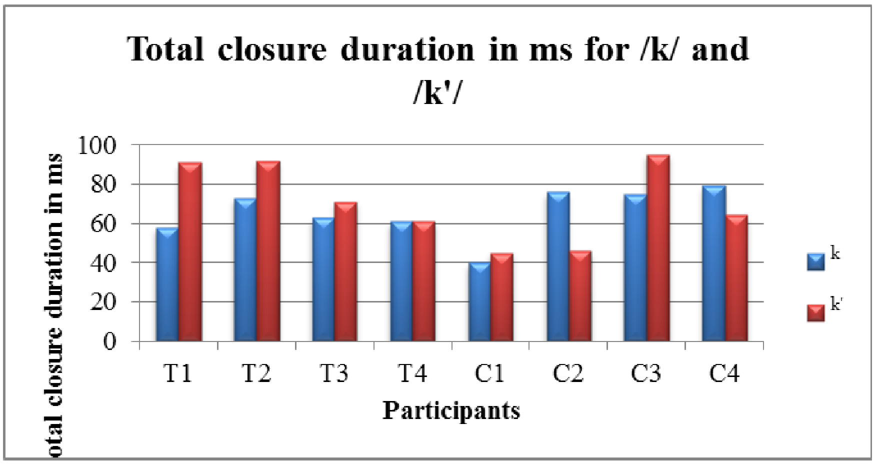


Figure 11.7 Individual mean total closure duration values for /t̪/and /t̪'/ (upper) and /k/ and /k'/ (lower). 'T' stands for 'typically-developing', while 'C' stands for 'cleft'

11.6.2.3. Consistency across tokens

Table 11.7 shows individual and mean total closure values of each participant. For typically developing children, except for T2, the individual values are consistent with the mean values. For T2, even though the mean values were equal for /k/ and /k'/, the individual values of /k/ were not always equal to the individual values for /k'/. For example, the total closure value for token 2 for /k/ was 61 ms, while the value for token 2 for /k'/ was 59 ms.

Table 11.7 Individual and mean total closure values (in ms) of each participant.

Typical					Cleft				
	/t̪/	/t̪'/	/k/	/k'/		/t̪/	/t̪'/	/k/	/k'/
	53	92	56	88		71	73	42	98
T1	61	84	53	89	**C1**	63	68	53	98
	56	87	66	95		64	75	45	99
Mean	**57**	**88**	**58**	**91**	**Mean**	**66**	**72**	**47**	**98**
	69	83	60	61		49	51	39	82
T2	72	74	61	59	**C2**	48	60	33	76
	71	81	61	62		47	61	44	75
Mean	**71**	**79**	**61**	**61**	**Mean**	**48**	**57**	**39**	**78**

T3	54	76	59	69	**C3**	36	46	22	58
	48	73	67	73		31	43	26	63
	58	78	62	72		30	38	30	68
Mean	**53**	**76**	**63**	**71**	**Mean**	**32**	**42**	**26**	**63**
T4	81	68	68	90	**C4**	63	58	58	47
	79	75	79	89		64	54	55	41
	83	72	71	96		60	49	52	42
Mean	**81**	**72**	**73**	**92**	**Mean**	**62**	**54**	**55**	**43**

Similarly, except for C1, all the individual values of the other three children with cleft palate were consistent with the pattern shown by the mean values. In the case of C1, even though he had longer mean total closure duration values for ejectives than for pulmonic stops, his total closure value for token 1 for /t̪/ was 71 ms, which was longer that the value of token 2 for /t̪’/, which was inconsistent with the pattern shown by the means. His second token for /t̪’/ had shorter (68 ms) total closure duration than the duration of his first token of /t̪/, which is not in agreement with the mean values.

11.6.3. Relative burst intensity

11.6.3.1. Group results

Table 11.8 and Figure 11.8 show mean relative intensity and standard deviation values for /t̪/, /t̪’/, /k/, /k’/ of the three groups. The typically-developing children had less relative burst intensity for the ejective stops (/t̪’/ and /k’/) than for the pulmonic ones (/t̪/ and /k/), indicating that the typically-developing children had louder bursts for the ejectives than for the pulmonic stops. This is consistent with the pattern for typical adults. In contrast, the children with cleft had larger mean relative burst intensities for the ejective stops (/t̪’/ and /k’/) than for the pulmonic ones (/t̪/ and /k/), suggesting that the children with cleft palate had softer bursts for the ejectives than for the pulmonic stops. As the data examined was limited, statistical significance could not be measured. For the typically-developing children and the children with cleft palate, the relative burst intensity differences were greater for the denti-alveolar stops than they were for the velars: -5.3 dB (mean differences for the denti-alveolar stops) and -1.5 dB for typically-developing children; and 2.5 dB and 1.2 dB (mean differences for the velar stops) for the children with cleft palate.

Table 11.8 Relative burst intensity [mean (SD)] Values in decibels.

Group	/t̪/	/t̪'/	/k/	/k'/
Typical adults	17.7 (4.9)	16.8(6.2)	14.4 (4.2)	10.8 (6.9)
Typical children	10.3 (3.8)	5 (2.9)	5.5 (0.6)	4 (1.4)
Children with cleft	10.8 (4.5)	13.3 (8.1)	8.3 (3.9)	9.5 (4.9)

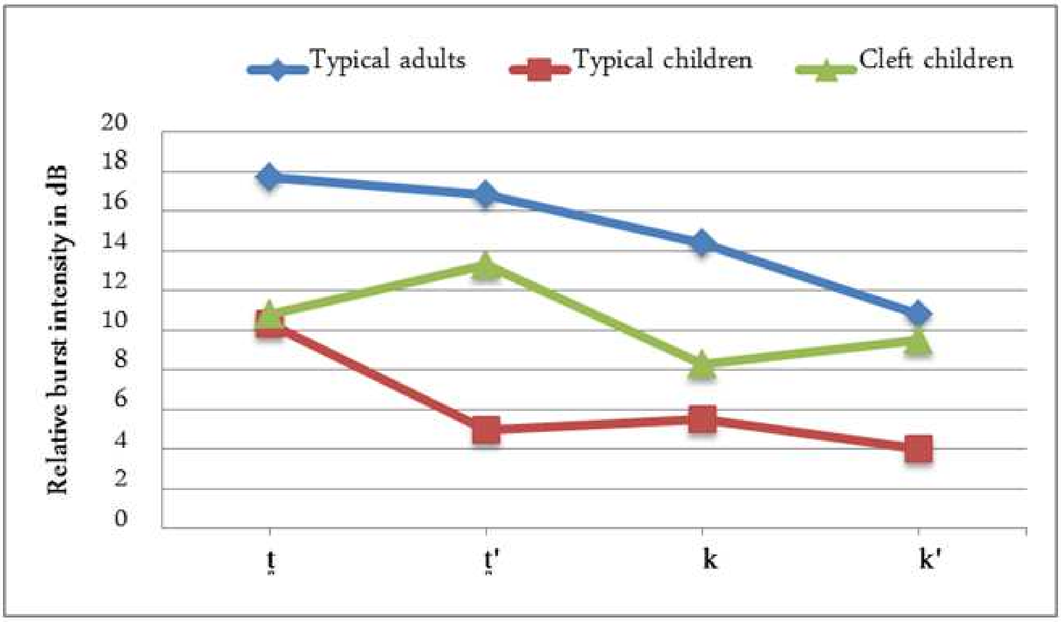


Figure 11.8 Mean relative burst intensity values for the two groups of stops.

11.6.3.2. Individual results

As can be seen from Figure 11.9, even though the degree varies from child to child, all the typically-developing children had less relative burst intensity for /t̪'/ than for /t̪/.

Contrarily, all the children with cleft palate but C4 had greater relative burst intensity for /t̪’/ than for /t̪/. C4 had less relative burst intensity for /t̪’/ than for /t̪/, suggesting that she had louder /t̪’/ than /t̪/. All typically developing children except T2 had less mean relative burst intensity for /k’/ than for /k/. T2 had almost equal mean relative burst intensity values for /k/ and /k’/. While two of the children with cleft palate (C3 and C4) had less mean relative burst intensity for /k’/ than for /k/, one (C1) had larger mean relative burst intensity for /k’/ than for /k/ and the remaining child (C2) had equal mean relative burst intensity values for /k/ and /k’/.

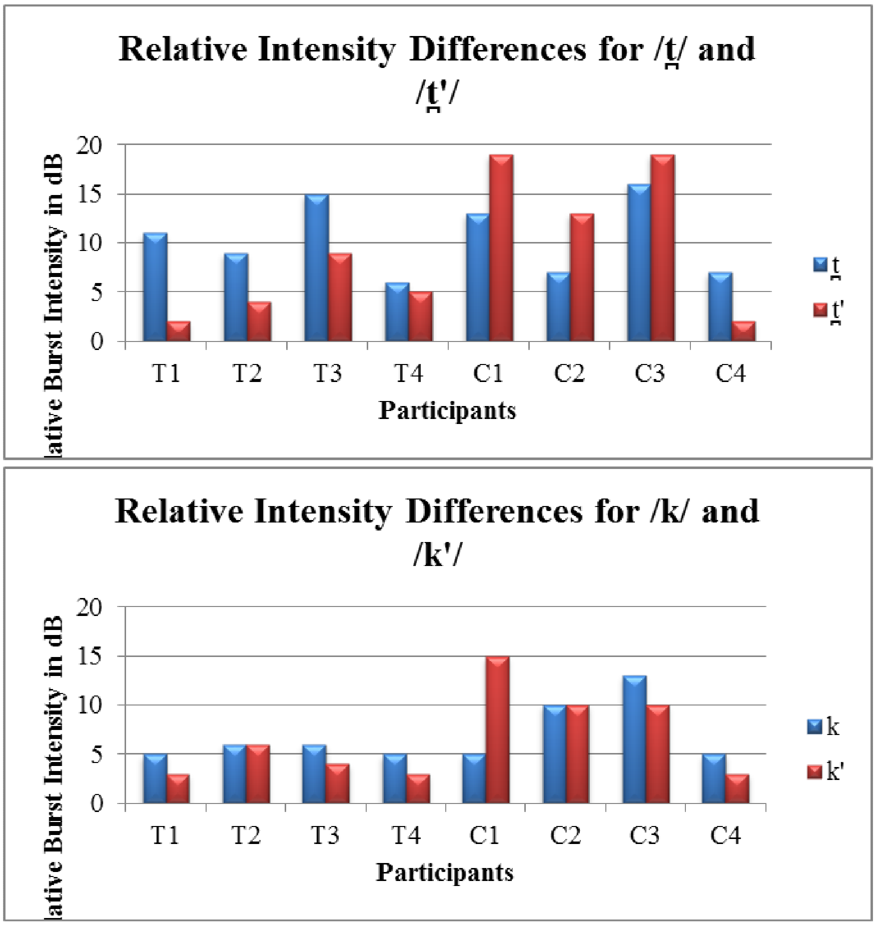


Figure 11.9 Individual relative burst intensity for /t̪/and /t̪’/ (upper) and /k/ and /k’/ (lower). ‘T’ stands for ‘typical’, while ‘C’ stands for ‘cleft’

11.6.3.3. Consistency across tokens

Table 11.9 shows individual and mean relative burst intensity values of each participant. Except T1, whose individual values were consistent with the pattern shown by the mean values, the individual tokens of the typically-developing children did not always follow the pattern shown by the mean values. For example, the mean relative burst intensity values for /k/ and /k'/ for T2 were equal (6 dB), however, the relative burst intensity of the individual tokens showed that T2's third token for /k'/, for example, had a relative intensity of 9dB which was greater than his second token for /k/, which had a relative burst intensity of 4 dB.

Table 11.9 Individual and mean relative burst intensity values (dB) of each participant.

Typical					**Cleft**				
	/t̪/	/t̪'/	/k/	/k'/		/t̪/	/t̪'/	/k/	/k'/
	9	3	5	3		13	21	5	18
T1	10	2	4	2	**C1**	14	19	8	13
	14	2	5	3		11	16	3	15
Mean	**11**	**2**	**5**	**3**	**Mean**	**13**	**19**	**5**	**15**
	8	7	5	4		10	15	8	9
T2	9	3	4	4	**C2**	7	11	9	10
	11	3	8	9		5	12	12	12
Mean	**9**	**4**	**6**	**6**	**Mean**	**7**	**13**	**10**	**10**
	14	7	5	3		17	19	16	8
T3	11	9	6	3	**C3**	20	22	9	12
	20	10	8	5		11	16	13	9
Mean	**15**	**9**	**6**	**4**	**Mean**	**16**	**19**	**13**	**10**
	6	4	6	4		11	2	5	2
T4	6	5	3	2	**C4**	5	2	7	4
	6	5	5	3		6	3	6	3
Mean	**6**	**5**	**5**	**3**	**Mean**	**7**	**2**	**6**	**3**

For the cleft group, C1 and C4 had individual relative burst intensity values which are consistent with the pattern shown by the means. For the remaining two children, what the mean values showed was not always true for individual tokens. For example, the mean relative burst intensity values of C3 for /t̪/ and /t̪'/:16 dB and 19dB, respectively, showing that the latter had greater mean values, which was not always reflected in the individual tokens. For example, the second token for /t̪/ had 20 dB, which was greater than the value of the third token for /t̪'/.

11.1. Discussion

This chapter addressed the following research questions:

- *For the children who did not produce a perceptible contrast between the pulmonic and ejective stops, is there acoustic evidence for covert contrasts?*
- *If there is any evidence for covert contrasts, which acoustic features did the children use to signal the contrasts?*
- *Are there any similarities/differences between the children with cleft palate and their non-cleft peers with respect to VOT, closure duration and relative intensity for pulmonic and ejective stops?*

The children with cleft palate were compared with typically-developing children and adults on three acoustic measures: VOT, total closure duration and relative burst intensity, for the pulmonic and ejective stops pairs: /t̪/ /t̪'/ /k/ /k'/.

Table 11.10 summarises the group production patterns. In terms of VOT, both the typically-developing children and the children with cleft palate showed the same patterns as the typical adults did. That is, all groups generally had longer VOTs for ejectives than for the pulmonic stops. The adult VOTs increased as the place of articulation moved from anterior to more posterior, i.e., from denti-alveolar to velar pace of articulation, which is consistent with previous reports (e.g., Lisker and Abramson, 1964; Lisker and Abramson, 1967). Both the typically-developing children and the children with cleft palate exhibited this pattern for ejectives, but not for the pulmonics. This may suggest that the children in both groups might have not had motor speech skills that are mature enough to achieve adult-like VOT patterns.

From a developmental perspective, even though it has been reported that children at around the age of six years are able to produce stops with adult-like VOTs (e.g., Gilbert and Purves, 1977), variability in VOT productions continues well beyond the normal period of phonological acquisition (e.g., Tingley and Allen, 1975; Zlatin and Koenigsknecht, 1976; Whiteside *et al.*, 2003). For example, the study by Whiteside *et al.* (2003) investigated the developmental patterns of VOT in 46 typically-developing English-speaking children (aged between 5;10-13;2 years), and found that variability in VOT decreases with age; and that no significant age differences between the 11- and 13-year olds were evident, suggesting that levels of variability in VOT may begin to stabilize at this stage within the human lifespan. Moreover, a recent study by Lundeborg *et al*. (2012) examined VOT in 150 Swedish-speaking children (aged 8-11 years) and 36 adults speaking the same language and found that the children developed adult-like VOTs between 9 and 10 years. Moreover, Macken and Barton (1980) proposed a three-stage model of use of VOT by typically-developing children at different stages. The authors hypothesized that children less than three years of age are expected to (1) initially produce only short-lag VOTs for stops intended as voiceless (and voiced), then (2) produce a difference in VOTs for voiced and voiceless stops that do not correspond to adult values, and (3) finally produce VOTs that approach but are still shorter than adult values. In the present study, given that three of the four children from each group (typical and cleft group) were aged between 5;1-5;7 years, it is not surprising that their VOT values did not behave completely like adults.

