Dedicated to

MY BELOVED BROTHERS

CHINTUAND MINTU

&

MYSHANKY

CERTIFICATE

This is to certify that Dissertation entitled ACOUSTIC ANALYSIS OF INTONATION IN NORMALS AND DYSARTHRICS : DECLARATIVE STATEMENTS AND YES - NO QUESTIONS is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Register No. M 9723.

Dr. (Miss) S.NIKAM
Director
ALL INDIA INSTITUTE OF
SPEECH AND HEARING
MYSORE-570 006.

Mysore
May, 1999.

CERTIFICATE

This is to certify (hat the Dissertation entitled ACOUSTIC ANALYSIS OF INTONATION IN NORMALS AND DYSARTHRICS: DECLARATIVE STATEMENTS AND YES - NO QUESTIONS has been prepared under my supervision and guidance.

Dr. R. MANJULA
(Guide)
Lecturer, Department of
Speech Pathology,
ALL INDIA INSTITUTE OF
SPEECH AND HEARING,
MYSORE-570 006.

Mysore.
May, 1999.

ACOUSTIC ANALYSIS OF INTONATION IN NORMALS AND DYSARTHRICS: DECLARATIVE STATEMENTS AND YES - NO QUESTIONS.

Vandana(S)
Reg No. M 9723

A Dissertation Submitted as part of fulfillment for the final year M.Sc. (Speech and Hearing) to the University of Mysore.

ALL INDIA INSTITUTE OF SPEECFI AND HEARING
MYSORE-570 006

May, 1999.

DECLARATION

This Dissertation entitled ***ACOUSTIC ANALYSIS OF INTONATION IN NORMALS AND DYSARTHRICS: DECLARATIVE STATEMENTS AND YES - NO QUESTIONS*** *is the result of my own study under the guidance of Dr. R. Manjula, Lecturer, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other Diploma or Degree.*

Mysore.
May, 1999.

Reg. No. M 9723.

ACKNOWLEDGMENTS

First and foremost, 1 would like to express my deep sense of gratitude to my guide and teacher, **Dr. R.MANJULA** for her constant support, guidance inspiration and concern that made this study possible. Thanks for being with me ma'am, for patiently listening to my doubts, constantly encouraging me and giving me valuable suggestions.

I thank Dr. (Miss) **Nikam,** Director, All India Institute of Speech and Hearing, Mysore for having given me the permission and opportunity to undertake this dissertation.

I am indebted to all **my Teachers** for the foundation they have given and the faith they have in me.

1 would like to extend my sincere gratitude to **Mrs. Indira Prakash** for her timely help in recording the test items. Ma'am without you, this dissertation would not have been possible.

I am indebted to **Dr. Venkatesh** for helping me in statistical analysis.

I extend my sincere gratitude to **Suchitra Ma'am, Sujatha Ma'am, Vijayashree Ma'am and Pusha Ma'am** for their timely help.

A special thanks to all the **subjects** who cooperated in testing and made this study a reality.

Sandeep, Archana, Arul, Selva, Hema, Shantha, Anandhi, Uma, Mili, Ramya, Vimi, Namitha, Delcy, Savitha, Mamatha, Rakhee, Vani, Sonia,Sarah and Pallu - In this busy world, not many people extend their **helping** hands. Thank you very much for helping me during analysis.

Amma and Anna: To you I humbly owe for what I am today.
Not a volume of words would suffice to say of my pride and joy
in being of you to the very end of my existence **I will Love you.**

Shankar You are Unique and you are special too.
There is no one else who is quite like you
warm thoughts of you just seem to bring,
A cheerful touch to everything.

You have been a source of encouragement, my tower of strength, my best friend, my companion and the most wonderful person I will ever know. Thank you so much for being there for me always.

Chintu and Mintu: No words can explain what you mean in my life and will be there for you forever.

Vaishnavi: Thank you so much for your love, affection and thoughtfulness, you have shown towards me.

Thatha, Atha and Mama: It's your silent prayers and blessings which has given strength to complete my studies.

Meera Aunty, Uncle, Kamu and Sony: Thank you for your hospitality, love and affection you have shown me during my stay at AlISH.

Viji, Arthi,Jayashree, Vijima,Suman & Reena: You are the kind of friends I would like to be to others. I miss you all a lot.

Anjana, Radhika and Sridevi: I shall ever be indebted to you all for your friendship.

Anitha and Sabby: Thank you very much for lending me a helping hand whenever I needed.

Chaya, Purnima, Jaya & Prachi : The very little time I have spend with you were the times I loved most. Thank you for all those beautiful moments especially your friendship which has added colour to my life.

Hia, Sanyu, Chandan , Sapna and Krithika: Thank you very much for helping me during the course of my studies.

I would like to thank all my **classmates** for their timely help and support.

Last, but not the least, I would like to thank **Mrs. Manjula & Mr. Kumar** for their tireless effort and neat work which has given life to the study of mine.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Speech is a unique dynamic motor activity through which we express our thoughts, emotions, respond to and control our environment (Duffy, 1995).

The meaning of the spoken utterance can be understood completely without any ambiguity, only when an individual identifies not only the spectral quality of speech segments (vowels, consonants and semivowels) but also its frequency, amplitude and time variation ie., suprasegmentals. (Darwin, 1975).

Suprasegmentals, otherwise termed as prosody of speech is multifaceted. It is not a single homogenous entity, but has many features (Pitch, loudness, duration and pauses) and components (Intonation, Tempo, Stress and Rhythm) (Crystal, 1981).

Intonation, a component of prosody, is defined as, "variation in fundamental frequency as a function of time". (Collier, 1991). It is the salt of an utterance without it, a statement can often be understood, but the message is tasteless and colourless. Incorrect use of it can lead to embarrassing ambiguities (Delattre, 1963).

Among the prosodic features, intonation has been studied extensively. Many studies have indicated that intonation provides information regarding discourse, attitudes,

intentions and speech register (Brazil et al, 1980 and Crystal, 1982). These can be distinguished based on some typical pitch characteristics such as (i) rise or fall of Fo, (ii) Terminal F_o contour and (iii) overall contour. (Hargrove and McGurr, 1994). For example, literature indicates that more often Yes-No questions have a typical pattern of rising F_o contour compared to other interrogative types, and can be distinguished from statements where a falling F_o contour is seen (Magdics, 1963; Mickey, 1977; Dascalu, 1979; and Manjula, 1997).

It is well evidenced that many individuals with communication impairment due to hearing and neurological disorders have difficulty in producing the intonation patterns.

Phillips et al.(1968) reported that hearing impaired children have difficulty in producing an interrogative which has a terminal pitch rise as opposed to declaratives characterized by terminal fall. In dysarthrics, reduced variation in intonation difference compared to non dysarthric subjects has been reported (LeDorze et al, 1994 and LeDorze et al, 1998).

Dysarthria is a neurogenic speech disorder. It is a collective name for a group of related speech disorders that are due to disturbances in muscular control of speech mechanism resulting from impairment of any of the basic motor processes involved in speech execution (Darley, Aronson and Brown, 1975).

For the production of appropriate intonation, all the systems especially the respiratory and laryngeal systems should be intact (Hargrove and McGurr, 1994).

Dysarthria is caused due to lesion at various sites either the peripheral or central nervous system or both (Murdoch, 1990). This results in different speech deficits. Prosodic deficit, like other speech defects are common in dysarthric speech. It is believed that intervention strategies aimed at improving prosodic deficits will improve the overall speech intelligibility and speech naturalness. This in turn will reduce the handicap of the individual. (Barnes, 1983; Caligiuri and Murry, 1983; Murry, 1983; and Yorkston et al, 1983).

Attempts have been made to study whether the prosodic deficits seen in dysarthric speech are due to difficulty in comprehending the different prosodic patterns (Scott et al, 1984 and Speedie et al, 1990) or due to inefficient production. (Monard-krohn, 1947; Canter, 1963; Darley et al, 1969; Caekebeke et al, 1991; LeDorze et al, 1994 and LeDorze et al, 1998). Majority of the studies have found reduced prosodic values in dysarthrics and attributed it to impairment in speech production mechanism.

NEED FOR THE STUDY:

In dysarthrics, unlike, normals, the various components of prosody (Intonation, Stress, Tempo and Rhythm) has not Ween studied extensively. Since intonation serves

several communication roles and facilitates other dimensions of communication, it is very essential to know the pattern of intonation used in various structures and contexts of dysarthric speakers. It is also essential to know the type and extent of prosodic deviation in dysarthric speech. This in turn will help us in developing different assessment and treatment profiles to suit the individual needs.

AIM OF THE STUDY:

The aim of the present study was to analyze and compare the intonation patterns of Yes-No questions and declarative statements in the speech of dysarthrics and normal subjects.

METHODOLOGY

Twenty male subjects (10 normals and 10 dysarthrics) in the age range of 40-86 years who were age matched were asked to imitate forty model utterances of Kannada language (20 Y-N questions and 20 declarative statements). Only those imitated questions and statements which were ruled out for speech dysfluencies or other deviations were chosen for acoustical analysis.

Acoustical analysis was carried out to obtain speech waveform, F_o curve, relative intensity and duration of the Y-N questions and declarative statements using the

speech analysis software program (VAGHMl) of voice and speech systems (VSS). The results were compiled and discussed under following sections.

I a) The Maximum and Minimum F_o in Y-N questions and declarative statements.

b) Range of F_o and Variation in F_o in the Y-N questions and declarative statements.

II. Mean F_o of initial syllable versus Fo of terminal syllable for Y-N questions and declarative statements.

III. Mean F_o of the terminal word and terminal syllable in Y-N questions and declarative statements.

IV. Terminal Fo contour in Y-N questions and declarative statements.

V. Declination of F_o in Y-N questions and declarative statements.

IMPLICATION OF THE PRESENT STUDY

1. The study provides an insight into the variation in intonation patterns seen in normals and dysarthric speakers for the Y-N questions and declarative statements.

2. The study can be replicated with different types and severity of dysarthria. This in turn will enable comparison of intonation pattern in the subgroup of dysarthria.

LIMITATION

1. The severity of the dysarthria is not controlled.

2. Only male subjects are taken up for the study.

3. Subjects imitated the model utterances. Hence the speech sample is limited to a simulated context only.

REVIEW OF LITERATURE

Language is a set of arbitrary symbols used to communicate thoughts and ideas. Language is expressed in various forms. Speech is one of the most important and characteristic form of language used in a human being. The sounds of speech are referred to as the segmental features. There are other features involved to indicate the way in which the segments are said.

These include loudness variations, pitch variation, duration changes, voice quality and others. Such features usually are extended over utterances longer than one sound and are hence referred to as Supra segmentals or Prosodic features (Cruttenden, 1986).

Intonation is one aspect of prosody. It is defined as " the perception of changes in the fundamental frequency of vocal fold vibration" (Netsell, 1973). According to Grunwell and Huskins (1973), intonation not only implies a neurophysiological change in vocal fold vibration, but it is also a linguistically based parameter. Intonation has the following communicative roles.

(a) It can be used to convey attitudes such as warning, boredom, surprise and neutrality (Crystal, 1982).

(b) Brazil et al. (1980) claim that speakers use intonation to signal whether information is new or old.

(c) Intonation also has grammatical function (Hargrove and McGarr, 1994).The normal terminal intonation pattern in a simple declarative and imperative sentence in English is falling and on the other hand, Yes-No questions have terminal intonation that rises.

(d) Intonation provides information about discourse and about speakers attitude (Brazil, 1980).

The role played by intonation in pragmatics of speech has attracted attention for a number of reasons. Linguists have been interested in characterizing different types of intonation pattern that exist, meaning conveyed by these patterns, the temporal relation of the F_o contour to the speech segments and the relationship between stress and syntax. Psycholinguists have examined intonation as an indirect source of evidence about the units of planning of speech and the parsing of speech. From application point of view it has been considered that the use of information carried by F_o could improve automatic speech recognition. Intonation also plays an important part in the intelligibility and naturalness of synthetic speech (Pierrehumbert, 1981). The relevance of indepth studies in this area is also contributory in correction of speech in the normal and abnormal population.

Stress, fundamental frequency, duration and intensity are related to intonation (Yorkston, Beukelman and Bell, 1988). Hirschberg and Ward (1992) investigated the four prosodic variables duration, amplitude, pitch range and spectral characteristics and found that pitch range contributed more in the interpretation of particular intonation contour followed by spectral characteristics. Amplitude and duration did not play a significant role in the interpretation of an intonation contour.

According to Hargrove and McGarr (1994), acoustically, intonation is an indicator of changes in fundamental frequency, perceptually, it is an indicator of changes in pitch and physiologically, it is the result of respiratory and vocal fold changes. Thus producing an intonation contour requires a good respiratory and phonatory control and is usually affected in neurological disorders.

