AN ACOUSTIC ANALYSIS OF A PATHOLOGICAL SPEECH: THE CASE OF AN AMHARIC SPEAKING PERSON WITH FLACCID DYSARTHRIA

BY

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TABLE OF CONTENTS

PAGE

LIST OF FIGURES, GRAPHS, PICTURES AND TABLES

LIST OF FIGURES

LIST OF GRAPHS

LIST OF PICTURE

LIST OF TABLES

ABSTRACT

It is an established fact that language is the chief distinctive feature of humans. Unfortunately, there are a number of individuals missing usage of language and/or speech partially or entirely, from the beginning or lately, momentarily or for a long time, usually for defined reasons or for reasons which cannot yet be explained. This work particularly attempts to investigate the extent of abnormality of the speech of an individual with Flaccid Dysarthria. The subject was diagnosed as a Primary Lateral Sclerosis patient, which is a progressive degenerative motorneuron disease, that is, nerve cells in the body gradually die off. It affects only some of the nerve cells in the body--those that control voluntary movement of muscles. The main objective of this study is to acoustically analyze the patient's vowels, consonants, intonation contours and duration.

Acoustic methods were employed to examine the speech of the patient. More specifically, the data were from solicitation and spontaneous utterances of the subject. They were digitally recorded, sampled and quantized, then fed into a speech analyzer software called Praat. The interpretations of the data were done on the basis of the facts revealed by the software.

Accordingly, the patient's vowels were found to be confined to the center of his oral cavity and have a hypernasal quality. The qualities of his consonants also showed how the problem is serious. Most of the consonants are so distorted that it is difficult to identify them on spectrograms. The suprasegmental aspects of his utterances also exhibit deviant patterns. Hence, the patient's speech lacks intelligibility.

CHAPTER ONE

INTRODUCTION

Since its emergence, Linguistics has customarily been dedicated to the description of human languages as they are typically and normally spoken by their respective native speakers. To this end, most linguistic researches aim at describing languages spoken under normal circumstances while there are abundant cases where language/speech is oddly formed and perceived. Particularly, in spite of its significance, the study of how human nerves and muscles have to do with speech processing, production and perception processes has not been of chief concern in linguistics for a long time. Putting this straight out, linguistics, as a science of language study, has not yet invested as much consideration as it is supposed to so as to deal with speech impairments.

This thesis is thus intended to fill a small gap with regard to the study of speech disorder related to neuromuscular activities of speech production in Amharic. More specifically, it tries to focus on what is really going on in the articulation and acoustics of the speech of a thirty-five-year-old Amharic speaking individual with flaccid dysarthria by the name Yohannes Abreha. He was diagnosed as a patient of Primary Lateral Sclerosis (PLS) disease.

Primary Lateral Sclerosis (PLS) is a progressive degenerative motorneuron disease, that is, nerve cells in the body gradually die off. It affects only some of the nerve cells in the body--those that control voluntary movement of muscles (Armon, 2003). The loss of the nerve cells causes muscles to become stiff and difficult to move; and some of its symptoms include: difficulty in walking, such as tripping or stumbling, difficulty in speaking or swallowing, trouble in moving the arms and doing tasks such as combing hair or brushing teeth and painful muscle spasms in the legs, back, or neck (Armon, 2003).

As mentioned above PLS is motor neuron diseases (MNDs hereafter); and according to the National Institute of Neurological Disorders and Stroke, MNDs are a group of progressive neurological disorders that destroy cells that control essential muscle activity for speaking, walking, breathing, and swallowing. Normally, messages from nerve cells in the brain (called *upper motor neurons)* are transmitted to nerve cells in the brain stem and spinal cord (called *lower motor neurons)* and from them to particular muscles. When there are disruptions in these signals, the result can be gradual muscle weakening, wasting away, and uncontrollable twitching (called fasciculations). Eventually, the ability to control voluntary movement can be lost. The causes of sporadic (non inherited) MNDs are not known, but environmental, toxic, viral, or genetic factors may be implicated (Armon, 2003).

Common MNDs include amyotrophic lateral sclerosis (ALS), progressive bulbar palsy, and progressive muscular atrophy in addition to primary lateral sclerosis. So, linguistics in general and phonetics in particular are very useful in studying the speech deviation caused by motor neuron diseases of different sources.

1.1. Literature Review

The production of speech involves about seven different but coordinated phases. According to Catford (1988:3-7), these phases are *neurolinguistic programming* phase, *neuromuscular* phase, *organic* phase, *aerodynamic* phase, *acoustic* phase, *neuroreceptive* phase and *neurolinguistic identification* phase.

The *Neurolinguistic programming* phase is the stage in which conceptualization and coding/decoding of speech process begins. This phase is followed by the *neuromuscular* phase in which specific 'motor commands' flow out through motor nerves to muscles in the chest, throat, mouth, etc. As a result, these muscles contract in whole or in part, successively or simultaneously, more or less strongly. Following the *neuromuscular* phase, the *organic* phase acts as a result of the muscular contractions occurring in the neuromuscular phase, the organs to which these muscles are attached adopt particular postures or make particular movements.

The *aerodynamic* phase is the result of the movements of organs during the organic phase. Thus, the organs act upon the air contained within the vocal tract. Next comes the *acoustic* phase in which air molecules oscillate in ways that can be perceived by our sense of hearing. Then, the *neuroreceptive* phase follows. In this phase, the sound-wave, acts on the hearer's eardrum, setting it to vibrate in step with the wave-form, and the vibrations are transmitted by the little bones of the middle ear to the inner ear or cochlea, where they stimulate sensory endings of the auditory nerve. Neural impulses from the nerve-endings travel up the auditory nerve to the brain where they give rise to sensations of sound.

Finally, in the *neurolinguistic identification* phase the incoming signals via the neuroreceptive phase are identified.

So any problem happening to one or more of these phases results in what is ordinarily referred to as language or speech disorder, that is, problems of language processing, articulation and/or perception. The next subsection is a brief résumé of the most common types of language/speech problems.

1.1.1. Language/Speech Disorders

The concept of language/speech disorder encompasses a number of different types of language/speech defect. These include: *Aphasia* (inability to express thought by means of speech as a consequence of certain brain disorders), *Apraxia* (a disorder of the nervous system that affects the ability to sequence and say sounds, syllables, and words-- not due to muscular weakness or paralysis), *Agraphia* (inability to write), *Deafness* (simply defined as inability to hear), and *Dysarthria* (a speech disorder caused by the problem of muscular weakness or neurological impairments).

Thus, language/speech disorder is a collective term which includes impairments of language *comprehension* and *articulation*. It can also be manifested on all language skills namely, speaking, listening, writing and reading.

Garman (1990:416) categorizes language/speech impairment as the ones happening to non-verbal cognitive functions (i.e., intellectual vs language abilities) and to peripheral functioning (i.e., speech vs language abilities). And he further makes distinction between total and partial loss of language. The focus of this study, of all types of language/speech impairments identified, is the one that is strongly associated with the neuromuscular phase. That is Dysarthria (sometimes called anarthria). The following subsection will, in some details, discuss about Dysarthria and its types.

1.1.2. Dysarthria and its Types

According to Garman (1990:417), dysarthria is an impairment of muscular function, affecting non-linguistic as well as linguistic control of the vocal tract. It is further defined as a group of speech disorders caused by disturbances in the strength or coordination of the muscles of the speech mechanism as a result of damage to the brain or nerves (http://www.stayinginshape.com/3osfcorp/libv/p21.shtml).

Moreover, dysarthria is a motor speech disorder which largely happens due to breakdowns in movement control of one or more muscle groups that compose the speech mechanism.

It could be caused by *Parkinson's disease*, *stroke* (i. e., brain damage caused by a lack of blood flow to part of the brain), *brain injury*, *tumors* (i. e., broadly defined as any abnormal local increase in size of a tissue or organ), *cerebral palsy* (i. e., a range of neuromuscular disorders caused by injury to an infant's brain sustained during late pregnancy, birth, or any time during the first two years of life), *Lou Gehrig's disease* (i. e., progressive, fatal disease of the motor neurons (nerve cells) that control the skeletal muscles of the body), *Huntington's disease* (i. e., hereditary, progressive disease of the nervous system characterized by involuntary twitching movements of the arms, legs, face, and body), or *multiple sclerosis* (i. e., chronic, unpredictable, and often progressive disease of the central nervous system that attacks and destroys tissues in the brain and spinal cord).

Generally, dysarthria is characterized by different symptoms, depending on the extent and location of damage to the nervous system. The usual symptoms that a dysarthric person may experience, as given in http://www.stayinginshape.com/3osfcorp/libv/p21.shtml, include:

- "slurred" speech
- speaking softly or barely able to whisper
- slow rate of speech
- rapid rate of speech with a "mumbling" quality
- limited tongue, lip, and jaw movement
- abnormal intonation (rhythm) when speaking
- changes in vocal quality ("nasal" speech or sounding "stuffy")

- hoarseness
- breathiness
- drooling or poor control of saliva
- chewing and swallowing difficulty

Yet, dysarthria is also a cluster term that can be used to classify various types of neuromuscular speech disturbances that result from notable degrees of one or more abnormalities involving speech musculature, including weakness, paralysis, incoordination, sensory deprivation, exaggerated reflex patterns, uncontrollable movement activities, and excess or reduced tone (Dworkin, 2002).

The pioneering works of Darley et al. (1975) led to the general model of dysarthria classification that continues to be used to date. Accordingly, six primary forms of dysarthria are identified; a seventh type has been added to the differential diagnostic scheme in the past decade. The seven dysarthria subtypes are *Spastic*, *Unilateral Upper Motor Neuron*, *Ataxic*, *Hypokinetic*, *Hyperkinetic*, *Flaccid*, and *Mixed* (Dworkin, 2002). For the purpose of this study only flaccid dysarthria is considered because the overall linguistic and physiological conditions of the subject of the study demonstrates are much more similar to the symptoms of flaccid dysarthria than the rest.

Accordingly, flaccid dysarthria is caused by damage to nerves that emerge from the brainstem (cranial) or spinal cord and travel directly to muscles that are involved in speech production. These nerves are generically referred to as lower motor neurons. Cranial nerves V, VII, X, and XII are of great importance because they supply the chief muscles of speech production, namely, the jaw, lips, voice box and palate, and tongue respectively. The cervical spinal nerves innervate the diaphragm, and the thoracic spinal nerves stimulate the chest and abdominal wall muscles, all of which are involved in speech and/or breathing activities. The types of neuromuscular problems that arise as a result of injuries to these nerves depend upon which and how many nerves are disturbed. In general, the types of abnormal muscle signs occurring in patients with damage to lower motor neurons include paralysis, weakness, reduced speed of movement, depressed tactile feedback, limited reflex behaviors, and atrophy or shrinkage of muscle tissue.

Analyses of the electrical activity of involved muscles using needle electrodes frequently reveal disturbed firing patterns or twitch-like behaviors known as fasciculations. In a structure like the tongue, which is not covered with thick overlying skin, fasciculations can sometimes be evident by shining a flashlight on the surface at rest. This pathologic feature is an important differential diagnostic sign of damage to the cranial nerve XII. Patients with limited lower motor neuron damage usually exhibit less severe flaccid dysarthria than those with more widespread damage.

Additionally, the actual nerves that are damaged dictate the specific types of speech difficulties that may occur[1]. For example, if a focal lesion involves only the cranial nerve VII, as in Bell's palsy, only the lip musculature will be weakened. The result in this case usually produces minimal dysarthria. However, damage to multiple cranial nerves, as often occurs in certain degenerative conditions like Lou Gehrig's disease, are likely to cause severe speech difficulties. The most common speech signs observed in patients with flaccid dysarthria, regardless of the cause or severity, include articulation

[1] These facts are the bases for the kind of association that this study plans to comment on the type of speech problem in question and the nerves and muscles that are responsible for it.

imprecision, hypernasal voice, hoarse and breathy vocal quality, and slow-labored speech rate (Dworkin, 2002).

Brain stem strokes, tumors on the brain stem or along the course of the cranial or spinal nerves, muscular dystrophy, and general injuries to these nerves as a result of head trauma or surgical complications are among the most frequent causes of flaccid dysarthria. If spinal nerves that supply the limbs are also damaged, as may be the case in some of these clinical populations, co-occurring paralysis of these structures is likely to complicate the rehabilitation program. Swallowing problems may occur in some cases, depending upon which and how many cranial nerves are involved.

1.1.3. Nerves and Muscles vs Speech Production

A nerve, in simple terms, can be defined as a bundle of fibers forming a network that transmits messages in the form of impulses between the brain or spinal cord and the body's organs. Although neural mechanisms involved in speech production are poorly understood, animal and human post-mortem dissections, carried out by many careful workers during the past century, have provided detailed knowledge of the gross anatomy of the nervous system. For example, there is a good understanding of where various nerve fibers originate and end, what types of synaptic connections exist, and what individual neurons look like (Denes and Pinson, 1963:102-103).

With regard to the muscular activities, the muscle can be described as a tissue that can undergo repeated contraction and relaxation, so that it is able to produce movement of body parts, maintain tension, or pump fluids within the body. Comparatively, the muscular system has been better understood than the nervous system. The primary reason for this could be a matter of accessibility. Most of our muscles are found out of the brain and therefore are easy to get to without highly sophisticated diagnostic devices or risky and complicated surgery. However, the electrochemical activities that take place at the junction between the nerves and muscles are still in question.

Now, the crucial question would be what nerves and muscles and their coordinated activities have to do with speech organs and further with the production and sequencing of particular speech sounds. I relation to this matter, Fromkin (1965:161) has the following to say:

> For the bilabial stops /b/ and /p/ different motor commands produce different muscular gestures for these consonants occurring in initial position and in final position. There is, however, an apparent invariance in the gestures which produce the allophones of these phonemes. In other words, the neuro-muscular characteristics of /b/ in initial position in an utterance were found to be relatively identical regardless of the vowel which followed.

