

INTONATION IN MALAYALAM - SOME ASPECTS

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God, Thou art the giver of life, the remover of pains and Sorrows, the Bestower of happiness, O, creator of the Universe, May we receive thy supreme sin - destroying light, May thou, guide our intellect in the right direction.

Dedicated to

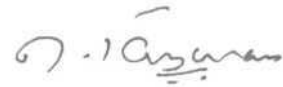
My Dearest

Amma & Achan

CERTIFICATE

This is to certify that this dissertation entitled "**INTONATION IN MALAYALAM - SOME ASPECTS**" is the bonafide work in part fulfilment for the Degree of Master of Science (Speech and Hearing) of the student with register number M9810.

Place: Mysore
Date : May 2000



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CERTIFICATE

This is to certify that this dissertation entitled: "**Intonation in Malayalam - Some Aspects**", has been prepared, under my supervision and guidance.

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DECLARATION

This dissertation entitled "**INTONATION IN MALAYALAM - SOME ASPECTS**" is the result of my own study under the guidance of **Dr. N.P.Nataraja**, Professor and Head of the Department of Speech Science, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Place: Mysore

Date : May 2000

Reg. No. M9810

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INTRODUCTION

The development of human civilization is made possible to a great extent, by man's ability to share experiences, exchange ideas, and to transmit knowledge from one generation to another. Language is used to communicate with each other. "Language is a purely human and non-instructive method of communicating ideas, emotions and desires by means of a system of voluntarily produced symbols" (Sapair, 1921). Language in the general sense is any symbolic code-vocal or gestural or any other similar code that is used to express or to understand thoughts, ideas and feelings.

Verbal communication (speech) is the fastest and most common form of language used by man. Speech is an integral part of the total personality revealing the speakers environment social contrasts, and education. There are many indications that language is the vehicle of personality as well as thought for when a person speaks, he tells us not only about the world, but also, through both form and content about himself (Fillmore 1942).

The basic units of speech are termed segmental features. Segmental features are thus called, because they are discrete in nature. However, in a communication situation, the true meaning of the message is transmitted not only by what is said, but also by how it is said, by how words are emphasized, and also by the speaker's mood and attitude towards what is said. The influence of features which involve the way in which segmentals are said, extends longer than one sound. Hence, these features are termed suprasegmental features (Cruttenden, 1986).

The suprasegmental features are otherwise called prosody also. Prosody is an umbrella term, and is used to refer to the use and perception of variations in

vocal parameters to communicate and understand suprasegmental information. The changes in suprasegmental features alter the meaning of an utterance, even when there is no change in the segmental structure. Unlike the segmental element which can be represented in graphic form through writing, prosody is a feature of spoken communication only. These features are considered as one of the most important, but highly evasive properties of spoken language (Price, Ostendorf, Shattuck - Hufhagel and Fong 1991). Prosody includes the intonation, stress, tempo, and rhythm (Herivel, Rietveld and Gannen, 1994). Intonation is one aspect of prosody and it is an important factor in normal speech. It is defined as the variation of speech pitch or fundamental frequency (Fo) as a function of time (Collier, 1991). "Intonation, like everything else in a language, is one instrument in an orchestra" (Bolinger 1972). Intonation is the result of complex interaction with and within the different levels of language such as the semantic, pragmatic, syntactic, phonotactic, rhythmic and other factors (Rossi, 1993). If this aspect of prosody is affected one can feel the aberration in speech. Many times a sentence spoken to express a particular emotion with in appropriate intonation does not bring the wanted effect on the part of the listener and the speaker is misunderstood. One should know the different intonation patterns for different emotions before producing them.

To understand what a speaker has communicated, a listener must identify the segment that is comprising the utterance, and the order in which they occur, but a good deal of information is also encoded in the frequency, amplitude and time variations, i.e., the prosody of the utterance, and listeners make good use of it. Prosodic processing can be so efficient that the listeners will attend to prosodic continuity at the expense of semantic continuity (Darwin, 1975).

Many studies have indicated that the intonation of the language, can be distinguished based on some typical pitch characteristics that is based on the movement of F_0 such as: (a) rise or a fall in F_0 , (b) extent of movement over one or more syllables, (c) relation of the pitch curve with the temporal factors and (d) size of excursion (Cooper and Sorenson, 1977, Currie, 1979, O'Shaughnessy, 1979, Byrd, 1992, Hermes and Rump 1994).

Intonation has been studied extensively in English and European languages. Eastern languages have also been subjected for analysis to note the intonation phenomenon in them. There are very few studies which address the issue of intonation in the Indian languages (Sethi, 1971, Rathna, Nataraja et al., 1976 and 1982, Manjula, 1979 and 1997, Nataraja, 1981, Patil, 1984; Nandini, 1985, Ravishankar, 1987). Sethi (1971) in Punjabi language described some of the non-acoustic features of the questions and statements. Ravishankar (1987) described some of the non-acoustic features of the intonation phenomenon in Tamil language.

In the standard dialect of Kannada language, the study by Rathna et al., (1976 and 1982), investigated the influence of stress and context on intonation contour of Kannada in emotional sentences. Nataraja (1981) described the types of intonation contours of Kannada in emotional sentences. Nataraja (1981) also made an attempt to note the stress and intonation in four South Indian languages, in an emotional context. Nandini (1985) described some of the acoustic features of intonation in Kannada utterances. No reports regarding intonation in Malayalam is available to the present investigation.

Objectives of the Study:

1. To analyze the listeners (Native and Nonnative speakers of Malayalam) responses to the emotional utterances of the Malayalam speakers.

2. To see the patterns of intonation in the sentences spoken by the Malayalam speakers with various emotions.

Need for the study:

Disrupted prosody is one of the major category of disordered speech. The literature on communication disorders is filled with diagnostic description of the dysprosodic speech. Abnormal prosody is a primary characteristic of the speech of deaf. Further deficiencies in speech perception and production of prosodic features are present in large number of language disordered children and adults.

The study of normal prosodic aspects of speech is essential in the preparation of successful treatment methods aimed at the restoration or establishment of natural intonation. It helps the speech pathologists to plan and execute therapy in cases, as teaching intonation is a part of language therapy for deaf and other cases.

The present study aims at the study of intonation patterns of emotions in Malayalam. There have **not** been previous literature about any studies in emotion in Malayalam. Hence, there is a need for such a study in this language.

Hypothesis:

- 1) In Malayalam different intonation patterns are used in expressing different types of emotions i.e. there is fundamental frequency variation within the sentence as related to emotion expressed.
- 2) Intensity variations that occur in the sentences do not show difference between different types of emotions.

- 3) The native speakers can identify the intonation patterns better than non-native speakers.

Implications of the Study:

- 1) This study provides information regarding intonation in Malayalam language.
- 2) The intonation patterns identified by this study, can be used for giving therapy to the speech and language disordered, including the deaf children.
- 3) For further research.

The study is limited to:

- 1) Randomly selected sentences
- 2) The samples may not be equal to natural speech, as the dialogues are taken from film clippings.
- 3) Spontaneous speech is not considered in the study and no comparison was made between the intonation patterns in spontaneous speech and the sentence selected from the audio-tapes of film stones.
- 4) Synthesized speech was not used,so the intonation patterns of the test sentences were not isolated from the other prosodic variables.
- 5) Speech sample of any adults is considered.

REVIEW OF LITERATURE

Language is a set of arbitrary symbols used to communicate thoughts and ideas. Language is expressed in various forms and speech is one of the most important and characteristic form of language used by human beings.

Speech is a form of communication by which transmission of information takes place by means of sound waves which are in the form of acoustic energy (Fant, 1975). It is an established communicative system of arbitrary and conventionalized acoustic symbols, produced mainly by the action of muscles of the respiratory and upper respiratory tracts (Travis[^]). Speech is man's primary method of communication. It may be viewed as the unique method of communication evolved by man. The speech sounds are produced utilizing the flow of air exhaled from the lungs.

Speech, by its great flexibility, permits man to produce a variety of signals to commensurate with the richness of his imagination. At the same time, the ability to think in terms of purposiveness and causality enables man to expand enormously his use of reciprocal communication for the co-ordination of social activities (Eisenson and Irwin 1963).

The sounds of speech are referred to as the segmental features. There are other features involved to indicate the way in which segments are said. These include the loudness variations, pitch variations, duration changes, voice quality, stress, accent style and others. Such features usually extend over utterances longer than one sound and are hence referred to as 'Supra-Segmentals'¹ or 'Prosodic features' (Cruttenden, 1986). It is seen that a good speech which adequately contributes to social interaction possess these features.

Prosodic features extend over varying domains. They extend over short stretches of utterances like one syllable or one morpheme or one word, or may extend over relatively longer stretches of utterances like one phrase, one clause or one sentence. The prosody of connected speech is analysed and described in terms of variations of different features.

Prosody of speech embraces all variations of pitch, time and loudness introduced by the speaker in order to emphasize words and syllables and make his/her speech interesting (Darley, 1975).

Prosody has been viewed as decorative ornamentation, functioning to make speech more aesthetically pleasing. Prosody functions as the foundation for structural support for the organisation of speech communication (Freeman, 1983). Although segmental phonemes, additional information is carried by the prosodic features (Anisworth, 1976).

There are three features of prosody which are most consistently used for linguistic purposes, either singly or jointly. They are:

- variations in pitch
- length (and)
- loudness

These features are perceived by listeners. Pitch concerns the increase or decrease in fundamental frequency of the voice over one syllable or over a number of successive syllables. Variation in length concerns the relative durations of a number of successive syllables or the duration of a given syllable in one environment relative to the duration of the same syllable in another environment.

Loudness concerns changes of loudness within one syllable or the relative loudness of a number of successive syllables (Cruttenden 1986).

Stress and accent are two other characteristics of speech. When certain syllables in polysyllabic words are given an extra stress, then it is known as accent. Accent is primarily a matter of convention and it is concerned with correctness in word pronunciation.

Intonation and inflection are two other characteristics of speech which go hand in hand with pitch. Inflection is the shift in pitch during the utterance of a syllable. There are times when it is appropriate to speak with a minimum of inflection. But a person who consistently talks with a monopitch will find his listener either irritated or asleep.

A true monotonous voice is comparatively rare, but it dominates any conversation by its difference. Intonation is an exclusive term referring to pitch as a function of time and may be applied to a simple inflection.

Denes (1959) states that "the phonemic sequence is not the only linguistic form, in which information to be transmitted by speech, factors like intonation, stress and rhythm also make their contributions. Recognition of these factors will not only provide the listeners with additional information about the speaker's intention but, because they help to indicate the speaker's line of thought, they will also affect phoneme recognition".

According to Pisoni and Saweesh (1975), "Prosody may serve as the interface between low level segmental information and higher level grammatical structures in speech". Later this interfacing role of prosody was elaborated by

stating that "Prosody carries direct phonetic cues to certain semantic and grammatical classes".

Fry (1968) suggests that in the analysis of language structure, the phonological level must be separated from the prosodic level and the resulting phonemic string only serves as a vehicle for prosodic elements. The differences in sound quality which forms the basis of the phonemic system constitutes the fundamental contrastive elements of language and it is the prosodic features whose contrastive function embraces these different phoneme strings. In some natural languages, it is the differences of intonation and rhythm that decides the prosodic features and in a few languages like Burmese and Vietnamese the differences in voice quality also have a linguistic function in determining the prosodic features.

Prosodic features including intonation, rhythm and stress fulfil important functions in speech perception and production. Perceptually, prosodic information assists the listener in segmenting the flow of speech by contouring words. Syntactically, prosodic features help differentiate about different patterns. Lexically, prosodic features aid in differentiating grammatical categories, such as verbs and nouns. In addition, prosodic features also relate to specific pragmatic functions. For example contrastive stress is used to distinguish between topic and comment (Chafe, 1970). He also added that it is used to distinguish new and old information in discourse. The new information is generally stressed while the old information is not. Bolinger (1972) explained the linguistic stress functions to set off elements which carry a heavier information load and which the speaker wishes to place into focus. In production, speaker can speak rapidly and carelessly stress on unstressed elements controlling on careful articulation on only critical elements.

Another major function of stress is to indicate the syntactic relationship between words or parts of word.

Variation of pitch in speech are mainly instrumental in the expression of logical aspect of meaning. They also contribute significantly in the expression of emotional meaning. It was found by careful experimentation that both experienced and inexperienced speakers use the widest inflection for 'anger'¹ and the narrowest for 'grief. One might almost say that excitatory emotional states express extremely narrow variations (Gray and Wise, 1959).

For the comprehension of speech, not only discrimination of consonants are necessary, but melody of the language are necessary, which are compared against the fixed patterns that have been learned. Stress, intonation and inflection are the aspects which denote the variations in pitch continued with the other attributes of voice like loudness and time (Greene, 1964).

Barry (1981), regarding the functions of prosody states that:

1. The prosody has a guide function, i.e. it helps the hearer
 - (a) To extract the relevant signal from the noise.
 - (b) To direct the hearer's attention to the most important element of an utterance.
2. It divides longer sentences into smaller units.
3. It signals the information focus of a sense and with a tonal accent or one of the words in the unit.

4. It expresses the interactional role of an utterance within a complex sequence.

5. It indicates the speaker's attitude.

Prince et al. (1991) reported that only the prosodic differences were able to reduce ambiguity in the perception of phonetically similar sentences. The disambiguity was chiefly attributed to the prosodic changes at the syntactic boundaries and the prominences.