Dysarthria is a neurogenic motor speech disorder which is characterized by a slow, weak, imprecise and uncoordinated movements of speech musculature (Yorkston, Beukelman and Bell, 1988). Both acoustic and perceptual studies show prosodic deviations as a primary characteristic feature in speech patterns of dysarthric individuals (Darley, Aronson and Brown, 1969; Rosenbek and Lapointe, 1988; Schlenck, Bettrich and Williams, 1993).

Intonation is no more considered as icing on the cake as in the earlier period. It makes a significant contribution to the naturalness of speech. (Darwin, 1975). Clinical

researchers have only recently begun to focus on the prosodic disturbances of dysarthria. Various assessment and intervention techniques are now available for studying the nature of prosodic disturbance. Keatley (1975), has suggested that an assessment of intonation could be done using Yes-No questions which appears to be sensitive to prosodic disturbance.

The questions or interrogatives in many languages are generally classified into four types (Schiffman, 1979; Shankarabhatta, 1978). They are

1. WH Questions: Here the information is sought from the listener using different question words like what, how, where, why, which, who, whom.

2. Yes-No Questions: Questions belonging to this category expect an Yes or No answer from the listener.

3. Alternate Questions: Here the listener has to choose from two alternate answers offered by the questioner through his questions.

4. Echo Questions. Questions which try to get confirmation from the listener by added structures such as "Isn't it?" "That's all" or in other words, questions where a questioner echoes his own utterance to confirm an answer which he expects are called the Echo questions.

Among the four question types, the Yes-No questions have an intonation which is distinctively different from other sentence types. They usually present a high F_0, there is suppression of declination phenomenon and there is a high terminal F_o contour. (Magdics, 1963; Bolinger, 1978; Cruttenden 1986; Patil, 1984; Gosy and Terken 1994).

This study attempts to study and compare intonation in Y-N questions and declarative statements uttered by normals and dysarthrics.

The relevant literature has been reviewed under two main sections.

(a) Intonation in Normals.

(b) Intonation in Dysarthrics.

INTONATION IN NORMALS:

In many languages, utterances are spoken on one expiration of breath, forming a breath group. (Jones, 1940 and Lieberman, 1967). The overall Fo shape in a breathgroup depends on the type of sentence. (O'Shaughnessy and Allen, 1983). They pointed out that the overall F_o shape in a breathgroup, for English utterance other than Y-N questions, starts at a relatively low level, rises rapidly on the first emphasized syllable and gradually declines to reach a very low level. In Yes-No questions, F_o differed from the typical pattern by falling less after the initial rise and rising rapidly at

the end to the highest level in the utterance. This has been referred to as declination by Cruttenden(1986).

Declination refers to the fact that the pitch of voice is most commonly lower at the end of the sentence than it is at the beginning (Cruttenden, 1986). This declination phenomenon has been observed in a number of languages especially for statements in Dutch (Cohen and t'llart, 1967), in English (Bolinger, 1964 and Maeda, 1976), in Italian (Magno-caldognetto, 1978) and in Japanese (Fujisaki, 1979).

Various methods have been proposed to study the declination phenomenon (1) Top line rule (Cooper and Sorenson, 1981) (2) Regression line view and zero line view (Ladd, 1983).

The regression line theory viewed declination as one which was manifested by abstract lines drawn through selected points (usually accent peaks) in actual contour. This approach has been followed by a number of investigators. (Thorson, 1979; Vaissiere, 1983; Cooper and Sorenson, 1981 and Manjula, 1997). According to this model, in questions, the declination phenomenon has been turned off by the speakers resulting in an upward sloping.

Several physiological evidences have been offered for declination phenomenon by various investigators. Eg: Decline in Transglottal pressure (Lieberman, 1967 and Hixon, 1971) (ii) Trachea pull (Maeda, 1976).

Vaissiere (1983) noted that, apart from suppression in declination phenomenon, a terminal rising contour was present in Yes-No questions. He also noted that the speakers had a tendency to use the lower F_o in a sentence when they ceased voicing. The final fall in F_o was accompanied by low intensity and by lengthening of the final elements which acted as a cue to the listener to indicate that the utterance was ending. However, speakers could counteract this tendency to convey linguistic information. The rise in terminal F_o contour was the most important feature distinguishing simple declarative from Yes-No questions. This was earlier reported by Majewski and Blasdell (1969) for polish and American English, Contini and Boe (1975) for French, Mickey (1977) for English, Magno-caldognetto (1978) for Italian, Nishinuma (1979) for Japnese, Dascalu (1979) for Romanian, Thorsen (1980) for Danish, Patil (1984) for Dharwad dialect in Kannada and Manjula (1997) for standard Kannada language and terminal falling F_o for declarative statement has been reported by Bolinger (1965) and Lieberman (1967).

Bolinger (1978) in a survey of 32 non tone languages, reported that 32 were found to have a terminal rise or overall higher pitch for questions. He further stated that Y-N questions had a falling intonation also. A Yes-No question can have a rise or fall depending on attitude or emotion.

In their experiment, O'Shaughnessy and Allen (1983) examined the effects of modality operators such as sentential adverbs, modals, negatives and quantifiers on F_o

pattern. These modality operators were chosen because they formed inherently contrastive classes which had varied tendencies to produce deviations in Fo contour. It was found that the important words in each sentence were marked intonationally with rises or sharp falls in F_o compared to gradual falling in unemphasized words.

Among interrogatives, a particular word was placed high. In WH questions, the interrogative pronouns were placed high, whereas in Yes-No questions, the F_o raised overall. They noted two major difference between Yes-No questions and other sentences.

1. The middle of the utterance exhibited only a very slight declination.

2. The F_o increased sharply on the last word to the highest level, rather than falling to the lowest level as in other sentences.

Thus, it can be noted from the literature that Y-N questions have high Fo, terminal rise in F_o and suppression of declination phenomenon as opposed to declaratives which are characterized by low F_o, terminal fall and declination of F_o contour.

INTONATION IN DYSARTHRICS

Dysarthria is a group of speech disorders resulting from disturbance in muscular control-weakness, slowness or incoordination of the speech mechanism due to damage to the central or peripheral nervous system or both. The term encompasses coexisting neurogenic disorder of several or all the basic processes of speech: Respiration, Phonation, Resonation, Articulation and Prosody (Darley, 1969a).

Prosodic deficits are common in dysarthric speech. Darley, Aronson and Brown (1969a), in their perceptual study ranked monopitch and monoloudness as the tenth most deviant speech dimensions among the thirty eight deviant speech dimension for all of the disordered group.

Since dysarthria can be caused due to lesion at various sites in either or both the peripheral and central nervous system, attempts have been made to find whether dysarthrics have deficits in comprehending prosody or in producing it.

Scott, Caird and Williams (1984) found deficits in the ability to recognize and produce anger and interrogation in Parkinsonism patients. They also had difficulty in discriminating affective and grammatical functions of prosody and matching speech with facial expression. They concluded that prosodic deficit seen in Parkinsonism is not simply the result of bradykinesia and rigidity in respiratory and laryngeal musculature, but due to deficit in comprehending the prosody.

Similar results have been reported by Speedie et al. (1990) in patients with Huntingtons disease. They used tape recorded speech filtered sentence and subjects were asked to indicate whether the tone of voice belonged to affective prosody or propositional prosody. They found Huntingtons disease patients had difficulty in comprehending both affective and propositional prosody.

These studies suggest that there could be involvement of subcortical structures contributing to deficits in prosodic comprehension. But the earlier perceptual studies carried out by Canter (1963) ; Monrad-krohn (1947) and Darley et al. (1969) suggested that, it is a disorder of vocal tract musculature. These results have been further supported by acoustic studies done on prosodic aspects in different types and severity of dysarthria.

Spectrographic analysis of speech of thirty patients with idiopathic parkinsonism disease by Darkins et al. (1988) showed marked reduction in pause duration and pitch contour when compared to normals. They found prosodic production abnormality without any significant loss of prosodic competence suggesting that knowledge of linguistic rules to make distinction is retained and concluded that it could be due to a faulty speech production mechanism.

Caekebeke et al. (1991) conducted a study which was mainly concerned with the verification of dysprosody in patients with Parkinsons disease. The subjects were asked to interpret the facial expression which was presented using cartoons and were also

asked to select appropriate cartoon for sentences presented. Subjects were asked to read the sentences which were in prepositional and affective prosody. Contradictory to Scott (1984), these subjects were able to appreciate emotion when it was visually or vocally presented. The study disagrees with the suggestions that Parkinsons disease is a more general disorder in the processing of emotion. They do support Scott's (1984) study stating that they have difficulties in producing appropriate loudness, pitch and duration.

LeDorze, Ouellet and Ryalls (1994) studied the intonation features of Yes-No questions versus declarative statement and that of speech rate in dysarthric speakers. They found that subjects produced lesser intonation differences than normals. Their speech was slower when compared to normals. Declarative sentences were produced a slower mean rate than interrogatives. The reduced intonation difference was attributed to Lieberman's breath group theory (Lieberman, 1967). According to this theory laryngeal tension needs to be increased near the end of an interrogative sentence inorder to compensate for reduction in pulmonary air naturally occurring near the end of an utterance. The reduced intonation difference could be caused by a loss of control in speech breathing or to a reduced ability of laryngeal structures to respond to the requirements of interrogatives.

Prosodic characteristics of speech of people with Parkinsons disease and Friedreich's ataxia were compared with normal speakers by LeDorze et al. (1998). The subjects had to repeat forty simple sentences of five-seven syllables in length

(Interrogatives and Declaratives) in natural manner as possible. The analysis of data showed that ataxic speaker had a slower speaking rate. They also found no difference in rate between normals and patients with Parkinsons disease. All the groups produced interrogatives at higher F_o and the variation was small in neurologically impaired group. The dysarthrics also had lower mean intonation difference. They concluded that eventhough both Parkinsons disease and ataxic dysarthrics showed prosodic deficiencies, their prosodic competence was intact.

From the review of literature, it can be concluded that like normals even dysarthric speakers can bring about changes in pitch and inflectional changes but the variation produced by them is less than that of normals. Also, the prosodic disturbance seen in dysarthrics are not due to loss of knowledge required to make prosodic disruption but due to an impairment in speech production mechanism.

METHODOLOGY

Intonation, a feature of prosody is extensively studied in interrogatives (Jones, 1909; Abe 1955; Danes, 1960, Patil, 1984 and Manjula, 1997) and declarative statements (Lieberman, 1967; Bolinger, 1964; Cohen and t'Hart, 1967; Fujisaki, 1979) uttered by normals. Review of literature indicates that dysarthric individuals exhibit poor control over prosodic variation, including intonation in speech when compared to normals. [LeDorze et al. (1994) and LeDorze et al. (1998)]. This study aimed at analyzing and comparing the intonation parameter in normal and dysarthric individuals for a set of Y-N questions and declarative statements.

OBJECTIVE:

The aim of the present study was to analyze and compare intonation in Yes-No questions and declarative statements in dysarthric and normal speakers.

HYPOTHESIS:

1. The intonation produced by dysarthrics is not significantly different from the intonation produced by normal speakers for both Y-N questions and declarative statements.

2. The intonation of Y-N questions is not significantly different from intonation of declarative statements produced by dysarthric speakers.

3. The intonation of Y-N questions is not significantly different from intonation of declarative statements produced by normal speakers.

A. SUBJECT:

Twenty male subjects (10 normals and 10 dysarthrics) with age ranging from 40-86 years were selected. All the subjects were native speakers of Kannada. The subjects were divided into two groups, Group I and Group II. Group I consisted of ten dysarthrics. The type and severity of dysarthria was determined by clinical appraisal and by using Frenchay dysarthria assessment (Enderby, 1980). The Group I consisted of five mild, three severe and two moderate category of dysarthria (9 spastic and one flaccid variety). The Group II consisted often normal speakers who were age matched with dysarthric speakers.

B. CRITERIA FOR SELECTION OF SUBJECTS:

(i) Criteria for selection of dysarthric speakers:

(a) Only those dysarthric speakers with confirmed diagnosis of dysarthria without co-existing disorder of aphasia or cognitive impairment were selected.

(b) The subjects who could speak standard dialect of Kannada with **a** minimum mean length of utterance of two to five words were considered.

(c) Subjects who has not undergone speech therapy or those who had attended speech therapy for less than two months were considered.

(ii) Criteria for selection of normal speakers:

(a) Subjects who did not have any neurological, hearing, or speech, language problems as assessed by an Audiologist and Speech Language Pathologist were considered.

(b) Subjects whose age, matched with the dysarthric speakers were chosen.