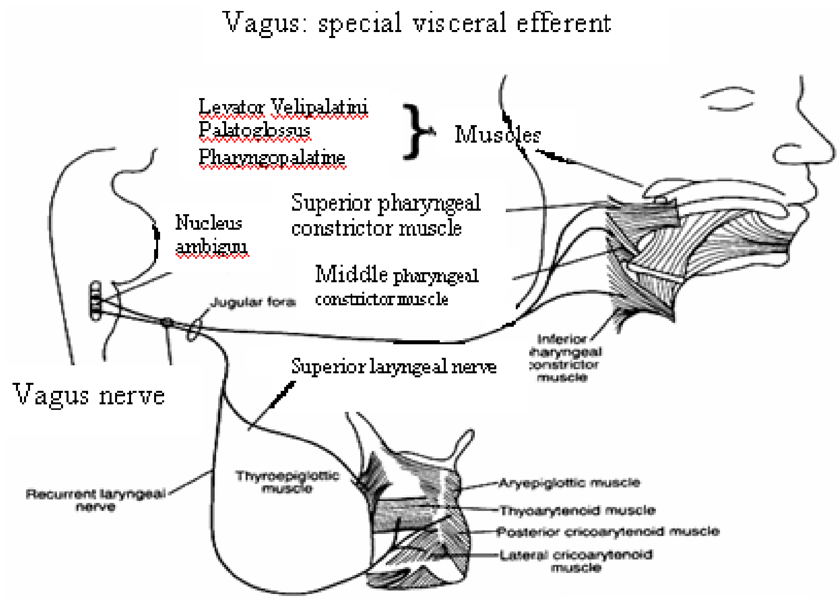
It is apparent that there are tight correlations between neuromuscular activities and production and ordering of particular speech sounds. The point is as explained by Tatham (1997:8) “a particular vocal tract configuration is required for uttering one particular phoneme (at the moment in isolation); this will involve the positioning of certain speech organs and requires activation of certain muscles associated with these organs."

The associations among speech organs, the nerves and muscles connected to them could also be pretty much clear by having a closer look at the connection of nerves to speech muscles. Consider the following table, whose content is taken from Garman (1990:92-3) and Berg et al. (2001) and summarized as follows.

Movable Articulators	Muscle/s	Nerve
Lips	Obicularis oris	Cranial Nerve VII (the Facial nerve)
Jaws	Buccinator and Superior pharyngeal constrictor	Cranial Nerve V (the Trigeminal nerve)
Tongue	Tongue	Cranial nerve XII (the Hypoglossal nerve)
The Velum	Stylopharyngeus	Cranial nerve IX (the Gloss pharyngeal nerve)
Vocal Cords	Thyroid cartilage and Inferior pharyngeal constrictor	Cranial nerve IX (the Gloss pharyngeal nerve)
The Lungs	Chest muscles	Cranial nerve X (Vagus nerve)

Table 1 The Relationships Existing among Articulators, Muscles and Nerves.

Though the link between a certain nerve and the corresponding muscle seems straightforward, each muscle or nerve is not exclusively related to a particular articulator. For example, look at the figure below which shows a variety of connections that cranial nerve X (Vagus nerve) has.



Picture 1 Vagus nucleus ambiguous with SVE projections to visceral muscles of larynx and pharynx (Adopted from Brodal (1992)).

The nerves and muscles involved in the speech production process, therefore, have many different functions and duties in addition to the parts that they take in speech formation. This entails, for example, if a particular nerve or muscle is damaged almost all of the activities that rely on it should be confirmed that they are inactive or abnormal.

1.1.4. Speech Organs, Sound Production and Transmission

In the study of speech impairment, other areas of interest are the type of speech the patient produces, the rate and intensity of his speech, the quality of voice and pattern of his intonation. This leads to the question of how speech sounds are customarily articulated and transmitted. In general, parts of the body connected with speech production (i.e., vocal organs) are the *lungs*, the *windpipe*, the *larynx*, (containing the *vocal cords*), the *throat* or *pharynx*, the *nose* and the *mouth* (Denes and Pinson, 1963:39).

Dworkin (2002), in addition, says that "notably, normal speech production involves the integration and coordination of five primary physiological subsystems: respiration (breath support); phonation (voice production); articulation (pronunciation of words); resonation (nasal versus oral voice quality); and prosody (rate, rhythm, and inflection patterns of speech)."

It is the coordinated work of the stated speech organs that produces speech sounds. Any defect to one of these organs will have an effect on the type, rate and/or quality of the sound to be produced. Laver (1994) clearly puts the central ideas of articulatory phonetics as a description, which accounts for the changing configurations and other actions of the speaker's vocal apparatus. He defines acoustic phonetics as a level of description, which consists of statements about the physical consequences of the vocal apparatus and in the air between the speaker and the listener.

1.1.5. The Study of Language Impairments

In fact, before the contributions of linguistics to the study of language/speech disorder a number of earlier areas of knowledge have touched the subject to some extent. As Crystal (2001) puts it, the earliest references to difficulties with spoken or written language can be found in ancient texts: stuttering, loss of speech, and pronunciation disturbance are noticeable and dramatic effects, and have for centuries generated interpretations which have ranged from the medical to the demonic. In linguistics, as mentioned before, the study of language/speech disorder is a recent development that seeks a great deal of linguists' attention and that of the people from related fields.

Here in Ethiopia, though no well-thought-out survey has been conducted, it is assumed that there are several people with language/speech problem of one sort or another; and research on such cases is almost neglected for a number of reasons. The primary one is perhaps lack of awareness, that is, not to be conscious of the role linguistics can play in language-problem spotting and offering solutions. Linguistics is usually thought of as a discipline that can describe languages and theorize about them. And yet we clearly find language related matters rummaging around the findings of linguistics.

1.2. Objectives

The main aim of the study is to point out the basic differences between the speech of a person with disorder and ‘normal’ speech. Moreover, sorting out which differences are really causes of communication barrier and why are the focus of the research.

Specifically, the thesis is meant to critically analyze the quality of the patient’s speech sounds (i. e., vowels and consonants), how he adjusts intonation levels, the time he takes to produce sounds; and further the rate and flow of his speech (i.e., fluency), in comparison to 'normal' speech.

1.3. Methodology

The first step taken to meet the defined objectives is review of related literature, through which comparable research areas were examined. The review basically ranges from the general issues of neuromuscular disorders that are associated with language/speech processing and production, their main causes and symptoms, the relationships that exist between the nerves and muscles of speech to the specific matters like what flaccid dysarthria is, and its relation to articulatory and acoustic premises that have direct relevance to this study.

Following the literature review, data collection was an imperative task given that the work is an empirical one. The data for this study were recorded from seven individuals. One is the patient and the other six are ‘normal’ male adult individuals, who are native speakers of Amharic. They all speak the Addis Ababa (the 'standard') dialect of Amharic. The data does not take females' speech into consideration and is also confined to a particular age range (30-40). This is because the central objective of the study is to compare the patient's speech (who is a 35 year old male individual) with the speech of male individuals of similar age and to see the extent to which the patient’s speech deviates.

The mean of the data from the ‘normal’ individuals was considered as a point of reference. That is not to confuse individual speech differences with the variations due to the abnormality of the patient's speech. The selection of the individuals was done based on the linguistic as well as nonlinguistic backgrounds that they share with the patient. Some of these backgrounds that are relevant for language variations are dialect, first language, the number of languages they speak and/or understand occupation, age and sex.

The frequency values of formant structures (**F_1**, **F_2** and **F_3**) chosen as the 'normal' reference values are thus the mean frequencies of the formant frequencies of each vowel as produced by each of the six informants. Since consonants are essentially examined by using spectrograms and since there is no way of having an average spectrogram of different spectrograms, the speech (of the six informants' speeches) that appeared to be very similar to the 'normal', during the production of vowels, was taken as the reference for the comparisons of consonants.

The recordings were done in a computer using a noise-canceling microphone. They were digitized with a sampling rate of 16 kHz, and 16-bit samples and quantized with 16-bit and stored in a wave format. As stated above, the analysis was done using a speech analyzer software called Praat.

1.4. Significance of the Study

Among other things, this work could contribute to some understanding of language impairments and a glimpse of the methods of identifying their sources as well as ways of treating them. In Ethiopia, this research possibly makes people aware of language/speech disorders from a scientific perspective, which in turn, enables them to think of logical methods of solving the problems when they happen rather than associating them with traditional and superstitious thoughts.

This research indicates that linguistics in general and phonetics in particular could help locate where the problem of dysarthria in Amharic speaking patients is rooted. It also yields meaningful guidelines on how the treatment (i. e., therapy) could better be provided.

In Ethiopia, language/speech pathology and therapy are not given attention in medical schools of our universities. This study could thus be triggering for the promotion of language/speech pathology/therapy curriculum in the universities. Finally, since the acoustic analysis of speech/language problems has not yet been undertaken meaningfully in Ethiopia, the researcher believes that the present study will initiate other scholars to engage in the field.

CHAPTER TWO

VOWEL ACOUSTICS

2.1. The Physical Properties of Speech Sounds

In this chapter, the acoustics of the patient's vowels in comparison with the 'normal' speech will be discussed in detail. The most important principle of physics on which verbal communication is based is that vibrating bodies send out waves that are propagated in the environment. Our articulatory organs produce a number of vibrations; these vibrations need a medium to be transmitted through. The medium through which speech sounds travel is normally the air. Vibrations of pendulum and tuning fork are the classic examples which have been used to explain how speech sounds are produced and transmitted across the air and interpreted by the listener (Shriberg and Kent, 2003, Heffner, 1964, Denes and Pinson, 1963).

Speech sounds, therefore, are the result of the vibrations of the vocal folds by the air provided by three systems, namely, respiratory (the lungs), laryngeal, and supralaryngeal (part of the speech mechanism that lies above the larynx) systems; and shaped by the speech organs.

Speech sounds vary depending on a number of factors. Among others, the system that provides the air for the vibrations of the vocal folds, how much energy is provided, how the speech organs shape the vibrations are the major ones. The causes for the differences of sounds can be grouped into three main physical properties. They can be different in pitch, loudness, and/or quality. They can be the same or different in pitch and loudness, but might differ in quality (Shriberg and Kent, 2003, Ladefoged, 1969, 2001).

The pitch of a speech sound depends on the rate of vibration of the vocal folds. In a sound with a high pitch, there is a higher frequency of vibration than in a sound with a low pitch. Because each opening and closing of the vocal folds causes a peak of air pressure in the sound wave, we can estimate the pitch of a sound by observing the rate of occurrence of the peaks in the waveform.[2] The pitch of a sound is that auditory property that enables a listener to place it on a scale going from low to high (Ladefoged, 2001: 164).

Frequency is a technical term for an acoustic property of a sound; it is the number of complete repetitions (cycles) of vibration in air pressure occurring in a second. The unit of frequency measurement is Hertz, usually abbreviated as Hz. Generally, the loudness of a sound depends on the size of the variations in the air pressure. Just as frequency is the acoustic measurement most directly corresponding to the pitch of a sound, so acoustic intensity is the appropriate measure corresponding to loudness. It is usually measured in decibels (abbreviated as dB) relative to the amplitude[3] of some other sounds (Ladefoged, 1969, 2001, Shriberg and Kent, 2003, Heffner, 1964, Denes and Pinson, 1963).

In order to get a better understanding of some of the concepts mentioned above it is imperative to have a deeper look into the acoustic analysis of the speech sounds produced by the patient in comparison to the 'normal' one.

[2] The most common representation of the speech signal is the oscillogram, often called the waveform.
[3] Amplitude is the increase (or decrease) of air pressure at a given point during a sound.

2.2. The Acoustics of Vowel Sounds

Before describing the patient's vowels having a general picture of the acoustics of vowels in general would be very useful. Vowel production is a matter of shaping the vocal tract so that its resonance[4] frequencies reinforce selected harmonic components of the laryngeal tone (Shriberg and Kent, 2003:305). The human vocal tract has several effective resonance frequencies, and their combined effect on the laryngeal tone yields a vowel sound. As the vocal tract changes its shape and length, its resonance frequencies change and the vowel quality therefore changes (pp, 305). In brief, vowels are made by adjusting the resonator (vocal tract) to shape the laryngeal tone in certain ways. The oral and nasal cavities are resonators that reinforce or strengthen some sound waves at the expense of energy of other sound waves.

It is also important to understand that formants are features of the resonating cavities lying above the vocal folds. As these cavities are reshaped by changes in the positions of the tongue, jaw, and lips, the formant structure also changes. Hence, formant structure is determined by the length and shape of the vocal tract. On the other hand, the frequency of the vocal fold vibration (fundamental frequency) is determined by the length and tension of the vocal folds (see Shriberg and Kent, 2003).

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[4] Resonance is a frequency-selective reinforcement of sound energy. In other words, energy at certain frequencies is strengthened.

2.3. Formant Structures

Based on the movements and positions of the tongue during the production of vowels, there is a common way of representing vowels of languages diagrammatically as *high* vs *low*, *mid* vs *center*, *front* vs *back*. This kind of vowel demonstration in relation to the movements and positions of the tongue is confirmed as problematic. Because it does not precisely point out the degrees of the positions of the tongue. In other words, the articulatory account of representing vowels graphically has been criticized for its inaccuracy on vowel positions. The following quote from Ladefoged (2001:176-7) evidently makes clear the points just discussed.

> ... *traditional* articulatory descriptions are not entirely satisfactory. They are often not in accord with the actual articulatory facts. For well over a hundred years, phoneticians have been describing vowels in terms such as high versus low and front versus back. There is no doubt that these terms are appropriate for describing the relationships between different vowel qualities, but to some extent phoneticians have been using these terms as labels to specify acoustic dimensions rather than as descriptions of actual positions.

In fact, it is difficult to remove the auditory effect of the vocal folds frequency so that we can easily identify vowel types; yet, an acoustic measurement of the actual frequencies of the formants of vowels provides a relatively better representation of the sounds. More importantly, as Jayaram (1997) claims, among the various evaluation techniques employed in assessing speech disorders, the technique of acoustic analysis by a computer has proved to be very reliable. The acoustic phonetic analysis of neurologically disordered speech permits considerable insights into the detailed nature and possible origin of such a disorder.