The typically-developing children generally had longer VOTs than the children with cleft palate, although the differences in VOTs observed between the two groups of children were smaller than those noted between the adult values and those of the children. It has been suggested (e.g., Macken and Barton, 1980; Ohde, 1985; Hewlett, 1988; Lim *et al.*, 2001) that young children go through a period of producing longer VOTs than those of adults. Moreover, the mean VOT value differences between the two groups of children might be explained by the common finding in previous studies that suggests that typically-developing children produce VOTs for voiceless stops with greater intra-speaker variability than adults and the level of variability in speech output decreases as a function of the maturing motor speech skills (e.g., Kewley-Port and Preston, 1974; Macken and Barton, 1980; Barton and Macken, 1980; Nittrouer, 1993; Koenig, 2000; Whiteside *et al.*, 2003). Furthermore, for the children with cleft palate, given the challenges that they may have in achieving typical valving, coordinating laryngeal and supralaryngeal gestures appropriately might not be an easy task (Whiteside *et al.*, 2003).

There were also differences in terms of mean total closure durations between the three groups. Derib (2011) reported that closure duration did not distinguish ejectives and pulmonic stops in typical adult speakers of Amharic, as no systematic differences were evident. However, both the children with cleft palate and the typically-developing children had longer mean total closure values for /t̪’/ than for /t̪/. The two groups of children differed in mean closure duration for /k/ and /k’/: the typically-developing children had longer closure duration for /k’/ than for /k/, while the cleft group had shorter closure duration for /k’/ than for /k/.

The children with cleft palate did not show a systematic pattern that differentiates the ejectives and pulmonic stops; whereas the typically-developing children demonstrated a consistent pattern for the two groups of stops, i.e., longer mean total closure for ejectives than for pulmonics. However, even though the mean total closure values showed that the children with cleft palate, as a group, did not systematically use closure duration to differentiate the ejectives from the pulmonics, two of the children (C1 and C3) actually used longer mean closure duration for the ejectives than for the pulmonics. The variations in total closure durations observed among the cleft children and those between the two groups of children could be attributed to individual differences in the maturing motor speech skills. Particularly, the variations noted among the children with cleft palate might be attributed to “the diverse and creative responses of individual speakers to the articulatory and perceptual constraints presented by the cleft” (Harding-Bell and Howard, 2011:277).

Table 11.10 Summary of comparisons on duration and intensity measures

VOT		
Group	/t̪/ vs. /t̪’/	/k/ vs. /k’/
Typical adults	Shorter for /t/ than for /t̪’/	Shorter for /k/ than for /k’/
Typically-developing children	Shorter for /t̪/ than for /t̪’/	Shorter for /k/ than for /k’/
Children with cleft plate	Shorter for /t̪/ than for /t̪’/	Shorter for /k/ than for /k’/
Closure duration		
Typical adults	Shorter for /t̪/ than for /t̪’/	Longer for /k/ than for /k’/
Typically-developing children	Shorter for /t̪/ than for /t̪’/	Shorter for /k/ than for /k’/
Children with cleft plate	Shorter for /t̪/ than for /t̪’/	Longer for /k/ than for /k’/
Burst intensity		
Typical adults	Softer for /t̪/ than for /t̪’/	Softer for /k/ than for /k’/
Typically-developing children	Softer for /t̪/ than for /t̪’/	Softer for /k/ than for /k’/
Children with cleft plate	Louder for /t̪/ than for /t̪’/	Louder for /k/ than for /k’/

In the above table, to make the comparison simpler, burst intensity is considered rather than the relative intensity, as it is more intuitive. So, instead of using ‘greater relative burst intensity for /t̪/ than for /t̪’/’ for example, ‘softer for /t̪/ than for /t̪’/’ is used, as they mean the same thing, according to the data.

Concerning relative burst intensity, the typically-developing children, like the typical adult speakers, had lesser relative burst intensity for both ejectives (/t̪'/ and /k'/) than for the pulmonic stops (/t̪/ and /k/), suggesting that they had louder burst intensity for the former than for the latter. The children with cleft palate, however, had greater relative burst intensity for the ejectives (/t̪'/ and /k'/) than for the pulmonic stops (/t̪/ and /k/), indicating that they had softer burst intensity for the ejectives than for the pulmonic stops. This could be because of a result of an unavoidable decrease in intra-oral pressure due to possible articulatory and aerodynamic challenges involved in producing the ejectives. In other words, as the production of ejectives requires a closure at the glottis and at a place above the glottis so as to produce a build-up of air pressure behind the place of articulation (Ladefoged and Maddieson, 1996), it would be difficult for the children with cleft palate to produce the required amount of intra-oral air-pressure, if air escapes through the velopharyngeal port.

In summary, (a) all the three groups showed similar patterns in terms of VOT; (b) the differences in VOT values, observed between the two groups of children, were smaller than those noted between the adult values and those of the children; (c) closure duration does not distinguish ejectives and pulmonic stops in typical adult speakers of Amharic (Derib, 2011). The reason why this parameter was examined in the speech of the children with cleft palate was that it has been shown that strategies of signalling phonological contrasts using measurable physical components of speech in a way that is different from one used by adults and typically-developing children has been previously reported in the cleft literature (e.g., Howard, 1993, 2012). (d) The typical-developing children's use of intensity, was markedly greater for ejectives than for the pulmonic stops, differently from the children with cleft palate. This last finding therefore appears to explain why the typical-developing children's pulmonic stops vs. ejective contrasts were perceptually distinguishable, as compared to the cleft children who made perceptible contrasts.

Table 11.11 shows the patterns that each child used for the two groups of stops. The tick mark indicates consistency within each participant on each acoustic parameter, that is, the child demonstrating a consistent pattern for the two groups of stops, regardless of the typical pattern. For example, C1 had longer VOT for ejectives (/t̪'/ and /k'/) than for pulmonic stops (/t̪/ and /k/). It is interesting to note, however, that although some of the children demonstrated consistency, their pattern might differ from that of the other children or the adult norm. For example, C4 consistently had shorter VOTs for ejectives than for pulmonic stops, but this pattern is the opposite of that of the other cleft children, typically-developing children and the adult norm. As noted above, such strategies of contrasting phonemes using different components of speech or different patterns from one used by adults and typically-developing children has already been reported in the literature (e.g., Howard, 1993, 2012). This supports the fact that the strategies employed by individual speakers in dealing with the articulatory and perceptual challenges associated with the cleft may vary from one child to the next.

Table 11.11 Acoustic parameters consistently used to signal ejective-pulmonic contrast.

Participants	***Consistent VOT***	***Consistent TCD***	***Consistent RBI***
C1	✔	✔	✔
C2	✔	✘	✘
C3	✔	✔	✘
C4	✔	✘	✔

TCD = total closure duration; RBI = relative burst intensity

C1 used longer mean VOTs, longer mean total closure duration, and greater mean relative burst intensity for ejectives than for the pulmonic stops. His VOT patterns were similar to the ones reported for typical adults, i.e., longer mean VOTs for ejectives than for pulmonics. His relative burst intensity patterns were opposite to the adult patterns. He also used total closure duration consistently, i.e., longer mean total closure for ejectives than for the pulmonic stops. However, total closure duration was reported to be irrelevant in distinguishing the two classes of stops in typical adult speech (Derib, 2011). The use of relative burst intensity in a different pattern from the one used in adult phonology plus the use of the acoustic parameter that does not distinguish the stops in question in typical adult speech might have been the reasons why the pulmonic-ejective contrasts could not be perceived in the speech of C1.

The only parameter that C2 used consistently was VOT, i.e., longer mean VOTs for ejectives than for pulmonic stops. One may argue that the distinction in VOT alone might be so subtle that it could not be perceptually detected. However, it has been suggested (e.g., Eimas *et al.*, 1971; Le Jan *et al.*, 2007) listeners need at least a difference of 20 ms between VOT values to perceive the difference between two phonemes belonging to distinct phonemic categories; and the differences in VOT values between /k/ and /k’/ were not more than 20 ms. This suggest that a typical use of one physical component of speech alone may not be adequate to signal phonemic contrast.

Consistent mean VOTs and mean total closure duration patterns were noted in the speech of C3, i.e., she had mean longer VOTs and longer mean total closure duration for ejectives than for the pulmonic stops. The VOT patterns were similar to the ones reported for typical adults; however, as total closure duration is irrelevant to signal the pulmonic-ejective contrast in adult phonology, the combination of VOT and total closure might have not been adequate to make the pulmonic-ejectives contrasts perceivable to the listener. C4 had consistent mean VOTs and mean relative burst intensity patterns, i.e., shorter mean VOTs and lesser mean relative burst intensity for ejectives than for pulmonic stops. Even though this child’s mean relative intensity had similar pattern to that of the typical adult, her mean VOTs pattern was opposite to that of typical adults. This might be the reason why the contrasts were not perceived. It could be the case that the pattern used by C4 was different from that of typical adults due either to an intentional decrease of VOTs for perceptual purposes, or an unintentional decrease due to possible articulatory and aerodynamic difficulties involved in producing the ejectives. Some evidence is available in the literature supporting the former possibility. For example, Chapin *et al.* (1982); Hewlett (1988) and Forrest *et al.*, (1990), have reported cases where knowledge of phonological contrasts and attempts to signal the contrasts were apparent, but the acoustic cues used to signal the contrasts were not consistent with those employed by typically articulating children or adults.

The examination of the acoustic parameters suggested that at least three of the children with cleft palate (i.e., C1, C3 and C4) were aware of the pulmonic-ejective contrast and signalled it but in such a way that the listener cannot perceive the contrast. Making an articulatory distinction between phoneme classes indicates, as Sell *et al.* (1994:8) noted, "an appreciation of the need to signal a phonological contrast, i.e., the speech difficulty is phonetic in nature". Even though these observations suggest that the majority of the atypical speech production features noted in the speech of these children were phonetic in origin, they have phonological consequences for listeners, as the pulmonic-ejective contrasts were neutralized in listeners' perceptions. It is important to note that the fact that the typically-developing children, who did signal the contrast to listeners, were not entirely using the three parameters differently from the children with cleft palate suggest that there may be other physical components of speech involved in signalling the contrast between ejectives and pulmonic stops, which require further investigation.

In conclusion, the present study supports earlier findings that acoustic analysis of atypical speech sound realisations may provide greater insight into the phonological knowledge possessed by certain children with speech difficulties (e.g., Catts and Jensen, 1983; Gierut and Dinnsend, 1986; Forrest *et al.*, 1988; Forrest, *et al.*, 1990; Howard, 1993; Scobbie, *et al.*, 2001; Howard, 2012). The observations made in this study are encouraging enough to merit further systematic investigation in cleft palate speech. The next chapter, which is the final one, will provide a general discussion of the results presented in the preceding chapters.

Chapter 12: Discussion

12.1. Introduction

This chapter revisits the speech production features noted in Amharic-speaking children with cleft palate in relation to those reported from other languages and discusses the cross-linguistic similarities and differences in relation to various theoretical issues such as universal vs. language-specific aspects of cleft-related speech, the association of timing of surgery to speech output, and the phonetic and/or phonological dimensions of the speech production impairments associated with a cleft palate. A large body of literature exists on speech characteristics of English-speaking individuals with cleft palate. As noted in Chapter 2, there are also a number of studies published on patterns of speech production in languages other than English, which include: Eurocleft (Eurocleft Speech Group, 1993) on Danish, Dutch, English, Norwegian and Swedish; Eurocran (EUROCRAN Speech Project, 2008) on English, Danish, Swedish, Norwegian and Finnish; Willadsen (2012) on Danish; Landis and Thi Thu Cuc (1975) on Vietnamese; Yamashita *et al*. (1992) on Japanese; Wu *et al*. (1988) on Mandarin; Paynter (1984) and Casal *et al.* (2002) on Spanish; Sell and Grunwell (1990) on Sinhala; Stokes and Whitehill (1996) and Gibbon *et al*. (1998) on Cantonese; Shahin (2006), Al-Tamimi *et al.* (2011) and Al-Awaji (2012) on Arabic; Baranian (2012) on Farsi.

These studies have shown that many of the phonetic characteristics associated with cleft palate are universal (Brøndsted, *et al.*, 1994; Henningsson and Willadsen, 2011). However, as languages vary in terms of the number of sounds and phonetic and phonological features, one would expect these cross-linguistic differences in phonetic and phonological systems to result in differences in the speech output of individuals with cleft palate with different linguistic backgrounds. For example, words such as *kept* in English and /t̪'ɨbk'/, '*tight/strict*', in Amharic, do not present the same kind of articulatory and aerodynamic challenges to speakers of the two languages, because even though the syllable structures of the words are the same (i.e., CVCC), the sounds making up the words are different; notably, the Amharic speaker has the added challenge of maintaining a perceptible difference between the pulmonic and ejective consonants for phonological purposes. Language specific features previously reported in the literature include: the use of bilabial fricative [ɸ] for /s/ and /f/ (Stokes and Whitehill, 1996; Gibbon *et al.*, 1998), and of initial consonant deletion (Whitehill *et al.*, 1995) in Cantonese; the use of implosives for a pulmonic consonant (/k/) (Shahin, 2006) and an ejective [k'] for the alveolar trill /r/ in Arabic (Al-Awaji, 2008).

In addition to the particular challenge the Amharic phonological system may present for individuals with cleft palate in maintaining the contrasts between pulmonic and non-pulmonic consonants, other features of Amharic such as consonant gemination and the alveolar trill may add to the challenge. As described in Chapter 10, there were a number of instances where some of the children used different realisations for geminated consonants from the ones they used for their singleton counterparts. For example, realisations of the geminated /b/ as [b͡ʔ] (e.g., as in /ʧɨbbo/ '*bonfire*' realised as [ʔɨ̃b͡ʔõ]) and the singleton one as a different realisation (e.g., [b̃], [ʔ], [m̥]) was a recurrent feature (e.g., in the speech of EZ, BZ, HA, ES). Use of glottally-reinforced consonants for geminated segments, contrasting with a range of other realisations for their singleton counterparts, was commonly noted in the present study. As suggested in Chapter 10, this could be due to the fact that geminated consonants require more pressure and force than the singleton ones. Previous reports of realisations of geminated segments in cleft-related speech could not be found in the literature.