C. EXPERIMENTAL DESIGN:

Step I:

Ten declarative sentences in Kannada were selected. The mean length of utterance of these sentences varied from three to six words per statement. The same ten declarative sentences were used to elicit Yes-No questions. Thus twenty sentences were formed (10 declarative statements and 10 Y-N questions) [Appendix].

A 'Good speaker' was selected to serve as a model. The speaker was required to utter ten Y-N questions and ten declarative statements. The "good speaker" in this study was a qualified Speech Language Pathologist who also had experience in dramatics and a working knowledge in the area of "Prosody".

Three trials were given in total wherein the ten declaratives and ten Y-N questions were expressed three times. [10 Y-N questions + 10 statements (I trial) x 3 trials = 60 utterances (30 Y-N questions and 30 statements)]. The Y-N questions and declarative statements in all the three trials elicited were recorded in a random order.

Step II:

An Ahuja stereo tape recorder (model 4040S) with unidirectional mic was used. The mic kept at a distance of less than eight inches from the speakers mouth. While recording, appropriate gain was maintained and the deflection of then VU meter was monitored.

In order to check whether the model speaker had effectively expressed the declarative statement and Y-N questions, a pilot study was planned.

Pilot study:

The sixty utterances of the model speaker was played to five judges. The judges were Speech Language Pathologists with working knowledge in the field for not less than five years. The judges were not aware of the objectives of the study. Judges were asked to listen and indicate on a checklist provided by the experimenter whether the utterance was a statement or Y-N question or 'any other' (used as a distractor). The utterances were pre-recorded and played one by one with a gap of thirty seconds to allow the judge to indicate their choice. This task was carried out individually for each judge and without mutual consultation. Only those utterances of the model speaker identified as a Yes-No question and/or a statement by all the five judges were retained for the final analysis. These were considered as the model utterances. In total, forty model utterances were selected.

Step III:

Data collection:

(a) Task: The subjects in Group I and Group II were required to imitate the forty model utterances of the speaker.

(b) Recording: The recording of utterances by Group I and Group II subjects were carried out in a room with minimum ambient noise level.

(c) Presentation of the stimuli: Each stimulus sentence was printed on a card to provide graphic cues and the model utterances were presented through the headphones.

(d) Instruction to the subjects :

niivu iiga kelavu vaakyagaLannu iyar Phonina muulaka kelLisikollutira. Prati vaakyada modolu Ondu ganTeya shabda Kelisuttade. nimage KeeLisuva vaakyavannu nimma munde iTTiruva ciiTiya meeluu barediruttene. iiga niivu, nimage KeeLisuva vaakyavannu adu heege KeeLisuttadyoo haageyee heeLabeeku. modaleraDu vaakyagaLannu abhyaasa maaDoona arthavaaite? Shuru maaDooNavee?

"A set of sentences will be presented to you through head phones. You will be hearing a bell ring before each sentence. The sentence you hear through headphone will also be written on the card which will be placed in front of you. You have to imitate the sentence you hear in the same manner as it is said. We shall first try with two sentences. Have you understood? Shall we start now?"

If the subjects were unable to imitate with two trials, the instructions were repeated and more trials were given until the task was understood by the subject.

(e) Recording of the subject responses: The model utterances imitated by dysarthric and normal subjects were recorded using Ahuja stereo cassette tape

recorder model 4040S with unidirectional mic. The mic was kept at a distance of less than eight inches from the mouth of the speaker. While recording the gain was maintained appropriately and the deflection of the VU meter was monitored.

D. ANALYSIS OF DATA:

(a) Perceptual Analysis: The utterances imitated by dysarthrics and non dysarthric group was subjected to perceptual analysis. This was done in order to check if the subjects of both the groups were successful in imitating the model utterances. The sample was played to two judges. The judges were asked to listen and indicate on a checklist provided by the experimenter whether all the utterances, uttered by both the groups were fluent and if so, whether the utterances produced belonged to Y-N question or declarative statement or 'any other category'. Only those utterances of the subject judged to be appropriately imitated by the judges were further subjected to acoustic analysis. In total two hundred and seventysix utterances (77 statements, 76 Y-N questions imitated by normals, and 64 statements and 62 Y-N questions uttered by dysarthrics) were analysed.

(b) Acoustical Analysis:

(i) Instrumentation used for acoustic analysis:

The acoustic analysis was carried out using the following steps:

The speech samples were digitized using the speech interface systems of Voice and Speech system (VSS) at a sampling rate of 16KHz using the program 'Record ' of VSS software. Digitized data was stored on the hard disk of the computer. The 'INTON' program of VAGHM1 software package of Voice and Speech Systems (VSS) was used to extract the fundamental frequency and intensity readings of the sample. The extracted F_o and I_o for each utterance was stored on the hard disk of the computer and displayed on the screen of the computer. Printout for F_o I_o curves and waveform were obtained using a printer. The tabulated values of F_o and I_o at every ten milliseconds was also obtained using the software package.

Most of the studies use syllable as a fundamental unit (Mermelstein, 1975; Manjula, 1997). Therefore, in the present study syllable was considered as a basic unit for further analysis.

The aimsof this analysis were

(1) to locate the syllable boundaries of all the syllables of the sample.

(2) to tabulate the average frequency, intensity and duration of the syllable.

The following parameters were collected using the analyzed speech sample in normals and dysarthric speakers.

I. (i) Maximum and Minimum F_o in Y-N questions and declarative statements.

(ii) Range of Fo and Variation in F_o in Y-N questions and declarative statements.

II. Mean F_o of initial syllable versus terminal syllable in Y-N questions and declarative statements.

III. Mean F_o of terminal syllable and terminal word in Y-N questions and declarative statements.

IV. Terminal F_o contour in Y-N questions and declarative statements.

V. Declination of F_o in Y-N questions and declarative statements.

STATISTICAL ANALYSIS:

The raw data was subjected to statistical analysis. Unpaired t test was applied whenever found appropriate. The results and discussion are presented in the following chapters.

RESULTS AND DISCUSSION

The aim of the present study was to analyze the intonation features in sentences uttered as Yes-No questions and declarative statements by normal and dysarthric subjects. The Yes-No questions and declarative statements uttered by these subjects were subjected to acoustic analysis in order to extract the following features of intonation.

I a) The Maximum and Minimum F_o in Y-N questions and declarative statements.

b) Range of F_o and Variation in Fo in Y-N question and declarative statements

II. F_o in initial syllable versus F_o of terminal syllable in Y- N questions and declarative statements.

III. Mean F_o of terminal word and terminal syllable in Y-N questions and declarative statements.

IV. Terminal F_o contour in Y-N questions and declarative statements.

V. Declination of F_o in Y-N question and declarative statements.

1 A: **Maximum and Minimum F_o in Y-N questions and Declarative statements:**

Maximum F_O: It is the highest F_o value in an utterance.

Minimum Fo : It is the lowest F_o value in an utterance.

TABLE I: Mean and SD of Max F_o, Miu F_o and F_o Range in declarative statements and Y-N questions in normals and dysarthrics . [Within Groups

	NORMALS			DYSARTHRICS		
Variable	Max F_o in Hz	Min F_o in Hz	F_o Range in Hz	Max F_o in Hz	Min F_o in Hz	Fo Range in Hz
Statement						
l.N	77	77	77	64	64	64
2. Mean	226.79	1 18.00	109.01	182.98	110.53	70.20
3. SD	40.51	14.00	43.66	30.31	31.74	28.24
Questions						
l.N	76	76	76	62	62	62
2. Mean	264.26	138.40	125.78	199.16	124.48	82.42
3.SD	49.36	21.96	39.52	35.42	15.80	27.59
t - score	Sig.at .01 level	Sig.at .01 level	Sig.at .05 level	Sig. at. 01 level	Sig.at .01 level	Sig.at .05 level

From Table 1 and Fig 1, it can be seen that questions are produced with a relatively higher F_o than declarative statements in normals and dysarthric group. In

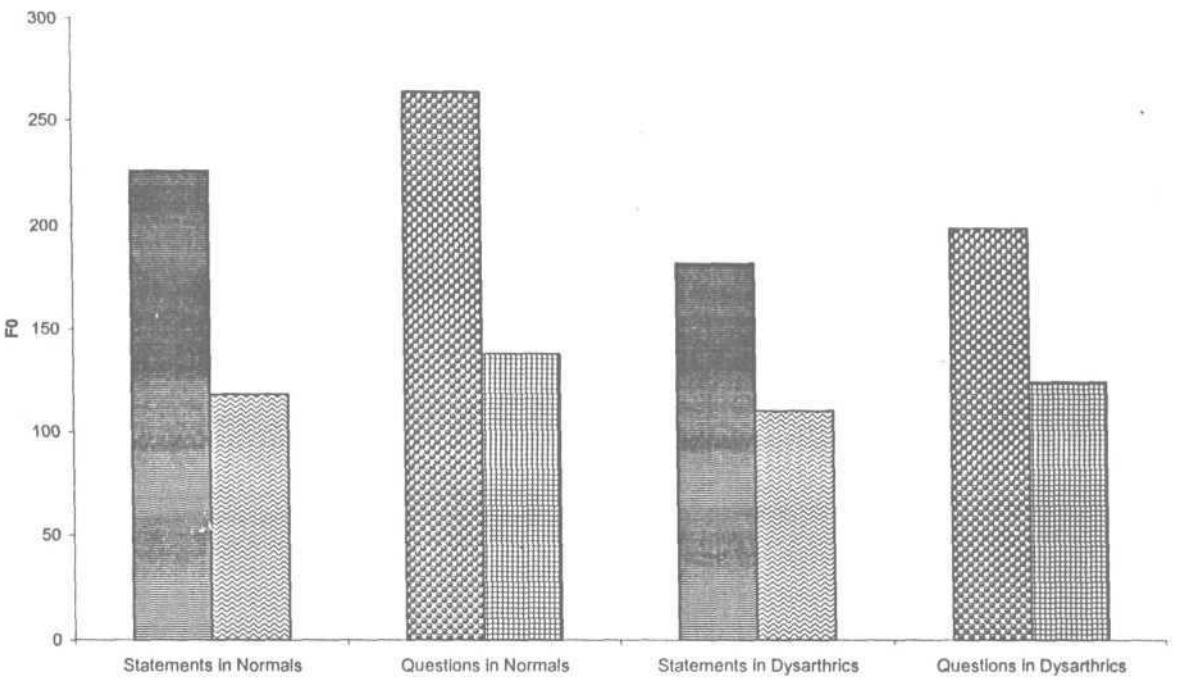
normals, the Maximum and Minimum F_o value for questions are 264.26 Hz and 138.40 Hz respectively which are significantly higher than Max F_o of 226.79 Hz and Min F_o of 118Hz for declarative statements. Similarly in dysarthrics, the Maximum and Minimum F_o for questions are 199.16Hz and 124.48Hz which are significantly higher than declarative statements where the Maximum F_o is 182.98HZ and Minimum F_o is 110.53Hz.

It has been reported by O'Shaughnessy, and Allen (1983) that in English, statements start with a relatively low F_o than Y-N questions.

The increased F_o in question could be attributed to increased laryngeal tension and increased subglottal air pressure as reported by Lieberman et al. (1967).

Even though dysarthric speakers produce questions with a relatively higher F_o than declarative statements, the Maximum and Minimum F_o found to be lower when compared to normals. The Maximum F_o and Minimum F_o for declarative statements in normals are 226.79Hz and 118Hz respectively which are significantly higher than the declarative statements produced by dysarthrics where in the Max F_o is 182.98Hz and Minimum F_o is 110.53Hz . Similarly for questions, in normals, the Max and Min F_o are found to be 264.26Hz and 138.40Hz respectively. Whereas in dysarthrics the Max F_o and Min F_o are found to be 199.16Hz and 124.48Hz respectively. (Fig I and Table II).

FIG :1 MEAN OF MAXIMUM AND MINIMUM F0 IN STATEMENTS AND QUESTIONS IN NORMALS AND DYSARTHRICS



MAX F0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

MAX F0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

MIN F0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

MIN F0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

TABLE U: Mean and SD of Max FoMinFo and F_o Range in declarative statements and Y-N questions in normals and dysarthrics [Between Groups

Declarative statements					Y-N questions			
Variables	N	Max F_o in Hz	Min F_o in Hz	F_o Range in Hz	N	Max F_o in Hz	Min F_o in Hz	F_o Range in Hz
Normals	77				76			
Mean		226.79	118.00	109.01		264.26	138.40	125.78
SD		40.51	14.00	43.66		49.36	21.96	39.52
Dysarthrics	64				62			
Mean		182.98	110.53	70.20		199.16	124.48	82.42
SD		30.31	15.80	28.84		35.42	31.74	27.59
t -score		Sig.at .01 & .05 level	Sig.at .01 & .05 level	Sig.at .01 & .05 level		Sig.at .01 & .05 level	Sig.at .01 & .05 level	Sig.at .01 & .05 level

According to Huttart (1968), increased fundamental frequency is directly related to the fundamental frequency of vibration of vocal folds. This requires certain physiological adjustments like increase in vocal fold length (Hollien and Moore, 1960); decrease in vocal fold thickness (Hollien, 1962); an increase in vocal fold elevation tilt (Hollien and Curtis, 1962); an increase in subglottal pressure (Ladefoged and Mckinney, 1963) or combination of these physiological changes.