Frequency values, especially the first three formant frequencies (i. e., $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$) have a great importance in relation to physiological facts in addition to being physical representations of a particular vowel. Heffner (1964:84) also makes a similar assertion on the fact that a formant frequency graph becomes a graph representation of physiological facts rather than a mere juggling of acoustic data if it can be shown that these formant frequencies are correlated with physical resonators which determine the character of the vowel. He, further, confirms the actuality of acoustic descriptions of tongue and jaw positions by saying, "In any event, we find a point-to-point similarity of configuration between the graphs of acoustic data and the diagrams deduced from physiological measurements of tongue and jaw positions" (pp, 85)

However, it appears that it is very difficult to assume that formant frequency values precisely show the tongue and jaw movements and positions, because there are a number of other things which have effects on the formant frequencies themselves like the size and shape of resonators. With this supposition the next section will try to show what the patient’s vowels look like.

2.4. The Patient's Vowels vs the 'Normal' in terms of F_1, F_2 and F_3 Differences

The difference between the patient's token and the 'normal' in frequency values of $\mathbf{F_1}$, $\mathbf{F_2}$ and $\mathbf{F_3}$ will be described. Accordingly, below is a table that has a set of figures of the first and second formant frequencies of the seven Amharic vowels (i, e, /ɨ/, /ä/, /ɑ/, /o/, and /u/) as produced by the patient and the averages of the frequencies of the six individuals' productions of each vowel. The first formant notifies about the height of the tongue and jaw movement while the second formant shows the degree of backness and frontness of the tongue during the production of vowels. See the tables below which contain the values for the first two formant frequencies ($\mathbf{F_1}$ and $\mathbf{F_2}$) and the difference between the 'normal' trend and the patient's formant frequencies.

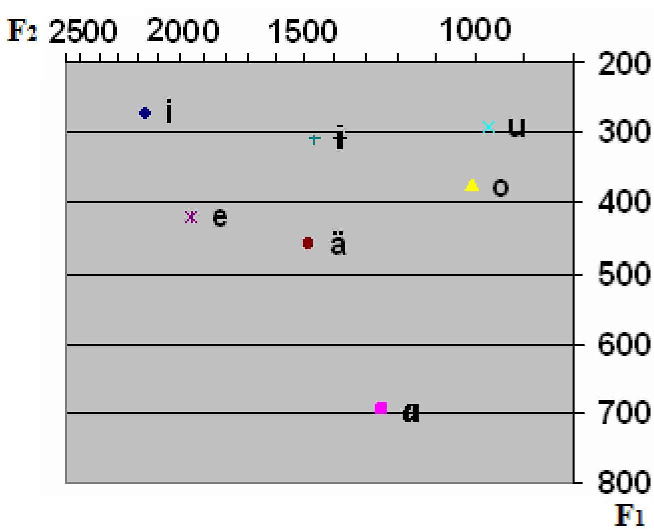
		Patient's Production	**'Normal' Production**
i	**F1**	361	271
	F2	1819	2145
e	**F1**	401	423
	F2	1656	1965
ɨ	**F1**	349	312
	F2	1537	1483
ä	**F1**	494	466
	F2	1379	1502
ɑ	**F1**	549	696
	F2	1295	1255
o	**F1**	405	378
	F2	1074	1010

u	F1	365	291
	F2	1159	813

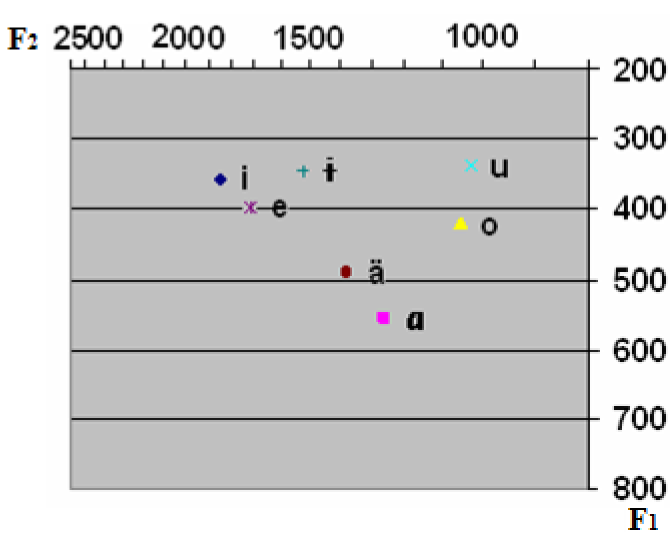
Table 2 First and second formant frequencies (in Hz) of the seven Amharic vowels as pronounced by the patient and the normal person.

		Normal – Patient
i	F1	-90
	F2	326
e	F1	22
	F2	309
ɨ	F1	-37
	F2	-54
ä	F1	-28
	F2	123
ɑ	F1	147
	F2	-40
o	F1	-27
	F2	-64
u	F1	-74
	F2	-346

Table 3 Differences in the first and second formant frequencies (in Hz) of the seven Amharic vowels as produced by the patient and the 'normal'.



Graph 1 A chart of the first formant on X-axis plotted against the second formant on the Y-axis for the seven Amharic vowels based on the mean of six male individuals.



Graph 2 A chart of the first formant on X-axis plotted against the second formant on the Y-axis for the seven Amharic vowels as produced by the patient.

Before describing tongue movements and positions in relation to $\mathbf{F_1}$ and $\mathbf{F_2}$ differences during the production of each vowel in the patient's as well as in the normal speech, it is important discussion the effect of vocal tract length on formant frequencies. Otherwise it would be difficult to interpret formant frequency changes directly in terms of tongue movements because the entire formant space shifts within the vocal tract length. Formant frequencies, made the resonances in speech, are an indication of the size of the vocal tract. The review of literature has shown that speech signals can provide estimates of not only vocal tract length but also vocal tract cross-sectional area as a function of distance from the glottis to the lips.

Thus, formant frequencies are used not only to show where roughly vowels are produced in the vocal tract; but they are also used to estimate the length of the vocal tract. It is obvious, for example, that a child's vocal tract is shorter and smaller than adult female's or adult male's vocal tract. Likewise, the vocal tract of an adult female is relatively shorter and smaller than that of an adult male's vocal tract. This fact is clearly seen in vowel charts where, for example, a child's vowel chart is smaller than the average adult vocal tract.

The vowel chart of the patient is similar to a child's vowel chart in that his vocal tract seems to be remarkably small. There are a number of reasons for this. In the following sections the effects of formant frequencies will be discussed.

2.4.1. First Formant (F_1)

Vowels that are produced with the raising of the front part of the blade of the tongue coming to the front upper part of the mouth are referred to as front vowels. Amharic front vowels are /i/ and /e/. Table 2 above has first and second formant frequencies for these vowels. From these frequencies, the extents to which the vowels are really front and high in the patient's productions as compared to the average productions can easily be seen.

As can be noted from the formant frequencies and the corresponding graphs, the **F_1** frequency for /i/ in the patient's production exceeds the average by about 90Hz. This may be because the patient's tongue is abnormally lowered by the stated amount of Hz. In other words, for the patient to produce a normal sounding /i/, his tongue needs an additional 90Hz upward move. The abnormal opening and closing of his mouth could be another reason for the **F_1** variation since the shape and size of the vocal tract (therefore the resonance) can be affected by the opening and closing of the mouth. So bear in mind that in addition to the movement of the tongue the movement of the lower jaw (in conjunction with other factors) has a lot to do with varying formant frequencies.

For /e/, the situation is better. The patient's production of this vowel sound normal though it reveals a small difference, that is, about 22Hz, which can be considered as an individual variation. However, in the case of /i/, the difference arose because the patient's tongue could not be raised to what has been called the 'normal' point of reference; whereas for /e/ his tongue is lifted up above the reference point. This, technically, means that his /i/ and /e/ are produced in the ‘normal’ range as can be seen on the graphs. There could be a number of reasons for this state of affair. One reason can be the amount of physical effort (degree of muscular movements) for the articulation of each vowel. It is an established fact that /i/ is more front and higher than that of /e/; and there is no question that /i/ needs more contraction or tension of the muscles of the tongue than /e/

does. In relation to this, the patient's speech is slow-labored one and his mouth opens abnormally to some degree, which has substantial effects on formant frequencies.

The position of the velum can also be another reason for the kind of frequency variations observed in /i/ and /e/. The amount of the air stream coming through the oral cavity is reduced if the velum is lowered; which puts affects the quality of the vowel. The patient's voice is found to be hypernasal, which, in other words, means that the velum is lowered to a considerable degree and as a result part of the air stream that must have passed through the oral cavity goes through the nasal cavity.

Another reason comes from the extent to which the mouth is open to produce the vowels. In other words, the patient's tongue might have been sufficiently raised to the extent that would enable it to produce the vowels but his lower jaw is not active enough to properly shape the sounds. So, since /i/ is produced with a fairly closed mouth the patient's /i/ is considerably low; by the same token, /e/ is produced with a moderately opened mouth and therefore the patient's /e/ sounds normal and even a little higher. In relation to the above points, the situation can also be explained with respect to the size of the oral and laryngeal cavities adjusted by the movements of the tongue and the jaw.

According to Heffner (1964:84), the higher the tongue is raised, the larger the resonator producing the lower formant **(F_1)**, in the sense that the higher the tongue is raised the larger this resonator and the lower its natural frequency of resonance will become. Also in the same way it might seem that there may be a correlation between the degree of advancement and retraction of the tongue and the size of the resonator producing the upper formant (**F_2**) in the sense that the more advanced the tongue, the smaller this resonator, and the more retracted the tongue, the larger this resonator and hence the lower the pitch of the formant it will produce.

Accordingly, in the normal production of /i/, for example, the first formant frequency is less than the patient's one. This means that the patient's tongue is unable to be raised sufficiently so that the resonator that produces **F_1** becomes larger and in consequence the frequency becomes lowered.

So, for all of the high vowels his tongue is abnormally lowered and as a result the resonator that produces **F_1** becomes smaller, which in turn, makes the frequencies higher. This problem is much more severe for the high-front vowel /i/ and high-back /u/ than it is for the high-central / i / (see Table 2 above). This is obviously because for /i/ and /u/, his tongue, from its rest position, makes frontward as well as backward moves in addition to the upward moves; while for /ɨ/, just upward movement is enough. As to the difference between /i/ and /u/, the abnormal opening of the patient's mouth caused his /u/ to be higher than /i/. The following box shows that the degree of tongue elevation problem is minimal for the central vowel /ɨ/ as compared to the front and back ones.

-90 Hz		**-37 Hz**		**-74Hz**
/i/	→	**/ɨ/**	←	**/u/**

With regard to the mid and low vowels, similar tendency is observed except in the case of /e/ and /ɑ/. As mentioned above, for /e/ the patient's tongue is more raised than the 'normal' and for /ɑ/ his **F_1** frequency is much lower than the normal (the difference is 147Hz), which is not only because his tongue is more raised than it has to be but since /ɑ/ is articulated with an extremely low tongue position but with a relatively widely opened mouth—and his mouth is already abnormally open—so the resonance becomes larger and as a result the natural frequency becomes lower. Consider the situation, in the box below, where the **F_1** frequency difference declines from mid front vowel /e/ to mid central vowel /ä/ and further to mid back one /o/.

22Hz		**-28Hz**		**-27Hz**
/e/	→	/ä/	→	/o/

As the shape of the oral cavity becomes narrow as it gets to the back, the frequency differences also decrease. In broad terms, the effect of the abnormal mouth opening is greater for the front mid vowel and gets smaller and smaller as it goes to the center and further to the back.

A more general situation of the patient's vowel production discloses that if a vowel is normally produced with a closed or nearly closed mouth, then the patient's tongue becomes lower than the average; and if a vowel is produced with a widely opened mouth, then his tongue will be elevated.

In addition to the effects that the abnormal mouth opening puts on the qualities of the patient's vowels, his tongue, too, cannot be raised enough to produce some of the vowels; and it is also unable to make enough downward move for the other vowels. This entails that his tongue is abnormally raised when it is at rest; because the lowest move that his tongue could make is at elevated position (about 147Hz higher than the 'normal' elevation for /ɑ/).

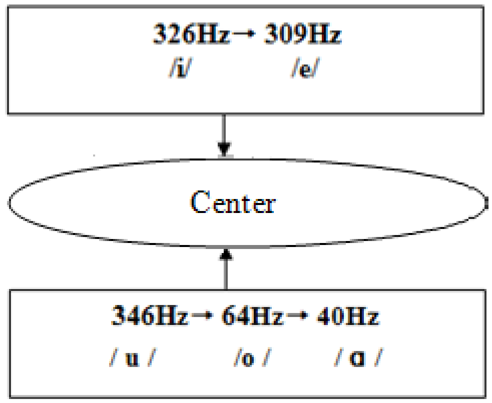
2.4.2. Second Formant (F_2)

F_2 frequency is significant in recognizing the horizontal movements and positions of the tongue. An even more accurate indicator of frontness/backness than F_2 is the *difference* between the first two formants, i.e., $F_2 - F_1$. For the purpose of this work just F_2 frequency is used to designate tongue advancement and retraction because F_2 values are found to be almost similar to $F_2 - F_1$ values.

F_2 frequency for the /i/ is less in the patient's production than the average by 326Hz. Putting this in other way, the patient's tongue is abnormally retracted by the stated frequency to produce /i/ that sounds 'normal'. The same is also true for /e/; his tongue is abnormally retracted by 309Hz. Similarly, the patient's tongue is abnormally retracted for the central vowel /ä/ by 123; and it is also abnormally advanced for /ɨ/ by 54Hz. The abnormal retraction is large for /ä/ than it is for the other above mentioned three vowels. The case of the mid central vowel reveals one important fact, that is, the patient's tongue is abnormally retracted when it is at rest. This is because /ä/ is normally produced only by lifting the tongue a little bit upward from its rest position—no extra forward or backward move is needed.