Regarding the alveolar trill /r/, an interdental [n̪̊] was a frequent realisation noted in the speech of five children (BM, EY, TB, EZ, BZ). No child in the current study managed to achieve target /r/. Shahin (2006) reported that her Arabic-speaking children realised /r/ as [l] and [ɾ]; and Guillen and Barlow (2006), as cited in Cordero (2008), observed backing of /r/ to uvular trill [ʀ] in Spanish-speaking children with repaired palate, patterns not observed in the present study. The articulatory and aerodynamic precision required to produce /r/ (e.g., Recasens, 1991; Ladefoged and Maddieson, 1996; Solé, 2002) appears to account for these atypical realisations. So, the alveolar trill /r/, being one of the frequent speech sounds in Amharic, presents another challenge for Amharic-speaking children with cleft palate, as opposed to English speakers, for example. In this chapter, the following research questions will therefore be addressed:

- What were the typical-speech development features identified in this and previous studies; and how are they related to patterns of speech development in other languages?
- What were the speech production features identified in the children with cleft palate; and how are they related to reports in other languages?
- Which compensatory articulations were most and least commonly observed, and how are they related to reports in other languages?
- Which consonants were most and least affected, and how are they related to reports in other languages?

In addition to discussing the speech production features noted in Amharic-speaking children and comparing and contrasting with those reported from other languages, the specific challenges that are faced by the children studied here will also be dealt with. Therefore, the chapter also discusses the results in relation to the following research questions.

- How was age of participants and cleft type related to their speech output; and how is this related to findings of previous studies?
- Were there phonetic variations conditioned by context and/or elicitation mode; and what were the phonological consequences of the speech features observed in the children's speech output?
- For the children who did not produce a perceptible contrast between the pulmonic and ejective stops, was there acoustic evidence for covert contrasts?
- What were the theoretical, methodological and clinical implications of the identified speech production features?

The chapter is in four parts. The first summarises and discusses the typical-speech development features identified in this and previous study; and how they are related to patterns of speech development in other languages. The second compares the cleft-type speech characteristics identified in this study with those previously reported for other languages and discusses them. In this section, a summary and discussion of other themes that are dealt with in this study (i.e., comparison of most and least attested compensatory articulation; comparison of most and least affected consonants; speech output vis-à-vis age at assessment/surgery and cleft type; phonetic variability and phonological implications; covert contrast) are also presented. In the third, the theoretical, methodological and clinical implications of the results of this study are discussed. The last part concludes and suggests some further research directions. The sections and sub-sections of the chapter are organised in such a way that they address the above outlined research question in succession.

12.2. Speech development in typically-developing Amharic-speaking children

Although the main goal of the present study was to describe the speech characteristics of Amharic-speaking children with cleft palate, an exploratory examination of typical speech development in Amharic-speaking children was also conducted in order to distinguish between: (a) atypical speech development unrelated to the cleft palate; (b) atypical speech development related to the cleft palate; and (c) atypical speech patterns characteristic of structural atypicalities. A further aim was to identify typical developmental patterns, evidenced in typically-developing young children's speech, which are age-appropriate and not, therefore, related to any kind of developmental speech difficulties, whether cleft or non-cleft. In common with children acquiring other languages, typically-developing Amharic-speaking children demonstrated typical systematic simplifications such as stopping and fronting as well as structural simplifications like cluster reduction and segment deletion. It is interesting to note that stopping of alveolar fricatives, and post-alveolar fricatives and affricates, which is a common developmental process in such languages as English, was not found in the speech of the control group of this study; nor have they been reported in Mekonnen (2008). If stopping of the consonants in question does not occur at all, or has it been suppressed by age 2;0 (the age of the youngest children studied in Mekonnen (2008)) is a matter that needs to be further investigated. The age range of the children in the present study does provide conclusive evidences, i.e., the subjects in this study are too old to detect early processes. No report of a language where this is the case could be found in the literature, suggesting the need to study the matter in a larger sample of children to confirm whether this is true across children of different ages.

In the speech of two- to four-year-old Amharic-speaking children, the alveolar fricatives /s, z/ are commonly realised as [ʃ] (Mekonnen, 2008). Studies (reported that Japanese-speaking children also showed a similar pattern where the more posterior [ɕ] was used for target /s/ (Nakanishi *et al.*, 1972; Beckman, *et al.*, 2003; Li, *et al.*, 2009; Li, *et al.*, 2011). Of course, [ʃ] and [ɕ] are produced on different lingual subsystems, i.e., the former is a tip/blade articulation whereas the latter is a dorsal articulation, but in terms of place of articulation, both are posterior to /s/.

In children acquiring English, however, a converse process is common, where /ʃ, ʒ/ are fronted to alveolar place and realised as [s, z], respectively (Weiner, 1979). Locke (1983) argued that, in terms of articulation, the anterior sibilant fricative /s/ is universally easier than its post-alveolar counterpart, /ʃ/. This hypothesis, as noted above, is not in agreement with reports on cross-language studies of fricative acquisition. More recent studies (e.g., Li *et al.*, 2009a) have shown that the articulatory difficulty argument may not stand up to scrutiny and that frequency or usage are more important. Li *et al.* (2009a) suggested that such language-specific differences in acquisition may be linked to differences in how the fricative contrast is represented acoustically between languages, as well as to the different distributional patterns between the languages. It is also important to consider the frequency of use of speech sounds in a language, as it appears that children produce speech sounds and sequences which have high frequency of use more accurately than those with low frequency of use (Edwards *et al.*, 2004; Munson *et al.*, 2005; Edwards *et al.*, 2011).

Generally, typically-developing Amharic-speaking children as old as five years of age have difficulty realising the alveolar trill /r/. As discussed in Chapter 7 and 10, in typical consonant acquisition, the trill is the most difficult consonant to learn, irrespective of language (e.g., Recasens, 1991; Ladefoged and Maddieson, 1996; Solé, 2002). This could be due to the fact that the alveolar trill requires very precise control of aperture and airflow with minimal deviation, which could be the reason why it is often acquired rather late (Recasens, 1991; Ladefoged and Maddieson, 1996; Solé, 2002). So, the fact that young children have difficulty producing /r/ can be attributed to the articulatory and aerodynamic precision required to articulate it. This suggests that suggests that different difficulties with different segments may have different origins in, e.g. articulation vs. usage.

Typically-developing Amharic-speaking children who are younger than four years exhibited *de-ejectivisation*, that is, the realisation of ejectives as their pulmonic counterparts. The production of ejective consonants is relatively more complex than that of the pulmonic consonants; and it is not surprising that young children de-ejectivised ejectives. Researchers of American Indian and Caucasian languages have reported that ejectives are acquired rather late (Jakobson and Waugh, 2002). It is a common practice of parents of young children who speak these American Indian languages to replace ejectives by plain stops when telling stories to their young children who have not yet assimilated ejective sounds (Jakobson and Waugh, 2002). This appears to relate to parents' perceptions of what might be easy or difficult, which is based on what they observe in children’s speech.

In summary, apart from the absence of stopping of alveolar fricatives, post-alveolar fricatives and affricates, and the realisation of /s/ as [ʃ], most of the developmental realisations patterns attested in the speech of Amharic-speaking children aged between 2;0 and 5;7 correspond to patterns reported for other languages.

12.3. Speech output of the children with cleft: cross-linguistic similarities and differences

12.2.1. Dental, interdental and linguolabial realisations

As described in Chapter 8, dental, interdental and linguolabial articulations were noted in the present study. These speech production features are among the common cleft-type speech characteristics across different languages (e.g., McWilliams, Morris, and Shelton, 1990; Trost-Cardamone, 1990; Brøndsted *et al.*, 1994; Sell *et al.*, 1994b, 1999; Howard, 2011). Such articulatory behaviours are often associated with a class III malocclusion related to the poor maxillary growth common in cleft palate. When the maxilla is small, the tongue has little room to manoeuvre to produce the alveolar targets. As a result, the tongue contact tends to be advanced. This may have caused or contributed to the realisations in question. Moreover, before surgery, as the palate was open, the tongue could either be advanced or retracted to places where tongue contact can be achieved. This may also account for the dental, interdental and linguolabial articulations observed here. Furthermore, the fact that, in Amharic, /t̪/ and /t̪'/ are denti-alveolar consonants may make them more prone to interdental and labiodental realisations.

12.2.2. Lateralization and palatalization

Lateralization and palatalization (as a secondary articulation) were also found in the speech of Amharic-speaking children with cleft palate. As discussed in Chapter 9, palatalization was the least preferred realisation in the present study. This will be further discussed later in section 12.2.12. Lateralization and palatalization are also among the cleft-type speech production features that are commonly reported for individuals with cleft palate across languages (e.g., Harding and Grunwell, 1996: English; Stokes and Whitehill, 1996: Cantonese; Shahin, 2006, Al-Tamimi *et al.*, 2011 and Al-Awaji, 2012: Arabic). Lateralization and palatalization are also often linked to Class III malocclusions such that a relatively anterior tongue position restricts the available space for the tongue to adapt to any irregular alveolar contours (Harding and Grunwell, 1996). This could have caused the atypical articulations observed in this study. Yamashita and Michi (1992), however, reported lateralized and palatalized realisations in the speech of Japanese-speaking children with VPI related to cleft, who had typical dental arches and occlusions. This suggests that there might be other factors causing or contributing to the articulatory features in question.

It is also important to consider the fact that lateral and palatal realisations of alveolar fricatives also occur in the non-cleft developmental speech disordered population (e.g., Hardcastle *et al.*, 1987; Howard, 1998). The implication could be that the atypical lateral and palatal realisations observed in the children studied here might be associated with some kind of developmental speech difficulties. The same would apply to dentalised alveolars, discussed above, which are a common immature pattern in speech development and a common persisting misarticulation.

Moreover, Harding and Grunwell (1996) suggested that if lateralization and palatalization cannot be attributed primarily to occlusal factors, perhaps factors such as alveolar fistulae, sensory loss in the palatal mucosa, dental overcrowding, hearing status and perceptual issues in early development or even early tongue movement patterns established for feeding, might precipitate secondary articulations. Hence, it may also be the case that these factors (alveolar fistulae excluded, as no child in the current study was reported to have one) might have caused or contributed to the atypical secondary articulations noted here. It is also important to consider the possible effects of cleft type in such realisations, because studies (e.g., Michi *et al.*, 1990; Yamashita and Michi

1992) showed that individuals with a UCLP and BCLP demonstrated atypical lingual movement more frequently than those with an ICP. Consistent with this, in the present study, of the four children who showed lateralized articulations, three had a UCLP and one had an ICP. The child who exhibited palatalization, as a secondary articulation, also had a UCLP. Hence, given children with a UCLP or BCLP do not have a typical dental arch by virtue of the cleft of the alveolus, the explanation that the palatalization and lateralization noted in the children studied here might be related to atypical dental arches and occlusions is plausible.

12.2.3. Double articulations

Double articulations were observed in the speech of some of the Amharic-speaking children with cleft palate in the present study. Several studies, for example, in English (e.g., Trost, 1981a; Dorf and Curtin, 1982; Stengelhofen, 1989; Trost-Cardamone, 1990; McWilliams, Morris, and Shelton, 1990; Grunwell, 1993; Sell *et al.*, 1994b, 1999; Gibbon and Crampin, 2002; Howard, 2004); Cantonese (e.g., Whitehill *et al*., 1995); Swedish (Persson *et al*., 2006) Arabic (Al-Awaji, 2012) have identified various atypical double articulations (e.g., labial-lingual, alveolar-velar, lingual-glottal) as a compensatory articulation in the speech of individuals with cleft palate. No study could be found which reported double articulations in individuals with cleft palate speaking Japanese.

Harding and Grunwell (1996) noted that double articulations, like backing, occur most frequently in the production of alveolar plosives. In the present study, of the five double articulation patterns identified in this study, two occurred in the production of bilabial plosives, two for the alveolar plosive /d/ and one for a post-alveolar fricative and ejective affricate. Contrary to what some previous studies have reported, e.g., Harding and Grunwell, 1993; Gibbon *et al.*, 2004, not many alveolar-velar double articulations were found in the children studied here. The only alveolar-velar double articulation was noted in the production of /d/. This could be because, in Amharic, the other pulmonic plosive produced at the (denti)alveolar place of articulation is /t̺/, which may not present as strong aerodynamic and articulatory challenges because it is voiceless (Malécot, 1968; Stevens, 1998). Gibbon *et al.*(2007) remarked that the most frequently reported type of double articulation involves glottal or pharyngeal constriction occurring simultaneously with closure at higher levels in the vocal tract (e.g., bilabial or tongue-palate constriction). Consistent with this, of the identified five double articulation patterns, four of them involved glottal constriction occurring simultaneously with closure at a bilabial, alveolar, post-alveolar or palatal place (as noted above, the remaining pattern involved alveolar-velar double articulation (i.e., /d/→[d͡g])). Explaining why the most common type of double articulations involve glottal articulation, particularly the glottal stop, Trost-Cardamone (1990) note that during glottal constriction the tongue is free to make simultaneous anterior articulatory contact. This appears to explain the relatively high incidence of double articulation involving a glottal stop noted in the present study.

12.2.4. Backing

As already mentioned, Trost (1981a) described several backed patterns of articulation including mid-dorsum palatal, velar, uvular, glottal and pharyngeal realisations of anterior oral consonants. Except pharyngeal realisations of oral consonants, all backed articulatory behaviours reported from other languages have been found in the present study. One may wonder why pharyngeal realisations, which are commonly reported for individuals with cleft palate in other languages, were not noted here. This could be due to the impact of sociolinguistic factors, specifically the phonological systems of other related languages such as Tigrinya, on the sound preferences noted in children studied here. Tigrinya, another Ethio-Semitic language closely related to Amharic, has pharyngeal consonants (/ħ, ʕ/), which are among the most important features that differentiate Tigrinya from many other languages in the sub-family, including Amharic. Studies (e.g., Fischer, 1958; Roberts, 1997; Docherty et al., 2006; Chevrot and Foulkes, 2013) have shown that children as young as 3 years are aware of the sociolinguistic relevance of phonetic variants. Given this and given the fact that Amharic and Tigrinya share several vocabulary items, using pharyngeal consonants as a compensatory strategy might make the children sound like Tigrinya speakers, which the children would try to avoid in order to maintain their Amharic-speaker identity. Hence, this might have contributed to the fact that the children studied here did not use any pharyngeal realisation. The implication is that sociolinguistic factors may also determine the choice of compensatory articulations that individuals with cleft palate employ in dealing with the articulatory and perceptual challenges that they face. As already discussed in previous chapters, a number of explanations have been given as to why backed articulations occur in the speech of individuals with cleft palate. These include, the occurrence of current or past VPI (McWilliams *et al.*, 1990; Chapman, 1993; D'Antonio and Scherer, 1995), current or past fistulae or residual cleft (e.g., Henningsson and Isberg, 1990; LeBlanc, 1996; Lohmander *et al.*, 2002), dental/occlusal anomalies (Golding-Kushner, 1995); and atypical neuromotor learning caused by structural anomaly (Hardcastle *et al.*, 1989; Moller, 1990; Russell and Grunwell, 1993; Nagarajan *et al.*, 2009).