In dysarthrics, the low pitch could be attributed to insufficient physiological adjustments. Darley, Aronson and Brown (1969b) attribute the presence of low pitch in dysarthrics to the hypotonicity of the laryngeal structures.

I B. Range of F_o and Variation in F_o in Y-N questions and declarative statements.

Range of F_o :

Range of F_o in a given sentence type is the difference between the maximum and minimum F_o values.

In normals, the maximum and minimum F_o values in an utterance are fluctuating and extensive, thus giving the perceptual picture of a well intoned' utterance associated with the normal use of other supra segmental factors. However in dysarthrics, the perceptual studies show a reduced range of F_o fluctuations (Darley, Aronson and Brown, 1969a,b).

In the present study, the mean F_o range for questions is found to be higher than declarative statements for both the groups. (Table 1). The Mean F_o range for questions in normals is 125.78Hz which is significantly higher at 0.01 level than mean F_o for declarative statements which is 109.01Hz. Similarly, a significant difference in mean F_o range at 0.01 level is seen for questions and declarative statements in dysarthrics. The mean Fo range is 82.42Hz for questions and 70.20Hz for declarative statements.

From Table 11 it can be seen that the range of F_o used by dysarthrics are significantly lower than normals for both the sentence types. Dysarthrics use a narrow range for Y-N questions and declarative statements. In Yes-No questions, dysarthrics use a range of 27-154Hz with a Mean F_o range of 82.42Mz which is significantly lower

than the range of 50-226 used by normals with the Mean of 125.78Hz. Also in declarative statements, dysarthrics use a range of 22-153Hz with a Mean of 70.20Hz as opposed to normals, who use a range of 39-196Hz with Mean F_o range of 190.01Hz.

It has been claimed in the literature that one of the functions of pitch range is to indicate degree of speakers involvement. That is, larger pitch range indicate a greater degree of involvement and smaller pitch range indicate a smaller degree of speaker involvement (Bolinger, 1986 and Hirschberg and Ward, 1992).

In Yes - No questions, the questioner expects an answer. Here there is a greater involvement on the part of the speaker, hence the range is wider when compared to declarative statements, where an answer is not expected resulting in a narrow range.

The production of wider pitch range requires good coordination laryngeal structure movements. These movements are affected in dysarthrics and hence a narrower range is seen in them. Darley Aronson and Brown (1969a, b) attributed the reduced F_o range to reduced range of muscular movements in laryngeal structures.

Variation in F_o

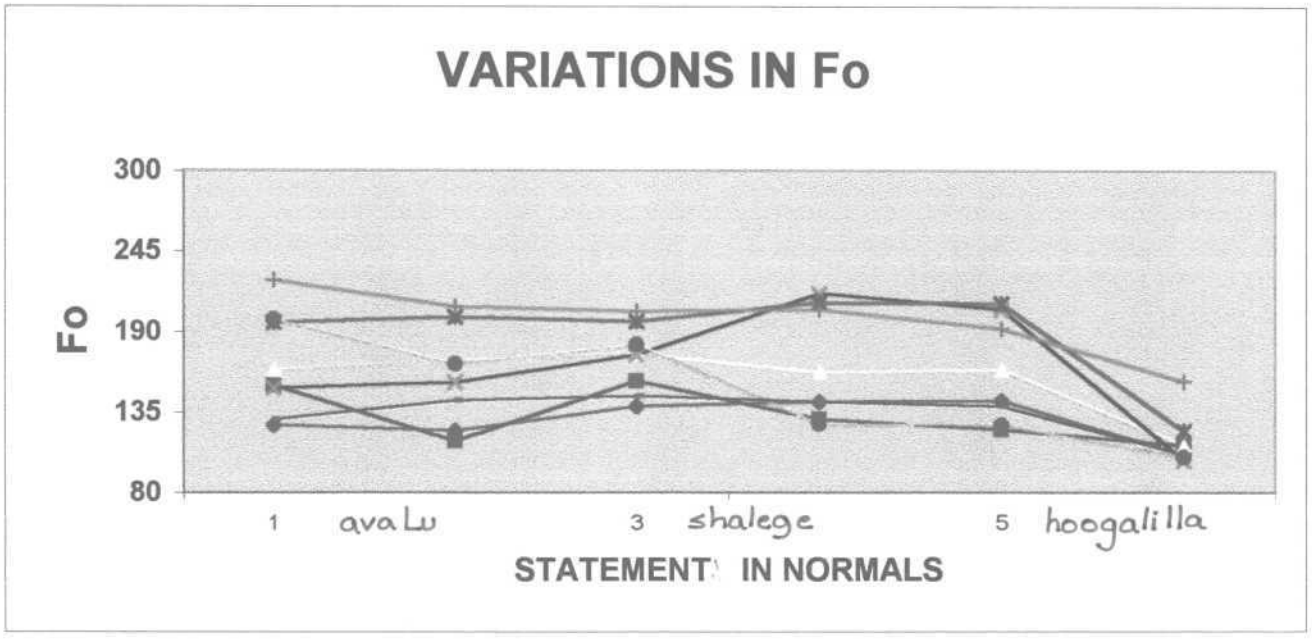
Range and variation in F_o is found to contribute to the interpretation of a particular intonation contour [Bolinger (1986) and Hirschberg and Ward (1992)]. The data is analyzed for variation in F_o Tor Y-N questions and declarative statements in

normals and dysarthrics. Figure 2&3 depicts the variation in F_o for the utterance avaLu shalege hoogalilla' produced as both declarative statements and Y-N question by eight normal and eight dysarthric speakers. It is seen that F_o variation is different for Y-N questions and declarative statements in both the subject groups. The questions are produced with wider F_o variation than declarative statements in normals and dysarthrics. On question, the speaker expects an answer, therefore uses a greater F_o variation whereas, in declarative statements, an answer is not expected resulting in usage of reduced variation in F_o.

Also, it is seen that dysarthrics use a lesser variation in F_o than normal subjects. The dysarthric individuals are not able to bring about significant rise and fall in terminal word when compared to their age matched normals. The clustering of data in dysarthric group can be due to limited F_o variation resulting in perception of monotony in their speech. But among eight dysarthrics, one subject could bring about the variation as that of normals. The use of larger F_o variation similar to that of normal in this subject can probably be attributed to the of speech therapy undergone by him , thus implying that effective speech intervention program could bring in changes in the speech of dysarthrics.

Reduced variation in Fo in dysarthria are reported in a group of Friedriechs ataxia and Parkinson disease patients for Y-N questions and declarative statements by LeDorze et al (1998). Similar results have been reported in other perceptual studies by Murdoch, Ingram and Chenry(1988) and Thompson and Murdoch (1995).

Fig 2: F_0 Variation in subjects for a declarative statement.



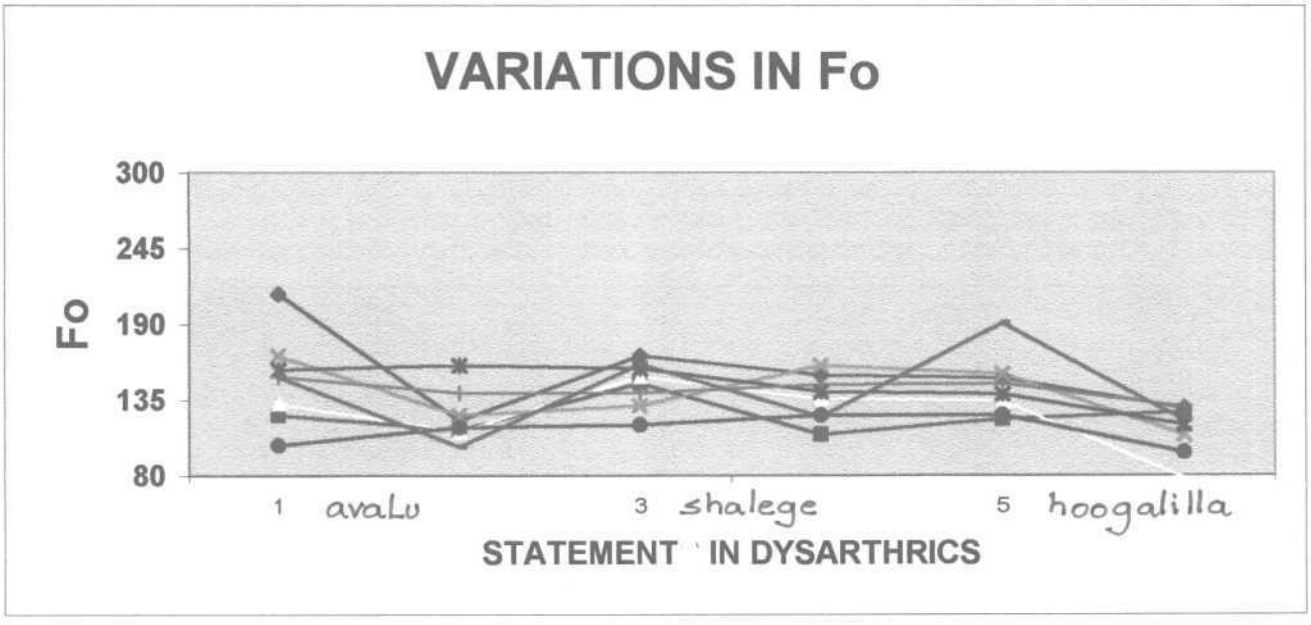
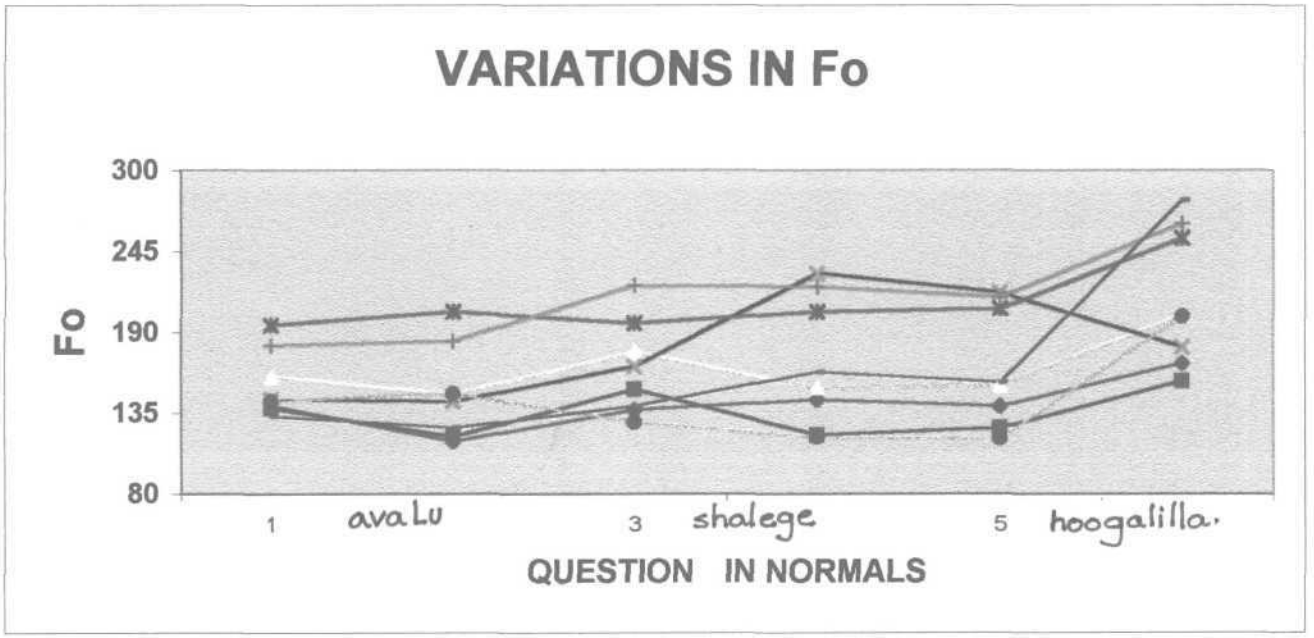
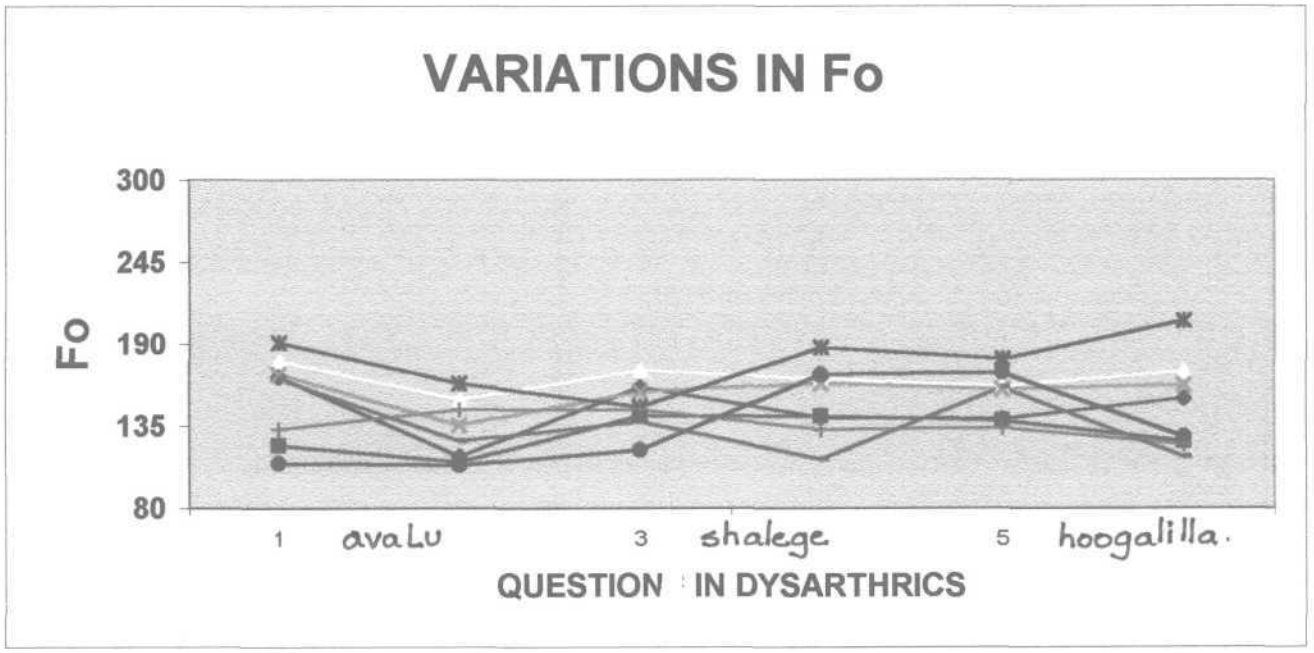