His tongue is also abnormally retracted for the front vowels as well as for the mid central one but not for the back ones. For the back vowels, his tongue is rather advanced than what is expected. It is advanced by 346Hz, 64Hz, and 40Hz, for /u/, /o/, and /ɑ/ respectively. The degree of abnormal advancement for these vowels declines as it goes from the high-back vowel /u/ to the mid-back one /o/ and further to low-back one /ɑ/. This is apparently because it requires more muscular effort for the patient's tongue to access the most high-back part of the oral apparatus than the mid-back. Likewise, it is simpler for his tongue to make only a backward move (in the case of /ɑ/) rather than lifting up and retracting (which is done in the case of /u/ and /o/). So, the more advanced the tongue, the smaller the resonator that produces $\mathbf{F_2}$ frequency and consequently the larger the frequency becomes.

Broadly speaking, as shown in the boxes below, the patient's tongue is more retracted for the front vowels and is more advanced for the back ones than the average articulations.



The directions of the arrows (in boxes) display that the movements of the patient's tongue are highly confined to the middle of his oral cavity (mouth). It does not sufficiently move to the front nor is it able to adequately move to the back. This fact is vividly seen on his vowel chart where the vowels are being concentrated at the center.

Now, the question is whether or not the cause for the abnormal formant frequencies is associated with only tongue movement problem or due to some other speech organs taking in the deviations.

In order to address this point a closer look at how each vowel is produced in terms of the degree of mouth opening and the shape of the lips could help. Accordingly, /i/, for example, is produced with unrounded, possibly elevated or retracted lips, closed or elevated jaw position, tongue body held in high-front position so that maximal constriction occurs in the palatal area; the pharynx is widely opened, advancement of tongue root and with the velopharynx normally closed unless a sound is nasal; and with velum tending to be quite high (Shriberg and Kent, 2003).

In light of the articulatory descriptions of /i/, the patient's vocal tract configuration differs at least in two ways: jaw and velum positions. As mentioned above, the patient's jaw is open to some level and the velum is also lowered. The abnormal opening of the mouth is strongly correlated to the movement of the mandible, which is in turn determined either by the medial pterygoid, which is the main jaw closing muscle and/or by the digastrics and the geniohyoid muscles which manage the opening of the jaw. Thus, in relation to the abnormal height of the tongue, the movements of the jaws are worth considering because the extent to which a mouth is open is also of a big role for sound qualities.

Another factor that determines the quality of a particular vowel is the configuration of lips. Lip shapes and movements are of course related to a certain extent to jaw movement. So far, $\mathbf{F_1}$ and $\mathbf{F_2}$ frequencies have strongly been correlated to tongue movements; however, in addition to tongue and jaw movements, the effect of lip shapes and movements are also of great importance to establish vowel qualities. It further could provide useful information on problems associated with lip movements in individuals with speech problems. Hence, the role of $\mathbf{F_3}$ frequency in identifying the extent of lip configuration in association with the patient's lip configuration will be discussed in the next section.

2.4.3. Third Formant (F_3)

As Heffner, (1964:38) says, the lips are complex muscular structures composed of fibers from a number the facial muscles joined together in a band, or girdle, surrounding the opening of the mouth. This band is called the orbicularis oris.

Thus, this muscle, among other muscles (e. g., the buccinator, the mentalis muscles and at least six bands of facial muscles to which the lips are subjected to), is mainly used to produce bilabial, labiodental, and labiovelar consonants like the following Amharic consonants: [p], [b], [m], [f], [v], [w], and of course vowels.

Lip configuration can be described by a variety of terms such as rounding, protrusion, retraction, spreading, eversion, and rounding (Shriberg and Kent, 2003:28), but in this study for the most part only the two states of lips—roundedness and unroundedness will be considered.

As mentioned earlier, lip rounding/unrounding is associated with the third frequency, though it has effects on the first and second formants as well. Lip rounding lowers $\mathbf{F_3}$. Let us consider, in the table below, the $\mathbf{F_3}$ frequency differences between the patient's articulations of /o/ and /u/ and the average (all of the vowels but /o/ and /u/ are unrounded).

		Patient's production	**'Normal' production**
F_3	**o**	2527	2391
	u	2216	2242

Table 4 Third formant (F_3) frequencies (in Hz) for /ɑ /, /o/ and /u/ in the articulations of the 'normal' and of the patient.

The assessment of the problem of lip rounding is not made by comparing the 'normal' with the patient's articulation of each vowel. Rather it is done between the **F_3** frequency difference that exists between the two vowels of the 'normal' and that of the patient. In other words, it is the **F_3** frequency decline within the articulations of the same individual that shows the extent of lip rounding.

Thus, since /o/ is made with a closed-mid jaw position and with rounded lips and /u/ is articulated with a closed jaw position and rounded and/or narrow lips, the comparison will be made between them. The contrast, therefore, goes from moderately open and rounded one (that is, /o/) to the closed and narrow rounded one (that is, /u/).

(a)	(b)
/o/ - /u/ **2527-2216** **≈ 311Hz**	**/o/ - /u/** **2391-2242** **≈149Hz**

F_3 frequency decreases in the articulations of the patient (a) and of the 'normal' (b).

The results in the boxes show an abnormal **F_3** frequency decline in the patient's production. The patient's /o/ resembles to the English open back vowel /ɔ/[5] in that the **F_3** frequency for /ɔ/ is 2540Hz—which is very close to the **F_3** of the patient's /o/. This, in other words, means that he has a difficulty of rounding his lips easily. In addition, the fact that his /o/ is open can also be a strong evidence for the assertion already made about his abnormal mouth opening.

The other evidence on the problem of lip rounding comes from the exaggerated decline of **F_3** in the patient's production. Normal **F_3** difference between successive back vowels does not go beyond 200Hz. As can be seen from the box (a), the decrease in frequency between the vowels is approximately 311Hz, which assumes one vowel between /o/ and /u/.

In general, what can be said about the conditions of the patient's lips is that he has a serious problem in rounding them. This claim is not only based on the acoustic data analyzed above but also on the observation made when he produces the rounded vowels and labialized consonants such as /k'ʷ/ as in /k'ʷuɑnk'ʷuɑ/ 'language'. Furthermore, he sometimes drools saliva—which could also serve as an additional evidence for the patient's problem of controlling lip movement.

[5] For the details see Ladefoged, 2001 pp.172.

2.4.4. Orality vs Nasality

Based on the position of the soft palate (velum), speech sounds are mainly categorized as *oral* or *nasal*. Oral sounds are those produced with the raising of the velum so that the entire air flow would pass through the mouth; whereas, nasal ones are made with lowered velum which allows the majority of the air to pass through the nasal cavity. As mentioned in earlier sections, the patient's speech is hypernasal which requires an abnormal lowering of the velum. For example, consider the spectrograms[6] of the vowels /ɨ/ and /ɑ/ as they are produced by the patient and by the other person.

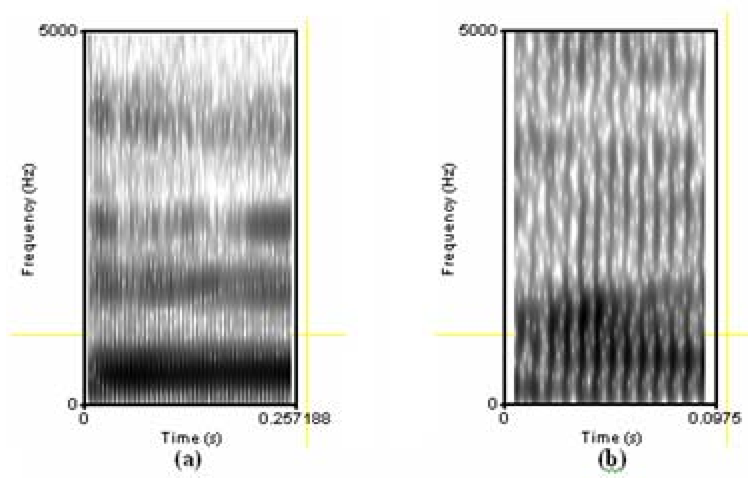


Figure 1 The Spectrograms of the Vowel /ɨ/as in /johɑnnɨs/ 'Johannes'; as produced by the patient (a) and the 'normal' production (b).

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[6] The spectrograms were taken out from the spectrograms that show the entire words (/johɑnɨs/ and /ʔɑnd/); so if they are not clear enough to examine the facts, please see them in the original larger spectrograms in Figure 3 and 7.

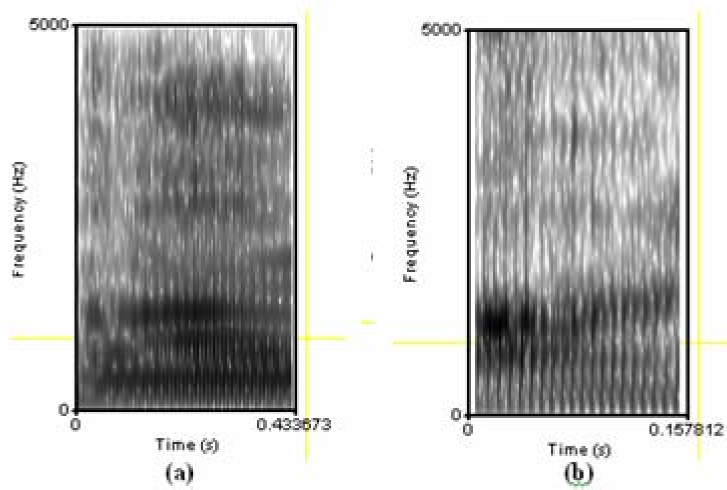


Figure 2 The Spectrograms of the Vowel /ɑ/as in as in /ʔɑnd/ 'one'; as produced by the patient (a) and the 'normal' production (b).

The spectrograms show that the patient's vowels are of hypernasal quality. As can be noticed from the illustrations above, in the patient's production of /ɨ/, we see a very dark area at lower frequencies, which shows nasality. The spectrogram, in his production of /ɑ/ is darker than it is for his /ɨ/. This is partly because he produces /ɑ/ (as it is normally produced) by drawing the back of the tongue towards the back of the oral cavity; and as a result the air that comes towards the oral cavity will be obstructed (at least partly) by the tongue and goes by the nasal cavity—since his velum is abnormally lowered regardless of the sounds. And partly because /ɑ/, in this particular case, is followed by a nasal consonant /n/. In fact, this is a normal tendency across the phonologies of a number of languages like English, for example. Whenever a vowel is followed by any nasal consonant speakers of English nasalize the vowel (e. g., in mæ̃n, /æ/ is nasalized as a result of /n/'s influence). But the patient's case is so deviant that all of his sounds are nasalized with different degrees. This assertion can be supported by the following spectrogram where we have hypernasality at lower frequencies.

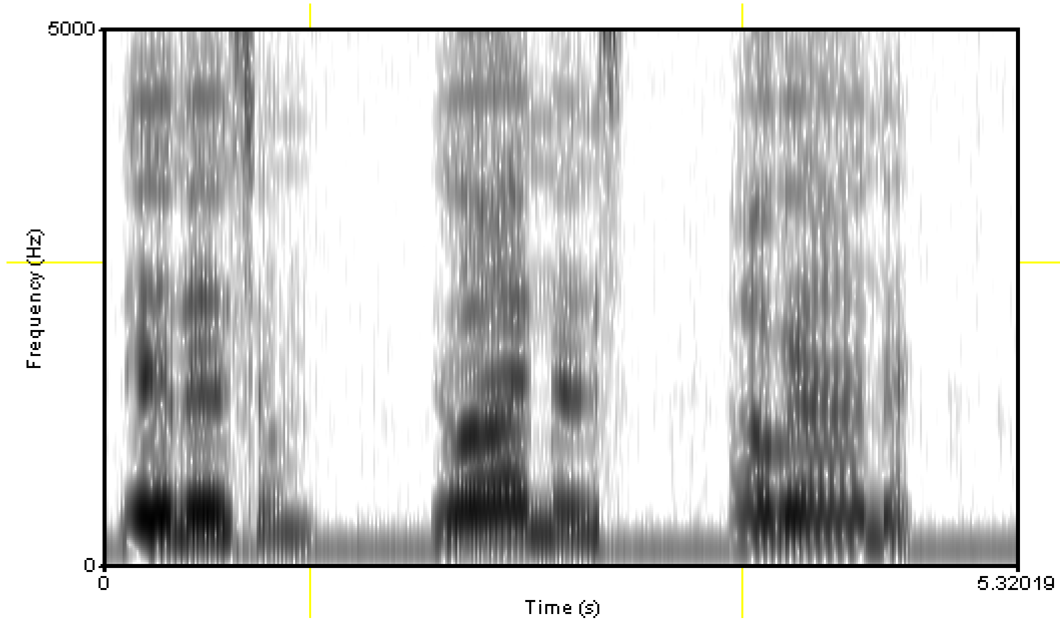


Figure 3 The Spectrograms of a sentence /jäne sɨm johɑnɨs näw/ which can be glossed as 'my name is Johannes' produced by the patient.

Hypernasality results from an abnormal nasal resonance, which in turn, can be caused by a number of things. Among others, velopharyngeal dysfunction (i.e., incomplete closure of the valve) and obstruction in the vocal tract can be mentioned. There are different noticeable effects that hypernasality has on formant frequencies. Since the movement of the velum is largely associated with the size and shape of the resonating cavities, its activities affect formant frequencies.

CHAPTER THREE

CONSONANT ACOUSTICS

3.1. Types of Consonants

The acoustics of consonant articulation is complex (Ladefoged, 2001, and Shriberg and Kent, 2003), because consonants are of several kinds, some vowel-like, some noise-like, some voiced, some voiceless, some long in duration, and some brief in duration. Thus, a fairly large set of acoustic descriptors is required to discuss the details of consonant acoustics. Nevertheless, the basic acoustic properties can be discussed broadly with respect to (1) the source of energy (voicing, frication, noise, burst noise); (2) the manner or degree of the vocal tract constriction (for example, complete closure for stops and affricates, narrow constriction for fricatives, nasal radiation for nasal consonants, or vowel-like oral radiation for liquids and glides); and (3) the place of the vocal tract constriction (place of articulation) (Shriberg and Kent, 2003:314).