In the case of VPI, the speaker may subconsciously be trying to achieve valving at a point inferior to the velopharyngeal valve, in an attempt to produce stopping or frication before pressure is lost through the velopharyngeal port (Whitehill *et al.*, 2003). Similarly, in the case of oronasal fistulae, the speaker presumably subconsciously is attempting to achieve a valve at a place posterior to the fistulae to prevent nasal escape of air (Whitehill *et al.*, 2003). Another possible factor is related to dental/occlusal anomalies, which may affect typical tongue posture, leading to retracted articulations. Moreover, an early-established articulatory gesture learned by children during the developmental period, again, presumably in a subconscious attempt to achieve velopharyngeal closure or to block escape of fluid through an unrepaired palate, may also be responsible for backed articulatory behaviour commonly observed in cleft population. Even though there seems to be not enough evidence supporting or refuting any of the above theories, the fact that backed articulatory patterns are observed even after the structural anomalies are repaired suggests that there may be a behavioural aspect to this articulatory process (Peterson-Falzone, *et al.*, 2010). Peterson-Falzone *et al.* (2006, 2010) remarked that mid-dorsum palatal realisations, for example, may be a result of a place compromise between anterior place and posterior place, learned in early speech sound practice as the tongue attempts to fill the unoperated cleft space in search of an articulatory contact. It could be due to the result of an articulatory gesture learned in the attempt to use the tongue to occlude an anterior/mid-palatal fistula. So, one or more of the factors mentioned above may be responsible for the backed articulatory behaviour observed in the children studied here. Except backing to the pharyngeal place, all of the other backed articulatory patters commonly attested in cleft-related speech across languages have also been noted in Amharic. The fact that backing to the pharyngeal place was not observed in Amharic, possibly for a sociolinguistic reason, supports the idea that even though most of cleft-related speech features are universal, there are also language-specific aspects.

12.2.5. Pre-nasalised consonants

As already noted, in a pre-nasalised sequence, a phase of nasal articulation occurs before, or in the initial part of, the articulation of a target oral segment. Pre-nasalisation is not recognised as a separate speech sound, but as a feature of a speech sound and is well attested in typical speech production in several languages (Maddieson, 1989). As already stated, pre-nasalised consonants were also noted in the speech of some Amharic-speaking children with cleft palate. This speech production behaviour is also commonly observed in cleft-related speech productions in other languages such as English (e.g., Russell and Sell, 2008).

12.2.6. Nasal consonants for oral consonants

Use of nasal consonants for oral consonants is another cleft type speech production feature commonly reported in the literature across languages. Some of the Amharic-speaking children with cleft palate also demonstrated such realisations, the most common pattern being /l/→[n], which may be attributed to residual cleft, fistulae or VPI (Hutters and Brøndsted, 1987; Harding and Grunwell, 1998b). The fact that /l/→[n] is a common pattern observed in the speech of the children studied here could be related to a number of articulatory and acoustic features of /l/.

In terms of articulation, /l/ requires more 'lingually complex' articulatory gestures than other alveolar consonants such as /d/ or /n/ (Ladefoged, 2005), making it one of the most difficult sounds to acquire (Shriberg and Kent, 1982; Gick *et al.*, 2008). In typical speech development, /l/ is substituted with [w] and [j], in English (Gilbers, 2002) and with [j] in Amharic, a process known as liquid gliding. This might explain the high incidence of /l/→[n] pattern. Acoustically, /l/ has both formants and anti-formants and hence is very similar to /n/ (Kent and Read, 2002). This may suggest two points. First, it could be the case that some of the children might not have perceived the difference between /l/ and /n/ and hence produced both as [n]. Alternatively, they were aware of the contrast between the two phonemes, and even attempted to produce /l/, but due to the accompanying nasal resonance it was perceived by the listener as [n]. In general, realisations of /l/ are not commonly reported in studies of cleft palate speech, which may be because it is not a pressure consonant. This makes it difficult to make cross-linguistic comparisons.

12.2.7. Weak oral pressure consonants

When intraoral air pressure is compromised due to a pressure leak at the velopharyngeal port, a loss of power in the production of high-pressure consonants happens. As a result, pressure consonants will be weakly realised. Weak oral pressure consonants are often produced for stop consonants in the speech of children with cleft palate across all languages (Henningsson *et al*., 2008; Henningsson and Willadsen, 2011). Weak realisations of oral pressure consonants were observed to some extent in the speech of all of the children with cleft palate studied here. These passive cleft-type speech production features have already been reported in the literature (Henningsson *et al*., 2008); and since they are generally results of structural anomalies associated with the cleft or VPI, significant cross-linguistic differences in the use of these speech production features would not be expected and have not been reported. Even though such passive realisations are often eliminated after palatal closure, in many children they may persist after surgery.

12.2.8. Vowels

Examination of vowel productions in individuals with cleft palate has not received as much attention as consonants. As Gibbon *et al*., (2010) noted, this could be due to, the widely held view that the ‘‘intelligibility of vowel sounds in cleft palate is rarely affected’’ (Morley, 1970:53). In the present study, in addition to the atypical nasalised realisation of vowels noted in the speech of most of the children with cleft palate, retracted realisations of high front vowel (/i/) was also observed in the speech of one child. This child demonstrated substantial backed consonant articulations, which might also have affected his vowels. Other than these, no atypical vowel quality was perceptually evident. This is consistent with studies which reported that atypical realisations of vowels were rare (e.g., Spriestersbach, *et al.*, 1956; Moll, 1969; Stout *et al*., 2011; Xue *et al*., 2011). However, some research has shown that other atypical speech production features such as an increased nasalisation may lead to atypical realisation of vowels in terms of tongue position (Yamashita and Michi, 1991; Gibbon *et al*., 2005; Howard, 2012). These studies demonstrated that, during the production of high vowels (e.g., /i/, /ʉ/ /ɪ/, /ɯ/, /u/), in the presence of increased nasalisation, the tongue may be raised up to an atypical high position, so much so that it makes full contact against the hard palate, which in turn may lead to atypical realisation of the vowels. Such realisations are observed by using instrumental techniques such as electropalatography (EPG), because the articulations are often perceptually identified as vowels not consonants by listeners. As EPG was not used in this study, such atypical realisations, which might have been present in the speech of the children studied here, could not be examined.

Overall, as noted in Chapter 8, the main atypicality in vowel production attested in the speech of the children studied here was hypernasality. Other atypical vowel qualities could not be identified perceptually with one exception, that is, retracted vowel articulation identified in the speech of one of the children (EY), which, as the studies cited above showed, could be due to increased nasality (Gibbon *et al*., 2010). The present study revealed that vowel production in cleft palate may be significantly affected but the atypical speech production mechanisms that are involved might not be identified using perceptual techniques, and hence it is important to invest more attention to vowels in order to better understand the nature of cleft-related speech production.

12.2.9. Phonation and laryngeal voice quality

In the present study, one of the frequently noticed phonatory atypicalities was devoicing of voiced consonants. As already noted, the devoicing of voiced consonants and substitution of voiced consonants by voiceless consonants may be associated with the fact that, in the presence of VPI, voiceless consonants are aerodynamically easier to produce than voiced ones, because the former have a higher intraoral pressure than the latter (Malécot, 1968; Stevens, 1998). This is due to the fact that setting the vocal folds into vibration to produce voiced sounds reduces the supraglottal air pressure, which, together with possible further reductions due to nasal emission, would make the production of voiced consonants more challenging than that of voiceless consonants. Again these articulatory patterns are common among individuals with cleft palate in other languages (e.g., Arabic: Shahin, 2006, English: Howard, 1993). In terms of laryngeal voice quality, as noted in Chapter 8, mild hoarse and creaky voice qualities were observed in some children in the present study. Other than these, no significant atypical voice quality has been perceived. These atypical phonatory patterns and voice qualities are not uncommon for individuals with cleft palate across different languages (e.g., Bzoch, 1964; McWilliams *et al.*, 1969; Van Lierde *et al.*, 2004).

12.2.10. Ejectives

Ejectives can be produced at a bilabial, denti-alveolar, alveolar, postalveolar, palatal, velar, or uvular place of articulation. Bilabial ejectives are generally uncommon; and even among those languages with a series of ejectives there are comparatively few with bilabial ejectives (Ladefoged and Maddieson, 1996; Maddieson, 2001). Ejective fricatives are also relatively rare in the world's languages (Maddieson and Precoda, 1991). In contrast, ejective stops are generally frequent across languages, and the most common place of articulation is velar (Maddieson, 1984; Best and McRoberts, 2003). This could be due to the fact that the auditory distinction between /k’/ and /k/ is greater than it is between other ejectives and their voiceless pulmonic counterparts (Ohala, 1996; Ladefoged, 2005). The authorities just cited argue that release bursts of back stops are generally more salient perceptually than those of front stops because, during the production of back stops, the vocal tract in front of the constriction is longer, therefore the burst release contains more information about the articulation. How ejectives are realised by individuals with cleft palate has not been previously reported in the literature, and Amharic is the first language containing ejectives to be reported. Examining the production of ejectives (in comparison with that of pulmonics) in children with cleft palate shows how these children manage the challenge of learning a language which contains both pulmonic and non-pulmonic consonants. As already discussed, Amharic-speaking children used various strategies to deal with the challenges posed by the cleft condition as well as by the phonological system of Amharic. In addition to the atypical use of airstream mechanisms, the children generally tended to employ posterior articulations, particularly substitution of glottal stop, for ejective consonants. As already noted, the fact that ejectives typically involve constriction of the glottis coupled with the known preference of individuals with cleft palate for glottal articulations, might account for the use of glottal stop more for ejectives than for their pulmonic counterparts.

Where implosive productions were noted, they were always used to realise target ejectives. The use of implosives for ejectives may be because implosives are perceptually different from pulmonic consonants and are produced mainly on an ingressive airstream, which therefore circumvents the problem of airflow being lost at the velopharyngeal port. Also, more click realisations were used by the children for target ejectives than for target pulmonics. Clicks require a very small air pressure trapped in the oral cavity so that a relatively small movement of the tongue produces a very large change in intraoral air pressure, and makes it possible to produce a loud release burst (Ladefoged and Maddieson, 1996). Moreover, the production of clicks (at least the closure phase) may not be significantly affected by VPI, as the build-up of air pressure is created within the oral cavity, before the velopharyngeal port. It is important to note that even though, from an aerodynamic perspective, non-pulmonic sounds (particularly clicks and implosives) seem to be relatively easier than ejectives for the children with cleft palate to produce, they were nevertheless not commonly used by many of the children. This could be attributed to several factors. One of the reasons might be that it is simply impossible or very difficult to produce clicks while having an unrepaired palate, and after surgery the children tend to continue using the articulatory behaviours established before surgery. It could also be because clicks are very salient perceptually, but comparatively rare cross-linguistically, so using them in languages in which these sounds are not part of their phonemic inventories would make the children's speech difficulty more obvious to listeners.

In terms of speech development, as discussed in Chapter 7 and summarised above, even in typical speech development, ejectives are acquired significantly later than their pulmonic counterparts, suggesting that they are relatively difficult sounds in terms of articulation. Lindblom and Maddieson (1988) also noted that ejectives are among the articulations which lack a basic or simple manner of production in their initiation, phonation, and articulation. Other examples include implosives, breathy or laryngealized vowels, prenasalised consonants, labialised, lateralized, and palatalized articulations. This may help to explain why the children with cleft palate demonstrated more atypical realisations for ejectives than for pulmonic consonants.

12.2.11. Summary of the speech characteristics

As discussed in previous chapters, Amharic-speaking children with cleft palate demonstrated a range of atypical speech production features including active and passive cleft-type speech characteristics, non-cleft developmental realizations, usage of atypical airstream mechanisms, retracted vowel production, atypical voice quality (i.e., mild hoarse and creaky voice quality) and atypical nasal airflow and nasal resonance. The results of the current study revealed that, in addition to the speech production features mentioned above, which have previously been reported in the cleft literature and are common across languages, there are also language-specific speech characteristics related to the phonetic and phonological systems of Amharic. For example, in maintaining contrasts between pulmonic and ejective consonants, the children exhibited a range of unusual airstream mechanisms. In common with children speaking other languages, the children in this study used a range of ingressive articulations (clicks and implosives) in order to avoid nasal escape of air during segmental articulation. Also, however, for ejective versus pulmonic contrasts, they used various atypical realisations and atypical airstream mechanisms. As has been discussed, the atypical realisations noted in the children with cleft palate are mainly products of the structural constraints affecting the aerodynamics of speech and articulatory gestures. However, in the present study, palatalization, as a secondary articulation was rarely noted and no backed articulation of oral/nasal consonant to the pharyngeal place articulation was recorded, possibly for sociolinguistic reasons.

12.2.12. Comparison of most and least attested realisations

As discussed in Chapter 9, of the identified atypical speech behaviours, backing appeared to be the most common compensatory strategy employed by the children with cleft palate in this study. More specifically, backing to the glottal place was the most common articulatory behaviour used. This is also true for individuals with cleft palate across languages (e.g., Howard, 1993, 2004; Chapman and Hardin, 1992; Chapman, 1993; Stokes and Whitehill, 1996; Hutters, *et al.*, 2001; Hardin-Jones and Jones, 2005; Shahin, 2006; Al-Tamimi, *et al.*, 2011). Chapman and Willadsen (2011) also remarked that glottal stops appear to be the most frequently occurring compensatory articulations identified in the speech of children with cleft palate cross-linguistically. As indicated above, the use of backed articulatory behaviours as a common compensatory strategy by individuals with cleft palate appears to be due to an attempt to create compensatory pressure areas by humping the back of the tongue or constricting the glottis (Warren, 1986; Peterson-Falzone *et al*., 2006). For at least some children, this articulatory behaviour seems to be included in the developing phonological system and to persist following palatal repair.

It is also interesting to note that weak oral pressure consonants and nasalised voiced pressure consonants were observed in the speech of all of the children with cleft palate. These speech production features are linked to the pressure leak at the velopharyngeal port compromising intraoral pressure and are common in individuals with cleft palate irrespective of language (Trost, 1981b). It is understandable that, before surgery, coupling between the oral and nasal cavity results in difficulty with production of pressure consonants. Even after the palatal cleft is repaired, for some children, as is the case with the children in this study, oral nasal coupling may persist after surgery, resulting in, among other things, the production of weak oral pressure consonants and nasalised voiced pressure consonants. This may happen if, for example, the surgery is not successful in restoring the velopharyngeal mechanism, or due to other reasons such as presence of a fistula, VPI, or to already established motor patterns.

The least common cleft-related realisation in the current study was palatalization, as a secondary articulation. In other languages (e.g., Cantonese: Stokes and Whitehill, 1996;

English: Sell *et al.*, 2001), it has been reported that this realisation is one of the common processes in cleft-related speech. As discussed above, palatalized articulations often have physical causes such as Class III malocclusion or small palate volume, causing rear displacement of the realisation of denti-alveolar or alveolar sounds. It is also important to consider sociolinguistic factors (e.g., avoidance of speech sounds that are associated with ‘less prestigious’ accent or dialects). In this regard, as noted in Chapter 4, in one of the dialects of Amharic (i.e., in the Wollo dialect) usage of palatalization is common, where all stops (affricates included), ejectives, trills, lateral approximants, become palatalized when followed by /ə/ or /e/. In most parts of the country where Amharic is used, particularly in Addis Ababa, people generally tend not to use regional dialects (such as the Wollo dialect), as they are considered as less prestigious than the ‘standard’ Amharic. As many of the children studied here were from and around Addis Ababa, they might have been consciously avoiding using palatalization in order not to sound like speakers of the stated dialect.