Fig 3: F_0 Variation in subjects for a Y-N Question.





The results of this study can be attributed to reduced movement of laryngeal muscles resulting in reduced vocal fold movement. This is well in agreement with the results observed by Darley, Aronson and Brown (1969b) where reduced variation in F_o was attributed to insufficient vocal variation.

In general, dysarthrics use lower pitch when compared to normals. Similar results are reported by LeDorze et al, (1998), Darley, Aronson and Brown (1969b). The reduced pitch in dysarthrics could be attributed to insufficient physiological adjustment in respiratory and laryngeal system. Darley et al (1969b) attributed low pitch in dysarthrics to hypotonicity of the laryngeal structures.

II. F_o of initial syllable (ISF_0) versus F_o of terminal syllable (TSF_0) in Y-N questions and declarative statements.

O'Shaughnessy and Allen (1983) pointed out that the overall F_o pattern for English utterance other than Y-N questions started at a relatively low level, rose rapidly on the first emphasized syllable and then gradually declined to reach a very low level. In Yes-No questions, F_o differed from a typical pattern of falling less after the initial rise and rising rapidly at the very end to the highest level in the utterance (O'Shaughnessy, 1979).

The terminal rise in intonation pattern is also reported in Y-N questions in other languages (Jones, 1957; O'Shaughnessy, 1979 and Bolinger, 1978 in non tone language; Patil, 1984 in Dharwad dialect of Kannada; Cruttenden, 1986 in English and Manjula, 1997 in standard dialect of Kannada).

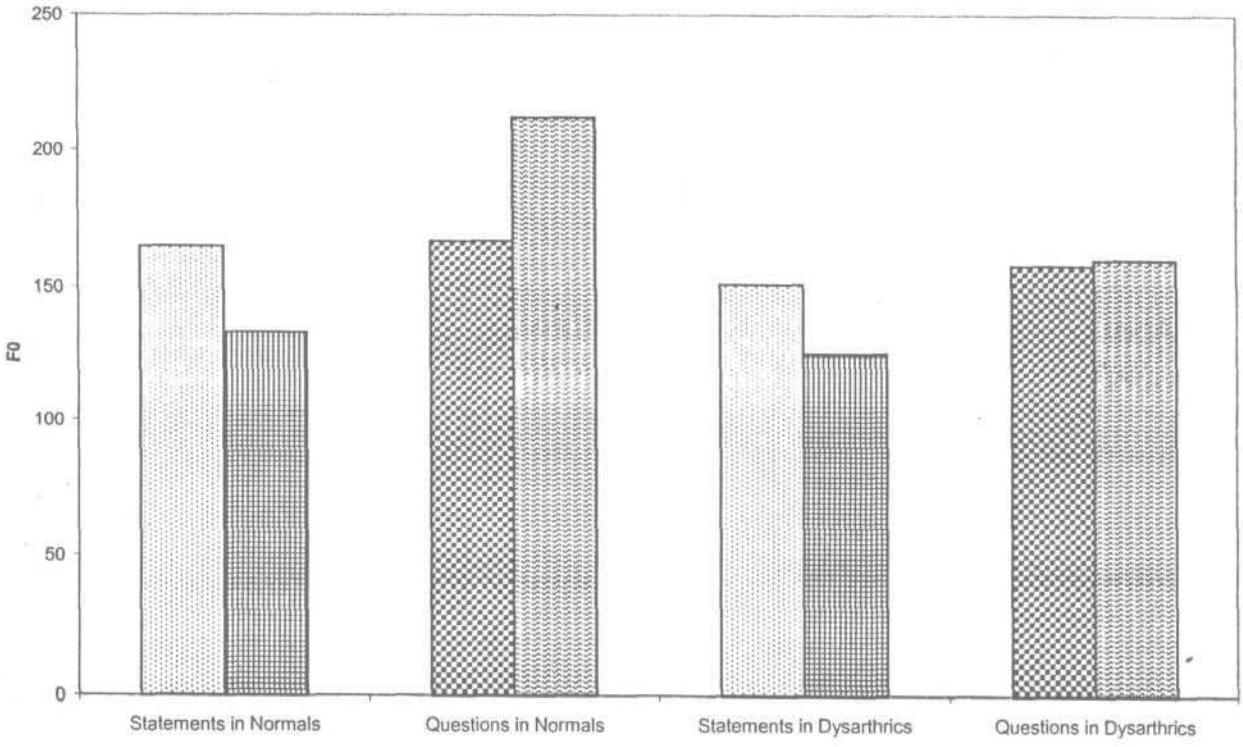
In view of these observations, the results are analyzed to note the F_o of initial versus F_o of terminal syllable in Y-N questions and declarative statements in both normals and dysarthrics.

TABLE III: Mean and SD of ISF_0, TSF_0 and TWF_0 in declarative statements and Y-N questions in normals and dysarthrics .

|Within Groups|

	NORMALS			DYSARTHRICS		
Variable	ISF_o in Hz	TSF_0 in Hz	TWF_o in Hz	ISF_o in Hz	TSF_0 in Hz	TWF_o in Hz
Statement						
I. N	77	77	77	64	64	64
2. Mean	165.15	133.02	156.94	151.21	125.32	140.14
3. SD	25.82	29.75	37.97	21.69	31.46	17.77
Questions						
l.N	76	76	76	62	62	62
2. Mean	167.00	212.93	203.60	158.56	160.25	165.75
3.SD	42.32	47.66	53.40	31.70	32.61	36.21
t - score	NS at .05 level	Sig.at .01 level	Sig.at .01 level	NS at. 05 level	Sig.at .01 level	Sig.at .01 level

FIG :4 MEAN F0 OF INITIAL VERSUS TERMINAL SYLLABLE IN QUESTIONS AND STATEMENTS IN NORMALS AND DYSARTHRICS



ISF0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

TS0F0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

ISF0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

TSF0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

TABLE IV: Mean and SD of **ISF_0, TSF_0 and TWF_0 in declarative statements and Y-N questions in normals and dysarthrics**

|Between Groups|

Declarative statements					Y-N questions			
Variables	N	ISF_o in Hz	TSF_o in Hz	TWF_o in Hz	N	ISF_0 in Hz	TSF_o in Hz	TWF_0 in Hz
Normals	77				76			
Mean		165.15	133.02	156.94		167.00	212.93	203.60
SD		25.82	29.75	37.97		42.32	47.66	53.40
Dysarthrics	64				62			
Mean		151.21	125.32	140.14		158.56	160.25	165.75
SD		21.69	31.46	17.77		31.70	32.61	36.21
t -score		Sig.at .01 & .05 level	NS at .01 & .05 level	Sig.at .01 & .05 level		NS at .01 & .05 level	Sig.at .01 & .05 level	Sig.at .01 & .05 level

Results from Table III , Fig 4 and Table IV depicts that both declarative statements and Y-N questions are initiated at the same level in both the groups. In normals the Mean ISF_o for declarative statements is 165.15Hz which is not significantly different from Mean ISF_0 for questions. (167HZ). Similarly in dysarthrics, the Mean ISFo for declarative statements is 151.21 Hz which is not significantly different from Mean $1SF_o$ (158.56Hz) for Y-N questions.

Questions, however are terminated at a higher level than declarative statements in both the groups. The Mean ISF_0 for questions in both normals and dysarthrics is 212.93Hz and 160.25 Hz respectively . which is significantly higher than mean TSF_0

for declarative statements. Mean TSF_0 in normals is 133.02Hz and dysarthrics is 125.32Hz.

However, for both questions and declarative statements, dysarthrics use a low pitch when compared to normals. This could be attributed to hypotonicity of the laryngeal structure suggested by Darley Aronson and Brown (1969b).

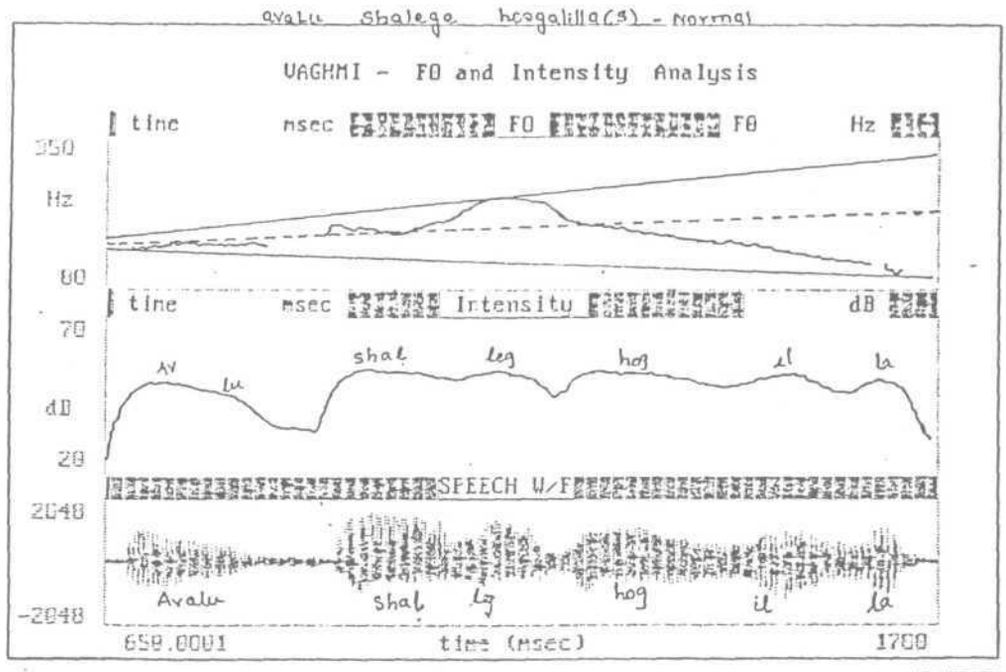
Fig 5 and 6 shows the movement of F_o in syllable initial to syllable final position. In questions, the rise from initial to final syllable F_o in dysarthrics is very minimal when compared to their age matched normals. The Mean ISF_0 for normal is 167Hz and TSFo is 212.93Hz whereas for dysarthrics, the Mean ISF_0 is 158.56Hz and TSF_0 is 160.25Hz.