In the following sections, some of the Amharic consonants will be discussed in light of these parameters. The descriptions of the consonants will be in a way that they could point out the basic differences that might appear between the 'normal' and the patient's speech.

The phonetic inventory of Amharic consists of consonant phonemes which are bilabials (p, b and m), labiodentals (f and v), alveolars (t, d, n, s, z, r and l), palatals (ʃ, ʒ, tʃ, dʒ, j and ɲ), velars (k and ɡ), glottals (h and ʔ), ejectives (p', t', s', tʃ' and k') and a labiovelar (w). Depending on the states of the vocal folds, these consonants are categorized into voiced (if the folds vibrate) or voiceless (if the folds do not vibrate).

3.2. The Patient's Consonants vs the 'Normal' Consonants

3.2.1. The Acoustic Nature of Stops and Fricatives

The voiceless stop consonants are well recognized for burst sound energy followed by a very short silence and then by a release of the burst. On a spectrogram, the gap from the burst of a stop consonant and to the beginning of the following sound is known as spike. The voiced ones do not have such spike as the voiceless ones.

There are, therefore, three stages for producing stops. One is the closing of the vocal organs (i. e., the closure phase), the other is the very brief silence that exists after the closure and release (i. e., the approach phase) and finally the release phase. These are the major points of focus in looking into voiceless oral stop consonants in a spectrogram.

So, for all voiceless oral stops, the closure phases are silence. This will show up as a blank region on a spectrogram. Because the closure phases of all voiceless oral stops are identical, in order to tell vowels apart on a spectrogram we have to pay attention to the properties of the approach phase and the release phase. Accordingly, there are two main audible cues for the stop's place of articulation.

The first one is release burst. There is an instant of turbulence after a stop is released. The average spectrum of this release burst looks like that of the fricative with the same place of articulation. For example, [t] on a spectrogram will appear as a blank space followed by a very brief burst of static concentrated at higher frequencies just like [s] (see Ladefoged, 2001:181-182). And the second one is formant transitions. As the vocal tract moves from its position for the consonant to its position for a following vowel, there are very brief influences on the formants at the beginning of the vowel.

On the other hand, the voice bar which appears near the base line of spectrograms shows voicedness of a sound. So, voiced consonants, like vowels, are associated with vertical voicing pulses on the spectrogram. In what follows, we shall examine the qualities of the consonants, on spectrograms, as they are produced by the patient and the ‘normal’ individual.

3.2.1.1. Voiced Stops

Voiced oral stops look much like voiceless stops on spectrograms, but differ in two respects. Firstly, there is some vocal fold vibration, in the voiced ones, which results in some visible darkness at low frequencies at the bottom of the spectrogram (often called a voice bar) and secondly, the release burst will be less noticeable. In light of these facts, let us consider the patient's articulations of three voiced stops (/b/, /d/ and /ɡ/). Below is a spectrogram of the words /bɨrr/ 'birr', /ʔand/ 'one' and /ɡɨn/ 'but'.

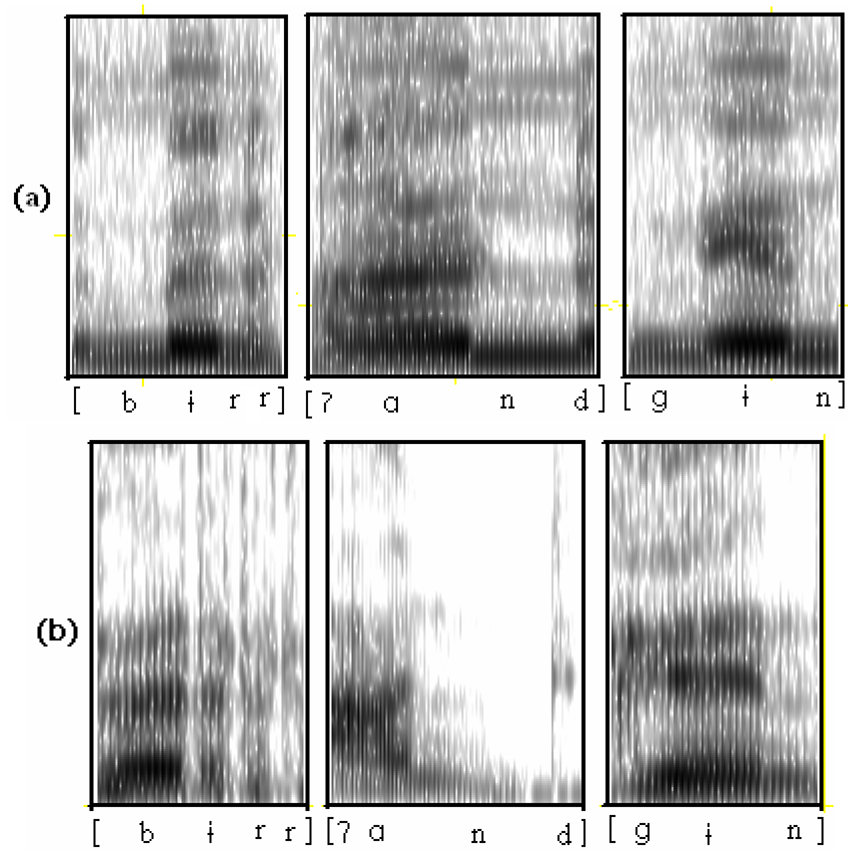


Figure 4 A Spectrogram of the words /bɨrr/ 'birr', /ʔɑnd/ 'one' and /gɨn/ 'but' as produced by the patient (a) and in 'normal' production (b).

Technically, there is almost no difference in the sounds during the actual closure of [b, d, g], and absolutely none at all during the closures of [p, t, k], for at these moments there is only silence (Ladefoged, 2001:179). Each of the stop sounds conveys its quality by its effect on the adjacent vowel. But in the patient's production of these stops, it is very difficult to see (on the spectrogram) the effects of the stops on the neighboring vowels even if the spectrogram is made rather darker than usual. This is, in fact, an expected characteristic of disordered speeches. The obstruction of the air is also noticeably weak.

Thus, in contrast to the normal patterns, with their clear vowel formants and noticeable segments of friction noise, the pattern for the patient's speech, with the already mentioned abnormal lowering of the velum (velopharyngeal incompetence), has more-often-than-not low frequency energy attributable to nasal resonance. It might be thought that the energy at low frequencies is the result of the vibration of the vocal folds. The same trend, however, is observed in his production of the glottal stop /ʔ/, which is normally produced with no vibration of the vocal folds. In addition, there are white areas in the spectrograms of the normal person who displays that there is no noise energy at certain frequencies; to the contrary, the spectrograms in (a) do not have these white spaces at any frequency—they are rather dark all the way through and are even darker at low frequencies. This shows that the patient's breathy voice as well as hypernasal speech qualities appear as noise energy at almost all frequencies.

The absence of the finely spaced vertical striations, which are visible in normal speech spectrograms, could also be another evidence for his breathy voice quality. For example, towards the end of /b/, in /bɨrr/, there is finely spaced vertical striation in (b) but it is missing in (a). This situation is not just limited to voiced oral stops but rather it appears in the voiceless ones too. The following section will make the above points clear with a discussion on voiceless stops.

3.2.1.2. Voiceless Stops

Let us now consider how the patient's voiceless stops are distorted. Look at the spectrograms below to see the extent to which /t/ and /k/ are differently represented in the two tokens.

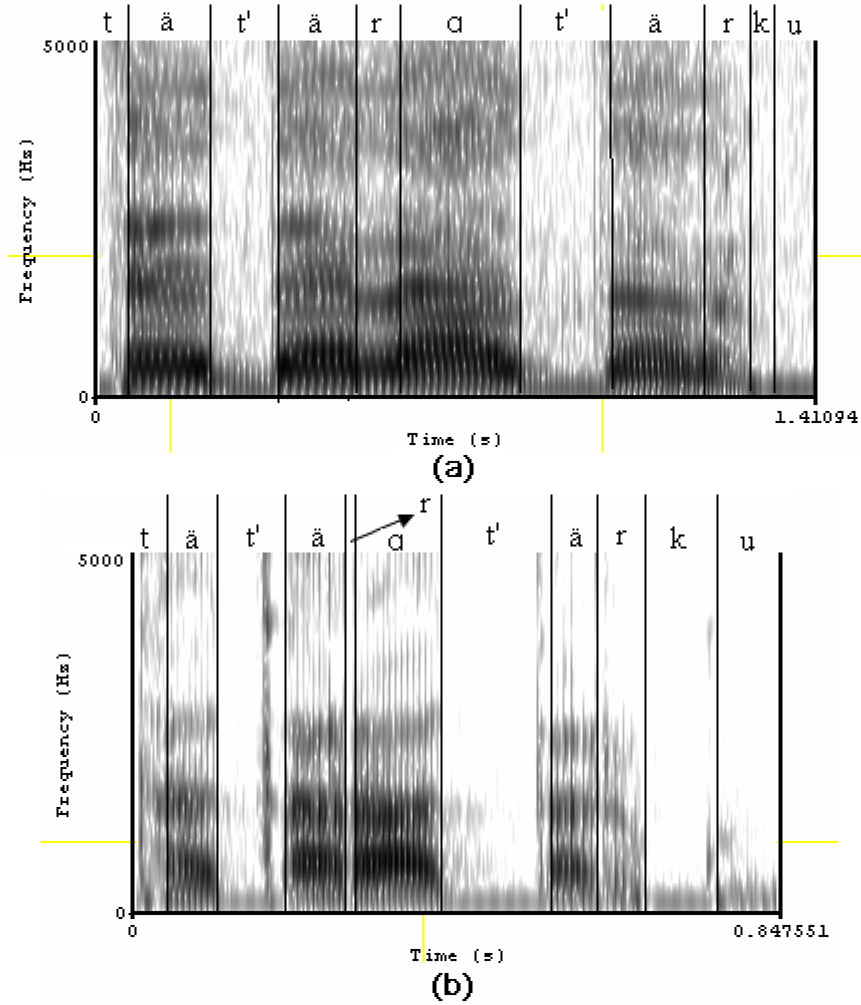


Figure 5 Spectrograms of the Sentence /tät'ärɑtt'ärku/ which can be Glossed as 'I doubted' as produced by the patient (a) and in ‘normal’ production (b).

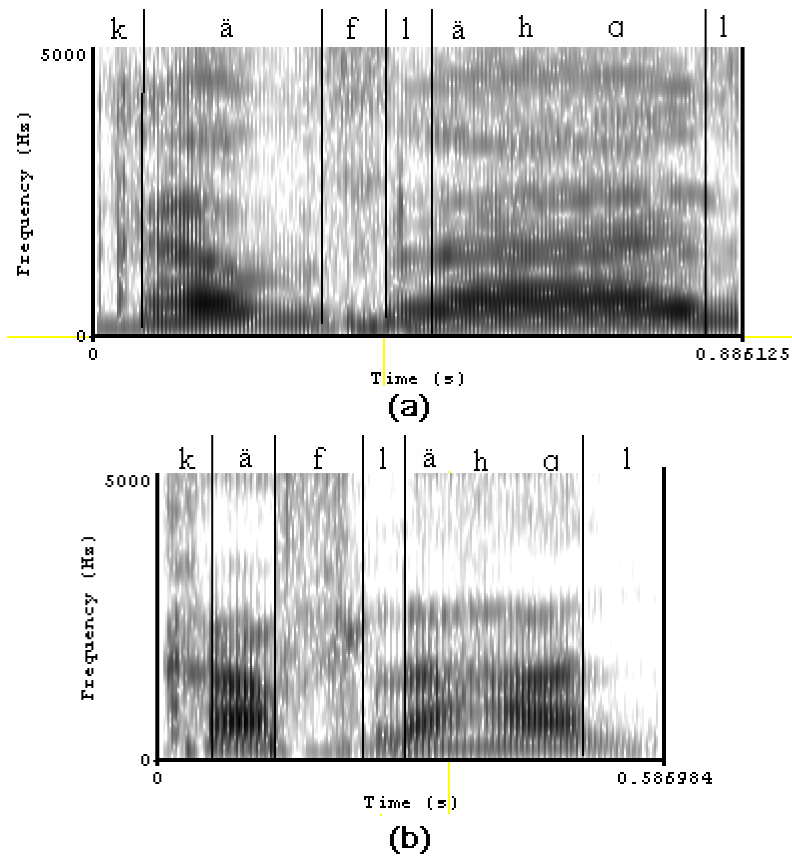
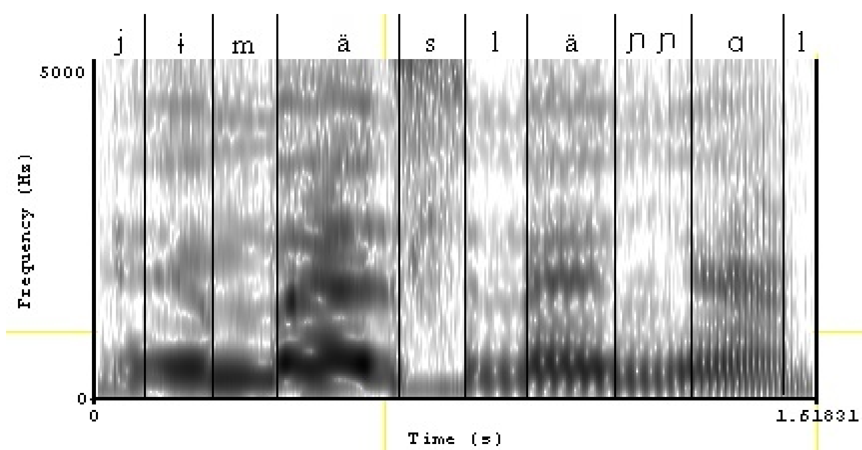


Figure 6 Spectrograms of the question /käflähɑl/ which means 'did you pay?' as produced by the patient (a) and in the 'normal' production (b).