12.2.13. Comparison of affected consonants

In terms of consonants most affected, /s/ was the most affected consonant, which is consistent with previous reports for other languages (e.g., Spriestersbach, *et al.*, 1956; Subtelny, 1959; Morley, 1970; Van Demark, 1979; Albery, 1991; Brøndsted, *et al.*, 1994; Harding and Grunwell, 1993). As already noted, this may be attributed to the articulatory and aerodynamic precision required for the production of /s/. /f/ was the least affected consonant, perhaps because it does not require high pressure compared to other pressure consonants. In terms of its acoustic properties, the overall amplitude of /f/ is low relative to other fricatives, suggesting that it requires relatively low acoustic energy, which in turn requires relatively low intraoral pressure. In terms of different consonant classes, /s/, /t̪’/, /d/ and /ʤ/ were the most affected fricative, ejective, stop and affricate consonants, respectively. A number of previous studies have reported that crosslinguistically /s/ is the most affected consonant, as just discussed. The ejective /t̪'/ is one of the most frequent sounds in Amharic, and it appears that, given that most of the children had a UCLP and BCLP, affecting denti-alveolar place of articulation, its place of articulation makes it more prone to atypical articulation than the ejectives produced further back. This may also be true for /d/.

12.2.14. Speech output in relation to age at assessment/surgery and cleft type

Concerning the relationship between age at assessment/surgery and speech output, even though the number of children in this study was not big enough to reach any firm conclusions, generally, the children in the last two groups (those aged between 8-10;11 and 11-14 years) showed more cleft-type speech realisations than those in the first group. (aged between 5 to 7;11 years) As discussed in Chapter 9, it has often been reported that atypical realisations decrease in the speech of children with cleft palate due to younger ages at time of primary palatal surgery, and there is a consensus in the literature that that early palate closure often results in a better speech outcome. The fact that all the children studied here were later-operated made it difficult to evaluate the effect age at surgery has on speech output. However, as noted in Chapter 9, the effects of the cleft condition on speech production appears to be positively correlated with age of surgery, meaning that the later the surgery, the greater the effect of the cleft condition on speech production (i.e., the more atypical the speech output). As discussed in Chapter 9, section 9.9., this is in agreement with previous studies, conducted in children who had surgery in earlier ages than the ages at which the children in the present study received surgery (e.g., Sell and Grunwell, 1993a; Hardin-Jones and Jones, 2005). Non-cleft developmental realisations were noted only in the first group, which contains the youngest children (aged between 5 to 7;11 years). Some of these realisations (e.g.,

/r/→[l]) were age-appropriate immaturities that are also observed in typically developing children, while others (e.g., /t̪/→[p]), though developmental realisations, were not age-appropriate. As discussed in Chapter 2, although the measures used to determine rate of speech development vary, it has generally become apparent that the speech output of children with cleft palate is often less well developed (delayed) than those of their non-cleft peers. It has been stated (e.g., Harding and Grunwell, 1996; Kuehn and Moller, 2000; Peterson-Falzone, *et al.*, 2001; Priester and Goorhuis-Brouwer, 2008) that the most significant factor for delays in speech development observed in children with cleft palate is the structural constraint associated with the cleft. However, there are also other factors such as frequent hospitalisations, hearing loss associated with middle ear effusion, most of which are again related to the cleft condition and may contribute to the delays.

With regards to cleft type as a function of speech production, the findings of the present study suggested that, in general, the children with a UCLP and BCLP realised more active realisations than those with an ICP. This is in disagreement with results reported in previous studies (e.g., Hardin-Jones and Jones, 2005; Chapman, *et al.*, 2008). For example, Hardin-Jones and Jones (2005) stated that no significant relationship was evident between cleft type and the number of children producing compensatory articulations. Furthermore, in terms of passive realisations, the children with a UCLP and BCLP exhibited more passive cleft-type realisations than those with an ICP. In other words, the UCLP and BCLP groups demonstrated more cleft-type realisations (active and passive) than the ICP group. This is consistent with previous reports and is not surprising, as the more severe the cleft, the greater its impact on speech becomes (e.g., Peterson-Falzone, 1990; Dalston, 1992; Karling *et al*., 1993; Albery and Grunwell, 1993; Hardin-Jones *et al.*, 2003).

12.2.15. Phonetic variability and phonological implications

Variability in speech production is not unusual for individuals with cleft palate (e.g., Kuehn and Moller, 2000; Klintö *et al.*, 2011; Howard, 2012) and a number of factors may lead or contribute to the observed variability in speech sound realisations. This study examined causes of inter-speaker phonetic variability and their phonological consequences. As already discussed in Chapter 10, some of the atypical segmental realizations found in this study were conditioned by word/syllable context and/or elicitation mode, while others were attested across different word/syllable contexts and in all sampling conditions. These factors include: atypical phonological development unrelated to the cleft palate, atypical phonological development resulting from the articulatory and/or perceptual constraints posed by the cleft condition, contextual factors (i.e., word/syllable contexts and/or elicitation modes). It is important to identify the root cause of the speech variability observed in these children in order to plan appropriate management. In the children studied here, there is no evidence that they had atypical phonological development unrelated to the cleft. In other words, it appears that the phonetic variability they demonstrated may be the result of the effects of the specific compensatory strategies used by a particular individual speaker. The children in the older group (aged between 11-14) were the most consistent. The decrease in variability in the children in the older group does not necessarily indicate that they had more accurate speech output; rather it could be due to the fact that they had a more established speech motor system (Kent and Forner, 1979; Smith, 1981; Sharkey and Folkins, 1985), making it difficult for new speech production behaviours to develop after surgery. The perceptual analysis suggested that the latter explanation appears to account for the decrease in variability in the children in the third group, as their repertoires are limited.

Most explanations of atypical speech output in individuals with cleft palate have focused on structural factors. However, several studies over the years have advocated a phonological approach towards understanding atypical speech production in this population. Phonological difficulties unrelated to the cleft could of course occur in a child with cleft palate. However, it has increasingly been suggested that atypical speech productions that initially occur as a result of structural limitations (phonetic disorder) may later result in a phonological disorder (e.g., Bzoch, 1997; Chapman, 1993; Russell and Grunwell, 1993; Harding and Grunwell, 1996; Harding-Bell and Howard, 2011). So, it is important to consider phonological perspectives in dealing with speech characteristics associated with cleft palate, as phonological approaches may not only provide alternative explanations of the causes of the speech atypicalities but also offer alternative approaches to intervention. As Harding-Bell and Howard (2011) note, a phonological approach to speech related to cleft palate focuses on the consideration of patterns of sound use rather than considering just the articulation of individual sound segments, because, in phonological terms, individual sound segments do not operate in isolation. This paradigm has been recognised as an effective way for working with cleft-related speech production (Grunwell and Russell 1988; Chapman and Hardin, 1992; Chapman, 1993; Harding and Grunwell, 1998; Harding-Bell and Howard, 2011), and it is indispensable if one wishes to compare those speech production features found in typical speech development with atypical patterns related to other types of developmental speech difficulties (Grunwell, 1982; Miccio and Scarpino, 2008).

12.2.16. Covert contrast

In Chapter 11, the use of covert contrasts for pulmonic-ejective contrasts was explored. Acoustic analysis indicated that at least three of the children with cleft palate (i.e., C1, C3 and C4) were aware of the pulmonic-ejective contrast and seemed to signal the contrasts consistently, although in such a way that the listener could not perceive them.

One of the implications of this observation is that the children are aware of the contrasts in question but are not able to signal them appropriately, due to the structural constraint associated with the cleft palate. This, in turn, suggests that for these children this particular speech difficulty associated with cleft palate is essentially phonetic in nature, even though it has phonological consequences. Moreover, the findings imply that covert contrasts need to be carefully examined, when perceived contrasts are judged to be absent, because determining the presence or absence of covert contrasts is of clinical significance, as features of speech realisations are evaluated and managed on the basis of perceived lack of contrast in their speech (Scobbie *et al.*, 2001). Furthermore, the findings also suggested that, if the children were making covert distinctions for the pulmonic-ejective contrasts, then it is quite possible that they were also making covert differences for other phonological contrasts such as voiced-voiceless and place of articulation contrasts, which have previously been reported in cleft-related speech (e.g., Howard, 1993).

12.3. Theoretical, methodological and clinical implications

One of the contributions of this study is that it provides information about cleft-type speech characteristics in a non-European language, i.e., Amharic, that has non-pulmonic (ejective) as well as pulmonic consonants. Speech characterstics in Amharic-speaking individuals with cleft palate has not been reported at all previously. The main component of speech sound production that is affected by the cleft condition is the aerodynamics of speech production, which governs the amount, direction and speed of air in the vocal tract during the production of speech sounds. If the aerodynamic mechanism of speech production is constrained in some way, learning the appropriate articulatory placements and movements for typical sound production would be a problem, even if there is no problem with articulation and motor learning. This is in part because, without typical aerodynamic mechanism, achieving the appropriate articulatory placements and movements alone would not yield the intended speech sound. Thus, attempts to achieve the appropriate aerodynamic mechanism may compromise the articulatory movements and placement required for the intended speech sounds. An alveolar-glottal backing pattern (e.g., /d/→[ʔ]), which is commonly observed in cleft-related speech across languages, can substantiate the above claim. As noted earlier, this production can be a result of an attempt to achieve valving at a point inferior to the velopharyngeal valve in order that stopping or frication can be produced before pressure is lost through the velopharyngeal port. This is the major challenge that children with cleft palate generally face.

In addition to dealing with the structural constraints which may affect articulation and/or perception, these children also have to handle the challenges posed by the phonological system of the language they learn. In this regard, the phonemic inventory of Amharic (i.e., pulmonic and non-pulmonic sounds) together with their distributional patterns in phonological units present a particular challenge in producing, sequencing, and contrasting speech sounds that require two different airstream mechanisms. The speech production features observed here also confirmed that the interrelationship of the aerodynamic-articulatory-acoustic mechanisms of speech production is so strong that one cannot function properly without the other (Ladefoged and Maddieson, 1996). Some of the compensatory strategies (e.g., backing) employed by the children showed that attempts to achieve aerodynamic goals compromised place and manner of articulation as well as the acoustic properties of the speech sound produced. Equally, when typical articulatory postures, manner and place of articulation were targeted or even achieved, aerodynamic targets became compromised. For example, a passive nasal fricative, which many of the children studied here demonstrated, is “the product of an intended /s/ with an unintended nasal airflow” (Harding and Grunwell 1998:338), demonstrating the fact that there is often a trade-off between achieving articulatory goals (e.g., maintaining accurate place and manner of articulation) and having typical resonance and airflow.

Another implication of the different speech production features noted here is that even though the strategies that individuals with cleft palate use to deal with the articulatory and/or perceptual constraints presented by the cleft are generally universal, different language speakers and even different individuals within the same linguistic community may respond to the challenges in various ways. These variations in response to the challenges posed by the cleft might be the result of individual's response to the articulatory and/or perceptual constraints and to the phonological system of their language. Moreover, it is established that high pressure consonants are vulnerable speech sounds for individuals with cleft palate; and the number of these vulnerable sounds varies from one language to the next. For example, as discussed in Chapter 2, compared to Hawaiian, which has only two pressure consonants, English has sixteen pressure consonants that are vulnerable to the cleft palate condition. Amharic has nineteen pressure consonants, indicating that the number of vulnerable consonants in the language is higher than it is in Hawaiian or even in English. In other words, generally, the effect of cleft palate for Amharic-speaking individuals is more severe (in terms of phonological contrastively and hence intelligibility) than it is for Hawaiian and English speakers. Of course, it is important to consider the frequency of individual sounds and sound contrasts in a language in order to a good picture of the relationships between consonant inventory and speech output and how they compare and contrast in different languages, because a language could have a larger inventory of sounds but some of the sounds might only occur in a very limited number of words or contexts.

This implies that for children with cleft palate, some languages may be more difficult to learn or cope with than others. These cross-linguistic differences in phonetic characteristics present a methodological challenge of comparing speech characteristics of individuals speaking different languages. As has been highlighted (e.g., Lohmander and Olsson, 2004; 2008), language-related factors (e.g., consonant inventories, phonotactics) are among the most important variables that need to be eliminated, when comparing speech derived from different languages. Lohmander and Olsson (2004) suggested that one way of taking language-specific phonetic features out of the equation, in cross-linguistic comparisons, is by considering speech units that are phonetically identical across languages because such units are influenced in the same manner by the cleft condition. This is done by identifying speech sounds that are shared by the languages and comparing phonemic inventories across languages. However, as was discussed in Chapter 2, this approach is not without drawbacks. For example, considering only phonetically similar speech units would compromise the amount and therefore representativeness of the speech units to be compared.

Moreover, even if designing assessments which avoid making comparisons between non-comparable phonetic units is possible, eliminating the possible effects that the language-specific features have on the cross-linguistically shared speech units would not be easy. For example, if the speech output of Amharic-speaking children with cleft palate is to be compared with that of English speakers, realisations of ejectives would not be considered as these sounds are not part of the English phonemic inventory. Comparing only the pulmonic consonants may not give a complete and accurate picture of the speech production features of the Amharic speakers, because even though ejectives are not considered in the comparison, the fact that they exist in the phonological system of the language might affect the way the pulmonic sounds realised.

In other words, while learning how to speak, the Amharic-speaking children are expected to contrast pulmonic and ejective consonants, which dictate how pulmonic sounds are learned in relation to ejectives. Hence, simply considering speech units that are phonetically identical across languages may not fully avoid language-specific factors for direct comparison of speech output. Moreover, when planning and executing assessments, it is very important to highlight the differences between languages in terms of both structure and acquisition.

Regarding implications for assessment and intervention in the clinical context, one of the issues that need to be considered is the most and least frequent types of atypical speech realisations exhibited by the children. As has been discussed, the most frequent compensatory articulation observed in the children studied here is glottal stop substitution. Clinically, atypical use of glottal stop has been described as the most challenging compensatory articulation to deal with (e.g., Kuehn and Moller, 2000; Peterson-Falzone, *et al.*, 2001; Scherer, *et al.*, 2008). This is particularly true if this articulatory behaviour becomes established in the child's phonetic and phonological repertoire, which is the case for the children studied here. This coupled with the fact that the children studied here were late operated (i.e., with previously well-established speech habits) may make intervention rather challenging. This implies that, given the difficulties encountered in remediating atypical use of glottal stop, it is vital to consider intervention models that may prevent the habituation of such compensatory speech patterns before they become established. This is why one of the main focuses of intervention models has long been to deal with glottal realisations, which are common in cleft-related speech.

It is also important to know the most problematic individual consonant and/or consonant class in order to plan intervention. For Amharic-speaking children with cleft palate, as already noted, /s/, /t̪'/, /ʤ/ and /d/ were the most affected fricative, ejective, affricate and stop consonants, respectively. In terms of consonant classes, for example, more glottal substitutions (which are challenging to correct) were noted for ejectives than for pulmonic consonants. When planning intervention, it is therefore reasonable to work on the most problematic sound classes and individual sound segments of the sound class. But, it is also important to consider the fact that the selection of the sounds to be targeted needs to be done in the context of the most frequently occurring sounds and contrasts in the words of the language in question. Another important finding which has significant clinical implications is the fact that the children with cleft palate demonstrated phonetic variability across different word/syllable contexts and across different modes of elicitation. Some of these variations were consistent while others were unpredictable.