"Intonation is the salt of an utterance. Without it, a statement can be often understood, but the message is tasteless, colorless. Incorrect uses of it can lead to embarrassing ambiguities". (Delattre, 1972). Words have basic intrinsic meanings, these lexical meanings are the ones found in the dictionary. The intonation meaning is quite the opposite. Rather than contributing to the intrinsic meaning of a word, it is merely a shade of meaning added to or superimposed upon that intrinsic lexical meaning, according to the attitude of the speaker. In actual speech, the speaker is often more interested in the speaker's attitude, than in his words i.e., whether a sentence is spoken with a smile or with a sneer. (Pike, 1945). Intonation is the linguistic form in which the speaker organizes certain kinds of information (Denes 1959).

Some researchers like Bolinger (1972) consider intonation as only a peripheral part of oral communication. It is the rise and fall in the fundamental frequency (FO). This is not only thought of as a grammatical signal of completeness and incompleteness, but also as emotional gauges of tension and relaxation.

According to Bolinger (1972), "Intonation is not as central to communication as some of the other traits of language. If it were so, we could not

understand some one who speaks in a monotone". "This is like the saying that voicing is not crucial to communication because we can understand whispered speech". (Ling, 1971).

Denes (1959) writes that intonation is the linguistic form by which the speaker's emotional attitudes are conveyed such as doubt, agreement, questioning, affirmation, continuing interest etc.

Intonation is the perception of changes in the fundamental frequency (FO) of vocal cord vibration during speech production (Minifie, 1973). The acoustic cues for prosodic features which have received the most extensive attention are fundamental frequency, intensity and temporal spacing of acoustic events.

Steele, (1965) was the first who worked on elusive side of spoken language and set it down in a clear and systematic visual form and gave it peculiar symbols. He called these missing components, melody and measure. Now-a-days melody is being called intonation by phoneticians.

Intonation is an exclusive term referring to pitch as a function of time or to long term variation in phrases over a numerous inflectional shifts (Greene, 1964).

Fair banks (1940) used the term intonation to include both inflection and pitch shift. He used inflection to identify the pitch change within a single phonation and pitch shift to identify change in pitch from the end of one phonation to the beginning of the next phonation.

Lehiste (1970) used the term intonation as linguistically significant functioning of fundamental at the sentence level. Contrastive function frequency of

the fundamental frequency is called 'tone' at the word level. She distinguished between lexical tone, grammatical tone and morphemic tone.

Lexical tone is found in languages in which contractive tone is associated with differences in the meaning of roots and stems (independent of stem formatives). Such languages are Chinese and Slovene.

'Grammatical tone' is one in which a difference in tone signals a difference in grammatical function without changing the lexical meaning or overt morphological structure.

'Morphemic tone'¹ is used in instances in which the tone as a root is predictable from the presence of a suffix morpheme, which need not carry the tone overtly.

Among the studies of intonation, some describe the units of intonation of a language and some describe the intonation contours along with their attitudinal meanings. "The general characteristics of the intonation seem to be shared more broadly than those of any other phenomenon commonly gathered under the label of language" (Bolinger, 1972). According to Bolinger (1972), description of intonation in a language can be divided into two groups. (1) Atomist (2) Global.

The atomist view describes the relationship between subunits of language and intonation. In the atomistic aspect of intonation, the linguistic features are determined by factors like the fundamental frequency, intensity and duration (Pike 1945, Denes, 1959; Bolinger, 1972). The atomistic approach is also called the 'level' approach, with each level corresponding to a phonemic unit (Bolinger, 1972). The 'global' view describes the entire FO contour, giving their grammatical

or attitudinal meanings. This approach is also called the 'tune' approach (Bolinger 1972).

According to Cruttenden (1986), languages can be divided into the 'tone languages', 'intonation languages', 'stress accent languages' and 'pitch accent languages'. In intonation languages, intonation involves the occurrence of recurring pitch patterns, each of which are used with a set of relatively consistent meanings, either on single words or on groups of words of varying length. Grammatical constituents of any level, upto the sentence may be treated as separate intonation groups having their own meaningful tune. Intonation groups or intonation phrases generally correspond to constituents of sentences, in a somewhat loose way.

In tone languages, pitch is the principal exponent of intonation. Pitch is also used for differences of tone in tone languages. Tone is a feature of lexicon, being described in terms of prescribed pitches for syllables or sequences of pitches for morphemes or words; where as intonation is a feature of phrases or sentences (Cruttenden, 1986). Tone concerns the pitch patterns of words. A change of meaning is produced if one tone is exchanged for another on one syllable, while keeping the segmental composition unchanged. This situation results in sets of words distinguished only by tone and applies to many languages of the far east (Bolinger 1972).

Intonation differs from tone in the type of meanings it conveys. While tone is used for contrasts in lexical meaning or to produce modification of meaning of the utterance such as cases or tenses, the meanings conveyed by the intonation are often less concrete. Intonation may indicate a discoursal meaning like inviting a listener to make a contribution to the conversation, or an attitudinal meaning. In

some languages, the meanings associated with intonation may come nearer to the grammatical use of pitch in tone languages. This is the case where the use of particular tunes is closely tied to functional sentence types, such as statements, yes-no questions and commands (Cruttenden, 1986).

"The distinction between the 'Stress accent' languages and the 'Pitch accent' language has never been very clearly defined" (Cruttenden, 1986). According to him, the term 'Stress accent' is usually used to refer to languages, like English, using pitch primarily for intonational responses. It implies that prominent syllables in such languages are marked primarily by 'stress' which in this sense seems to mean breath force or loudness.

Cruttenden (1986) states that in 'pitch accent' languages such as Japanese, words with an accent realize the accent by a high pitch on the accented syllable which is followed by a low pitch on the following syllable. The pitch of unaccented syllables is predictable by rule i.e. an initial unaccented syllable is low, any other unaccented syllables before the accents are high, and all unaccented syllables following the accent are low.

Bolinger (1975) states that there are three features of intonation which have similar uses in all languages. They are:

1. Range: The range conveys emotions. When we are excited our voice extends its pitch upwards. When we are depressed, we speak almost in a monotone.
2. Direction : It is usually connected with pause.
3. Relative height: It is associated with the importance given to particular word or words in a sentence.

Intonation also play a useful role in the determination of voice quality, (Brown, Strong, and Rencker, 1973) and in recall of verbal materials (Leonard 1973). Sweet (1978) distinguished eight tones in all, some being more fundamental than others. They are : level, high rising, low rising, high falling, low falling, compound rising, compound falling and more emphatic.

Palmer (1922) distinguished four basic types of tones falling, high rising, falling rising and low rising which are almost invariably intensified and hence are considered normal. He also described intensified falling tone and two kinds of tonal sequence.

1. Co-ordinating: ($\backslash, /, \backslash, /$) where the tone groups are identical.
2. Subordination ($\backslash, /, \backslash, \backslash$) where the tone groups are dissimilar.

In the analysis of intonation, some investigators use the 'Contour analysis' (Eg: the British investigators) and some other investigators use the levels analysis. (Eg. the American investigators). In level analysis, levels of stress or prominence, pitch declination throughout the intonation group, and pitch at terminal junctures (such as falling, rising, or level pitch are considered). In contour analysis, the location of 'nucleus' and the pitch movement or contour movement with reference to the nucleus are considered.

Different types of intonation contours are identified with reference to the 'nucleus' of an utterance. In British English, the intonation is usually described in terms of contour shape using a fall/rise opposition. The fall-rise behaviour of FO is also studied extensively in American English. This is described in the studies on the perception of synthetic speech. (Studdert-Kennedy and Hadding, (1973) and the phonetic structure of intonation (O'Shaughnessy, 1979; Ladd, 1983). Some

theories and approaches concerned with intonation have focussed on the semantic correlates of statements and questions. (O'Shaughnessy, 1979), attitudinal or non-attitudinal changes (Uldall, 1972). At acoustic level, FO contours are studied in terms of direction of movement within the utterance and the behaviour of the terminal portion of the utterance where as some others have considered the variations of FO across "intonation groups" (Cruttenden 1986) and phrase boundaries (t'Hart and Cohen, 1973).

Intonation groups have been variously called 'sense groups', 'breath groups', 'tone groups', 'tone units', 'phonological phrases'. The intonation groups are demarcated by the use of pause and other boundary markers.

The intonation of a language contributes to a system of distinctive units and patterns (Crystal, 1969; Hans Kurath, 1971). These patterns are also reported to present a wide range of cross language similarities. Similarities are seen in the use of pauses, fundamental frequency fluctuations, intensity and durational contrasts (Vaissiere, 1995). Various models are proposed for the description of intonation in various languages (Thorsen, 1979; Pierrehumbert, 1979; Cooper and Sorenson 1981; Vaissiere, 1983; Ladd, 1983).

Fundamental frequency contours in speech are shaped by a number of different factors during speech production. Two of the most commonly studied factors are intonation and segmental structures. The interaction between segmental and suprasegmental structures have often been less explored and less understood (Silverman, 1986). Apart from pitch, duration (length) and loudness, are also considered as important attributes of intonation (Cruttenden 1986).

Most research on prosody has focused on the characteristics of isolated sentences. The formulation of rules describing the prosodic characteristics of text

and discourse has received little attention. However, in the past few years there have been an increasing number of publication in the area of prosody in text. Descriptions which are based upon different theoretical assumptions are available for different languages (Sluijter and Terken, 1993; Swertz and Gelyuykens, 1993; Nakajima and Allen, 1993).

Studies have shown that speech reading performance in deaf can be improved when it is complemented with information about the fundamental frequency. Attributes of FO, namely, its presence or absence and its tendency to rise and fall in frequency during the course of an utterance have helped in perception of connected speech (Grant, 1987).

Perception of the prosodic aspects takes place by tracking the fundamental frequency and thereby perceive significant changes in fundamental frequency (FO) resulting in various intonation contours. Listeners perceive the proper fundamental frequency even when it is absent, as long as they can hear the harmonic structure formed by multiples of the FO (Fry, 1975). To perceive the prosodic features of stress, listeners apparently use frequency, intensity and duration as perceptual cues. Fry (1978) has stated that the fundamental frequency is the most powerful cue to stress. The prosodic feature of juncture can be cued by silence vowel lengthening, or by features such as presence of voicing or aspiration.

Intonation groups align with larger syntactic constituents and most commonly it correspondence with clauses. But very often they also correspond with adverbials which are modifying a whole clause. Different description of intonation have emphasized grammatical meanings, attitudinal meaning and discursal meanings. Emphasizing grammatical meanings suggests that there are typical tones associated with syntactic structure like declaratives, interrogative and

imperatives, and that the discorsal meanings usually associated with these structure that is statements, questions, and commands will also have typical tones even when they are not marked syntactically.

A discorsal approach to the meaning of tones deals with concepts like shared mutual knowledge of speaker and listener, the desire of the speaker to dominate listeners and the sort of expectation which a speaker has about a listener's reply (Cruttenden, 1986).

Intonation can be determined by linguistic features like the fundamental frequency, intensity and duration. These cues may carry segmental information also. Most of the investigators refer to the fundamental frequency, as the essential ingredients of intonation, but some do not. "The intonational differences heard as high or low, rising or falling are primarily related to the frequency of the sound waves" (Labo 1961).

According to Pike (1945) and Labo (1961) the variations in fundamental frequency is the basis for various intonation contours. This above statement was not found always true according to Denes (1959) and the support for this statement was obtained from the whispered speech, because there is no vocal fold vibrations and hence no fundamental frequency, but still the speaker is able to convey to listener much of the information that is normally considered to be contained in the form of intonation.

Intensity, which is a function of transfer of energy through the vocal tract, is determined by subglottal air pressure, degree of constriction and length of the vocal tract. Therefore there are a number of options for altering any of the parameters (i.e. varying FO while holding intensity constant or vice-versa) which requires compensatory adjustments. But there is sometimes a strong tendency for

changes in one parameter to be accompanied by some change in the other (i.e. while increasing vocal intensity, most speakers also rise FO).

Fundamental frequency (FO), is a stronger cue than intensity, also tends to be used in conjunction with other cues and is in most circumstances a sufficient but not a necessary cue. In general, the FO contour of a simple, declarative sentence or clause shows a FO peak on the first stressed syllable, with a gradual decline of FO on the final syllable of the utterance group. Faster, shorter rises and falls in FO occur during overall falling contour and coincide with the production of syllables perceived as stressed. Acoustic studies have shown that major clause and phrase boundaries of a variety of sentence type are typically characterized by a fall-rise pattern (Cooper and Soreson, 1977). The lowest point in the FO fall occurs just prior to the syntactic boundary. The FO rise may begin either just before the boundary or just after the boundary.

Many experiments were conducted to see the relationship of intonation and the different acoustic characteristics. Methods such as speech analysis and speech synthesis methods were used and the analytical experiments were conducted with measuring the changes that occur in the acoustic characteristics of the speech wave when the various 'tones' of intonation are spoken. The synthesis experiments aimed to see the kind of intonation recognized by the listeners when they hear synthetic sounds generated according to various predetermined patterns. It was found that simple relationship existed between intonation and fundamental frequency - a straightforward fall in frequency for a falling 'tone' or a simple rise in frequency for a rising intonation 'tone'.

When the intensity graphs were checked, it was found that on many occasions the shape of the intensity-time curves were similar to that of

fundamental frequency-time curves. The exception was the high-rise 'tone' for which two curves were consistently different. Also, the intensity curves always started and ended at zero while the frequency would start and end at any value. These effects would probably be less pronounced in speech over longer duration than when syllables are considered. A study done by Denes (1959) confirmed that the movement of the third formant was related to the changes of intonation pattern.