The words in the spectrograms in **Figure 5** and **6** begin with voiceless stops (i. e., /t/ and /k/ respectively). In the normal productions of /t/ and /k/, there are blank spaces (although the space is small in the case of /t/) followed by a very brief burst of static concentrated at higher frequencies. The same situation is also seen in the ejective /t'/. In the patient's production, however, there is no clearly appeared blank space in /t/, for example. His /k/, on the other hand, seems to have this blank space although it is not 'blank' in the real sense. The space is rather prolonged and followed by a relatively long burst of static concentrated at almost all frequencies.

The confusion that these sounds create on the spectrograms can be taken as a metaphor of the confusions that appear when we actually communicate with the patient. This is not a mere assumption; but rather proved experimentally. I had ten individuals listen to his speech and all of them said that they found his speech to be hardly intelligible unless the patient was able to speak in a bit louder manner and willing to repeat most of his utterances. This, though, is very difficult for him to do as he becomes easily tired.

A question may arise on why /h/, in **Figure 6**, is not segmented to show both its fricativeness and voicelessness. Is it because his speech is breathy voice (which is sometimes called murmured /h/)? Ladefoged (2001:124) addresses this matter by saying “an intervocalic /h/ as in "ahead" (in English), becomes voiced since during its production, the vocal folds are in the similar position”; that is why I found it difficult to draw a separating line between the vowels and /h/.



(a)

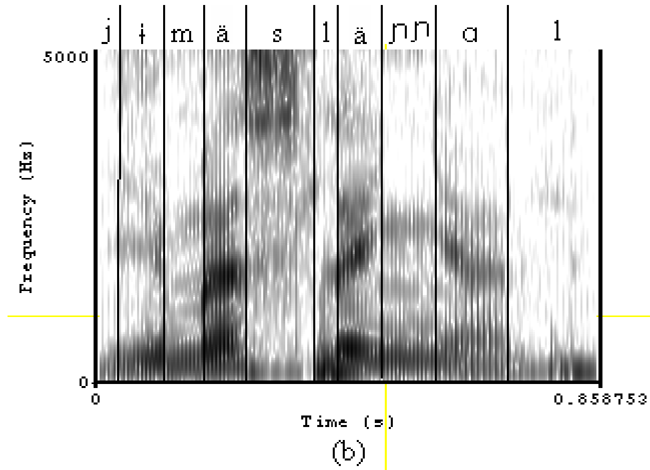


Figure 7 Spectrograms of the question /jɨmäsläɲɲɑl/ which means 'I think so' as produced by the patient (a) and in the 'normal' production (b).

3.2.1.3. Ejectives

Figure 5 above shows that the patient's ejectives are not strongly released. Normally, ejectives are produced with a glottalic eggressive airstream mechanism; and they are represented, on spectrograms, with a relatively blank space followed by a brief spike.

Furthermore, in the same spectrograms below, we observe a black area at the bottom for all of the sounds. However, the causes and degrees of blackness in (a) and (b) are quite different. In (b), it is very light and is a sign of noise energy, whereas in (a), it is the effect of the hypernasality as well as breath voicedness of the patient's voice.

3.2.1.4. Fricatives

To the contrary, the patient produces fricatives (particularly the voiceless ones) much better than the other clusters of consonants. This is because fricatives are produced as a result of a friction sound energy and do not require more energy. As shown in the spectrograms above (in **Figure 6** and **7**), the patient's /f/ and /s/ look like the 'normal' with little deviations.

3.2.2. The Acoustic Nature of Sonorants

The other cluster of consonants falls under the banner of sonorants, which includes nasals and approximants. And according to (Ladefoged, 2001:181) in nasal consonants, there is usually a very low formant (**F_1**) and although the location of the higher formants (**F_2** and **F_3**) varies, generally there is a large region above the first formant with no energy. The movements of formants for the approximant /j/ are like those in a movement away from a very short /i/ (pp, 181). Let us consider, in the following subsections, what the patient's nasals and approximants look like as compared to the 'normal' ones.

3.2.2.1. Nasals

The case of nasals is quite relevant to show the abnormal conditions of the patient's velum. As has been mentioned frequently in earlier sections, the patient's speech is of a hypernasal quality such that we find no abrupt change in the spectrogram at the time of the formation of the articulatory closure. If we look at the spectrograms in **Figure 4**, the normal productions of /n/ in /ʔɑnd/ 'one' and /gɨn/ 'but' are represented with a large region above $\mathbf{F_1}$ with out energy, whereas in the patient's production there is an extended energy above $\mathbf{F_1}$. The same is true for /m/ and /ɲ/ shown in **Figure 7**.

This fact, in accordance with the abnormal vowel nasalization discussed in one of the above sections, points to the claim that there is some sort of problem related to the muscles of the velum and/or to the nerve that innervates them. It could also be a breathing problem.

3.2.2.2. Approximants

The rationale behind treating the trill /r/, lateral /l/ and the approximant /j/ together is that in many literature they are grouped in a collective term as approximants. In fact, the term lateral can also be applied to other speech sounds to distinguish them from their central counterparts. In this case, lateral is used to refer to the central /l/ and not to the actual lateral /ɬ/. The major feature that describes the patient's /r/ is that it sounds more like /l/.

In normal first language acquisition process, children at some stage use /l/ in the place of /r/; and at a certain stage before they do this they, in most cases, use /j/ in the place of /l/. One of the attributes of speeches of individuals with dysarthria is that their speeches are like 'baby-talk' caused by motor control problems.

The primary properties that relate the patient's speech to the so-called 'baby-talk' are his speech is slow, distorted and he substitutes some sounds with others; and the substitutions are similar with what children do at different stages of their first language acquisition. As can be noted form **Figure 4**, he produced /bɨrr/ as /bɨll/. It might be difficult to tell, from the spectrogram, whether the geminated /r/ is pronounced as /l/ or not. But comparing the geminated /r/ in **Figure 4** with his /l/ in **Figure 6** shows the alteration. They are very similar. This substitution is not accidental but it is predictable. He pronounces /r/ as /l/ only when it is geminated in words like /t'ɨrr/ 'January' and /kɨrr/ 'thread'; and when it is single, as in the case of **Figure 4**, he produces a distorted /r/ since the distortion is a common to all of his sounds. One possible reason for this variation could be geminated consonants require a relatively strong muscular movements in order to exert more emphasis on a segment. As to /l/, nothing special is observed other than the regular distortion.

The approximant /j/[7], however, provides a big evidence for his abnormal speech. Below are spectrograms of the word Johannes (pronounced, in Amharic, as /johɑnnɨs/) as produced by the patient (a) and by the normal person (b). In fact, **Figure 6** has spectrograms of a word that starts with /j/ but it is not so stretched that it is difficult to see the deviation.

[7] I deliberately left out the case of the semivowel /w/ because its situation is very much similar to his production of /u/.

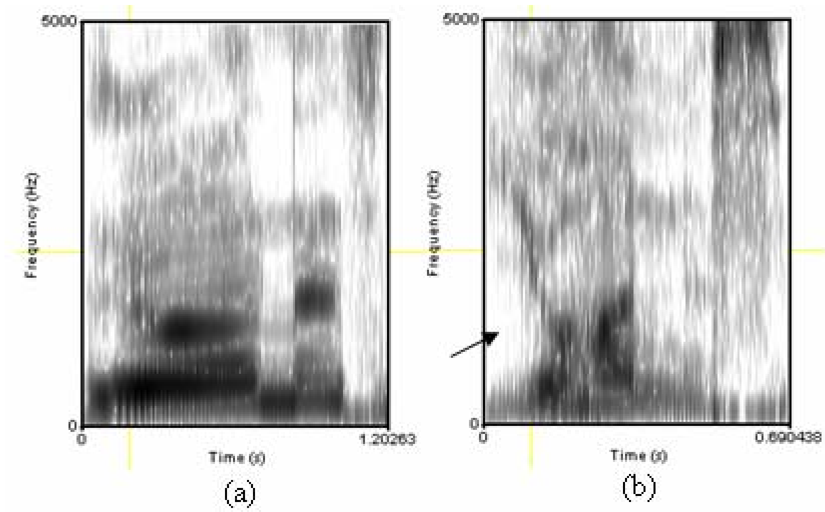


Figure 8 Spectrograms of the patient's name Johannes pronounced, in Amharic, as /johɑnnɨs/ as produced by the patient himself (a) and in the normal production (b).

In the normal production of /j/, there is an area between the first and the second formants with no energy. The arrow in (b) indicates this area. In the patient's production, however, this area is not as blank as it is in (b). Furthermore, it is difficult to mark the point where /j/ ends and the following vowel /o/ begins.

Thus far, the segmental aspects of the patient's speech have been analyzed. In other words, the chief consideration has been on the comparisons of the patient's vowels and consonants with the 'normal' conditions. The next chapter will concentrate on the other important aspect of speech namely, prosody. It will particularly be devoted to the discussions of intonation and duration.

CHAPTER FOUR

INTONATION AND DURATION

4.1. Aspects of Speech Laid on Segments

Consonants and vowels are referred to as segmental because, in principle, any utterance can be segmented into a finite number of non-overlapping consonants and vowels. Segments follow each other in time. Yet, speech involves more than stringing together these individual segments in a sequence. Suprasegmental features (prosodies) are other aspects of speech laid on top of a segment or group of segments.

We define segments in terms of place and manner of articulation, states of the glottis, and air steams mechanism, but we can not do the same for suprasegmentals because they are supplementary elements that change the voice quality of utterances. The idea of prosody (suprasegmental) basically includes duration, stress, tone, pitch accent and intonation. The objective of this work is not to treat all of these notions. Rather focusing on two of them, namely, intonation and duration with reference to the patient's speech.

4.2. Intonation: Types and Uses

By intonation is meant the way physical or prosodic parameter of fundamental frequency is perceived as regular pitch patterns across a sequence of speech units (Botinis, 1998). In other words, there is a constant change in the pitch of the voice when we utter sentences. The difference between speaking and singing is that in singing we hold a given note for a noticeable length of time and then jump to the pitch of the next note. But in speaking, there are no steady-state pitches (Ladefoged, 2001:99). The intonation of a sentence is, therefore, the pattern of pitch changes.

Different literature suggest, in general, that there are about four types of intonation pattern so far identified. These are: Rising intonation, that is, the pitch of the voice increases over time; falling intonation, that is, the pitch decreases with time; a dipping intonation, that falls and then rises; and a peaking intonation that rises and then falls. However, these intonation types are not the only ones; there are many different contours of intonation in languages.

Intonation is often thought of as being directly linked to the speaker's emotions. No doubt that emotions are expressed through intonation levels and it is for this reason that intonation is often referred to as iconic and must be studied in relation to the entire gestural setting, particularly in relation to facial expressions and expressive body languages. Lexical and grammatical meanings, along with body languages and all accompanying physical expressions, are expressed through intonation as well. Grammatical meanings like *focus*, for example. In Amharic (and in English too), contrastive emphasis is marked using an intonational accent. Consider the following sentence, for instance, /lämɨsɑje dɑbbo ʔɨfällɨgɑllähu/ which means 'I want **bread** for my lunch' (as opposed to 'injera'—a traditional Ethiopian staple food). In producing this sentence the speaker exerts extra pitch and therefore intensity on 'bread' as marking emphasis.

4.3. Some Notes on Amharic Intonation System

In order to clearly see the problems of intonation patterns of the patient's speech it is very important to have some understanding of Amharic intonation system. Alemayehu (1987) has labeled Amharic as an intonational language based on the function of pitch. He has also made a detailed description of intonation contours of different types of declarative, imperative and interrogative sentences. In this work, only some of the declarative and interrogative sentences of the patient in comparison with the normal trend will be examined.

With regard to declarative sentences, there are at least five different ways of supplying the declarative sentences with intonation (for further discussion, see Alemayehu, 1987:106). The pattern of the pitch differs depending on which constituent of a statement is given more prominence. As mentioned above, among the five types of declarative sentences presented by Alemayehu, this work only considers what he calls Declarative I. The contour of Declarative I sentence is a simple assertion statement. The pitch begins at a somewhat low level and rises on the penultimate word and gradually falls to the speaker's base line. And declarative II sentence is represented by emphasis that the speaker wishes to put on a constituent of a sentence and by the rise associated to the emphasis (ibid). It is believed that these types of declarative sentences are enough to see the deviation of the patient's speech.

The other type of sentences to be considered is interrogatives. Like Alemayehu (1987:169) claims, in Amharic, there are two different ways of making question sentences: Either by making use of question words like /mɨn/ 'what', /lämɨn/ 'why' and so on; or by assigning specific intonational features to otherwise structurally affirmative constructions resulting in the different Yes/No questions (ibid). Though there are different types of questions constructed by using question words and intonation pattern, in this work, we will only be looking at one sentence for each. This is because the main purpose of this work is just to show the fact that the patient's speech is deviant with respect to intonation and not to describe all of his intonation patterns in different types of sentences.

4.4. Intonation Patterns of the Patient's Speech as Opposed to the 'Normal'

With the discussion of intonation types and their associated meanings let us now examine what the patient's intonation patterns look like. Four utterances were extracted from the subjects' speech for analysis. Two of them are declarative sentences, and the other two are interrogative sentences. Below are waveforms and Fo trajectories (fundamental frequency graph) of an assertive sentence (i. e., Declarative I).