In normals, the questions starts at a higher level and fall less rapidly after the initial rise and rises rapidly at the end to the highest level in utterance. This is in par with earlier studies [O'Shaughnessy (1979) and O'Shaughnessy and Allen, (1983)]. Like normals, even dysarthrics tend to rise their laryngeal tension to indicate that the utterance is a question. But the effect produced by them is minimal.

According to Lieberman's breath group theory (Lieberman, 1967), "all other things being equal, laryngeal tension needs to increase near the end of an interrogative in order to compensate for the reduction in pulmonary air stream naturally occurring at the end of an utterance in order to rise the F_o and create an interrogative".

Fig 5: F_0 I_0 and waveform for a declarative statement.

avaLu shalege hoogalilla (s) - Normal



avaLu shalege hoogalilla (s) - Dysarthric.

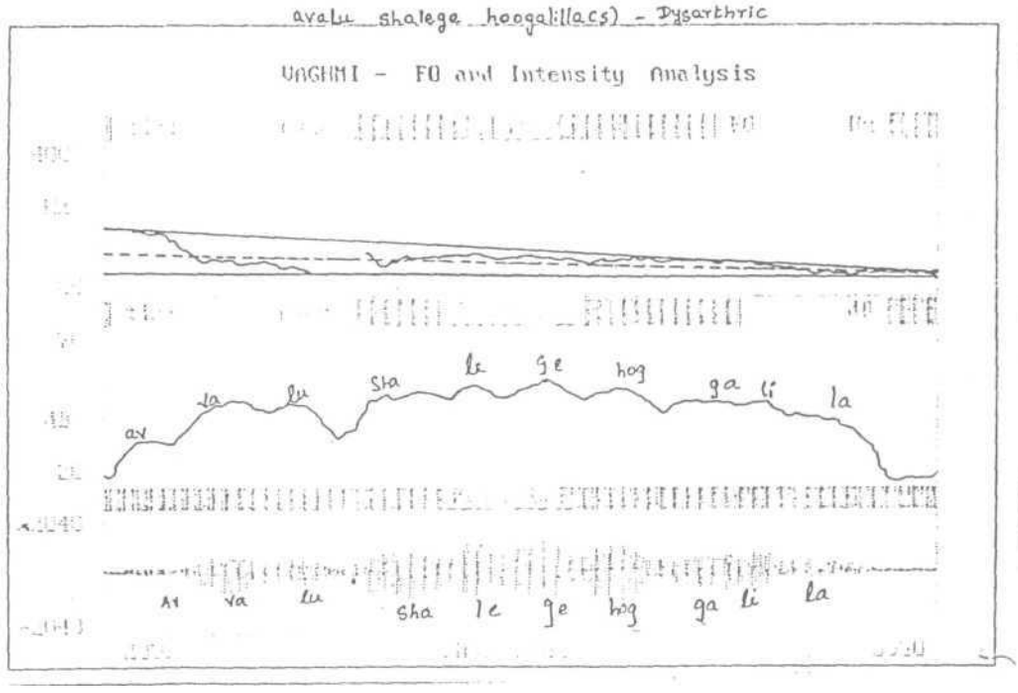
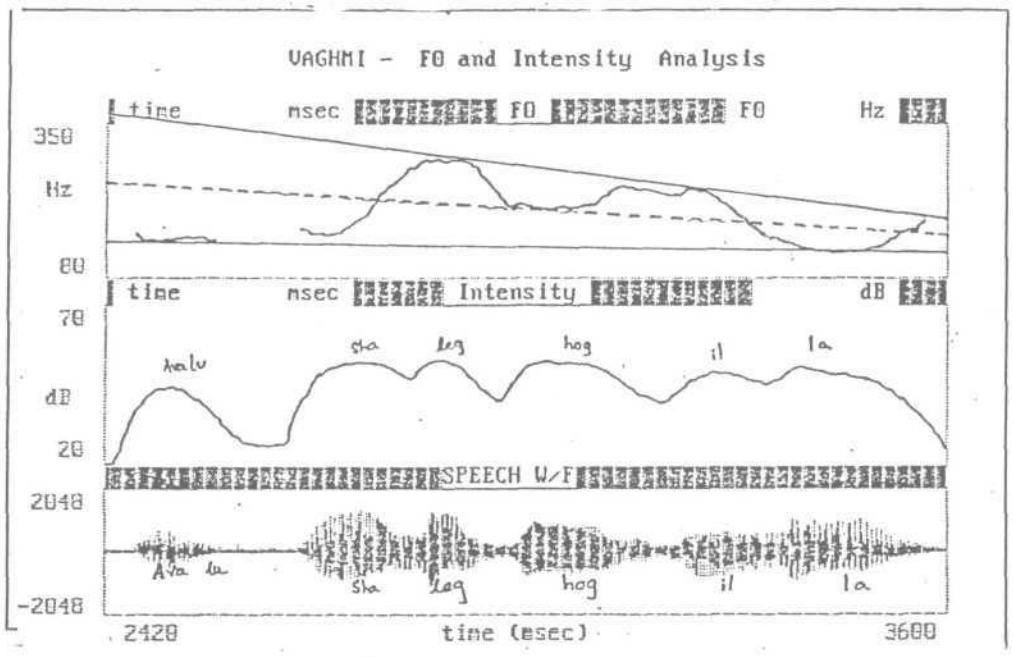
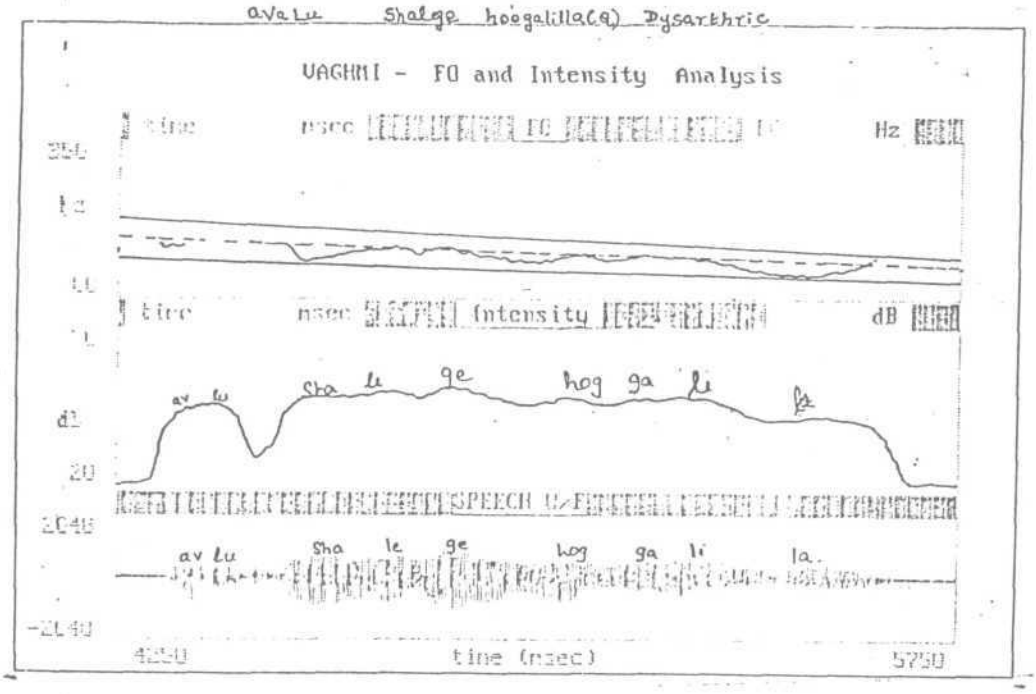


Fig 6: F_0 I_0 and waveform for a Y-N question.

avaLu shalege hoogalilla(Q) – Normal.



avaLu shalege hoogalilla (Q) - Dysarthric.



This is not seen in dysarthrics. The reason can be attributed to insufficient control of either respiratory and or laryngeal system to bring about the effect. This implies that dysarthrics have preserved prosodic competence inspite of significant loss in prosodic performance.

In declarative statements, however, there is no difference between the two groups. The declarative statements start at low level when compared to questions. The Mean ISF_o for declarative statements in both normals and dysarthrics are 165.15Hz and 151.21Hz which is lower than Mean ISF_o for questions (Mean ISF_o in normals is 167Hz and dysarthrics is 158.56Hz) and rise rapidly on the first emphasized syllable and then gradually fall to reach a low level. The Mean TSF_o for normal and dysarthrics are 133.02Hz and 125.32Hz. The reduction in Mean TSF_o when compared to Mean ISF_o in both the groups is due to reduced pulmonary air stream naturally occurring near the end of an utterance. This finding is in agreement with earlier study by Lieberman (1967).

III Mean F_o of terminal syIlable(TSF_0) and terminal word (TWF_0) in Y-N questions and declarative statements.

The phenomenon of rise and fall in F_o at the end of the question is well documented (Jones, 1909; Contini and Boe, 1975) in French; (O'Shaughnessy, 1979; O'Shaughnessy and Allen, 1983) in English; (Hadding - Koch, 1961) in Finnish;

(Magno-caldognetto, 1978) in Italian; (Dascalu, 1979) in Romanian; (Patil, 1984; Manjula, 1997) in Kannada.

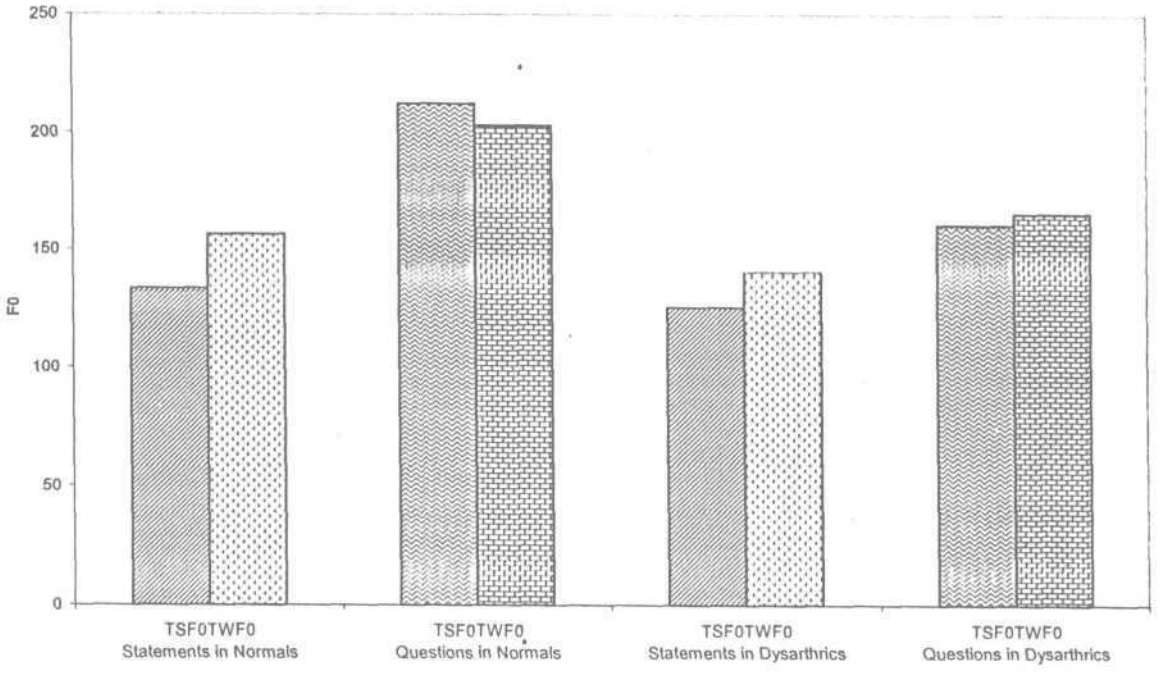
According to Magdics (1963); Mickey (1977); Vaissiere (1983) and Patil (1984), the terminal contour of the last syllable is an important feature in distinguishing simple declaratives from Y-N questions. Thus, the final rise in the Y-N question could be due to rise in F_o over the terminal syllable or a rise in F_o spread over the terminal word.

Even in dysarthrics, terminal rise is seen, but the contrast between declarative statements and Y-N questions is reduced. LeDorze et al (1994) and LeDorze et al 1998).

Taking these observations into consideration, the data is analyzed to compare the Mean F_o values of final syllable and final word in Y-N questions and declarative statements in both normal and dysarthrics. The results are shown in Table III, IV and Fig 7.