As already noted in the previous chapters, speech variability may imply difficulties in phonological processing, although there is no evidence suggesting that the children studied here had phonological difficulties. Speech variability may also be associated with a typical developmental process, where articulatory simplifications are gradually resolving, which is not the case for the children with cleft palate in this study. It has been suggested that, if speech variability is neither associated with a typical developmental process nor with phonological difficulty, then it may specifically be related to the influence of the cleft (Harding and Grunwell, 1996, Harding-Bell and Howard, 2011). It is therefore important to identify the root cause of speech variability in the individual child's speech production because the speech variability noted in one child may be explained by the impact of the cleft, while inconsistent speech production features in another child may be better understood with reference to typical phonological developmental processes.

The relationship between timing of palate repair and speech output, which relates to the need for early intervention discussed above, is another subject which was dealt with in this study. In common with the literature, as already discussed in Chapter 9, the results of the present study suggest that if the children had had earlier palate repairs their speech output would have been better, which could be substantiated by the fact that the youngest children in the study (although they were also later-operated) had better articulation and resonance. As suggested in the literature, all of the children in this study would have benefitted from palate repair earlier than the ages at which they received surgery. However, as discussed in the Chapter 1, in Ethiopia, due to several factors (e.g., poor socioeconomic conditions, a severe shortage of qualified professional to undertake surgical treatment, long distances to travel for surgical services, and lack of information regarding the availability of surgical services) many children still do not get treatment for palate closure at the appropriate time. It is therefore crucial to improve the cleft care management in Ethiopia.

In addition to improving surgical facilities, the need for a speech and language therapy service is also very important. There seems to be a general misconception in the country among individuals with cleft palate and their parents that surgery alone would make a great deal of difference in the lives of the individuals with cleft; and they believe that their lives would improve significantly immediately after surgery. This implies lack of awareness about the cleft condition and its treatment, which needs to be addressed. One of the contributions of this study is therefore to create and raise awareness and inform future developments in cleft care in Ethiopia by providing much-needed evidence for the need for early intervention.

12.4. Conclusion, limitations and future directions

The aim of this study was to describe the speech output of Amharic-speaking children with repaired cleft palate. As has been described and discussed in the previous chapters, cleft lip and palate significantly affects articulation, resonance and voice in Amharic-speaking children with repaired cleft lip/palate. The speech characteristics of the children studied here have been described. These speech production features have been considered in relation to cleft-related speech production features reported for other languages. Some of the atypical segmental realizations observed in this study were conditioned by word/syllable context and/or elicitation mode, while others were attested across different word/syllable contexts and in all sampling conditions. Phonetic variability and its phonological consequences have also been explored.

Another research theme considered in this study was whether speech output was related to age at assessment/surgery and/or cleft type in the children studied here. The results suggested that the youngest children had relatively better speech output, in terms of articulation and resonance, than the older groups, indicating the children generally would have had better speech if they had had earlier cleft repairs, even if that meant repairs which were still relatively late in comparison with the norms for developed countries. The results suggested that the effects of the cleft condition on speech production appears to be positively correlated with age of surgery, meaning that the later the surgery the more atypical the speech output. This is consistent with previous reports. In terms of cleft type, the children with UCLP and BCLP produced more cleft type (active and passive) realizations than those with ICP. Again this is in agreement with previous reports. Furthermore, the findings of this study revealed that in addition to the features of speech production associated with cleft palate which are common across languages, there are also language-specific speech production characteristics related to the phonetic and phonological systems of specific languages. As already discussed, Amharic-speaking children with cleft palate employed various strategies in order to manage the particular speech production challenges posed by the Amharic phonological system. In particular, in maintaining segmental contrasts, they used a range of unusual airstream mechanism.

In common with children speaking other languages, the children in this study employed a range of ingressive articulations (clicks and implosives) in order to avoid nasal escape of air during segmental articulation. Also, however, for ejective versus pulmonic contrasts, they used various atypical realisations (e.g., a preference for glottal realisations of ejectives) and atypical airstream mechanisms (e.g., realisation of ejectives as pulmonics). Examination of speech production in Amharic adds to our understanding of the effects of a cleft palate on speech production. This study also provides information about universal as well as language-specific speech characteristics associated with cleft palate, and hence the data serves as an input for cross-linguistic comparison.

It is also important to note that one of the most important products of the current study is the development of the Amharic GOS.SP.ASS, which was based on the GOS.SP.ASS (Great Ormond Street Speech Assessment: Sell *et al*., 1999). Devising the Amharic GOS.SP.ASS sentences was the most important part of the process of the development of the protocol, which is an important contribution to the study of cleft speech in Ethiopia. The Amharic assessment material also has a list of single words which were used to elicit speech sample in a single-word context. The sentences and words were devised based on guidelines suggested in Sell *et al*. (1999). The materials were well-suited for this study, and may be able to contribute to the assessment process used by speech-language therapists in clinical setting in the future. However, as indicated in Chapter 6, in the future, the protocol needs to be tested more rigorously in terms of reliability and validity; and its efficacy should also to be evaluated. In general, the process of devising the Amharic protocol and using it for the present study suggested that the general GOSPASS approach as applied to ‘new’ languages appears to be suitable, with relevant modifications that account for the structure of the language for which the protocol is developed or adapted for.

It is also significant to point out the limitations of this study. The study suffered from the small sample (i.e., 20), which affected statistical analysis. Attempts to persuade some possible participants to attend the phonetics laboratory of Addis Ababa University, which is located rather far away from the clinic were unfortunately unsuccessful, which also affected the sample size. As noted in Chapter 9 and 10, the limited sample size made it difficult to get statistically significant results. Another limitation of the study is that it does not report patterns of speech production in children with cleft palate younger than five years of age, due to shortage of well-documented studies on speech development in typically-developing Amharic-speaking children. This made it difficult to compare results of the present study with reports of early speech production patterns in young children with cleft palate speaking other languages. Moreover, the fact that speech production behaviours of Amharic-children with cleft palate under five years of age have not been described here also made it difficult to examine the relationship between early speech development and later speech, which, as discussed in Chapter 2, is an interesting area to study.

In addition, the lack of systematically documented information on structural development (e.g., skeletal relationships/occlusion) of the children with cleft made it difficult to explain some of the speech production behaviours (i.e., dental and interdental articulations) in relation to structural atypicalities the children might have had.

Furthermore, as noted in Chapter 9, the fact that the number of children in each cleft group was not comparable (i.e., 5 children with an ICP, 10 with a UCLP and 5 with a BCLP) made the comparison of speech productions based on cleft type difficult. Furthermore, the methods used for this study are not without weaknesses. As discussed in Chapter 3 and 5, phonetic transcription and perceptual ratings have various pitfalls. In this study, attempts were made to test the reliability of phonetic transcription and perceptual ratings. Although the results of the reliability exercise showed that the transcriptions and perceptual ratings presented in this study meet the basic standard set in the literature, the level of agreement still needs to be improved. Regarding the acoustic analysis, one of the major limitations was that the substantial nasal emission and nasal resonance encountered in the data made it difficult to perform some acoustic measurements.

Because of the fact that the speech and language therapy clinic in which the data for the children with cleft palate was collected, did not have aerodynamic equipment, it was not possible to gather aerodynamic data. Clearly such data would have provided a further interesting perspective on resonance and airflow in general and in the production of ejectives and their pulmonic counterparts in particular. This is another area which it would be valuable to pursue in future studies.

The findings of the current study and the limitations outlined above provide the following insights for future research:

- A number of variables can influence the course of speech development in children with cleft palate. Many of these variables are identical to those observed for typically-developing children, so, it is very important that speech development of typically-developing Amharic-speaking children is well documented.
- Speech development of Amharic-speaking children with cleft palate should also be researched thoroughly, using a longitudinal design.
- Considerably more research will need to be done to describe speech characteristics associated with cleft palate in other less familiar languages, which will provide more information about universal atypical speech production features associated with cleft palate. In particular, it is important to examine speech production in individuals with cleft palate speaking languages that have consonants produced with non-pulmonic airstream mechanisms (ejectives, clicks and implosives). The potential effects of cleft palate on phonological learning for children with cleft palate need to be researched more extensively.

- The use of covert contrasts by children with cleft palate also merits further investigation, as this would shed light in determining the nature of the speech difficulty for individual children in the clinical setting (i.e. by their speech and language therapist) and for more research to further our knowledge about cleft speech generally.
- It is also relevant to examine sources of phonetic variability, which have clinical implications not just for cleft-related speech but also for developmental speech disorder.
- The study also supports the case for considering broader and more general issues relating to cleft and cleft care in Ethiopia and other developing countries. In this regard, for example, the true prevalence of cleft lip/palate in Ethiopia needs also to be studied carefully, which will have policy implications regarding providing support for individuals with cleft palate. Also, the possible options of providing care and management to individuals with cleft palate, particularly in remote areas of Ethiopia, need to be studied.

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Appendices

Appendix 1: Departmental ethics approval

The University Of Sheffield.

Department of Human Communication Sciences
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Head of Department
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2nd August 2010

Dear Abebayehu

Title: Speech production in Amharic speaking children with operated cleft palate

Thank you for your submission to the HCS Research Ethics Committee. The committee has reviewed your submission and supporting documents and grants you approval to commence the research.

We hope your project proceeds smoothly

Yours sincerely

pp Prof R Varley
Chair of HCS Ethics Committee

Appendix 2: Examples of information sheets and consent forms used for participant recruitment

The University Of Sheffield.

Research Project Information Sheet

Speech Production in Amharic-Speaking Children with Cleft Palate

Abebayehu Messele Mekonnen

Professor Sara Howard

Professor Mick Perkins

Professor Bill Wells

Department of Human Communication Sciences

University of Sheffield

You have been given this information sheet because you are being asked to consider whether or not you wish your child to take part in this research project. You will not be asked for a decision at this point. You are given two weeks to think about it and make your decision. Please read the information carefully and feel free to discuss this with others if you wish. If you need further clarification or have any questions, you can ask the chief investigator for this project, Abebayehu Messele Mekonnen or your child's speech language therapist who will be able to answer any further queries you may have.

This sheet will explain what is involved in the project in more detail. If you are happy for your child to take part you will be contacted by the chief investigator.

Whether or not you decide to take part in the study will not affect your child's normal speech and language therapy and he/she will continue to be seen by your therapist. You and your child do not have to take part and if you do decide to take part you are still free to withdraw from the study at any point without having to give a reason. If you withdraw from the study no record of your child's participation to that point will be kept by the researchers.

Thank you for reading this information sheet.

The Research Team

Abebayehu Messele Mekonnen is a lecturer at Addis Ababa University, Ethiopia and PhD student in the Department of Human Communication Sciences, The University of Sheffield, UK. Dr Sara Howard and Professor Mick Perkins work in the Department of Human Communication Sciences, The University of Sheffield, UK lecturing, supervising and carrying out research into communication impairments.

What are we hoping to find out?

The project aims to investigate how speech production is affected in Amharic-speaking children who have had an operation for a cleft palate. Studies on other languages have shown that cleft lip and/or palate often affects speech production, but there are currently no studies on cleft palate speech in Amharic. The aim of this project is therefore to describe the speech production of Amharic-speaking children who have had an operation to repair a cleft palate.

We intend to do this by making audio and video recordings of the children's speech. We will then listen to the recordings and make detailed phonetic transcriptions of the speech (writing down how the children are producing sounds using a special symbol system). From this information we will investigate whether the speech production of the children with cleft palate is different from typical speech and look at the ways in which it differs. Understanding more about how cleft palate affects speech production in children who have had surgery may help speech therapists to provide better treatments so that children with cleft can speak better.

Why has my child been asked to take part?

We have asked your child to participate because with the help of their speech and language therapist, they have been identified as:

- having recently had surgery for a cleft lip and palate
- being aged between 5-14 years old
- currently attending speech and language therapy for a speech difficulty related to their a cleft palate
- not having a severe hearing impairment

Does my child have to take part?

No. It will be your choice as to whether you would like your child to take part in the research project. It will not affect your child's allocation of speech and language therapy in any way. You will still see your normal speech and language therapist.

If you do decide he/she can take part, you will be asked to sign a consent form. You can withdraw at any stage and at this point any recordings of your child's speech will be destroyed. This will not affect their speech and language therapy at all.

What will happen if my child decides to take part?

If your child decides to take part, the researcher, Abebayehu Messele Mekonnen, will give you a ring to discuss the project with you and arrange appointments to suit you. Next time you bring your child for an assessment appointment for speech therapy this will be held at Yekatit 12 Hospital. Then, your child will be asked to say some words and sentences, which he/she normally does as part of his/her clinical routines. The speech therapist will record your child's speech for the purposes of the research project. Then we can use the recordings to look at and listen to your child's speech later. We can show you or your child how we will do this before your child decides if he/she would like to take part.

The researcher, Abebayehu Messele Mekonnen, will keep copies of the speech recordings and video securely locked in his office (your speech and language therapist will also keep original copies for his/her normal clinical purposes). Only members of the research team (Abebayehu Messele Mekonnen and his supervisors) will have access to the recordings.

Your child will be given an anonymous code for the duration of this project so they are not identifiable on any written material produced by the researcher or on computer (also password protected). You can have free access to listen to or watch the recordings should you wish.

What are the potential disadvantages and risks of taking part?

Recording your child's speech is a routine part of speech therapy and hence we don't see any specific risks or disadvantages to your child taking part. We will need you to be available to come for one session at Yekatit 12 Hospital for the recording session, with the date and time arranged specifically with you to ensure that it is convenient.

What are the potential advantages of taking part?

We cannot promise this study will help your child, although the information we find will be passed on to your child's speech and language therapist and we will send you a report of our findings. We hope the information we find may contribute to improving the treatment of individuals with cleft palate speech in the future. If you are interested to know about the results of the study we will send you a report of our findings.

Will my child be identified in any way through taking part in the project?

The video will contain footage of your child saying some words and sentences and will not be edited to make your child's face anonymous. However, only the research team and yourselves will have access to the video. You will be specifically asked whether you consent to the video being shown for any additional reason such as a scientific presentation or for teaching others. You do not have to agree to this if you do wish your child to participate in this study. If you do agree you will be asked to view the video before it is used to check you are happy for us to use the footage. We will ask you to sign to say you consent the video to be used for any additional purpose at the time it is needed.

The recordings will be kept for the duration of this study (until 2013) and, if it becomes necessary, you will be asked to give your consent for longer term storage. For example, it may be that the recordings would help us in designing new therapy techniques in the future. You are free to refuse to give this extra consent. When the recordings are no longer being used for research purposes, they will be destroyed.

What will happen to the results of the project?

The results will form part of the researcher's PhD thesis and may be published in scientific journals or presented at research conferences. The results may also be presented to local groups and organisations supporting children with speech difficulties.

The research data collected on this project could possibly be used for future research, as part of scientific presentations, or for teaching or informing others about our findings. You will be specifically asked whether you wish the data to be used for other purposes. You will not have to agree to this and if you are happy for us to use the data you will be asked to sign to say that you consent to the data being used for these additional purposes.

What will happen if I do not want my child to take part in the project, or if I change my mind about this at a later date?

You do not have to agree for your child to take part in the project and this will not affect your child speech and language therapy provision in any way. You and your child are free to withdraw from the study at any point and you will not be asked to give a reason for this. If you withdraw, all copies of recordings of your child will be destroyed at that point. If you withdraw from the study at any point, this will not affect your child's speech and language therapy in any way. It is completely your choice.

What if there is a problem or I wish to make a complaint?