O'Shaughnessy and Allen (1983) in their study found that the sentence level determined the overall FO shape. Most of these utterances were spoken as an expiration of breath, forming a breath group (Jones, 1940; Lieberman, 1967). They pointed that the overall pattern of FO in a breath group, for English utterances other than Yes/No 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, FO differed from the typical pattern by falling less after the initial rise, and rising rapidly at the very end to the highest level in the utterance (O'Shaughnessy, 1979).

Remez and Rubin (1993) demonstrated that a sinusoidal replica of a sentence evoked a clear impression of intonation despite the absence of the primary acoustic correlate of intonation, the fundamental frequency. The experiments however, determined that the listeners represented the sinusoidal intonation as a pattern of 'relative pitch changes' which correlated with the frequency of the first formant, and that the sinusoidal sentence was probably a close match to the 'pitch height' of the first formant.

With reference to phrase level, which was the second hierarchical level, O'Shaughnessy and Allen (1983) agreed with Lee (1956), Denes (1959), Olive (1975), who reported that certain portions of the utterances were often marked by

FO changes at major syntactic breaks. They further stated that within the normal gradual FO fall of the breath group, such breaks were indicated by discontinuities in the FO pattern, such as a sharp FO fall, followed by a rise on the final voiced phone before the break. Delattre et al. (1965) had pointed to the fact that this 'continuation rise' FO pattern was used to signal to the listener that the sentence was not yet complete because an FO fall to a low level indicated finality. In Swedish, Bruce and Granstrom (1989), reported a decrease in FO value before the boundary and a moderate reset after the boundary.

Terken (1991) framed two different hypothesis to evaluate the role of FO in the perception of intonational prominence. According to 'Max' hypothesis, prominence was determined by the scaling of FO maxima and according to 'change' hypothesis, prominence was determined by the magnitude of FO changes. Neither hypothesis gave a satisfactory account of the results and it was concluded that perceived prominence was related in a complex way to the range of FO values employed.

t'Hart, Collier and Cohen (1990) reported that in Dutch intonation, at least ten pitch movements were distinguished. These distinctions were based on whether the movement was a rise or a fall, or whether it extended over one or over more than one syllable, on its temporal position in the syllable, and as its excursion size. These pitch movements were realized between declination lines, declination being defined as the gradual lowering of the pitch in the course of an utterance or part of an utterance.

Some of the intonation characteristics are shared by most of the language in the world. This is called the 'Universality' of intonation. Attempts have been made by several investigators to compare different languages of the world.

However, no definite and conclusive results have been drawn regarding this aspect as some are arguing for it and some against it (Larson and Pike, 1949; Pence 1964; Abe 1955; Hadding and Kennedy, 1964). Bolinger (1972) considers that the causes of these universal features, as not linguistic inheritance, but as the intonation is gestural, which is also connected with physiology of speech and with the nervous system. Thus some consider that there is universality in intonation across the languages.

Vaissiere (1983) also stated that usually, in many languages, the largest rise or the highest FO value was located in one of the first three or four syllables of the utterance (i.e. within the first lexical word). However, speakers were able to counteract this natural tendency to a certain extent, by creating a local widening or narrowing of the expected range to mark boundaries or emphasis in complex sentence when they ceased voicing. The final fall was often accompanied by a lower intensity and by a lengthening of the final elements, which acted as cue to the listener to indicate that the utterance was ending. Again, however, speakers could counteract this tendency to convey linguistic information. The terminal contour of the last syllable, according to this investigator, was the most important feature in distinguishing simple declarative statements from yes-no questions in a number of languages. This was also earlier reported by Contini and Boe (1975) for French, Magno- Caldognetto (1978) for Italian, Nishinuma (1979) for Japanese and Dascalu (1979) for Romanian, Thorsen (1980) for Danish. It was noted by these investigators that when used for marking interrogation, a terminal rising contour was accompanied by a suppression of the declination tendency. But this effect was language specific. In some languages interrogatives could be characterized by a falling intonation and in others, a rising contour could be typical for declaratives. Even in yes/no questions, where the interrogative mode was indicated by the syntax, and in WH- questions, a rising contour was optional.

Ladd et al. (1985) analysed the results of the listeners judgement of the affect conveyed by short recorded utterances in which the voice quality, intonation contour type and the FO range were systematically and independently manipulated. Results indicated that the FO range and voice quality were independent of the effects on the way the utterances were judged. It was also independent of the effects due to inter- speaker differences and the differences of verbal content. It also suggested that the differences of FO range, as was commonly assumed, had continuous rather than categorical effects on affective judgements.

Lieberman and Michaels (1962), conducted an experiment to show the importance of the fundamental frequency and amplitude in intonation. Pitch pulses were electronically derived from the utterances of three male speakers of American English. They were asked to read eight neutral test sentences in certain emotional modes for example: a question, an objective statement, a fearful utterance, a happy utterance etc. Recordings of these were presented to separate groups of naive listeners who categorize the emotional modes in forced judgement tests. Results of the tests showed that with unprocessed speech, the listeners were able to correctly identify the emotional content 85% of the time. When only pitch information was presented, correct identification was made 44% of the time. When amplitude information was added to the pitch information, the identification rose to 47%.

Denes (1959) in one of his experiments used a 'vocoder' which is an analysis - synthesis telephone system in which a simplified version of the speech wave is transmitted. The output consisted of a sound wave with a spectrum that in broad outline corresponded with the spectrum of the speech wave produced by the speaker. This spectral pattern could be excited at will with a periodic or a noise source, producing either voiced speech or whisper, and when present, the

fundamental frequency of the output could be controlled separately. The vocoder was used in the following ways:

- 1) The output was permanently switched to a whisper.
- 2) The output was permanently switched to voiced speech, with the fundamental frequency kept constant, producing monotone speech.
- 3) The output was permanently switched to voiced speech with the fundamental frequency varied according to some arbitrarily determined patterns. For example, the speech input consisted of a word pronounced on a falling intonation and the pattern of fundamental frequency variation of the output was given a rising or a rising-falling pattern.

The input consisted of mostly words and very few sentences which were pronounced by expert phoneticians on a number of different tones i.e., high-fall, low-fall, high-rise, low-rise, fall-rise and rise-fall. The corresponding output of the vocoder, which was adjusted in turn to all three conditions outline above, was then interpreted by a few phonetically trained listeners. The results showed that listeners had **little** difficulty in distinguishing the intonation 'tones' when the vocoder was switched to whisper. The intonation was largely lost when monotone was used and the experiment was inconclusive when the fundamental frequency pattern of the output was varied arbitrarily.

In a study conducted by Ross and Duffy (1973), to find out which portion of the frequency curve contained sufficient prosodic features for listeners to correctly identify the intended emotions of speaker, an actor and actress simulated nine different emotions with the same passage in each of the nine different spoken

paragraphs. The passage was edited, from the tape (thus keeping the lexical information constant) and presented to listeners under five listening conditions:

- i) No filtering
- ii) 600Hz low pass frequency filtered
- iii) 450 Hz low pass frequency filtered,
- iv) 300 Hz low pass frequency filtered,
- v) 150 Hz low pass frequency filtered.

The results showed that the intended emotion of a speaker could be identified with perception of only the lower audible frequencies of speech.

Ancient Sanskrit literature opined that different types of intonation should be used in different situations (from the Natya Sastra, quoted by Savithri, 1978). It is said that intonation will always be made high, excited and faster in a rejoinder, confusions, harsh approach, representing sharpness and roughness, agitation, weeping, threatening, terrifying and calling one at a distance.

Intonation will be grave and slow in conditions of sickness, fever, grief, hunger, thirst, deliberation, deep wound from a weapon, communicating, confidential words and in states of anxiety. Intonation will be grave and fast in women's soothing children, panic and attack of cold. Intonation will be slow, excited and of low pitch in following an object lost after being seen, hearing anything about a desired object or person. Communicating something desired, mental deliberation, envy, anything which cannot be adequately expressed, telling stories, rejoinder, conclusions, misery, grief, surprise, jealousy, anger, joy and

lamentation. Grave and slow intonation can be used in words containing pleasant sense and bringing in happiness. Excited and high intonations can be used in words which express sharpness and roughness.

Abe (1955) compared the systems of English and Japanese and found similarities in the use of questions and statement tunes. This was attributed to the 'universal nature' than to chance and concluded that these constitute human speech.

Bolinger (1972) tried to reason out, the causes for these universal features. According to him, there is no possibility of linguistic inheritance, since it is a kind of gesture. Intonation is gestural in some respects because a downward dip of pitch is accompanied by a submissive or placating blow of the head. It is also connected with the physiology of speech and with the nervous system in general. The universal lowering of pitch towards the end of unexcited discourse results automatically from running out of lung power. Subglottal pressure raises and lowers pitch, other things being equal. The universal raising of pitch for question and other keyed-up utterances is probably due to higher nervous tension in the body as a whole, which has the local affect of tensing the vocal cords.

Uldall (1960) stated that 'attitude measurement' which seemed to be a promising technique by which to attempt to find out whether a group of subject from the same linguistic community would agree on the 'meanings of intonations, and whether some few very general dimension of meaning' in the emotional area could be extracted. In her experiment, the same sentences were presented with differing intonation contour (imposed upon it synthetically) to a set of subjects who rate each sentences plus intonation as to whether it conveyed the impression that the speaker was bored or interested, rude or polite, agreeable or disagreeable and write down a list of ten paired opposite on a seven point scale, using the

"semantic differential technique (Osgood, Susi and Tannenbaum, 1957). Four sentences in English were used in this experiment and these four sentences were intended to be kept as colorless as possible so that, it would allow the intonation to add as much as possible to their meaning, so that it would represent situations as possible when combined with different intonations. Sixteen intonation contours were applied to these four sentences. It was concluded that:

1) contours of small range of frequency or small change of direction at the end are the most discussed and are often rated as being pleasant.

2) The smooth contours preceeding steadily in one direction (particularly downward) are found more pleasurable than broken contours with a change of direction or movement up and down of strong and weak syllables.

3) Statements can be pleasant when either falling or rising at the end, while on the questions and the command contours final rising tends to be the pleasant ones.

4) In determining the factor of 'interest' vs 'lack of interest' the final rising or falling of the contour is not important.

5) In determining the 'authoritative'-'submissive' factor, the range of pitch is more important than the final rise or fall.

Sorenson and Cooper (1979), reported that F_0 of the first stressed is higher by 6% for longer (13.8 word) sentences than for shorter (7.5 word) sentences.

Pollack, Rubenstein and Harowitz (1960) conducted a study where four talkers instructed to read neutral sentences and sound happy or sound bored etc. There were sixteen modes of expression. Listeners had to identify the intended

mode of expression drawing their responses from a limited number of
Four factors on the identification of modes of expression were studied.

They were;

1. The number of response alterations.
2. The effect of noise.
3. Whispering (to abolish speech pitch characteristics)
4. Temporal samplings.

In general it was concluded that high levels of correct recognition may be achieved for a defined small number of modes of verbal expression for a defined small number of talkers by a familiar listening crew. With the talkers mode of expressions reasonably high levels of recognition may be achieved with sharply reduced acoustical information (low signal to noise ratios) of short samples or whispered speech.

Another study conducted by Huttar (1968) where in the emotional states of an adult American speaker, as reflected in 30 utterances were evaluated by 12 subjects on a seven point semantic differential scales. The emotional states of the persons whose speech was studied were measured indirectly by means of listeners response, and the prosodic features of the utterances were studied by two means.

1. Acoustically by means of a sound spectrography.
2. Perceptually by means of listeners response.

Significant correlation was found between some acoustical variables and the judgements of some types of emotions. Higher correlations were found between

the acoustic variables and judgements of degree of emotion. Correlation coefficient between judgements of emotion and judgements of prosodic features were in general higher than the correlations involving the acoustic variables. Degree of perceived emotion were found to be highly and positively correlated with fundamental frequency range. This study presumed that the increased muscular activity associated with emotion is in some way related to an increase in pitch.

It is hypothesised that when a listener hears the first portions of an utterance he begins generating expectancies in real, based on a number of prosodic features, including tempo and rhythm. This strategy is viewed as reducing processing load and increasing processing efficiency (Freeman, 1983). Even before an utterance begins, the listener has knowledge of the possible maximum length of the first and subsequent major constituent units, since a breath group cannot exceed respiratory constraints. After the first few syllables an individual can have even more precise estimate of the probable length of the sentence, because F_0 tends to fall rapidly in short sentences and more gradually in large sentences.

In general, it was concluded that high levels of correct recognitions may be achieved for a defined small number of verbal expressions for a defined small number of talkers by a listening crew familiar with the talker mode of expressions. Reasonably high levels of recognition may be achieved with sharply reduced acoustical informations (low signal to noise ratios), short samples of whispered speech.

Graddol and Swann (1983) conducted a study about the relationship between speaker height and weight and speaking fundamental frequency in a socially homogeneous group. The results of this study suggested that, in male sample the speaker height is related to average speaking fundamental frequency

(SFF). The female sample differed from the male sample in such a way that the SFF did not, correlate well with their lowest attainable FO and the women's height did not correlate well with their lowest attainable FO, suggesting that height is not a good indicator of the size of women's vocal apparatus. A further investigation of the passage in which a close relationship was found between (male) speaker heights and median SFF showed that the strength of the relationship was affected by intonational characteristics, in particular the declination pattern. This suggest that one of the sex difference found may be due to different intonational patterns used by women and men, an interpretation which received support from other research suggesting that women's voices are more variable in FO than men's.

Studies regarding whether listeners are able to recognize the language of an utterance from information on prosodic structure alone were carried out. Atkinson (1968) processed samples of English and Spanish speech by generating a pulse train which retained the fundamental frequency and overall amplitude characteristics of the original. Although no overall success rates are reported in this study, Atkinson states that here subjects were in close agreement and that their scores were significantly better than chance.