The results indicate that the Mean F_o of final syllable and final words are more in Y-N questions than declarative statements for both the groups. The Mean F_o of final syllable (212.93Hz and 160.25Hz) in Y-N questions for normal and dysarthric subjects is significantly higher than the Mean F_o of final syllable (133.02Hz and 125.32Hz) in declarative statements for normal and dysarthric subjects respectively. Also the Mean terminal word (203.60Hz and 165.75Hz) in questions is significantly higher than the

FIG: 7 MEAN TSF0 AND TWF0 IN STATEMENTS AND QUESTIONS IN NORMALS AND DYSARTHRICS.



TSF0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

TSF0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

TWF0 IN STATEMENTS IN NORMALS AND DYSARTHRICS

TWF0 IN QUESTIONS IN NORMALS AND DYSARTHRICS

mean F_o of terminal word (156.94Hz and 140:14Hz) in declarative statements for normal and dysarthric group respectively.

It is seen from Fig 7 that the Mean terminal syllable F_o (212.93Hz) are higher than Mean values of terminal word (203.60Hz) in Y-N questions for normals, whereas in dysarthrics, the Mean terminal F_o of the final syllable (160.25Hz) is lower than Mean terminal F_o value of final word (160.25Hz) in Y-N questions.

Normals are able to rise the F_o of terminal syllable effectively to indicate that the utterance is a Y-N question whereas in dysarthrics, although there is an attempt they are unable to bring about the terminal rise.

This is supported by Lieberman's breath group theory of intonation by Lieberman (1967).

In case of dysarthrics, because of their physiological limitation due to neurological lesion they have not been able to increase the fundamental frequency as compared to their age matched normals.

The reduced intonational value in dysarthrics shows that they do not lose their knowledge of prosodic contrast but have difficulty in producing the intonation patterns. This is in par with other research findings by Darkins (1988), Caekebeke (1991), LeDorze et al (1994) and LeDorze et al (1998).

IV Terminal F_o Contour

The terminal contour is the course of F_o (rise, fall, level) from syllable to syllable final position of the terminal syllable of Y-N questions and declarative statements in normal and dysarthrics.

Table V: Percentage occurrence of rise and falls on Terminal Fo contour for declarative statements in Normal and Dysarthrics.

GRADIENT TYPE	NORMALS	DYSARTHRICS
Rise	2.59%	4.68%
Fall	97.40%	95.30%

The data is analyzed to study the behavior of terminal contour in Y-N questions and declarative statements in normal dysarthrics. It is seen from Table V that declarative statements are characterized by larger percentage of terminal fall (97.40%, 95.3%) than rises (2.59% and 4.68%) in normals and dysarthrics respectively.

The terminal fall in declarative statements could be attributed to reduction in pulmonary air stream which naturally occurs at the end of the declarative statements (Lieberman, 1967).

Table VI: Percentage occurrence of rise and falls as Terminal F_o contour for questions in Normal and Dysarthrics

GRADIENT TYPE	NORMALS	DYSARTHR1CS
Rise	60.52%	40.32%
Fall	39.47%	59.67%

Table VI depicts the terminal F_o contour for questions in both normals and dysarthrics. Terminal F_o contour for questions have a higher percentage of rises (60.52%) than falls (39.47%) in normals.

Increase in fundamental frequency towards the end of an utterance in Y-N questions could be attributed to Lieberman's (1967) breath group theory of intonation.

The lower percentage of terminal rises in dysarthrics show that they attempt to bring out the utterance as questions but because of the physiological limitation they are not able to produce it effectively.

This reinforces the idea that dysarthria does not represent a loss of knowledge of prosodic contrast, but rather the inability to produce it. This is in agreement with other studies by Darkins et al (1988); Caekebeke et al (1991); Le Dorze et al (1994) and Le Dorze et al(l998).

V Declination of F_o in Y-N questions and declarative statements

Declination of F_o means constant downward drift in F_o. It is observed in majority of the sentences (Vaissierre, 1983; Cruttenden, 1986; Thorsen, 1979 and Cooper and Sorenson, 1981)

The regression line model and the zero line model are in general, the two main methods used to describe declination in various languages (Ladd, 1983). However, it was found that regression linemodel is better in defining more specific pattern of slope and shape of declination in Kannada language (Manjula, 1997).

Hence, in the present study regression line model was selected to study the declination phenomenon in Y-N questions and declarative statements in normals and dysarthrics.

The regression line method [Thorsen, (1979); Cooper and Sorenson, (1981) and Vaissierre, (1983)] maintains that declination is manipulated by abstract lines drawn through selected stress peaks in actual contour.

Fig 5 & 6 shows the analysis of declination phenomenon using regression line model. In both the groups questions show a rising F_o declination when compared to declarative statements where a falling F_o declination is seen.

The declination phenomenon can be explained in terms of shape and slope of declination.

Slope of declination:

There are two types of slope observed in the data ie., Rising and Falling.

Rising Fo declination refers to rising slope from the syllable initial to syllable final position.

Falling F_o declination refers to a falling slope from syllable initial to syllable final position.

Table VII - Percentage occurrence of rise and fall in slope of F_o in declination in Yes - No questions in normal and dysarthrics.

SLOPE OF F_o	NORMALS	DYSARTHRICS
Rise	63.15%	20.96%
Fall	36.84%	79.03%

From table VII, it is seen that Y-N question have a higher percentage (63.15%) of rising F_o declination than falling F_o declination (36.84%) in normals. On contrary, dysarthrics show a lower percentage of rising F_o declination (20.96%) than falling F_o declination (79.03%).

The low gradient raise in F_o declination of dysarthrics shows that the prosodic competance, is preserved inspite of significant loss in prosodic performance. The reduced rising F_o declination in question in dysarthric could be attributed to poor speech breathing control or to reduced ability of the laryngeal structures, to respond to the requirements of interrogatives.

Table VIII: Percentage occurrence of rise and fall in slope of F_o in declination in declarative statements in normal and dysarthrics.

SLOPE OF F_o	NORMALS	DYSARTHRICS
Rise	1.29%	0%
Fall	98.70%	100%

It is seen from Table VIII that for both groups, the percentage of falling F_o declination (Normal 98.70% and Dysarthric 100%) are more than rising F_o declination (Normal 1.29% and Dysarthric 0%) in declarative statements.

This could be attributed to reduced pulmonary air pressure occurring at the end of the utterance as reported by Lieberman (1967).

Shape of declination: The different types of shape of declination are

Linear: a linear declining F_o which has a straight falling or rising course.

Asymptote: a declining F_o which is linear for some duration followed by change in course of the declining Fo in an opposite direction.

Irregular: a general declination tendency in F_o behavior noticed over the utterance, but one with small sequence of rises and falls in between the utterances. (Manjula, 1997).

In the present study, only linear declination is seen. In short utterances of one breath group asymptote and irregular patterns will not be present (Ladd, 1983 and Vaissiere, 1983).

The results of present study demonstrate reduced F_o, reduced range and variation in F_o, reduced percentage of terminal F_o rises and low gradient raise in declination when compared to their age matched normals. The reduced variation in the intonation patterns of dysarthrics could be due to poor control over respiratory and laryngeal system due to neurological lesion. This poor performance demonstrated by them reinforces the idea that dysarthria do not represent a loss of knowledge of the prosodic contrast but rather in the ability to produce it. However, sufficient physiological studies are also needed to further substantiate the above view.

SUMMARY AND CONCLUSION

Prosody is an intrinsic aspect of speech and is important in speech perception and production. It signals the linguistic and emotional features of speech and makes speech more aesthetically pleasing. Intonation is a feature of prosody. It is defined as variation in fundamental frequency as a function of time (Collier, 1991). Each sentence type has a particular intonation which can be distinguished based on few features like rise or fall in F_o and terminal F_o contour. It is well highlighted in the literature that Y-N question have a rising F_o when compared to declarative statements and this forms a primary distinguishing feature between the two sentence types.

Prosodic deviations are primary speech disturbances reported in dysarthric speech. Prosody not only improves speech naturalness but also contributes to overall speech intelligibility. Hence, the present study was planned with objective of analyzing the intonation in normal and dysarthric subjects using Y-N questions and declarative statements.

Methodology: Twenty male subjects (10 normals and 10 dysarthrics) in the age range of 40-86 years were taken. They were asked to imitate forty model sentences consisting of Y-N questions as well as declarative statements. The sentences which were imitated appropriately without any dysfluency or other disturbances was considered for acoustical analysis.

Analysis was carried out using speech analysis software program of "VAGHMI" of Voice and Speech Systems. The 'INTON' of vaghmi was used to extract fundamental frequency, intensity and duration for both the sentence types in normal and dysarthric subjects. The speech waveforms were tabulated into syllable units in order to the readings of F_oI_o and duration. Using F_oI_o table, the following parameters were calculated.

I a. Maximum and Minimum F_o in Y-N questions and declarative statements.

b. F_o Range and Variation in F_o in Y-N questions and declarative statements.

II. Mean initial syllable F_o versus mean terminal syllable F_o in Y-N questions and declarative statements.

III. Mean TSF_0 and Mean TWF_0 in Y-N questions and declarative statements.

IV. Terminal F_o contour in Y-N questions and declarative statements.

V. Declination in F_o in Y-N questions and declarative statements.

The results of the present study are summarized as follows:

1. The Maximum and Minimum F_o for Y-N questions were higher than declarative statements in dysarthric group as well as in normal group.

2. The Maximum find Minimum F_o in Y-N questions and declarative statements were lower in dysarthrics when compared to their age matched normals.

3. The range and variation in F_o were found to be more in Y-N questions than declarative statements in both the subject groups. However, the range and variation in F_o in dysarthrics for both the sentence types was limited when compared to normal subjects.

4. For Y-N questions in normals, there is a significant F_o rise from syllable initial to syllable final position whereas in dysarthrics, the rise in F_o was minimal.

5. Both the normal and dysarthric group showed a fall in F_o from syllable initial to syllable final position in statements.

6. Unlike normals, dysarthrics showed an increase in terminal word F_o then terminal syllable Fo for Y-N questions.

7. In normals, there was a higher percentage of F_o rise from syllable initial position to syllable final position of the terminal syllable of Y-N questions. Both normals and dysarthric showed a higher percentage of F_o fall from syllable initial to syllable final position of the terminal syllable of the declarative statements.

8. Dysarthrics showed a lower percentage of rising F_0 declination from initial syllable to final syllable in Y-N questions when compared to normals, whereas in declarative statements higher percentage of falling F_o declination were present in both the groups.

Conclusions:

It is concluded that for the production of appropriate intonation, respiratory and laryngeal system should be intact which are affected in dysarthric due to neurological lesion. This loss of control in respiratory and laryngeal structures has resulted in reduced execution of intonation dimensions in the dysarthrics. However they do seem to retain the fundamental aspects of normal intonation. This reinforces the thought that dysarthria does not represent the loss of knowledge of prosodic contrast but reflects the inability to produce it. It also implies that intervention in the form of speech therapy helps improve the competence in speech production. However physiological observations are needed to further support the above view.

Recommendations:

1. Replication of the study on different types and severity of dysarthria can be carried out.

2. The physiological correlates of the acoustical aspects in intonation can be investigated.

3. The intonation patterns in dysarthrics can be studied in various levels of discourse and compared with the present study.

BIBLIOGRAPHY

Abe, I. (1955). Intonation pattern of English and Japanese. In Intonation-Selected readings by D.L.Bolinger (Ed). Penguin Books Ltd, England, 1972.

Barnes, G.J. (1983). Suprasegmental and prosodic considerations in Motor Speech disorders. In Clinical dysarthria by W.R.Berry (Ed). College-Hill Press, California.

Bolinger, D.L. (1965). Cited in The structure of intonational meaning- Evidence from English by D.R.Ladd. Indiana University Press, London, 1978.

Bolinger, D.L. (1978). Cited in Intonation by A.Cruttenden. Cambridge University Press, Cambridge, 1986.

Bolinger, D.L.(1986). Intonation and its parts: Melody in spoken English. Stanford University Press, Palo Alto.

Brazil,D., Coulthard,M., and Johns,C. (1980). cited in Prosody management of communication disorder by P.M.Hargrove and N.SMcGarr. Singular Publishing Inc, California, 1994.

Caekebeke,J., Schinkel,A.J., Linden,M.E., Burma, O.J.S., and Roos, R.A.C.(1991). The interpretation of dysprosody in patients with Parkinsons disease. Journal of Neurology, Neurosurgery and Psychiatry, 54,145-148

CaIigiuri,M., and Murry,T. (1983). The use of visual feed back to enhance prosodic control in dysarthria. In Clinical dysarthria by W.R.Berry (Ed). College-Hill Press, California.