If you have any concerns feel free to discuss these with the researcher, Abebayehu Messele Mekonnen (+251911428266; in Ethiopia and +447879534409; in UK) or his supervisors Dr. Sara Howard (+44 (0) 114 222 2418; email: hcs-support@lists.sheffield.ac.uk) or Professor Mick Perkins (+44 (0) 114 222 2418; email: hcs-support@lists.sheffield.ac.uk) or your speech and language therapist. If you wish to discuss concerns with someone unrelated to the project you can contact Professor Shelagh Brumfitt, who is the Head of the Department of Human Communication Sciences, University of Sheffield, (+44 (0) 114 222 2418; email: hcs-support@lists.sheffield.ac.uk). If you are not satisfied your concerns have been dealt with satisfactorily by the people above, you can complain formally to the Registrar and Secretary of the University of Sheffield, Western Bank, Sheffield, S10 2TN. If you cannot speak English, you may use Amharic to write about your complaint. This should be sent to my supervisor, Dr. Sara Howard (see below for details), who will be responsible for translating your complaint into English and respond to it.

Who has reviewed this project to ensure that it is of a suitable research standard and that it meets ethical requirements?

This project has been reviewed by the **Department of Human Communication Sciences Research Ethics Review Panel, University of Sheffield.**

If you have any questions, please contact the researcher,

Abebayehu Messele Mekonnen
Department of Human Communication Sciences
University of Sheffield
31 Claremont Crescent
Sheffield
S10 2TA
Tel: +251911428266 (in Ethiopian) +447879534409 (in UK)
Email: a.mekonnen@sheffield.ac.uk

Thank you for reading this information sheet

The University Of Sheffield.

Research Project Consent Form

SPEECH PRODUCTION IN AMHARIC-SPEAKING CHILDREN WITH CLEFT PALATE.

Professor Sara Howard

Professor Mick Perkins

Professor Bill Wells

Department of Human Communication Sciences

University of Sheffield

Abebayehu Messele Mekonnen

Department of Human Communication Sciences

University of Sheffield

Please initial the boxes below, as appropriate

1. I confirm that I have read and understood the information sheet for the project named above and that I have had the opportunity to ask questions about it. ☐

2. I understand that my child's participation is voluntary and that I am free to withdraw my consent at any time without giving a reason. ☐

3. I understand that the speech recordings and written information about my child will be given a code to keep my child anonymous and my child's name will not be disclosed. ☐

4. I understand that the video footage of my child will not be edited and my child's face will not be anonymous on the video. ☐

5. I give permission for my child to take part in the above research project. ☐

---

6. I give permission for the anonymised video and/or audio recordings collected for this study to be stored, securely and confidentially, for longer than the duration of the study. I understand that when the research team judges that no further analyses will be carried out on the recordings, they will be destroyed. ☐

7. I give permission for video and/or audio recordings of my child's speech to be used for teaching purposes in the education of students in the Department of Human Communication Sciences, University of Sheffield, UK and Department of Linguistics, Addis Ababa University, Ethiopia. ☐

8. I give permission for video recordings and/or audio recordings of my child's speech to be included in scientific presentations at conferences and meetings of other academics and professionals working in related area. ☐

______________________	____________	________________
NAME OF PARTICIPANT	DATE	SIGNATURE
(or legal representative)		

<u>Abebayehu Messele Mekonnen</u>	____________	________________
CHIEF INVESTIGATOR	DATE	SIGNATURE

(To be signed and dated in the presence of the participant)

A copy of this form, once signed by all parties and dated, will be given to the parent, together with a project information sheet. A copy of the signed and dated form will be kept in the main project file, in a secure location, by the project team.

Appendix 3: Great Ormond Street Speech Assessment '98- Amharic Version GOS.SP.ASS '98-A

Name:	Date:
Age:	Patient No.
Gender:	Recording/Tape No.
Type of cleft:	First language
Contact Person:	Address:

Resonance

Hypernasality	0--1--2--3	□ consistent		□ inconsistent
Hyponasality		□ present		□ absent
Cul-de-sac-resonance		□ present		□ absent
Mixed resonance		□ present		□ absent
Nasal Emission	0--1--2	□ audible	and/or	□ inaudible
		□ accompanying	and/or	□ replacing
consonants				
		□ consistent		□ inconsistent
Nasal Turbulence	0--1--2	□ accompanying	and/or	□ replacing
consonants				
		□ consistent		□ inconsistent
Grimace		□ present		□ absent
		□ consistent		□ inconsistent

Mirror Test		pa pa pi pi ka ka ki ki
	Right	---
	Left	

Voice □ Normal □ Dysphonic

Consonant realisations

	Labial					Labiodental		Danti-alveolar		Alveolar			
	m	p	p'	b	w	f	v	t̪	t̪'	n	d	s	s'
SIWI													
SFWF													

	Alveolar			Postalveolar				Palatal		Velar			Glottal	
	z	l	r	ʃ	ʒ	ʧ	ʧ’	ʤ	ɲ	j	k	k’	g	h	ʔ
SIWI															
SFWF															

Cleft-type characteristics (CTCs)

Anterior oral CTCs	**Posterior CTCs**
□ Misarticulations of tip and blade sounds □ Dentalization □ Interdental articulation □ Linguolabial articulation □ Lateralization/Lateral articulation □ Palatalization/Palatal □ Double articulation	□ Backing in the oral cavity □ to mid-dorsum palatal □ to velar □ to uvular □ Backing to post-uvular □ to pharyngeal □ to glottal □ Active nasal fricatives
Non-pulmonic realisations □ Ejectives for pulmonics □ Implosives □ Clicks	**Passive CTCs** □ Weak/nasalized consonants □ Passive nasal fricatives □ Nasalised voiced pressure consonants □ Absent pressure consonants □ Gliding of fricatives/affricates

Transcription of speech

Developmental realisations

Summary of speech pattern

□ Normal consonants □ No CTCs □ Anterior CTCs □ Posterior CTCs

□ Non-pulmonic □ Passive CTCs □ Developmental realisations □ Other

Speech and language therapy

□ Unnecessary □ Waiting list □ Therapy ongoing □ Regular review

□ Unavailable □ No uptake

Location

Relevant information from parents

Visual appearance of speech

□ Unremarkable □ Tongue tip appearing

□ Tight upper lip □ Asymmetry of facial movement

Oral examination

Nose	☐ Unremarkable	☐ Deviated septum	☐ Obstructed	☐ Other______
Lips	☐ Unremarkable	☐ Restricted movement	☐ Open mouth posture	
Occlusion	☐ Class I	☐ Class II	☐ Class III	☐ Anterior open bite
Dentition	☐ Unremarkable	☐ Supernumerary	☐ Missing teeth	☐ Malaligned
Tongue	☐ Unremarkable	☐ Poor mobility	☐ Abnormal posture	☐ Tongue tie
Palatal Fistula	☐ Present	☐ Absent		
Fistula Size	☐ Minute < than 2 mm	☐ Small between 2-5 mm	☐ Medium between 5-8 mm	
	☐ Large >8 mm	☐ Complete breakdown		
Fistula Location	☐ Uvula	☐ Soft palate	☐ Junction soft/hard palate	
	☐ Hard palate-post alveolus	☐ Buccal sulcus	☐ Other (describe)_______	
Palate Mobility	☐ Marked	☐ Moderate	☐ Slight	
Soft Palate	☐ Bifid uvula	☐ Notch	☐ Blue/thin looking	
	☐ Suspected incorrect muscle alignment		☐ Apparently short	
Nasopharynx	☐ Tonsils		☐ Apparently deep pharynx	
	☐ Pharyngeal wall movement		☐ Pharyngeal flap	
Language	☐Apparently normal	☐ Delayed	☐ Disordered	

Speech understandability

☐Always easy to understand ☐ Occasionally hard to understand

☐ Often hard to understand ☐ Mostly or always hard to understand

Speech acceptability

☐ Normal ☐ deviates from normal to a mild degree

☐ deviates from normal to a moderate degree ☐ deviates from normal to a severe degree

Aetiology

☐ Suspected VPI	☐ Confirmed VPI	☐ Abnormal dentition
☐ Malocclusion	☐ Diagnosed hearing loss	☐ Suspected hearing loss
☐ Oral fistula	☐ Cleft palate history	☐ Intellectual deficit
☐ Developmental	☐ Environmental	☐ Syndrome

Areas requiring further assessment

Management plan

Additional notes

Speech and language therapist **Signature**

Amharic sentences for use with GOS.SP.ASS. ’98

ማሜ አመመው።
/mamme aməməməw/
Mamme has become ill.

ፓፒ ፓፓዬ ገዛች።
/pappi pappaje gəzza/
Pappi bought papaya.

ባየ አበባ ይወዳል።
/bajjə abəba jɨwəddal/
Bayye likes flower.

ወፉ ፍየሉ ላይ ተቀመጠ።
/wəfu fɨjəlu laj təkk’mət’ə/
The bird sat on the goat.

አየለ ቲቪ አየ።
/ajjələ tivi ajjə/
Ayele watched TV.

ጳጳሱ ጳውሎስን አዩት።
/p’ap’p’asu p’aulosɨn ajjut/
The bishop saw Paulos.

ናኒ አይኗን አሸች ።
/nani ajnuan aʃʃətʃ/
Nani rubbed her eye.

ሊሊ ወለሉ ላይ ተኛች።
/lilli wəlelu laj təɲɲatʃ/
Lilli slept on the floor.

ቲቲ ወተት ትወዳለች።
/tɨtti wətət tɨwəddalətʃ/
Titi likes milk.

ዳውድ አደይ ቤት ሄደ።
/dawd adəj bet hedə/
Dawed went to Adey’s house.

ሲሳይ እያሱ ቤት ገባ።
/sisaj ɨjjasu bet gəbba/
Sisay entered into Eyasu’s house.

ዘሩ አዋዜ አዘዘ።
/zəru awaze azzəzə/
Zeru ordered hot pepper paste.

አይጡ ውሃ ጠጣ።
/ajt’u wɨha t’ət’t’a/
The rat drank water.

አፄው ፆመው ፀለዩ።
/as’ew s’oməw s’ələju/
The emperor fasted and prayed.

የሻሼ ሻይ ይሸታል።
/jəʃaʃe ʃaj smells/
Shashe’s tea smells.

ዣንጥላው መያዣ አለው።
/ʒant’ɨlaw mjaʒa alləw/
The umbrella has got a case.

ቻቺ ቻዎ አለች።
/tʃatʃi tʃawo alətʃ/
Chachi waved goodbye.

ጂጂ የእጅ ሰዓት አላት።
/ʤɨʤi jəɨʤ səʔat allat/
Jiji has got a hand-watch.

ጫላ ጨው ፈጨ።
/tʃ’ala tʃ’əw fətʃ’tʃ’ə/
Chala ground salt.

እረኛው ዋኘ።
/ɨrrəɲɲaw waɲɲə/
The shepherd swam.

ኪኪ ክክ ከካ።
/kiki kɨk kəkka/
Kiki ground split peas.

አጋ ዋጋዬ ጋ ሄደ።
/aga wagaje ga hedə/
Aga went to Wagaye’s place.

ቃቆ ቀይ ቀለም ተቀባ።
/k’ak’o k’əj k’ələm tək’əbba/
Kako painted himself red.

መዓዛ ሰዓት ገዛች።
/məʔza səʔat gəzzatʃ/
Meaza bought a watch.

ኃይሉ ውሃ ሲደፋ አየሁ።
/haljlu wɨha sidəfa ajjəhu/
I saw Hailu spilling water.

Words used to elicited single-word speech samples

Word	Phonetic transcription	English word	Target sound/s	Subject's production
መኪና	məkina	car	m- -k- -n	
ፓስታ	pasta	Pasta	p- -s-t-	
ቤት	bet̪	House/Home	b- -t	
ፈረስ	fərəs	Horse	f- -r- -s	
ጳጳስ	p'ap'p'as	Bishop	p'- -p'- -s	
ንጉሰ	nɨgus	King	n- -g- -s	
ልብስ	lɨbs	Cloth	l- -b-s	
ቴፕ	tep	Tape	t- -p	
መት	dɨmmət̪	Cat	d- -m- -t	
ሱሪ	suri	Trousers	s- -r	
ዝናብ	zɨnab	Rain	z- -n- -b	
ጡት	t̪'ut̪	Breast	t'- -t	
ፀሐይ	s'əhj	Sun	s'- -h-j	
ሽንኩርት	ʃɨnkurt̪	Onion	ʃ- -n-k- -r-t	
ዣንጥላ	ʒant̪'ɨla	Umbrella	ʒ- -n-t'- -l	
ችቦ	ʧɨbbo	Bonfire	ʧ- -b-	
ጀበና	ʤəbəna	Coffee Pot	ʤ- -b- -n	
ጫማ	ʧ'amma	Shoe	ʧ'- -m-	
ከበሮ	kəbəro	Drum	k- -b- -r	
ጋቢ	gabi	A cotton shawl	g- -b	
ቀሚስ	k'əmis	Skirt	k'- -m- -s	

Appendix 4: Consonant repertoire of the children with cleft palate

Consonant realisations of the children with cleft palate.

Participant	***Airstream***																					
SG	*Pulmonics*	***Place***	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***
		Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
		SIWI	m	**p͋**	**b̃** **m̪̊**	**m̪̊** **f͋**	**ʔ**	n	**n**	**ʔ**	**ʔ** **n**	**n** **n̪̊͋** **ʔ**	**z̪̃** **j̃**	**n̪**	**j̃** **ʔ**	**ʔ** **ɲ** **j̃**	**ʔ**	**ʔ**	**j̃**	**ʔ**	**ʔ**	**ʔ**	h͋
		SFWF	m	**p͋**	**b̃**	**f͋**		n	**n**	**ʔ** **t̪͋**	**ʔ**	**n̪̊͋**	**z̪̃**	**n̪**	**j̃**	**ʔ**	**tʃ̪͋**	**ʔ**	**j̃**	**ʔ**	**ʔ**	(shaded)	h͋
	Ejectives	***Place***	***Bilabial***					***(Denti)alveolar***							***Post-alveolar***					***Velar***			
		Target	p’					t̪’			s’				tʃ’					k’			
		SIWI	**p͋**					**ʔ**			**ʔ**				**ʔ**					**ʔ**			
		SFWF	(shaded)					**ʔ**			**ʔ**				**ʔ**					**ʔ**			
OS	*Pulmonics*	***SIWI***	m	p’	b	f	**b**	n	l **n**	t̪	t̪ d	**ʃ**	**ʃ**	**n**	**ʃ**	**ʃ**	t̪ **ʃ**	**d**	ɲ	k	g **k**	**ʔ**	h
		SFWF	m	p	b	f		n	**n**	t̪	t̪	**ʃ**	**ʃ**	**n**	**ʃ**	**ʃ**	t̪	**d**	ɲ	k	g		h
	Ejectives	***SIWI***	**b**					t̪			**k’**				**k’**					**k’ t̪’**			
		SFWF	(shaded)					t̪			**k’**				**k’**					**k’**			
EA	*Pulmonics*	***SIWI***	m	**b̃** **p͋**	b̃	f͋ **ɸ͋** **p͋**	v̪͋	n n̪͋	**n̪͋**	**t̪͋̃** **p͋**	**d̪̃**	**s̪͋** **t̪͋** **n**	**z̪̃** **z̪̃**	l̃	**s̪͋**	**ʒ̪̃**	**t̪͋̃**	**d̪̃**	ɲ	k͋	g̃	**ø**	h͋
		SFWF	m	**p͋**	b̃	f͋		n	**n̪͋**	**t̪͋̃**	**t̪̃**	**s̪͋**	z̪̃	l̃	s̪	**ʒ̪̃**	**t̪͋̃**	**d̪̃**	ɲ	k͋	g̃		h͋

	Ejectives	***SIWI***	p’					t̪’			s’				tʃ’					k’			
		SFWF	p̃̇					t̪̃̇			s̪̃̇				tʃ̃̇					k̃̇			
SA	*Pulmonics*	***SIWI***	m	p	b	f	**b**	n	l **d**	t̪	d **t̪’**	ʃ	ʃ	**l**	**s** ʃ	ʃ	tʃ	tʃ	ɲ	k	g **d**	ʔ	h
		SFWF	m	p	b	f		n	l	t̪	d	ʃ	ʃ	**l**	ʃ	ʃ	tʃ	tʃ	ɲ	k	g		h
	Ejectives	***SIWI***	**p**					t̪’			**s**				tʃ’					k’			
		SFWF						t̪’			**s**				tʃ’					k’			

Consonant realisations of the children with cleft palate.