Bonte (1975) used a similar technique to produce stimuli in three languages - English, French and Chinese. The average score reported for this study was 41% correct identification.

(1976) in a pilot study for the experiments reported here asked subjects to judge the language of short samples of English and French laryngograph output. The mean score for this experiment was 64.5% correct identification.

Ohala and Gilbert (1978) investigated whether their subjects could identify the language of utterance in samples drawn from spontaneously produced conversation in English, Japanese and Cantonese. The overall mean score reported was 56.4%. This study also reported on the effects of training in the task. The mean score for subjects who received training is reported as 58.1% correct identification. The authors also studied the effects of stimulus length on identification. Shorter stimuli (10 seconds or below) were correctly identified 55.1% of the time, whereas longer stimuli (15-25 seconds) were identified correctly 57.7% of the time.

Ladd (1996) suggests that cross linguistic difference among intonation languages may be classified using a taxonomy of systematic phonological and phonetic parameters. Following a well-established tradition for the description of differences in segmental phonology and phonetics within British Linguistics, he broadly suggests 'semantic', 'systemic', 'realizational' and 'phonotactic' distinctions in intonational structures.

Grabe (1998) conducted a cross-linguistic study to investigate the pitch accent realization in English and German. This study showed that English and German differ in the realization of phrase-final rising and falling pitch accents when accents are associated with segmental material which offers successively less scope for voicing. English 'compresses' rises and falls, both contours became steeper in order to complete the rise or fall in a short time span. German on the other hand, truncates falling accents, falls do not become steeper but simply end earlier. Rising accents, however, are compared just as in English. Within an autosegmental-metrical framework, the evidence may be interpreted as reflecting a case of two languages sharing a common inventory of phonological specification but differing in the way these specifications are realized in F0.

It is a well known fact that intonation patterns are acquired by children even before the acquisition of speech sounds. Even though no systematic studies were conducted, the importance of intonational variations in infant vocalizations and speech has been recognized and observations were noted down as early as in 1920s. The shift of intonation as a meaningful speech signal that has a reference to specific social situations was comparatively rapid. Schafer (1922) reported that a nine month old infant who responded to the intonation of a phrase by looking at the clock also looked at the clock when similar phrases were spoken with the same intonation. Lowenfeld (1927); Buhler and Hetzer (1928) reported that infants from the age of 2 months onwards, responded positively to the human voice, while infants from the age of 3 months onwards responded positively to friendly tone and negatively to angry tones of voice.

Corlew (1968) conducted a study to know the development of the recognition abilities of intonation contours in English. He found that the first grade children matched the intonation with significantly fewer sentences than either the third or fifth graders. He also found that the performance of the girls were better than that of the boys on 'impatient' question and 'simple command' which indicated that there was a significant interaction between sex and intonation. The use of changing F_0 , perceived as the pitch pattern or intonation contour of phrase/sentence is particularly effective in expressing difference in attitudes and also difference in meaning. American English sentences are often characterized by a rise-fall intonation curve.

Rising intonation results chiefly from increased cricothyroid muscle activity, lengthening the vocal folds for faster vibration. Falling intonation accompanies the decrease in intensity at the end called the "breath group". The

decrease in subglottal pressure is accompanied by both intensity and F_0 declines. This pattern is called an 'unmarked breath group' (Lieberman, 1980).

There is some evidence that early communication is essentially suprasegmental in nature (Lewis, 1951; Lenniberg, 1967). Intonation patterns are acquired by children even before the actual acquisition of speech sound. In the very first few months of life, during the babbling stage and indeed during the very first minutes of life, children employ 'meaningful' intonational signals. The infant varies intonation patterns to express physiological and emotional needs. At the age of 6-7 months, the child begins to imitate the intonation of the adults talking to him (Nakazima, 1962). At about the same age, most babbles of children, are produced with a falling declarative intonation, but then the child begins producing both rising and falling, questioning intonation patterns (Tonkova Yompolstaya 1969).

Lieberman (1967) showed that the basic pitch of the babbling of two children at ten and thirteen months of age shifted towards the pitch of the adult speaking to them.

Infants have been found to discriminate between rising and falling patterns of intonation between 1.5 and 2 months (Morse 1972). By the age of eight months children could discriminate between a syllable pronounced with a rising intonation and the same syllable said with a falling intonation (Morse 1972).

Dore (1973), has reported that children learn and produce intonation patterns of the input language during the first year of life. With increasing age, prosodic patterns become more influenced by factors as phoneme structure and vocabulary. By 18 months, most normal children use intonation patterns typically produced by speakers in their language environment (Menyuk 1972) and by 2

years of age have less than 3% error in imitating simple rising and falling inflections (Kressin, Marquardt and Asp (1976). Koike (1977) Koike and Asp (1977) found that 5 year olds performed significantly better than 3 year olds on a more complex suprasegmental task.

Mallard and Daniloff (1973) have stated that 'if infants vocalisation can be categorized on dimension of emotional content ranging from euphoric laughter (pleasure) to extreme distress, then it is likely that the infants laryngeal mechanism supplies the acoustic cues, which listeners use to identify the emotional meaning of the cries. Their results revealed that glottal frequency best predicted judgments of emotional state, whereas duration and intensity were of lesser importance. As the fundamental frequency increased, the tendency to rate the vocalisation as distressed also increased. The investigator concluded that glottal frequency may be crucial parameter in an infant's signalling his emotional state to a listener, parent'.

An extensive cross sectional study was conducted by two Russian investigators, Tokova and Yampolskaya (1969), using 170 infants upto two years. It was found that above the first month of life, children reacted to disagreeable situation (hunger pain) and announced it with a peculiar variation of pitch in the cry. During the second month sounds of discomfort and placid cooing could be distinguished from sounds of happiness and then laughter appeared during the their month thereafter until the sixth month. The semantic content of the speech sounds was confined to these four forms; discontent, placid cooing, happiness, laughter, although the number of speech sounds increased.

Mallard and Daniloff (1973), conducted a study to determine which acoustic parameters were important to a mothers judgement of her child

vocalisation along a "pleasure-distress" perceptual dimension. Twentyfour vocalisations of a four month old child, were judged by the child mother for emotional content. An acoustical analysis was performed on the samples. Multiple regression analysis revealed that glottal frequency best predicted judgements of emotional state, where as duration and intensity were of lesser importance. As the fundamental frequency increases the tendency to rate the vocalisation as distressed also increased. The investigators concluded that glottal activity, particularly glottal frequency may be a crucial parameter in an infants signalling his emotional state to a listening parent". It is well known that intonation and stress, both of which are primarily glottally, mediated, are rather well developed before the first word is spoken. It seems likely that a child used the laryngeal system, in the early stage because it is better controlled and more highly developed than the articulatory system (Sheppard and Lane 1968).

The study of intonation and other prosodic aspects in pathological conditions of speech have also been studied.

Darley (1979), in the diagnosis of articulation disorder includes assignment of prosodic production features. He describes ataxic dysarthria as associations with the deviant perceptual dimensions of prosodic excess and phonatory prosodic insufficiency. Acoustic analysis demonstrate that this perceptual cluster can be resolved primarily as a distortion of the temporal pattern of speech; with lengthening of normally reduced (unstressed) syllables and the occurrence of inter syllabic pauses. They suggest that ataxic speech production involves a dissociation (as opposed to integration) of the syllables, with a tendency toward equal syllable duration, frequently abnormal pause intervals between syllables. This second description is clearly a preferable basis for treatment planning, even as an articulation analysis is preferable to the observation that the client does not say all

his sounds correctly. Acoustic analysis offered an access to critical diagnostic information.

Kent et al., (1979), describes the patterns of dysprosody in subcortical dysarthrias as a deterioration of relative syllable timing and a distortion of F_0 . 'Sweeping' is the marked dissociation of syllables in time. Such syllables have a marked tendency toward equal deviations and a monotypic F_0 pattern. Scanning speech is characteristics of ataxic dysarthrias.

Nandyal (1981) did a comparative study of intonation pattern between deaf and normal hearing subjects. Results showed that,

1. Variations in pitch levels of hearing impaired subjects were less than that of normal hearing subjects.
2. Rise and fall pattern was different for the two groups.
3. The duration over which the speech segment extended, was more in case of hearing impaired. It is probably due to this, the variation in intonation patterns tended to be more gradual in hearing impaired subjects and not as sharp in the case of normal hearing subjects.

Intonation problems in deaf can be divided into two major types -

1. Monotonous voice
2. Excessive erratic pitch variation

Kent (1979) describes three types of prosodic disturbances in neurological lesions.

1. Hyper prosody - Excessive or exaggerated prosody observed in some types of aphasia and manical states.

2. Dysprosody - Distorted prosody observed in cerebellar ataxia and in conjunction with some aphasias or speech ataxia.

3. Aprosody - Attenuation, reduction or lack of normal prosody observed in Parkinsons patients and in right hemispheric lesion patients.

Lieberman (1968), commented that it is possible to generalize about intonation to the extent of stating that short declarative sentence usually ends with a falling fundamental frequency contour.

Very few studies are available in the area of hemisphere specialization for intonation. Some of the acoustic correlates of intonation contours i.e. fundamental frequency and amplitude were shown to be lateralised in the right hemisphere (Day and Copeland 1971, Goodglass and Donerfeld, 1973), the lateralization for the intonation contours as such was not studied much.

Blumstein and Cooper (1974), conducted two dichotic experiments to investigate the lateralisation of intonation. Results from the two experiments suggested that the right hemisphere is directly involved in the perception of intonation and that normal language perception involved the active participation of both the cerebral hemisphere.

Hird (1993) acoustically analysed 'emotional tone'¹ of non dominant hemisphere damaged subjects. The purpose of his study was to investigate the effect of right hemisphere damage on the perception and production of emotional prosody. Eight male patients with altered prosody following strokes in the region

of middle cerebral artery of the right cerebral hemispheres and subjects with no history of neurological damage participated in the study. They showed no significant differences between the two groups on reception tests. Right cerebral vascular accident subjects produced significantly shorter utterances than the controls in all conditions. There was also a significant standard deviation between fundamental frequency and group.

The melodic intonation therapy for aphasias was devised by Stark et al., (1974), based on the rationale that the intonation contours are perceived in right hemisphere.

Study of intonation in Indian languages have been very few. Only a very few Indian languages have been studied on this aspect.

Rathna, Nataraja and Samuel (1976) conducted an experiment in Kannada to study the identification of intonation with reference to context. They have concluded that the listeners were not able to identify the correct pair of intonation sentences and context sentence. It was also concluded that it is possible to use a similar kind of intonation pattern in different contexts in Kannada language. Thus, the reference content may become important in identifying the intonation.

Manjula (1979), studied intonation in Kannada under nine emotional conditions using 36 sentences. She concluded that "the sentences in Kannada with emotion are expressed with a final fall in the intonation". A sentence with a specific emotion can be expressed with more than one type of intonation pattern, and a single intonation pattern may be used to express sentence with different emotions.

Nataraja (1982) compared the intonation contour in four Indian languages (Kannada, Tamil, Gujarathi, Hindi), under five emotional conditions (a) anger, (b) joy, (c) jealousy, (d) neutral, (e) mercy. He concluded that 'same intonation may be used to express different emotional conditions and further, the same contours are seen across the language being used". There seems to be common or 'universal' intonation contours across the languages studied.

Investigations of Rathna et al., (1982) showed that a relative increase in intensity, steepness of the intensity rise, a pause before the word and a large duration of the word are the features observed contributing to stress in Kannada language. Rathna et al., (1975) found that a pause before a word contributes to perception of stress in Kannada language.

Patil (1984) noted that the non-polar questions in Dharwad Dialect of Kannada language, when not emphasized, had a falling pitch level at the end. But, when coupled with an attitudinal implication it ended with a rise. The question word in non-polar questions, apart from having a high pitch, also displayed pitch movement. Sometimes question words were also found to be neutralized.

Rathna et al., (1982), did a study to find the influence of intonation patterns of part sentences on the identification of the contexts in which those part sentences are spoken. The results showed that it was not possible for the subjects to identify the correct context sentences when either only part sentence was spoken, or part sentence and context sentence was given together.

Chandrashekar (1985) conducted a study on different intonation patterns used for different emotions by speakers of Hindi language. The emotions considered were surprise, fear, frustration, jealousy, joy, anger, worry, grief and natural. He has concluded that:

Hindi speakers use different intonation patterns to express different emotions. The intensity variation was not related to emotions but the perception of pitch variation depends upon the fundamental frequency variation.

Nandini (1985), studied the intonation patterns that are used by the Kannada speakers, in expressing various emotions 30 sentences of various emotions were analysed both perceptually and instrumentally. The results showed that:

1. In Kannada different intonation patterns are used for expressing different types of emotions.
2. Terminal contours are important in determining different types of emotions.
3. Pitch is important for the perception of intonation.
4. The perception of pitch variations depend upon the fundamental frequency variations.
5. The intonation permits the identification of emotion type of sentences even when the context sentences are not present.
6. There was a correlation between the perceptual and the instrumental analysis.
7. Instrumental analysis provides minor details of frequency and intensity variations.

Nithun (1998) did a study to investigate the perception of emotion under conditions of marked fundamental frequency (F0). Six different sentences were studied in which both perceptual and instrumental analysis was done. The results showed that:

1) The intonation permits the identification of emotion of sentences even when the FO information is marked.

2) The emotion 'surprise' was best identified and the poorest identified emotion was 'anger'.

3) Trained judges could identify the pitch contours occurring in sentences, reliably and validly.

4) Females use larger FO range for all emotions when compared to males.

Srabanti (1999) conducted a study to find out the intonation patterns used by native Bengali speakers under different emotional conditions.