Canter,G.J, (1963). Speech characteristics of patients with Parkinsons disease I:. Intensity, Pitch and Duration. Journal of Speech and Hearing Disorders. 28, 221-229.

Chenery, H.J., Murdoch, B.E., and Ingram, J.C.L. (1988). Studies in Parkinsons disease: I. Perceptual speech analysis. Australian Journal of Human Communication Disorders, 16. 17-29.

Cohen and t'Hart. (1967). Cited in Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed.). Springer-verlag, Berlin, 1983.

Collier, R. (1990). On the perceptual analysis of intonation Speech communication, 9. 443-451.

Contini and Boe.(1975). Cited in Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed). Springer-verlag, Berlin, 1983.

Cooper,N.E., and Sorensen,J.H. (1981). Cited in Declination of fundamental frequency in speakers production of parenthetical and main clauses by B.J.Kutik, W.E.Cooper and S.Boyce. Journal of Acoustical Society of America, 73(5), 1731-1738. 1983.

Cruttenden, A. (1986). Intonation . Cambridge University Press, Cambridge.

Crystal,D. (1981). Cited in Prosody management of communication disorders by P.M.Hargrove and N.S.McGarr. Singular Publishing Group Inc, California, 1994.

Crystal, D. (1982). cited in Prosody management of communication disorder by P.M.Hargrove and N.S.McGarr. Singular publishing Group Inc, California, 1994.

Danes, (1960). cited in Intonation, Perception and Language by P.Lieberman. The MIT Press, Cambridge, 1967.

Darkins,A.W., Fromkin.V.A., and Benson.D.F. (1988). A characterization of the prosodic loss in Parkinson's disease. Brain and Language. 34, 315-327.

Darley, F.L., Aronson, A.E., and Brown, JR. (1969a). Differential diagnostic patterns of dysarthria. Journal of Speech and Hearing Research, 12, 246-269.

Darley, F.L., Aronson,A.E., and Brown,JR. (1969b). Clusters of deviant speech dimensions in the dysaitlirias. Journal of Speech and Hearing Research. 12,462-496.

Darley,F.L., Aronson,A.E. and Brown,J.R (1975a). cited in Acquired speech and language disorders: A neuro anatomical and functional neurological approach by B.E.Murdoch. T.J. Press Ltd, Cornwall, 1990.

Darwin,C.J. (1975). cited in Some prosodic aspects in Kannada by H.M Nandini. An unpublished Dissertation submitted as part fulfillment of Masters Degree, University of Mysore, Mysore, 1985.

Dascalu,L. (1979). On the intonation of questions in Romanian: The rising pattern. Review of Roum, Linguist, 24,35-41.

Delattre, P. (1963). cited in Prosody: Models and Measurements by A.Cutler and D.R.Ladd (Ed). Springer-verlag, Berlin, 1983.

Duffy, JR. (1995). Motor speech disorders: substrates, differential diagnosis and management. St.Louis: Mosby.

Eady,S.J., and Cooper,W.E. (1986). Speech intonation and focus location in matched statements and questions. Journal of Acoustical Society of America. 80, 402-415.

Enderby, P.(1983). Frenchay dysarthria assessment. College Hill press, SanDiego.

Fujisaki, (1979). cited in Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed). Springer-Verlag, Berlin, 1983.

Gosy.M., and Terken, J. (1994). Questions marking in Hungarian: Timing and height of pitch peaks. Journal of Phonetics. 22. 269-281.

Grunwell and Huskins.(1973). cited in some prosodic aspects in Kannada by H.M. Nandini. An unpublished dissertation submitted as a part of fulfillment of Masters Degree, University of Mysore, Mysore, 1985.

Hadding, K., and Studdert, K. (1964). An experimental study of some intonation contours. Phonetica. 11, 175-185.

Hargrove,P.M., and McGarr, N.S. (1994). Prosody management of communication disorder. Singular Publishing group Inc, California.

Hirschberg. J., and Ward, G. (1992). The influence of pitch range, duration, amplitude and spectral features on the interpretation of the rise - fall-rise intonation contour in English. Journal of Phonetics. 20.241-251.

Hixon, et al. (1971). cited Prosody: Models and Measurements. Springer-Verlag, Berlin, 1983.

Hollien,H., and Curtis, J.F. (1962). Elevation and tilting of vocal folds as a function of vocal pitch. Folia phoniatrica. 14,23-36.

Hollien.H., and Moore,P. (1960). Measurements of the vocal folds during changes in pitch. Journal of Speech and Hearing Research, 3, 157-165.

Hollien,H. (1962). Cited in Relation between Prosodic Variables and emotions in normal American English utterances by G.L.Huttar (1968). Journal of Speech and Hearing Research, 11,481 -487.

Huttar, G.L. (1968). Relations between prosodic variables and emotions in normal American English utterances. Journal of Speech and Hearing Research, 11, 481-487.

Jones, (1940). Cited in Suprasegmentals by I.Lehiste. The MIT Press, Cambridge, 1970.

Jones, (1957). Cited in Research on intonation during past 10 years by K.Magdics. Acta Linguistica, 13, 113-165, 1963.

Keatley, (1975). Cited in Motor speech disorders: substrates, differential diagnosis and management by J.R.Duffy. Mosby, St. Louis, 1995.

Kent,R.D., Netsell,R., and Abbs,J.H. (1979). Acoustic characteristics of dysarthria associated with cerebellar disease. Journal of Speech and Hearing Research, 22, 627-648.

Ladd, DR. (1983). Peak features and overall slope in Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed.) Springer-Verlag, Berlin.

Ladefoged,P., and Mckinney, N.P. (1963). Loudness, soundpressure and subglottal pressure in speech. Journal of Acoustical Society of America. 35. 454-460.

LeDorze, G., OueIlet,L., and Ryalls, J. (1994). Intonation and speech rate in dysarthric speech. Journal of Communication Disorders. 27. 1-18.

LeDorze,G., Ryalls, J., Brassard,C, Boulanger,N., and Ratte, (1998). A comparison of the prosodic characteristics of the speech of people with Parkinson's disease and Friedreich's ataxia with neurologically normal speakers. Folia Phoniatrica et. Logopaedica. 50, 1-9.

Lieberman, P. (1967). Intonation, Perception and Language. Research Monograph, 38. The MIT Press, Cambridge.

Maeda,(1976). Cited in Influence of segmental factors on fundamental frequency in fluent speech by N.Umeda. Journal of Acoustical Society of America. 70, 350-355, 1981.

Magdics, K. (1963). Research on intonation during the past 10 years. Acta Linguistica. 13, 133-165.

Magno-Caldognetto et al (1978). cited in Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed.) Springer-Verlag, Berlin, 1983.

Majewski, W., and Blasdell, R. (1969). Influence of fundamental frequencies on the perception of some synthetic intonation contours. Journal of Acoustical Society of America. 45, 450-457.

Manjula, R. (1997). Aspects of Kannada intonation in discourse (Interrogatives). Unpublished Doctoral thesis. University of Mysore, India.

Mermelstein, (1975). Automatic segmentation of speech into syllable units. Journal of Acoustical Society of America, 58, 880-883.

Mickey, K. (1977). On' high' and 'low' in English. Language Speech, 20(1). 20-39.

Miller and Tench.(1981). cited in Intonation by A.Cruttenden. Cambridge University Press, Cambridge, 1986.

Monrad-Krohn, G.H. (1947). Dysprosody or Altered melody of language. Brain, 70, 405-415.

Murry, T. (1983). Cited in Clinical management of dysarthric speakers by K.N. Yorkston, D.Beukelman and K.Bell. College-Hill Press, California, 1988.

Netsell, R. (1973). Speech Physiology. In Normal aspects of Speech, hearing, and language by F.D. Minifie, T.J.Hixon and F. Williams (Ed.). Prentice Hall, NewJersey.

Nishinuma .(1979). Prosody: Models and Measurements by A.Cutler and D.R. Ladd (Ed.). Springer-Verlag, Berlin, 1983.

O'Shaughnessy and Allen, J. (1983). Linguistic modality effects on fundamental frequency in speech. Journal of Acoustical Society of America, 74 (4), 1155-1171.

O'Shaughnessy . (1979). Linguistic features in fundamental frequency patterns. Journal of Phonetics, 7,119-145.

Patil,C. (1984). Intonation contours of Kannada in acoustic studies in Indian languages by B.B. Rajapurohit (Ed). CIIL, Manasagangothri, Mysore.

Philips, N.D., Remillard,W, Bass,S, and Pronovost, W. (1968). Teaching of Intonation to the deaf by visual pattern matching. American Annals of the Deaf. 116,239-246.

Pierrehumbert, J. (1981). Synthesizing Intonation. Journal of Acoustical Society of America. 70(4), 985-995.

Ramig, L. (1992). Cited in Interpretating the physiological basis of dysarthria from perceptual analyses. An examination of subjects with UMN dysarthria by EC. Thompson and BE. Murdoch. Australian Journal of Human Communication Disorders. 23(1), 1-23. 1995.

Rosenbek, J.C., and Lapointe, L.L. (1985). The dysarthrias: description, diagnosis and treatment. In Clinical management of neurogenic communication disorder by D.Johns (Ed). Little Brown Company, Boston.

Schiffman, H. (1979). A reference grammar of spoken Kannada. Final report OE, Goo-78-01861; International studies branch, U.S. Department of Health, Education and Welfare.

Schlenck, K.J. Bettrich, and Willimes, K. (1993). Aspects of disturbed prosody in dysarthria. Clinical Linguistics and Phonetics. 7 (2), 119-128.

Scott,S., Caird,F.I. and Williams,B.O. (1984). Evidence for an apparent sensory speech disorder in Parkinson's disease. Journal of Neurology. Neurosurgery and Psychiatry. 47, 840-843.

Shankarabhatta, D.N. (1978). Kannada vakyagaLu - aantarika racane mattu artavyavasthe. Mysore Printing and Publishing House, Mysore.

Speedie, L.J., Brake, N., Folstein, S.E., Bowers, D., and Heilman, KM. (1990). Comprehension of prosody in Huntingtons disease. Journal of Neurology. Neurosurgery and Psychiatry. 53, 607-610.

Thompson, EC, and Murdoch, BE. (1995). Interpretating the physiological bases of dysarthria from perceptual analysis: An examination of subjects with UMN type dysarthria. Australian Journal of Human Communication Disorders. 23.1-23.

Thorsen, N. (1980). cited in Prosody: Models and Measurements by A. Cutler and D.R. Ladd (Ed.). Springer-Verlag, Berlin, 1983.

Vaissiere, J. (1983). Language independent prosodic features. In Prosody: Models and Measurements by A. Cutler and D.R. Ladd (Ed). Springer-Verlag, Berlin, 1983.

Yorkston,K.M., Beukelman,D., and Bell,K. (1988). Clinical management of dysarthric speakers. College-Hill Press, California.

Zitter, AD. (1992). The perceptual salience of melodic variation. Contour shape and peak height. Journal of Phonetics. 20(1). 181-188.

APPENDIX

1. ಅವಳು ಶಾಲೆಗೆ ಹೋಗಲಿಲ್ಲ.
   avaLu shalege hoogalilla.

2. ಮೀರಳ ಮನೆ ಸಿಗಲಿಲ್ಲ.
   meeraLa mane sigalilla.

3. ಅವನಿಗೆ ಹುಷಾರು ಇರ್ಲಿಲ್ಲಂತೆ.
   avanige huSaru irlilvante.

4. ನಿಮ್ಮ ಮನೆ ಕೆಲಸದವಳು ಬರಲಿಲ್ಲ.
   nimma mane kelasadavaLu baralilla.

5. ಅವರು ದೇವರ ಪೂಜೆ ಮಾಡಿಲ್ಲ.
   avaru devara pooje maDilla.

6. ಅವನು ಊರಿಗೆ ಹೋಗ್ಲಿಲ್ಲಂತೆ.
   avanu uurige hoogalilvanTe.

7. ನಿನಗೆ ಉತ್ತರ ಸಿಗಲಿಲ್ಲ.
   ninage utra sigalilla.

8. ಅವರು ಊರಿಗೆ ಹೋಗಿದ್ರಂತೆ.
   avaru uurige hoogidrante.

9. ಹತ್ತನೆ ತರಗತಿ ಪರೀಕ್ಷೆ ತುಂಬಾ ಕಷ್ಟ ಇತ್ತಂತೆ.
   hatane taragaTi parikshe tumba kaSTaitante.

10. ಅವರು ಮನೆ ಬಿಟ್ರಂತೆ.
    avaru mane biTrante.

[**Note :** The ten sentences were used as Y-N questions and declarative statements in random order]