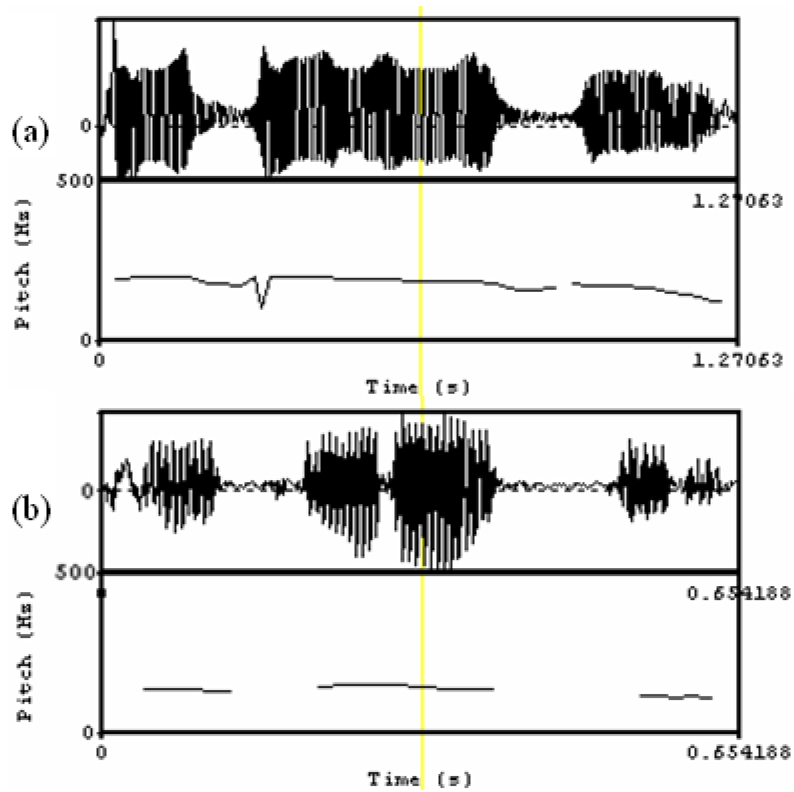


Figure 9 Waveforms and pitch graphs of a sentence /tät'ärɑtt'ärku/ glossed as 'I doubted' produced by the patient (a) and by the normal person (b).

In the figure above, the pitch graph, below the waveform, designates the pitch contour of the sentence. In this figure, the patient produced the statement /tät'ärɑtt'ärku/[8] just to declare the fact that he was not certain of something. In other words, the sentence, according to Alemayehu (1987:107), falls under Declarative I. The normal pattern of intonation for Declarative I, as mentioned above, starts with a fairly low pitch and finally falls to the speaker's base line. This is exactly what is seen in (b); but in (a), the pitch starts to go downwards at the start of the last syllable, that is, /-rku/ and as a result it is not loud enough to be heard. In fact, /-r/ is in a better situation than /-ku/. In other words, towards the end, the pitch of the last syllable falls even below the patient's base line.

The fact that /-rku/ is not audible in the sentence being analyzed reveals one important problem about the patient's speech, that is, he is not able to produce sentences with their complete meanings. Because Amharic is one of the languages whose morphologies are very complex; and therefore there are elements, in these languages, that are suffixed and mark grammatical meanings. So, in the patient's speech, it is possible and even probable for these elements not to be heard, which, in turn, makes his speech less intelligible. In this particular case, for example, /-ku/ marks person and number, as mentioned in the footnote, and yet does not have sufficient pitch that would enable it to be heard by normal human ear.

Technically when one sound has an intensity of 5 dB greater than another, it is approximately twice as loud; and a change in intensity of 1 dB is a little more than the

[8] This statement seems just one word because all the elements that mark different grammatical meanings are fused together. The suffix /-ku/, for example, marks person (i.e., fist person) and number (i. e., singular).

just noticeable difference in loudness (Ladefoged, 2001:165). In the above sentence, the mean intensity is 81 dB, and the mean intensity of the last syllable is 75 dB. It appears, therefore, that the last syllable is more than twice quieter than the average intensity for the entire sentence.

Similarly, the patient's /tt'/, too, has less intensity than the average. This shows that his speech is inaudible even for noticeable sounds like ejectives. And, as will be discussed latter, geminated consonants have a relatively higher pitch (therefore higher intensity) than their ungeminated counterparts. Yet in his production of geminated consonants, too, we observe similar problem of inaudibility. So his sentence can be written as [tät'ärɑ tt'ä↘rku].[9]

The other case where this deviation is also revealed more is in another declarative sentence (Declarative I): /jɨmäsläɲɲɑl/ glossed as 'I think so.' Below are the waveforms and pitch graphs of the sentence as produced by the patient (a) and the normal (b).

[9] Rising and falling intonations are marked by diagonal arrows—rising is marked by [↗] and falling by [↘].

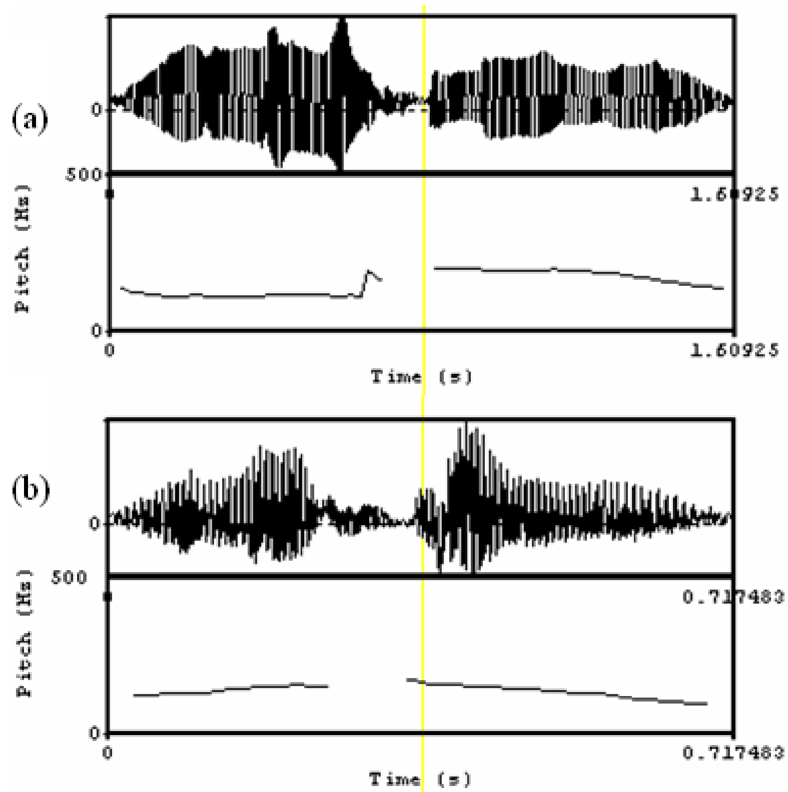


Figure 10 Waveforms and pitch Graphs of a Sentencese /jɨmäsläɲɲɑl/ glossed as 'I think so' produced by the patient (a) and by the 'normal' (b).

In the contours of the two productions of /jɨmäsläɲɲɑl/, there are at least two noticeable differences displayed in the pitch graphs. Firstly, the patient started the sentence with a raised but immediately falling pitch, but the normal pattern starts with a relatively low but rising pitch. Secondly, in (a) the pitch is raised all of a sudden at the middle of the second syllable (i. e., /-mäs-/) and immediately goes down at the end of the syllable. In relation to the second one, one might think that it is a kind of signal processing error committed by Praat, i.e., the software. However, it has been checked that it is not an error. This was done by zooming into the part of the signal that sounds abnormal and checking the flow of the harmonic waves. From what has been discussed so far, we can tell that the contour for a Declarative I sentence is abnormal. Let us now consider what the situation looks like in the case of questions.

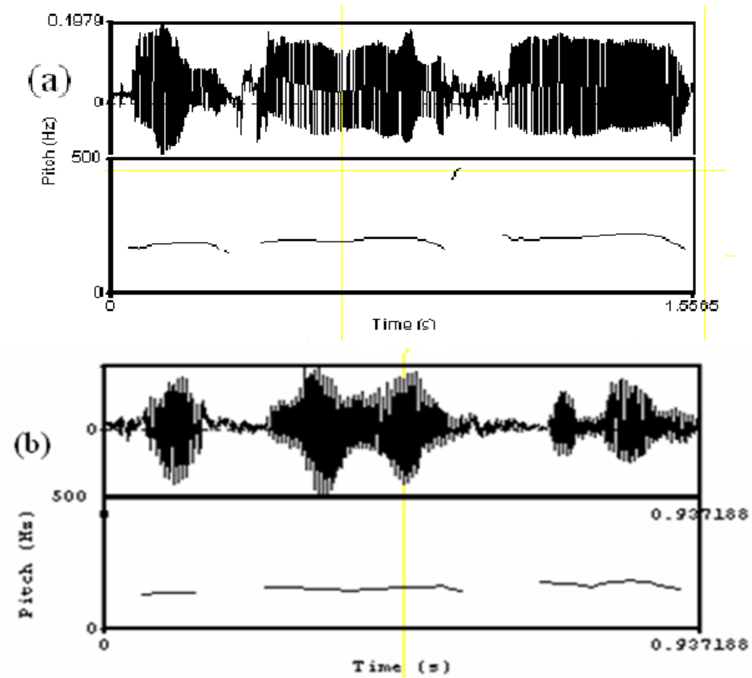


Figure 11 Waveforms and pitch graphs of a question sentence /käflähal siluɲ/ glossed as 'when they asked me whether I paid' produced by the patient (a) and the ‘normal’ production (b).

The above figure represents a question extracted from the patient’s narration. He was asking the researcher the question with an expectation of 'yes' or 'no' answer. As mentioned above, final falling pitch marks a ‘yes/no’ type of question in Amharic when the sentence is in a question form. The patient's intonation (i. e, (a)), seems to be normal and yet there is one deviation that we observe, that is, the Fo declines at the end of every intonation phrase. This is because he has a breathing problem which urges him to pause between segments.

Let us consider the intonation of another question sentence which strengthens the above assertions.

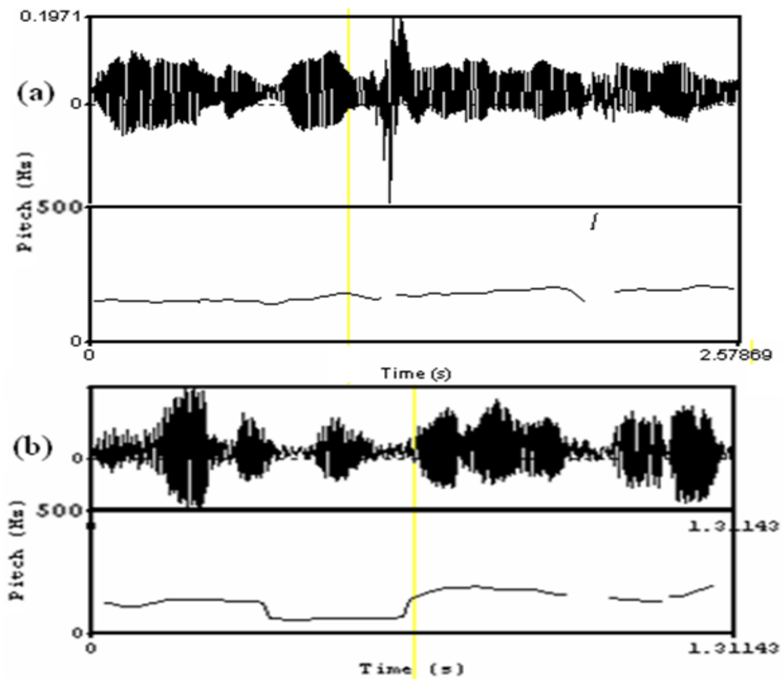


Figure 12 Waveforms and pitch graphs of a question sentence /ʔɨhe lɨdʒ ʔɨzi näw misärɑw[10]/ glossed as 'Does this guy work here?' produced by the patient (a) and by the 'normal' person (b).

The two productions are almost completely different in that (a) sounds purely a statement; whereas (b) sounds a genuine question. Among other things, the main reason for this difference is the final pitch patterns. One is falling and the other is rising. It is very natural for a question sentence like this one to end with a final rising intonation. The patient, however, sets the intonation the other way round.

In conclusion, from the discussions above it appears that it is very difficult, from his intonation patterns, to get what the patient exactly intends to mean. But it is relatively

[10] There are some differences between the patient's pronunciations of some of the words. He said /ʔɨhe/ to mean 'this', which is actually uttered as /jɨhe/, /ʔɨzi/ for /ʔɨzih/ glossed as 'here' and /misärɑw/ for /ʔɨ(jä)misärɑw/ which literally means 'who works (Masculine)'. Note that these are not errors made due to his physiological problem rather they are just facts found in any person's speech (usually in fast speech). They could also be considered as dialectal variations.

more effortless to grasp what he means from the context in which he utters sentences than in fragmented utterances like the ones just dealt with.

4.5. Duration

The term duration is often associated with the time a segment takes to be produced. On the basis of this assumption, we have terms like gemination and lengthening, to refer to consonant length and vowel length respectively. So, longer segments differ from their shorter counterparts with respect to a number of features. Among others, geminated segments are more audible and need more muscular actions than those which are ungemminated ones. Segment duration is predictably linked to speaking rate as other acoustic qualities (e.g. formant frequencies, rate of change in formant frequencies) change when speaking rate changes.

We, in normal fluent speech, alter our rate of speech dynamically and different people speak at different intrinsic rates; as a result, the physical duration of different parts of the speech signals including the durations of segments and syllables change with a change in speaking rate. In this section, an account of segment duration in the patient's speech will be given. Moreover, the time he takes to produce words, phrases and sentences in contrast with the 'normal' will be examined.

As has been mentioned in the previous chapter, the patient's speech is remarkably slow. This can be simply proved by looking at the times on the spectrograms and other displays of his speech as compared to the 'normal'. For example, the patient took 1.27063 seconds to produce the simple sentence /tät’ärɑtt’ärku/ ‘I doubted’ while the normal person took 0.654188 seconds for the same utterance. Similarly, the patient produced another simple statement /jɨmäsläɲɲɑl/ glossed as 'I think so' in 1.60925 seconds while the other person did it in 0.717483 seconds.