Both objective and perceptual analysis were done. The results obtained by objective and perceptual analysis follows:

- 1) In Bengali different intonation patterns are used in expressing various types of emotions.
- 2) The intensity variations do not show difference in pattern under different emotions.
- 3) The perception of intonation mainly depends upon the fundamental frequency variation.
- 4) Terminal contours are important in determining the form of the sentence, i.e. statements and 'Yes-No' questions.
- 5) The intonation pattern used by males and females do not differ.

- 6) The frequency and intensity range used by the females were greater in more number of emotions when compared to males.
- 7) The native Bengali speakers were able to identify the intonations much better when compared to non-native Bengali speakers.

Until now no comprehensive study has been done in Malayalam On intonation, except there are some references in the studies of Somasekaran Nair's (1997) Description of Cochin dialect of Malayalam (Page 22-26). The intonation patterns in Malayalam could be at the word level, phrase level or at the sentence level. Certain dialects of Malayalam exhibit very characteristic intonation pattern. In Malayalam generally, the sentences are verb-final both in finite and infinite sentences, and the verbs are the carriers of intonation unit.

Panikar (1973) has cited in his work of Description of Ernad dialect of Malayalam (page 3) that there are four types of significant combinations of the pitch level and the terminals. The pitch levels could low, mid and high and the terminals are rising, falling and suspense.

The present study here deals with the patterns of intonation for various emotions expressed by the Malayalam speakers.

METHODOLOGY

The review of literature on intonation shows that intonation plays an important role in language. Knowledge of intonation is essential for treating cases with delayed speech and language disorder. The speech therapist has the task of teaching use of speech at least to express emotions, to subjects, who have not been doing so. The information on intonation patterns in Indian languages is scanty. It is true with reference to Malayalam also. Therefore it was considered that it will be useful to study intonation patterns used by Malayalam speakers in expressing emotions.

The present study aims to find the various intonation patterns, that are used by Malayalam speakers in expressing different emotions. Audio recorded speech samples from popular Malayalam films expressing the following emotions were considered:

- a) Anger
- b) Fear
- c) Frustration
- d) Grief
- e) Jealousy
- f) Joy
- g) Neutral
- h) Surprise
- i) Worry

The study was carried out in following steps.

1. Selection of Material
2. Presentation of Material
3. Perceptual evaluation
4. Acoustical analysis
5. Relative results of perceptual evaluation with acoustic analysis.

Selection of Material:

Speech samples spoken by different actors were selected from the audio recording of popular films in Malayalam, which are available on cassettes. It was decided to use dialogues from audio cassettes of films on the following basis:

1. The emotions are expressed in conversation as natural as possible.
2. The subjects depicting various emotions in films are trained subjects.
3. The emotions are conveyed by speakers to the listener only through auditory mode, without visual cues.

Therefore it was considered that an independent variable has been operated to the maximum possible extent specifically and the intonation, has occurred in such a way so as to convey the required emotion. The films which have been considered as popular and acted by well known artists, selected for the study were:

1. Thenmavin kombathu -----> /θe:nma:vin kɔmbəu/
2. Rakthasakshikal sindabad ----> / rakθasa:kʃikl sinða:ba:d/
3. Kanmadam ----> /kanmɔdɔm/
4. Chemmeen ----> /tʃemmi:n/
5. Harikrishnas -----> /harikriʃnɔns/
6. The Godman -----> /ð gɔ:d mæn/
7. Patram -----> /patɾɔm/

In total, thirty six sentences expressing various emotions, were randomly selected from seven film audio cassettes. These sentences were selected on the basis of emotions identified by the experimenter. The experimenter was a native Malayalam speaker and is well versed with the language. The selection was done after testing the tape fully that the expressed emotion was decided on the basis of context & content of the sentences.

Preparation of Material

The following nine different emotions were considered for the study: anger, fear, frustration, grief, jealousy, joy, neutral, surprise, worry: These emotions were chosen because they are the primary emotions, commonly used by humans & commonly conveyed in speech.

Table 1: Number of sentences selected for each of the nine emotions and the sex of the speaker.

Emotion	No.of Sentences	Male	Female
1) Anger	4	2	2
2) Fear	4	2	2
3) Frustration	4	2	2
4) Grief	4	2	2
5) Jealousy	4	2	2
6) Joy	4	2	2
7) Neutral	4	2	2
8) Surprise	4	2	2
9) Worry	4	2	2
Total	36	18	18

Four sentences for each emotions were selected. These sentences were depicting emotions to the maximum possible extent, which could be easily identified. The sentences selected, with the emotions expressed in each sentence are given in Appendix A.

The thirty six sentences selected by the Malayalam native speaker as carrying various emotions are extracted from the seven audio cassettes of films (dialogues from original track) were transferred on to another audio cassettes (T-series CDing 60 cassette) using a sony stereodeck (CTS-W445S) and thus a master tape consisting of all 36 sentences spoken by Malayalam speakers - 18 adult males and 18 adult females, approximately in the age range of 30-35 years was obtained.

The native speakers selected for the perceptual evaluation had a good command of Malayalam language and using that for their day to day speech and the non-native speakers were neither exposed to Malayalam language or had any contact with Malayalam speakers. The subjects had no Knowledge of the purpose of the study. There were ten subjects each in both the groups.

The subjects were comfortably seated and the recorded sentences were presented to subjects using a sanyo cassette recorder. A response sheet (sample enclosed in Appendix B) was provided to each subject and the following instructions were given:

"You will hear recorded samples of sentences spoken by different individuals, both males and females. Listen to each sentence and try to identify the emotion expressed by the speaker. If you cannot identify at the first try, ask for a repetition. Among the various emotions given to you in the response sheet choose the one which you feel the speaker has conveyed. If you feel none of the emotions match, leave the space blank. If you identify a particular emotion write it down beside the sentence number."

The subjects were given as many repetitions needed to judge the emotion of the sentence. Responses given by the subjects were compiled and tabulated.

Analysis of the perceptual evaluation involved the following :

1. Whether non-native speakers could indentify the various emotions from the thirty six sentences in a similar manner as native Malayalam speakers.
2. Whether the context & the content of the sentences were important for perceiving the emotions for the native speakers.

Acoustic analysis :

The tape - recorded sample were analyzed using the computer program FOINT of Vaghmi, developed by Voice and speech systems, Bangalore. The following instrumental set up was used for acoustic analysis.

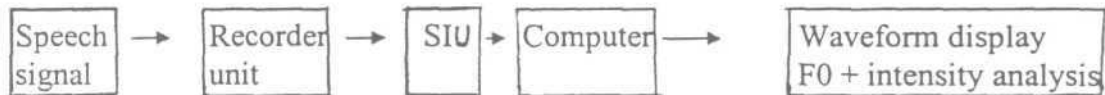


Fig : Block diagram showing the arrangement of instruments for the purpose of recording & analysis of speech.

Analysis procedure

The recorded sample, that is, each sentence at a time was fed through the speech interface unit (12 bit A/D converter) and digitised at a sampling rate of 1600 KHz and stored on the hard disk of the computer. Before digitizing, each sample was passed through antialiasing filter at 7.5 KHz with a roll off of 48 dB/octave. The level indicators of the speech interface unit was used to monitor the intensity level to avoid any distortion while digitizing the signal.

Each sentence was analyzed using the software packages SSL and Vaghmi, developed by Voice and Speech Systems, Bangalore and the fundamental frequency and intensity reading of the samples were extracted. The digitised signal was displayed on the computer screen using the programme 'Display', On execution of this programme, a specified portion of the speech signal would be displayed on the monitor of the computer. A vertical cursor, which could be moved horizontally, was used to mark specific portion on the waveform, highlight and listen to the signal present in the marked portion of the waveform, and to note the time at any given point or points on the waveform. Using this one could

segment, edit or measure the duration of any desired portion of the waveform. All the sentences spoken by the subjects of both the groups were analyzed using 'display' programme & temporal parameters were obtained.

Program FOINT of Vaghmi software was then used to extract the fundamental frequency and intensity curves for each sentence uttered by the subjects. This programme, enabled simultaneous visualizations of the fundamental frequency pattern for a given portion of speech signal, the intonation contours and also the waveform. A vertical cursor, which could be moved horizontally, enabled marking of a particular point on the wave form. The fundamental frequency and intensity measures corresponding to this point could be noted at the point where the cursor was placed on the waveform. Averaged fundamental frequency and intensity variations for each syllable were extracted and the following fundamental frequency (Fo) and intensity informations were also obtained for each sentence.

1. Mean fundamental frequency (in Hz)
2. Range of fundamental frequency (in Hz)
3. Mean intensity (in dB)
4. Range of intensity (in dB)

Analysis of these curves involved the following:

1. Mean FO for each of the thirty six sentences were calculated.
2. Noting the individual pattern of FO and intensity curves for each particular emotion.

3. The curves for different emotions expressed by males and females were separated - For example, all the curves of sentences expressing 'fear' in males were grouped together. Thus different patterns of curves produced were tabulated.

Eg: Rise - fall -rise etc. It was observed whether there was only are kind of pattern prevalent for a particular emotion conveyed by the Malayalam speaker.

4. The frequency and intensity at the beginning and end of a particular word and sentence was noted.

5. For each sentence, the range of frequency variations was calculated by subtracting the lowest frequency from the highest frequency. The average range of fundamental frequency, for a particular emotion, produced, by Malayalam speakers was calculated by dividing the sum of ranges of a particular emotion by the number of a sentences chosen by experimenter for each dimension. These ranges were then tabulated. The patterns were analyzed and then compared with the perceptual evaluation. Thus the identification of emotion by native and non-native speakers of Malayalam, based on perceptual evaluation was obtained. The same sentences were subjected to acoustic analysis to note the intonation curve with reference to each emotions expressed by both males and females and comparison by both the perceptual and acoustical analysis was done.

RESULTS AND DISCUSSION

The aim of the present study was to find out the intonation patterns, that are used by Malayalam speakers in expressing different emotions. The intonation was analysed both perceptually and acoustically based on the intensity and fundamental frequency features.

Intonation is the variation in the fundamental frequency (FO). This is not only thought of as a grammatical signal of completeness and incompleteness but also as emotional gauges of tension and relaxation (Bolinger, 1972). The acoustic cues for prosodic features which have received the most extensive attention are fundamental frequency, intensity and temporal spacing of acoustic events (most frequently expressed as duration and rate measurement). These cues may carry segmental information also.

The linguistic features of intonation are determined by factors like the fundamental frequency, intensity and duration. Most of the investigators refer to the fundamental frequency as the essential ingredient of intonation but some do not. "The intonational differences heard as high or low, rising or falling are primarily related to the frequency of the sound waves" (Labo, 1961).

The results of the studies by Denes (1959) showed that the control of the fundamental frequency of the synthesized sounds by the intensity of input did provide cues for the recognition of intonation.

In this study, as described earlier four sentences, for each of the nine emotion have been randomly selected from Malayalam film audio cassettes and analysed acoustically and perceptually i.e. thirty six sentences, eighteen spoken by males and eighteen spoken by females were analysed to note the intonation

patterns used in expressing different emotions by Malayalam speakers. The number of sentences selected for male and female speakers were the same for all emotions. The fundamental frequency (FO) variation and intensity (I₀) variation in a particular sentence was obtained using the FOINT module of VAGHMI programme. The FO curves and I₀ curves for the various emotions were obtained.

The terms 'steep', 'gradual', and flat have been used to describe the intonation patterns. The concept 'steep' is used to indicate a sharp rise and sharp fall, 'gradual' used to indicate a slower degree of rise or fall and 'flat' to indicate minimal variations in FO and intensity across time.

1. Anger:

Out of the four sentences depicting the emotion 'Anger' two were spoken by males and two by female speakers. The FO and I₀ variations of the four sentences are presented in table 1.1.1.

Table 1.1.1.: Showing Fo variations (FO-V) and Intensity variations (IO-V) in ' Anger' type of sentences.

Sl. No.		Sentence					
1.	Female	അമ്മേനും പെങ്ങളേയും തിരിച്ചറിയുന്ന പെണ്ണിൾ /ammeeneem penñaleem tiricariyatta cernñakal/ F0-V 339-333 333-263 315-228 317-412					
		IO-V 49-50 50-37 41-36 37-41					
2.	Female	നിർത്താനും നിന്ദയ്ക്കും ഇപ്രസാഹനം /nirttanam ninñate iiprasañnam/ F0-V 362-266 279-303 300-109					
		IO-V 56-42 51-55 53-44					
3.	Male	ഓരോരുത്തിപ്പിറ്റി പെണ്ണിനുവേണ്ടി നിന്ദയ്ക്കു തമ്പ്രാണെ കോന്നു അല്ല /oruteevitiññi penñinuveenti niñente tambrañne konnu allee/ F0-V 254-284 300-303 306-292 320-292 119-268 268-105					
		IO-V 55-48 49-52 52-55 54-47 46-55 55-42					
4.	Male	/മിസ്തർ അബ്ദുൾരാഹീം സൂക്ഷിച്ചു സംസാരിക്കാനും /mistarabduļrahiim suukñicca samsañrikkañnam/ F0-V 323-335 266-338 338-261					
		IO-V 40-45 54-58 58-42					

The frequency range and intensity range used by the subjects in the sentences expressing the emotion 'Anger' is displayed in Table 1.1.2 and Table 1.1.3 respectively.

Table 1.1.2: Showing frequency range in sentences expressing 'Anger'

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	571	87	484			
2.	F	382	109	273	356.75	378.5	335
3.	M	489	83	406			
4.	M	419	115	264			

Table 1.1.3: Showing intensity range in sentences expressing 'Anger'.