Participant	***Airstream***																						
TB	*Pulmonics*	***Place***	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
		Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
		SIWI	m	p̃̇ p̪̃̇	b̃ b̪̃	f̃̇	m̪̊	n	**n** n̪̊	t̪̃̇ t̪	d̃	n̪̊̃̇ ɬ̃̇	z̃	ɰ	ʃ̃̇	j̃	tʃ̃̇	g̃	ɲ	ʔ k̪̃̇	ʔ	ʔ	h̃̇
		SFWF	m	p̪̃̇	b̪	f̃̇		n	**n**	t̪̃̇	d̪	n̪̊̃̇	z̃	ɰ	ʃ̃̇	j̃	tʃ̃̇	g̪̃	ɲ	ʔ	ʔ		h̃̇
	Ejectives	***Place***	***Bilabial***					***(Denti)alveolar***							***Post-alveolar***					***Velar***			
		Target	p’					t̪’			s’				tʃ’					k’			
		SIWI	p̃̇					t̪̃̇			s̃̇				tʃ̃̇					k̃̇			
		SFWF						t̪̃̇			s̃̇				tʃ̃̇					k̃̇			
YD	*Pulmonics*	***SIWI***	m	p̃̇	b̃	m̪̊ f̃̇	ʔ	n	**n** w̃	ʔ h̃̇	d̃	n̪̊̃̇	**n** ŋ	**n**	n̪̊̃̇	ŋ	n̪̊̃̇ t̪ʃ̃̇	n̪̊̃̇	ɲ	k̃̇	g̪̃	ʔ	h̃̇
		SFWF	m	p̃̇	b̃	f̃̇		n	**n**	ʔ t̪	d̃	n̪̊̃̇	**n**	**n**	n̪̊̃̇	ŋ	n̪̊̃̇	n̪̊̃̇	ɲ	k̃̇	g̪̃		h̃̇
	Ejectives	***SIWI***	ʔ					ʔ			ʔ				ʔ					ʔ k’			
		SFWF						ʔ			ʔ				ʔ					ʔ			

NB	*Pulmonics*	***SIWI***	m	p͋	b̃	m̥̪ f͋	ʔ	n	n	t̪͋ h͋	d̃	n̥͋	n̥͋	ɽ̃ n	n̥͋	j̃	t̪͋ tʃ̪͋	d̃	ɲ	q͋	ɢ̃	ʔ	h
		SFWF	m	p͋	b̃	f͋ m̥̪		n	n	t̪͋	d̃	n̥͋	n̥͋	n	n̥͋	j̃	tʃ̪͋	d̃	ɲ	q͋	ɢ̃		h
	Ejectives	***SIWI***	p͋'					ʔ			ʔ				ʔ					q͋'			
		SFWF						ʔ			ʔ				ʔ					q͋'			
BN	*Pulmonics*	***SIWI***	m	p͋ p̪	b̃ m	f͋	m̥̪	n	n	c p͋	Ɉ d͡g	s͋ ç	z̃ ʝ	ɾ	ʃ͋ n̥͋	ʒ̃	c͋	ɟ	ɲ	k	ŋ͡g	ʔ	h
		SFWF	m		b̥	f͋		n	n	c	Ɉ	n̥͋	n̥͋	ɾ	ʃ͋	ʒ̃	c͋	ɟ	ɲ	k	ŋ͡g		h
	Ejectives	***SIWI***	p͋'					c'			ʔ				k͋'					q͋'			
		SFWF						c'			ʔ				k͋'					q͋'			

Consonant realisations of the children with cleft palate.

Participant	***Airstream***																					
		Plac	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
EY	*Pulmonics*	***Target***	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
		SIWI	m	p	b	ɸ	ṽ	n n̰	n̰ ɠ	c p	Ɉ ŋ͡g	ç	z̃ ʝ	n̪̈	ç n̥͋	ʝ ŋ͡g	c͋	ɟ tɬ͋	ɲ	k	ŋ͡g	ʔ	h
		SFWF	m	p	b̥	ɸ		n n̰	n̰	c	Ɉ	ç	n̥͋	n̪̈	ç n̥͋	ʝ	c͋	ɟ	ɲ	k	ŋ͡g		h
	Ejectives	***Place***	***Bilabial***					***(Denti)alveolar***							***Post-alveolar***					***Velar***			
		Target	p'					t̪'			s'				tʃ'					k'			
		SIWI	p'					k' ʔ			ç'				c'					k'			
		SFWF						k'			ç'				c'					k'			

NF	*Pulmonics*	***SIWI***	m	p’	ɓ̥ ɓ̃	ɸ	m̥	n	n	ʔ	ɲ ɗ ɲ͡ʔ	ṅ̥̟ ç	ʐ̃ ʝ	ɰ	ṅ̥̟	dʒʲ ɲ	ɲ ɲ͡ʔ ʔ	ʔ dʒʲ	ɲ	ʔ	ɲ ɲ͡ʔ	ʔ	h
		SFWF	m	p’	ɓ̥	ɸ		n	n	ʔ	ʔ ɗ	ṅ̥̟	ʐ	ɰ	ṅ̥̟	ɲ	ɲ	ʔ	ɲ	ʔ	ʔ		h
	Ejectives	***SIWI***	ṗ̟’					ʔ ɗ̣			ʔ				ʔ̩					ʔ			
		SFWF						ʔ			ʔ				ʔ̩					ʔ			
EZ	*Pulmonics*	***SIWI***	m͋	m	m̥	m̥		n͋	n̪	ṫ̪̟	ʔ	ṅ̥̟	ṅ̥̟	n	ṅ̥̟	ṅ̥̟	ʔ	ʔ	ɲ͋	ʔ	ʔ		ḣ̟
		SFWF	m͋	ʔ m	m̥ ʔ ɓ͡ʔ	m̥ f̩	m̥	n͋	n	ʔ	ʔ d̪̃	ṅ̥̟	ṅ̥̟	n	ṅ̥̟	ṅ̥̟ ʔ	ʔ	ʔ	ɲ͋	ʔ	ʔ		ḣ̟
	Ejectives	***SIWI***	ʔ					ʔ			ʔ				ʔ					ʔ			
		SFWF						ṅ̥̟ ʔ			ʔ ṅ̥̟				ʔ					ʔ			
WL	*Pulmonics*	***SIWI***	m	ʘ	ɓ̥ ʘ	ṁ̥̟ ṁ̥̟	ṁ̥̟	n	n	ṅ̥̟	ŋ͡g d̃	ṅ̥̟ ɬ̟̇	ṅ̥̟ ɬ̃	ʋ w b	ŋ̥̟̇	ŋ͡g	ŋ̥͡ʔ ŋ̥̟̇	ŋ̥̟̇	n̪	k̟̇ h	ŋ͡g	ʔ	ḣ̟
		SFWF	m	p’	ɓ̃	m̥		n	n	ṅ̥̟	ŋ͡g	ṅ̥̟	ŋ̥̟̇	b	ŋ̥̟̇	ŋ͡g	ʔ	ŋ̥̟̇	n̪	k̟̇	ŋ͡g		
	Ejectives	***SIWI***	ɓ̥					ʔ q’ ǂᵑ			s͌				ǀʔ					q’			
		SFWF						ʔ			s͌				q’					q’			

Consonant realisations of the children with cleft palate.

Participant	***Airstream***																						
		Place	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
		Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
	Pulmonics	***SIWI***	m͋	ʔ m	m̥ ʔ ɓ͡ʔ	m̥ f̩	m̥	n͋	n	ʔ	ʔ d̪̃	ṅ̥̟	ṅ̥̟	n	ṅ̥̟	ṅ̥̟ ʔ	ʔ	ʔ	ɲ͋	ʔ	ʔ	ʔ	ḣ̟

Participant	Airstream		m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
ES		**SFWF**	m̃	m	m̥	m̥		ñ	n̥	t̪͊	ʔ	n̥͊	n̥͊	n	n̥͊	n̥͊	ʔ	ʔ	ɲ̃	ʔ	ʔ		h͊
	Ejectives	***Place***	***Bilabial***					***(Denti)alveolar***							***Post-alveolar***					***Velar***			
		Target	p’					t̪’				s’			tʃ’					k’			
		SIWI	ʔ					ʔ				ʔ			ʔ					ʔ			
		SFWF						n̥͊ ʔ				ʔ n̥͊			ʔ					ʔ			
BM	*Pulmonics*	***SIWI***	m	p͊ p̪	b̃ m	m̥͊	ṽ	n̪	n̪	t̪͊	d̪̃	s̪͊	z̪̃	r̪̃	ʃ͊ ɬ͊	ʒ̃	tʃ͊ tɬ͊	dʒ̃ dɮ̃	ɲ	k͊ k̪	g̃ g̪	ʔ	h͊
		SFWF	m	p͊	b̪	m̥͊		n̪	n̪	t̪͊	d̪̃	s̪͊	z̪̃	r̪̃	ʃ͊	ʒ̃	tʃ͊	dʒ̃	ɲ	k͊	g̪̃		h͊
	Ejectives	***SIWI***	p̪͊’					t̪͊’ ʔ				s̪͊’			tʃ͊’					k͊’ ʔ			
		SFWF						t̪͊’				s̪͊’			tʃ͊’					k͊’			
AT	*Pulmonics*	***SIWI***	m	p’ p͊	b̃	f͊ m̥	b̪̃	n	n	ʔ	ʔ d͡ʔ	n̥͊	n̥͊	ɰ	n̥͊	ŋ	n̥͊	ʔ	ɲ	ʔ	ɲ	ʔ	h͊
		SFWF	m	p͊	b̃	f͊		n	n	ʔ	ʔ	n̥͊	n̥͊	ɰ	n̥͊	ŋ	n̥͊	ʔ	ɲ	ʔ	ɲ		h͊
	Ejectives	***SIWI***	p’					ʔ				ʔ			ʔ					ʔ			
		SFWF						ʔ				ʔ			ʔ					ʔ			
EM	*Pulmonics*	***SIWI***	m n	k͊	b̃ g̃	ç	ʔ	n	n	k͊ h͊	g̃	n̥͊	ɣ z̪̃	n	ç	ʔ	k͊	ʔ	ɲ	x͊	ɣ͊	ʔ	h͊
		SFWF	m	k͊	b̃	ç		n	n	k͊	g̃	n̥͊	ɣ	n	ç	ʔ	k͊	ʔ	ɲ	x͊	ɣ͊		h͊
	Ejectives	***SIWI***	ʔ					ʔ				ʔ			ʔ					q ʔ			
		SFWF						ʔ				ʔ			ʔ					ʔ			

Consonant realisations of the children with cleft palate.

Participant	***Airstream***																						
		Place	***Labials***					***(Denti)alveolar***							***Post-alveolar***				***Pal.***	***Velar***		***Glottal***	
		Target	m	p	b	f	v	n	l	t̪	d	s	z	r	ʃ	ʒ	tʃ	dʒ	ɲ	k	g	ʔ	h
		SIWI	m	p͊͡ʔ	b̃͡ʔ	m̥	ṽ̪	n	n	ʔ	d̃	n̥͊	n	!	n̥͊	ʒ̪̃	n̥͊	n̥͊	ɲ	ʔ	ʔ	ʔ	h͊

HA	*Pulmonics*				b̃	ḟ				ḣ	ʔ						tʃ						
		SFWF	m	p͡ʔ	b̃	ḟ		n	**n**	ʔ t̪	d̃	ṅ̥	**n**	!	ṅ̥	ʒ̃	ṅ̥	ṅ̥	ɲ	ʔ	ʔ		h̃
	Ejectives	***Place***	***Bilabial***					***(Denti)alveolar***							***Post-alveolar***					***Velar***			
		Target	p’					t̪’			s’				tʃ’					k’			
		SIWI	p͡ʔ					ʔ			ʔ				ʔ					ʔ			
		SFWF						ʔ			ʔ				ʔ					ʔ			
FM	*Pulmonics*	***SIWI***	m	ṗ	b̃	ḟ	ṽ̪	ṅ̪	ṅ̪	t̪̃ ṫ̪	ḋ̪	ṡ ṅ̥	z̪̃	ɽ̃	ʃ̇	ʒ̃	tʃ̇	dʒ̃	ṅ̪	q̇	g̃	ʔ	ḣ
		SFWF	m	ṗ	b̃	ḟ		n	ṅ̪	ṫ̪	ḋ̪	ṅ̥	z̪̃	ɽ̃	ʃ̇	ʒ̃	tʃ̇	dʒ̃	ṅ̪	q̇	g̃		ḣ
	Ejectives	***SIWI***	ṗ’					ɖ̥			s̰̃				tʃ̇’					q̇’			
		SFWF						ɖ̥			s̰̃				tʃ̇’					q̇’			
BZ	*Pulmonics*	***SIWI***	m	ṗ	b̪̃	ḟ	m̥̪	n	**n**	ṫ̪ ʔ	d̃	ṅ̥	ṅ̥	ṅ̪	ṅ̥	ṅ̥	ṅ̥	ṅ̥	ɲ	q̇	ʔ g̃	ʔ	ḣ
		SFWF	m	ṗ	b̃	ḟ		n	**n**	ṫ̪	d̃	ṅ̥	ṅ̥	ṅ̪	ṅ̥	ṅ̥	ṅ̥	ṅ̥	ɲ	q̇	g̃		ḣ
	Ejectives	***SIWI***	ṗ’					ṫ̪ ʔ			ṅ̥				ṅ̥					q̇’ ʔ			
		SFWF						ṫ̪			ṅ̥				ṅ̥					q̇’			
EM	*Pulmonics*	***SIWI***	m **n**	k̇	b̃ g̃	ç	ʔ	n	**n**	k̇ ḣ	g̃	ṅ̥	ɣ z̪̃	**n**	ç	ʔ	k̇	ʔ	ɲ	ẋ	ɣ̇	ʔ	h̃
		SFWF	m	k̇	b̃	ç		n	**n**	k̇	g̃	ṅ̥	ɣ	**n**	ç	ʔ	k̇	ʔ	ɲ	ẋ	ɣ̇		h̃
	Ejectives	***SIWI***	ʔ					ʔ			ʔ				ʔ					q ʔ			
		SFWF						ʔ			ʔ				ʔ					ʔ			