4.6. The Patient’s Duration vs the 'Normal'

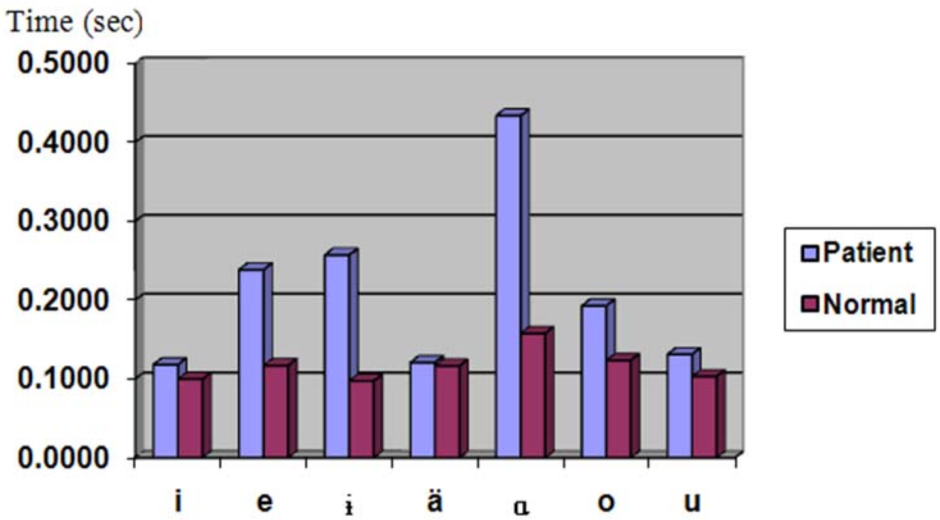
Since a segment (phoneme) is the smallest distinctive element that is capable of conveying a difference in meaning the discussion on speech duration (speaking rate) needs to begin with segment duration. This should be carried out by looking at the time a single segment takes in different words at different occurrences (initially, medially and finally) and in longer expressions and contrasting the patient's times with what we have been referring to as 'normal'. Yet, since, in Amharic, utterances which pretend to start with vowels actually begin with the glottal stop /ʔ/, which, in other words, means that we will not examine vowel durations at the initial position—only medially and finally. In addition, there is no word that ends with /ɨ/, so we will not have value for it at final position.

Disregarding individuals' variations in speech, all of the vowels of Amharic are 'short'. In other words, there is no word which is contrasted by vowel lengthening. Let us consider time differences in producing the seven Amharic vowels in the medial and final positions to see the scope of the abnormality of the patient's vowels in this respect. In the following table "M" stands for 'Medially' and "F" for 'Finally'.

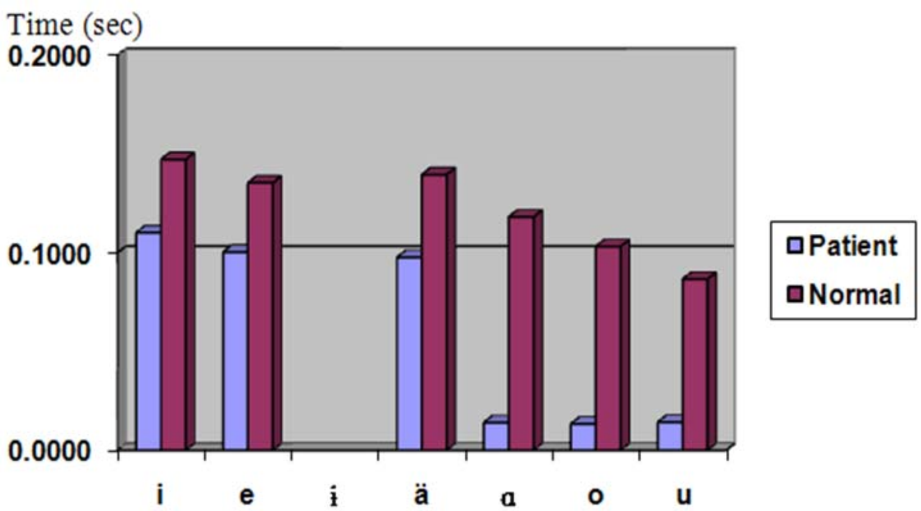
Vowel	Patient's production		'Normal'		Patient-'Normal'	
i	M	0.118197	M	0.099751	M	0.018446
	F	0.110045	F	0.147210	F	-0.037165
e	M	0.238560	M	0.117188	M	0.121372
	F	0.100340	F	0.135375	F	-0.035035
ɨ	M	0.257198	M	0.097527	M	0.159671
ä	M	0.120862	M	0.116667	M	0.004195
	F	0.097582	F	0.139501	F	-0.041919
ɑ	M	0.433873	M	0.157812	M	0.276061
	F	0.014062	F	0.118118	F	-0.104056
o	M	0.192772	M	0.123605	M	0.069167
	F	0.013331	F	0.103129	F	-0.089798
u	M	0.131216	M	0.103129	M	0.028087
	F	0.014250	F	0.086644	F	-0.072394

Table 5 Time differences (in seconds) between the patient's productions of the vowels and the 'normal' production.

Below are histograms that summarize the time differences stated in the above table.



Graph 3 Graphic representation of the time differences between vowel productions at word medial position by the patient and the 'normal' person



Graph 4 Graphic representation of the time differences between vowel productions at word final position by the patient and the 'normal' person.

From **Table 5** and the corresponding histograms that follow it, we can tell that the patient's speech is remarkably slow. In general, all of the patient's vowels are found to be longer than the 'normal' when they are pronounced medially. And all of them are shorter than the normal when they are pronounced finally. On average, the patient's vowels are abnormally longer by 0.096714 seconds when they occur medially; similarly they are abnormally shorter by 0.063395 seconds[11] when they occur finally.

It is true that the time that a single vowel takes might vary depending mainly on the type of sound that precedes or follows it. Considering the influence that this factor would put on the reliability of the comparison, the figures in the above table are averages of the times that every vowel (in both productions) takes when produced preceding and following different sounds.

Therefore, the average times, by which the patient's vowels are abnormally longer and shorter than the 'normal' prove the claim we have been making based on mere auditory observations. One important point that should be stated here is that his vowels are even shorter and inaudible when they occur finally in words that appear at the end of a longer utterance. This may be because of the inactive muscular coordination that result from his sickness; and may also be because the energy that comes out of his lungs is minimal and thus does not last long to produce longer utterances. For this reason, he takes brief pauses between sentences and some times within a sentence to reset his energy.

As to consonant durations, we can simply see the time differences between the two productions shown on the spectrograms in the previous chapter. Just to cite one instance from the data, consider the following waveforms where the word /bɨloɲ/ which would mean 'after he/it said to me' as produced by the patient (a) and by the ‘normal’ person (b).

[11] This figure does not account for /ɨ/ because this vowel does not have a value in final position.

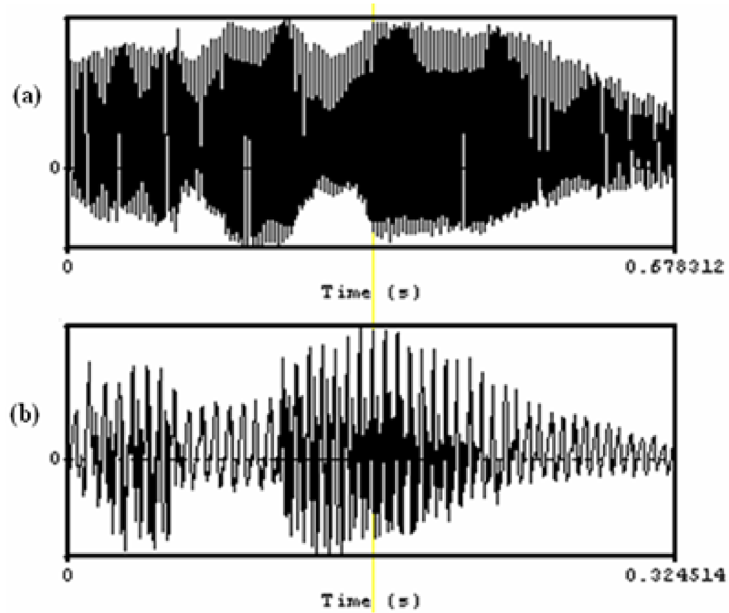


Figure 13 Waveforms of a phrase /bɨloɲ/ glossed as 'after he/it said to me' as produced by the patient (a) and the other person (b).

As can be vividly seen from the waveforms, the patient took 0.678312 seconds whereas the normal person took only 0.324514 seconds to produce the same utterance. This means that the patient used, for this particular utterance, almost twice a time used by the other person. Apart from the time variation, we can also observe the waves are very much squeezed together in the patient's production but they are relatively spread out in the other person's production. This is clearly because the same window length is used for both productions that have different durations.

Now let us look at the overall situations of the patient's speaking rate as opposed to the 'normal'. It is not surprising for different individuals to speak in various speaking rates. In spontaneous speech, some individuals speak in a fast way while others moderately and still some other people talk slowly. Although it would be difficult to label individuals' speech as 'fast', 'moderate' or 'slow' (because there are a range of speaking rates that fall in a continuum), there exists an average rate which integrates different rates of adult males' speeches.

Numerous literature provide different figures which correspond to the average speaking rate for adult male speech. However, most of the suggestions fall between 125-150 words per minute. To make use of this range as a reference scale we should be clear with what a ‘word’ is really supposed to mean. In languages like English where we have very simplified morphology, counting the number of words in a sentence is rather a simple task. This would not, however, be valid in languages which have complicated morphology. Amharic is one of the languages with complicated morphosyntax where a single word-like utterance can be a sentence. Therefore, trying to count the number of words uttered per minute would be difficult.

The best approach to know the problem of the patient’s speaking-rate is to look into some of his sentences and the normal person’s sentences which are of similar structures to the patient's ones and examine them from the perspective of time. By so doing, we can have a better picture of the problem of the patient's speaking-rate.

In view of that, it appears that his speaking rate and fluency get slower and slower as he speaks much for an already stated reason.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Thus far we have observed the extent to which the speech of a patient with flaccid dysarthria is deviant. His tongue, jaw and lip movement problems have been magnified by the acoustic data discussed on vowels. These facts are clearly seen in his vowel chart, and verified by the problem that the patient has in swallowing. When the researcher asked the patient whether he had chewing and swallowing problems he said the following: "Yes, I suffer from that. I chew slowly and if the piece of food is bigger than the usual ones, it is difficult for me to chew and swallow it."

His vowels were found to be confined to the center of his oral cavity and have a hypernasal quality. In fact, this abnormality is not only associated with his vowels; but rather his entire speech is hypernasal. The qualities of his consonants also showed how the problem is serious. They are so distorted that it is difficult to identify consonants on spectrograms. Moreover, suprasegmental aspects of his speech exhibit deviant patterns. His intonation counters are not in accordance with the normal pattern in that he can not adjust them so that they can convey the intended meaning. More importantly, the final patterns of his intonation are not normal and as a result there are cases where questions sound statements. One reason for this is that his breathing rhythm is not consistent.

Duration is also another area where we can clearly see the problems of his speech. The time he takes to produce segments has been found to be remarkably longer than the ‘normal’; his speaking rate, in turn is very slow. Thus, the fluency of his speech is in problem. He pauses now and then while speaking.

Perhaps I have to note that this work may not be considered as a conclusive one for a number of reasons. Firstly, it lacks data on other Amharic speaking dysarthric individuals. It would have been more conclusive if this work had considered a wide range of data. In fact, the researcher had made a great effort to find at least one more individual with the same type of disorder; unfortunately the patients that the researcher encountered were not victims of moterneuron diseases.

Secondly, this study lacks descriptions of the patient’s phonology, morphology, syntax, semantics and even pragmatics and discourse. These elements of the patient’s speech would provide a complete profile of the patient's speech/language. But the scope of the study and time constraint did not allow.

Having pointed out some important gaps for further research, the researcher would like to tip dysarthric patients with regard to what they are advised to do. Below are some of the techniques and steps suggested in the literature:

- introduce your topic with a single word or short phrase before beginning to speak in more complete sentences
- speak slowly and loudly; pause frequently
- check with the listeners to make sure that they understand you

- try to limit conversations when you feel tired, because your speech will be more difficult to understand
- try to use other methods, such as pointing or gesturing, to get your message across, or take rest and try again later

To make these exercises more meaningful and since interpersonal communication involves two persons (i.e., speaker and listener), a couple of points are also forwarded by way of advice to other people who communicate with dysarthric individuals. These are:

- control the communication environment by reducing distractions
- pay attention to the speaker (a person with dysarthria) and watch him/her as he/she talks
- be honest and let the speaker know when you have difficulty understanding him/her
- repeat the part of the message that you understood so that the speaker does not have to repeat the entire message
- if you are unable to understand the message after repeated attempts, ask yes/no questions or have the speaker write his/her message to you.

These recommendations are just from the point of view of communication. A dysarthric patient also needs to have methods and practices that help him/her improve his/her overall wellbeing. In this regard, there are a number of drugs and other medications suggested depending on the severity and the source of the problem. As to the speech difficulty, the main center of attention of therapy for dysarthria is maximizing the role of all systems necessary for speech processing and more specifically on those identified as affected.

It is also essential not to be hesitant to consult professionals whenever abnormal feelings happen around the vocal tract and, of course, anywhere in the body. Because the feelings might be manifestations of the diseases that would cause dysarthria. If this is done on time, there is a high possibility to control it if not to cure it completely.

As a final point, since a considerable number of Ethiopians lack awareness of such cases, they are reluctant to see clinicians primarily because they trust that speech/language disorders would not be addressed scientifically. As a result they try to treat such problems traditionally and spiritually. Traditional and spiritual medications of the people may not be undermined. However, scientific methods are grounded on more concrete experimental judgments and are therefore more reliable than just mere assumptions and myths, which might have worked in a certain situations but not in a sustainable way. Hence, trying to treat the problem traditionally based on these irrational and unjustified ideas may worsen the case and even eventually would lead to a situation which would not otherwise be cured.

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WWW SOURCE

http://www.stayinginshape.com/3osfcorp/libv/p21.shtml

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for degree in any university and that all sources of materials used for this thesis have been duly acknowledged.

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This thesis has been submitted with my approval as a thesis advisor.

Name ______________________________

Signature ___________________________