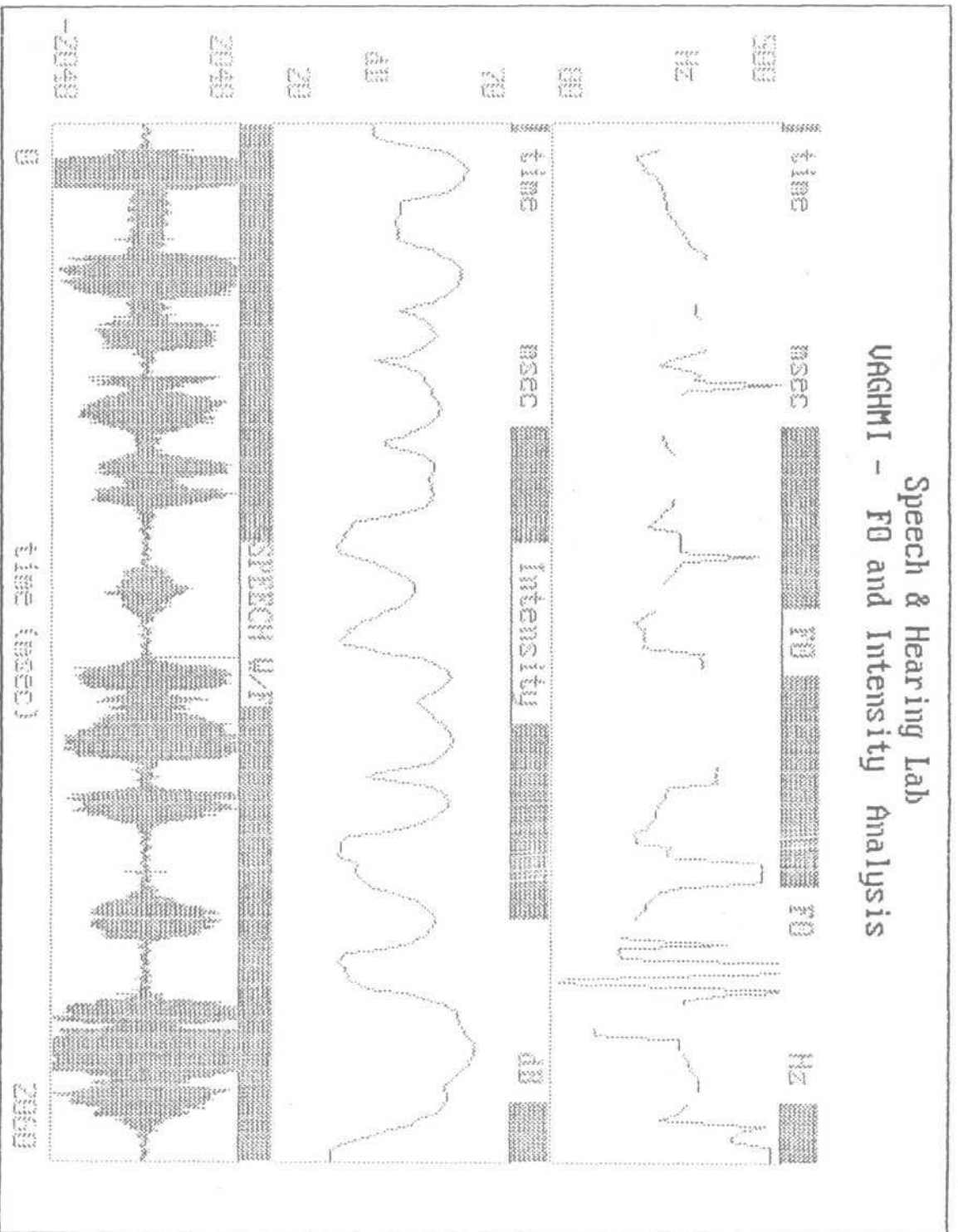
Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	62	41	21			
2.	F	59	44	15	18.25	18.0	18.5
3.	M	59	42	17			
4.	M	60	40	20			

It can be seen from Table 1.1.1., that all the four sentences expressing 'Anger' show an intonation pattern of Fall (Gradual) - rise - fall - rise - fall (gradual). The terminal contour of the 'Anger' depicted a gradual falling pattern. The intensity variations were quite consistent. There was decreasing energy at the end of the sentences. All the four sentences were depicting statements.

Comparing the fundamental frequency range and intensity range of females and males it was found that the females used a greater fundamental frequency range than males but it was not statistically significant. The intensity range was similar for both males and females.

Speech & Hearing Lab

VAGHMI - F0 and Intensity Analysis



Case No: 0119400

Client: SSI

1: Intonation pattern in anger: - fall (gradual) - rise - fall - rise - fall (gradual) - rise - fall (gradual)
 Display Others

Display

Others

Graph 1 shows the intonation pattern of fall (gradual) - rise - fall - rise - fall (gradual) type which was used by Malayalam speakers in expressing 'Anger'.

2. Fear:

Four sentences expressing the emotion 'Fear' have been analysed, out of which two sentences were spoken by males and the other two by female speakers. The Fo and Io variation of the four sentences are given in Table 1.2.1.

Sl. No.		Sentence			
1.	Female	ചേട്ടൻ /ceettan F0-V 148-307 I0-V 48.57	എന്നെക്കിലും പറിച്ചോ enternikilum parriyoo/ 307-351 57.43		312-218 57.43
2.	Female	എന്താ /enta F0-V 447-277 I0-V 41-46	പറിച്ചത് parriyata 277-295 46-54	അച്ഛൻ accanna/ 295-295 54-54	
3.	Male	പിൻമാറിയോ! /pinmaariyoo! F0-V 253-301 I0-V 55-32	എന്തായിത്തന്നെ അർത്ഥം entaayitinte artham/ 267-254 41-51		250-243 50-33
4.	Male	എത്രവക്കിലെ /etovakkiile F0-V 259-356 I0-V 44-32	എന്നുകൂട്ടത്തിൽ കൊലകയ്യെ ertekalutttil kolakayya 293-336 37-50	വിളയോ? viilumoo/ 339-367 47-51	366-280 51-41

The frequency range and intensity range used by the subjects in expressing 'Fear' is represented in Table 1.2.2. and Table 1.2.3.

Table 1.2.2: Showing frequency range in sentences expressing 'Fear'

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	396	83	313			
2.	F	460	262	198	285.0	255.5	314.5
3.	M	358	113	245			
4.	M	488	104	384			

It can be seen from Table 1.2.1., that Malayalam speakers in expressing sentences of emotion 'Fear' showed a Rise (sleep) - fall - rise - flab-fall (gradual) intonation pattern. The terminal contour in all the four sentences showed a falling type pattern except for the second sentence, which showed a fall - rise - fall - rise - fall - intonation pattern.

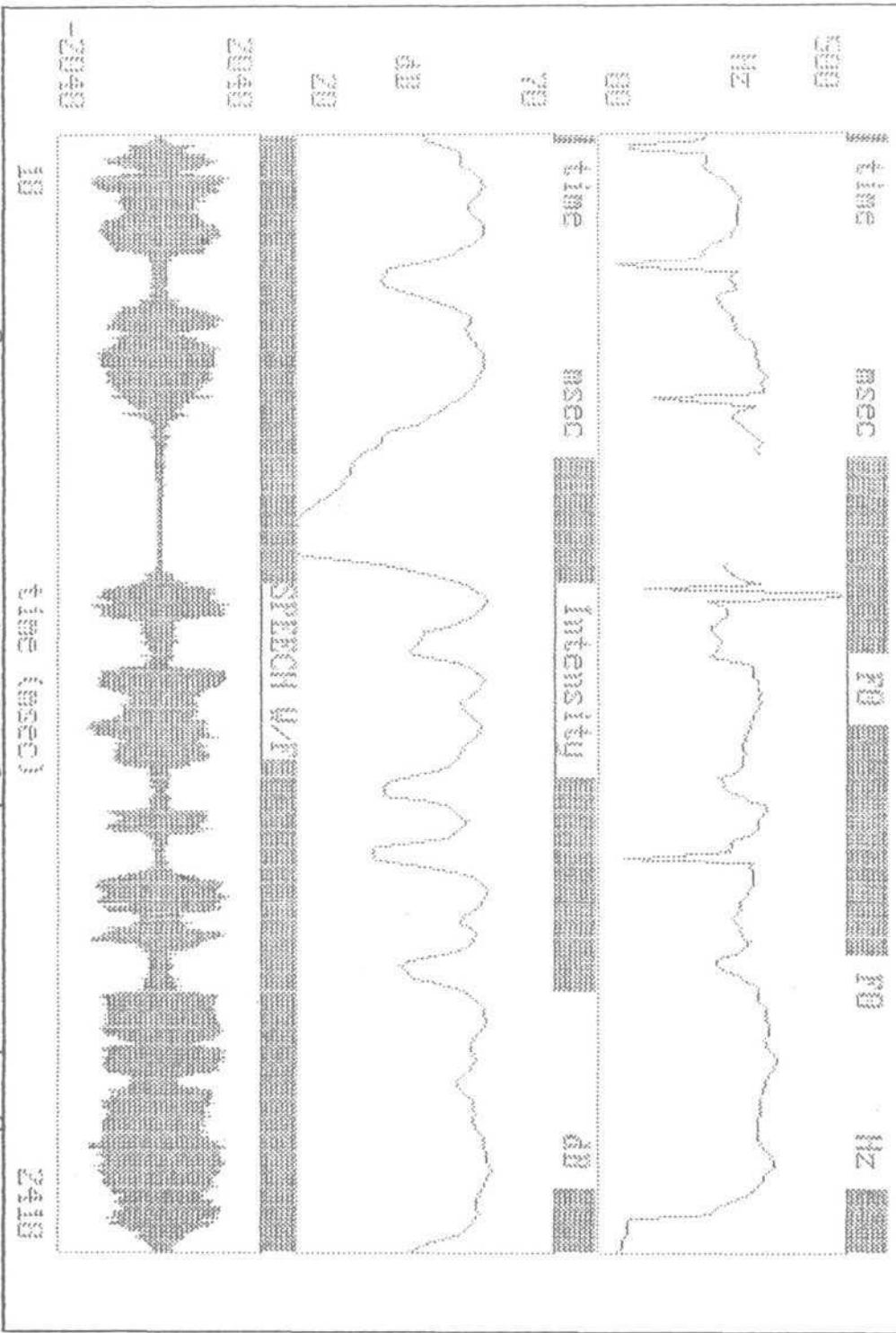
Table 1.2.3: Showing intensity range in sentences expressing 'Fear'.

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	58	45	13			
2.	F	55	41	14	18.75	13.5	24.0
3.	M	58	32	26			
4.	M	54	32	22			

All the four sentences taken in the sample for 'Fear' had a **question** form which did not elicit Yes-No response.

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a g e s s a n a g i o n e l
a g r a d a s g a m a t a b
a b a r e l a r a d a d
a h s y e r a

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2: Intonation pattern in fear :- rise (steep) - fall - rise - flat - fall (gradual)

Display Cursor Others

When the frequency range was compared between male speakers and female speakers, it was found that males used a higher fundamental frequency range than females but it was not statistically significant. In the intensity range the males used a greater intensity range than females and it was statistically significant. The intensity variations were quite consistent when compared with the same sex.

Thus, it is found that all Malayalam speakers use a rise (steep) - fall - rise - flat - fall (gradual) type of intonation pattern in expressing 'Fear' (Graph 2).

3. Frustration :

Here four sentences expressing the emotion 'Frustration' were taken. Out of these, two sentences were spoken by male speakers and two female speakers. The Fo and Io variations of the four sentences are noted in Table 1.2.1.

Sl. No.	Sentence			
1.	Female	ഇത്രകഷ്ടപ്പെട്ടു /itrakastppetta	ഇതൊക്കെ itokke	കൊടുങ്ങിവിടാൻ kotuttuviṭaan
	F0-V	333-320	320-322	322-340
	I0-V	40-34	39-38	38-40
		ഇവിടെ ഉടുക്കാൻ ivite utukkaan	തിന്നിയില്ലേൻ tunigillanṭ	ഇരിക്കുകയാണോ irikkukyaanonoo
	F0-V	288-367	367-368	378-319 319-177
	I0-V	40-34	35-35	38-41 41-32
2.	Female	ഇങ്ങനൊരു മരണലക്ഷണ ഞാൻജീവിതത്തിൽ കണ്ടിട്ടില്ലാ.		

		/iinanoru	marattalayane	Kaanjiivitatti	kantittilla/
F0-V		307-276	249-326	326-307	307-80
I0-V		39-55	55-51	51-49	49-41
<hr/>					
3.	Male	ഇവടെകാര്യമൊന്നും	ഇപ്പറമ്പുട്ടത്ത്	ചോദിക്കുന്നു	
F0-V		/ivatekoaryamonnum	ippamentatutta	coodikkanta	
		206-205	205-196	195-92	
I0-V		43-46	46-50	50-34	
		പിടിച്ചുകയറിയവരുടേത്		ചോദിച്ചാമതി	
F0-V		piticcukayaryavarutatutta		coodiccaamati/	
		177-163		163-102	
I0-V		50-53		53-48	
<hr/>					
4.	Male	എല്ലാവിട്ട്	മനുഷ്യനെപ്പോലെ	ജീവിക്കുന്നതൊന്നിടയാ	
F0-V		elloamvitto	manusyaneppode	jiivikkannamennavicaaricca	
		300-223	208-188	205-366	
I0-V		41-35	36-34	38-34	
		ജീവിപ്പിക്കില്ലെന്നൊക്കെ			
F0-V		jiivippikkillenavecca/			
		313-297			
I0-V		34-35			

The frequency range and intensity range used by the subjects in the sentences expressing the emotion on 'Frustration' is displayed in Table 1.3.2. and Table 1.3.3. respectively.

Table 1.3.2: Showing frequency range in sentences expressing 'Frustration'

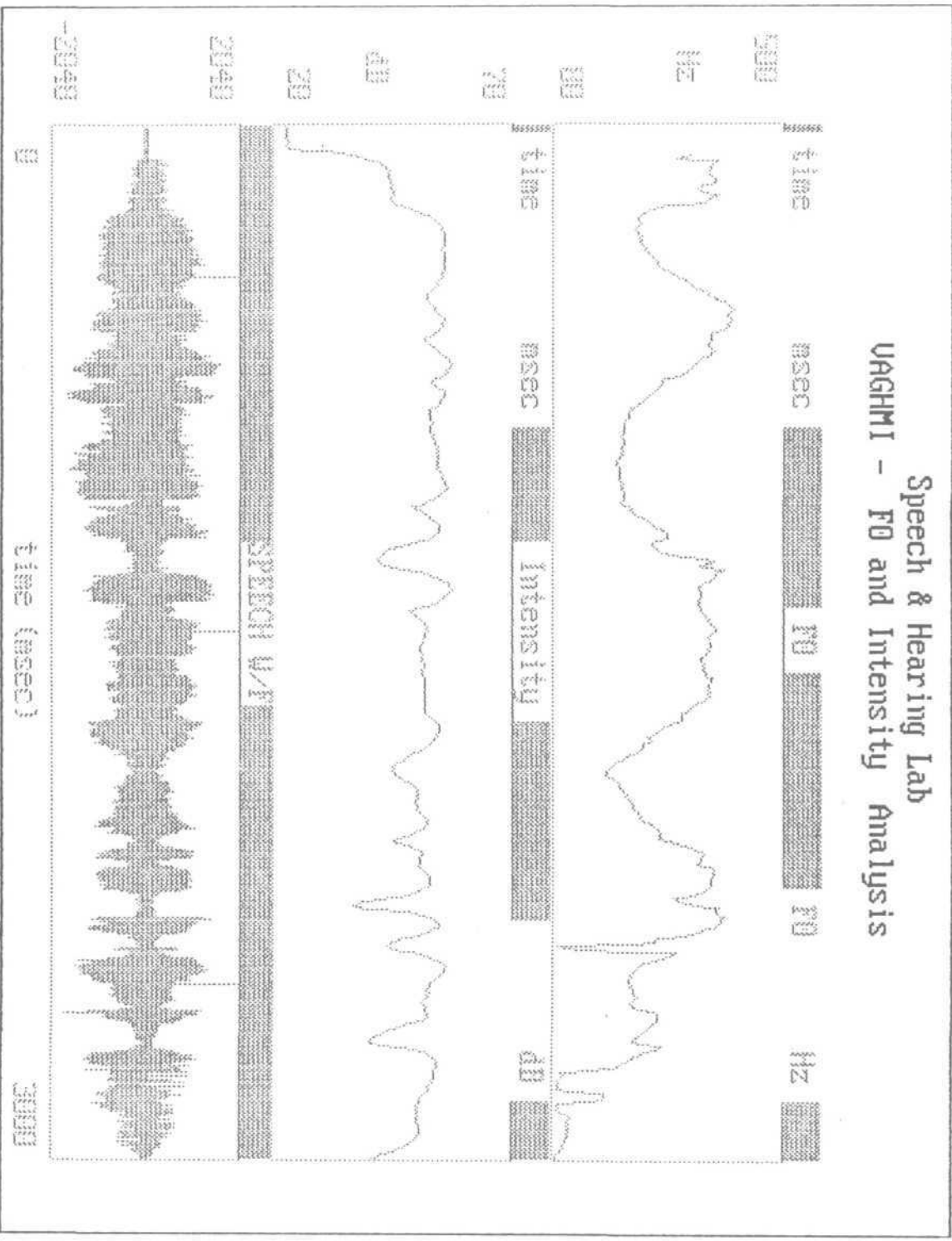
SI. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	539	280	259			
2.	F	410	83	327	313.25	293.0	333.5
3.	M	373	78	295			
4.	M	470	98	372			

Table 1.3.3: Showing intensity range in sentences expressing 'Frustration'.

SI. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	39	21	18			
2.	F	57	36	21	20.5	19.5	21.5
3.	M	53	34	19			
4.	M	41	17	24			

It can be concluded from Table 1.3.1., that Malayalam speakers expressing 'Frustration' followed a fall - rise (steep) - fall - rise - fall (gradual) type of intonation pattern. The terminal contour of all the four sentences expressing 'Frustration' showed a falling pattern. All the four sentences were in statement form.

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paramasol qaamcraan aomsh aqaliamamj Ahmsj 37 st.

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- 3: Intonation pattern in frustration:- fall-rise-fall-rise-fall (gradual)
- Display
 - Cursor
 - Others

The intensity variation was quite consistent in each sentence. The fundamental frequency range and intensity range showed that the males had a greater fundamental frequency range and intensity range than females, but it was not statistically significant.

Graph 3 shows the intonation pattern of Fall - rise (steep) - fall - rise - fall (gradual) type of intonation pattern which was used by Malayalam speakers in expressing 'Frustration'.

4. Grief:

Four sentences expressing the emotion 'Grief' were taken. Of these, two sentences were spoken by male speakers and the other two by female speakers. The Fo and Io variations of the four sentences are noted in Table 1.4.1.

Table 1.4.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Grief.'

Sl. No.	Sentences					
1.	Female	സാധാരണക്കാരുടെ കുട്ടി	ചെയ്യുന്ന	കാര്യമാണെന്നി	ചെയ്തത്	
		/saadhaaranyoru kutti	ceyyana	kaaryamaanonii	ceytata/	
	F0-V	261-520	415-260	216-228	228-191	239-234
	IO-V	54-34	43-58	50-43	43-58	46-36
2.	Female	ഇങ്ങനെയാവാൻ സാധിക്കില്ല.				
		/innaneyokkeyavunnā sādhanum karutiyilla/				
	F0-V	307-87	98-254	254-87		
	IO-V	45-47	46-47	49-43		

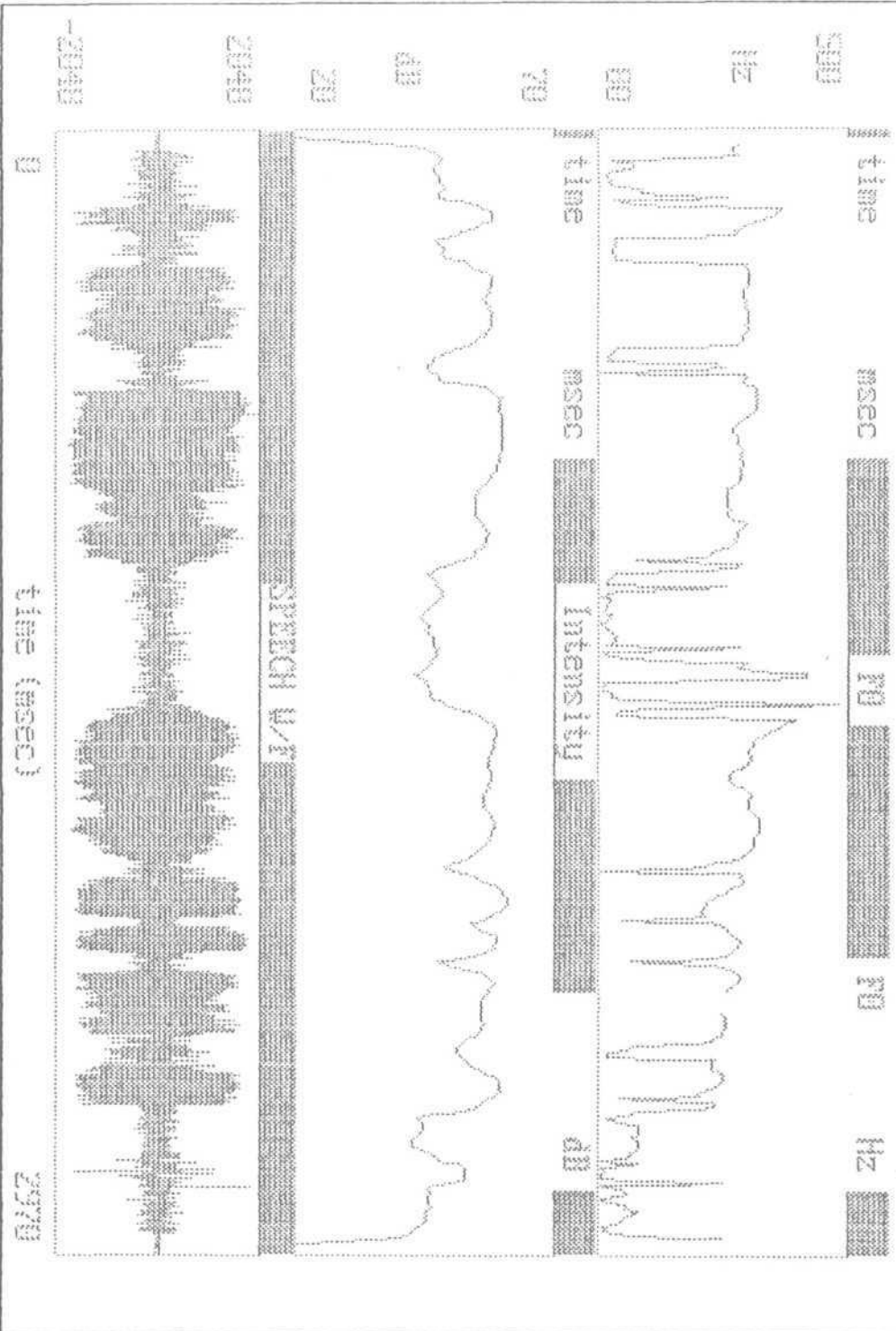
3.	Male	ആരാ	ഉടവാൾ	എറുവായിങ്ക	
	F0-V	/aara 275-174	utvaal 173-191	erruvainhuka/ 191-177	
	I0-V	36-54	53-51	51-55	
<hr/>					
4.	Male	സ്നേഹം	പലർക്കായിട്ട്	പോന്നത്	കണ്ടപ്പോൾ
	F0-V	/sneham 340-102	palarkkaayittu 142-154	poonatu 137-136	kantappool 417-133
	I0-V	37-36	33-37	34-37	32-33
		ഭ്രാന്തപിടിച്ചു		പോയൊരുട്ടി.	
	F0-V	bhraantupiticc 171-332	pooyorukutti/ 393-154		
	I0-V	41-35	32-32		

The frequency range and intensity range used by the subjects in the sentences expressing the emotion 'Grief is displayed in Table 1.4.2. and Table 1.4.3. respectively.

Table 1.4.2: Showing frequency range in sentences expressing 'Grief

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	520	126	394			
2.	F	484	80	404	342.75	399.0	286.5
3.	M	255	101	154			
4.	M	516	97	419			

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4: Intonation pattern in brief :- fall - rise - fall - rise - fall
 Display Cursor Others

Table 1.4.3: Showing intensity range in sentences expressing 'Grief.

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	60	29	31			
2.	F	59	43	16	20.0	23.5	16.5
3.	M	56	36	20			
4.	M	41	28	13			

It can be concluded from Table 1.4.1. that Malayalam speakers expressing 'Grief follow a fall - rise (steep) - fall - rise - fall type of intonation pattern. All the four sentences showed a falling terminal contour. There was a variation in the first sentence. The pattern seen was rise-fall (steep) - rise - fall type of intonation pattern. The other three sentences showed a similar pattern of fall - rise (steep) - fall - flat - rise - fall. Of the four sentences the first and third sentences were of question type. The first question was Yes-No type. The second and fourth sentence were in statement form.

When the frequency range and intensity range were compared, it was found that females used a greater fundamental frequency range and intensity range than males in expressing 'Grief, but it was not statistically significant.

Thus it can be concluded that Malayalam speakers used fall - rise (steep) - fall - flat - rise - fall type of intonation pattern in expressing 'Grief as shown in Graph 4.

5. Jealous:

Four sentences expressing the emotion 'Jealous' were taken. Of them, two sentences were spoken by male speakers and the other two by female speakers. The Fo and Io variations of the four sentences are noted in Table 1.5.1.

Table 1.5.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Jealous'.

Sl. No.		Sentence			
1.	Male	വരുത്തുന്നയാൾക്കുമധ്യേ	നിന്നൊരളോ	സമൂഹം	ചിലരെക്കെ
	F0-V	/varuttunmaarkkumaatre 146-209	siirrollo 209-219	naattukaarum 178-234	cilarokke 275-257
	I0-V	39-33	33-33	44-40	36-52
	F0-V	ഉവിടാങ്ങ. -ivitontee/ 257-241			
I0-V	52-55				
2.	Female	അവൾ	ചെല്ലുന്നതിടയാൽ	മിൻമേടിയാൻ	ആണുങ്ങൾക്കെല്ല
	F0-V	/aval 230-366	cellunnatumkaatta 366-386	miinmeetikkaan 395-404	aanunnaalalle 404-473
	I0-V	39-39	39-45	44-47	47-86
	F0-V	കുത്തിമിരിക്കുന്നത്. kuttiyirikkannata/ 142-293			
I0-V	42-32				
3.	Female	അവൾക്കെത്ത	പോകുകയാണി	പെണ്ണ്	ചിത്താവാണി
	F0-V	/ayalookkatte 288-270	pookkukonjaanii 282-318	penne 318-360	ciittayaavanata/ 351-101
	I0-V	45-35	45-49	49-39	36-37

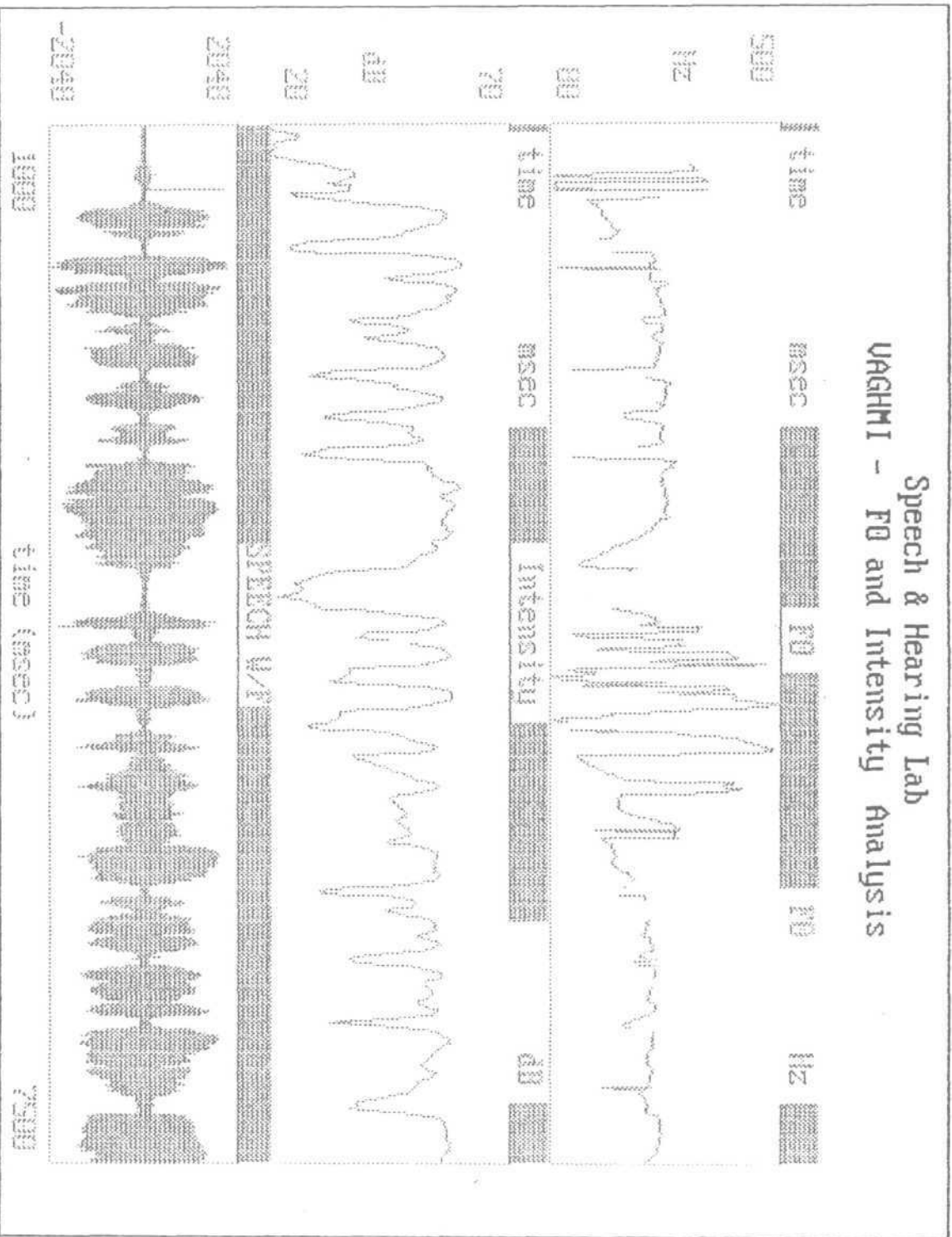
4.	Male	അവന്റെ /avante	മാരാക്കത്തിനപ്പോലേ marakkaattinepoole	അരപ്പണ്ണിനടി Orupennunteni
	F0-V	313-296	296-246	246-271
	I0-V	43-47	47-47	47-47
		അമ്പലമുക്ക് nāankappalmeetikkum/		
	F0-V	275-323		
	I0-V	45-44		

The frequency range and intensity range used by the subjects in expressing the emotion 'Jealous' is displayed in Table 1.5.2. and Table 1.5.3. respectively.

Table 1.5.2: Showing frequency range in sentences expressing 'Jealous'

SI. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	308	89	219			
2.	F	487	138	349	306.5	446.5	285.0
3.	M	406	99	307			
4.	M	433	82	351			

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Options: S: Intonation pattern in 'jealous' fall gradual rise steep fall rise fall
Display Cursor Others

Table 1.5.3: Showing intensity range in sentences expressing 'Jealous'.

SI. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	60	26	34			
2.	F	49	32	17	21.0	16.5	25.5
3.	M	50	34	16			
4.	M	49	34	17			

It can be concluded from Table 1.5.1. that Malayalam speakers while expressing the emotion 'Jealous' follow a fall (gradual) - rise (steep) - fall - rise - fall type of intonational pattern. All the four sentences were in statement forms. The terminal contour was of falling pattern.

When, the fundamental frequency range was compared between males and females, it was found that the females had a greater fundamental frequency range than males. For the intensity range, it was found that the males had a greater intensity range, than females. But both the frequency range and intensity range did not show any statistically significant differences between males and females.

Graph 5 shows the intonation pattern of fall (gradual) - rise (steep) - fall - rise - fall type which was used by Malayalam speakers in expressing 'Jealous'.

6. Joy:

Out of four sentences depicting the emotion 'Joy' two were spoken by male speakers and two by female speakers. The Fo and Io variations of **the four** sentences are noted in Table 1.6.1.

Table 1.6.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Joy'.

Sl. No.		Sentences					
1.	Female	ചേട്ടന്റെ കൂട്ടുകാരൻ വന്നിട്ടുണ്ട് ബോംബെന്റ് എട്ടൻ					
	FO-V	/ceettante kuuttukaaran vannittunta boombenna eettan 336-183 434-526 526-421 313-346 363-521					
	IO-V	29-39	32-33	33-38	40-30	31-24	
FO-V	പറഞ്ഞിട്ടുവന്നു ഭാരവച്ചിടാൻ ചേട്ടൻ വരൻ പറഞ്ഞു/ paranittuvannataa bhaavuvecchiyoota veegam varaan paranu/ 305-155 155-300 320-400 346-532 532-335 320-313						
	IO-V	38-40	40-37	37-40	34-34	34-37	37-26
2.	Female	ചെച്ചി		സമ്മതിച്ചു		വരുന്നിടത്താണ്	
	FO-V	/ceeci 102-248		sammaticcu 248-249		vaanikkollaan/ 299-320	
	IO-V	35-58		58-40		44-42	
3.	Male	കൊല്ലാം ഇത്രയും കൂട്ടാകൂട്ടി നാനിതുവരെ ഉണ്ടില്ലാ.					
	FO-V	/kollam itrayumnalla kuuttaankuutti nanituvare unittilla/ 14-172 347-137 137-125 295-132 132-96					
	IO-V	46-39	46-44	44-47	44-48	48-40	
4.	Male	നമുക്ക് മണ്ണാർശാല ഉത്സവം കാണാൻ പോകാനുണ്ട്.					
	FO-V	/namukka mannaarsaale ulsavam kaanaan pookanu!ataa/ 301-137 137-335 340-249 249-183 183-160					
	IO-V	36-40	40-35	40-44	44-40	40-32	

The frequency range and intensity range used by the subjects in the sentences expressing the emotion on 'Joy' is displayed in Table 1.6.2. and Table 1.6.3. respectively.

Table 1.6.2: Showing frequency range in sentences expressing 'Joy'

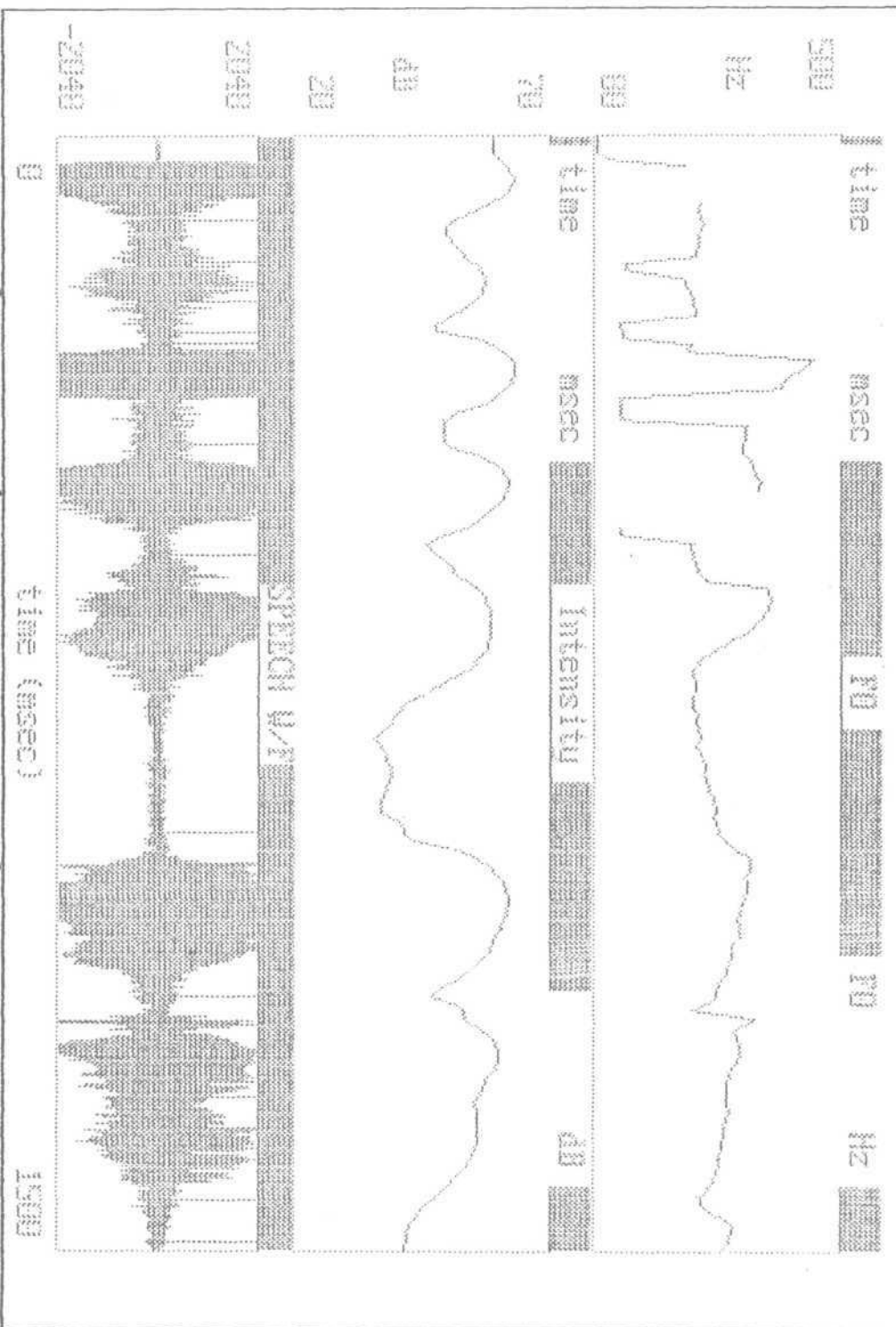
Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	566	132	434			
2.	F	448	83	365	346.0	399.5	292.5
3.	M	397	79	318			
4.	M	357	90	267			

Table 1.6.3: Showing intensity range in sentences expressing 'Joy'.

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	43	14	29			
2.	F	63	40	23	21.5	26.0	17.0
3.	M	51	35	16			
4.	M	50	32	18			

It can be concluded from Table 1.6.1. that the intonation pattern used for 'Joy'^{r1} by the Malayalam speakers was rise (steep) fall - rise - fall (steep). The first and fourth showed a falling pattern initially. **But** the overall pattern showed rise

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C: Intonation pattern in f0 :- rise - fall - rise - fall (steep)
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(steep) - fall - rise - fall (steep) pattern of intonation for 'Joy'. All the four sentences were in statement form. The intensity variations were not consistent for the first sentence, but it was quite consistent for the other three sentences. In all the four sentences there was a decrease in intensity at the end of the sentence.

Comparison of the fundamental frequency range and intensity range between the males and females showed that the females have a greater range in both fundamental frequency and intensity while expressing Joy. Both are statistically significant at the 0.05 level.

Thus it can be concluded that Malayalam speakers use rise (steep) - fall - rise - fall (steep) type of intonation pattern in expressing Joy from Graph 6.

7. Surprise:

Out of four sentences expressing surprise, two were spoken by males and other two by females. The Fo and Io variations of the four sentences analysed, are noted in Table 1.7.1.

Table 1.7.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Surprise'.

Sl. No.		Sentences				
1.	Female	ഇത്ര	പെട്ടെന്നു	വരുന്നില്ലോ!		
		/ itra	pettenna	vadanillyo! /		
	F0-V	325-433	433-389	389-244		
	IO-V	45-41	41-45	45-38		
2.	Female	എന്താ	പറ്റി	പെട്ടെന്നു		
		/ enta	parri	pettenna /		
	F0-V	387-428	428-425	407-365		
	IO-V	32-36	36-36	39-34		
3.	Male	ഔോ!	തമ്പ്രാൻചേട്ടൻ	എവിടെ		
		/ yyo!	tambraanceetan	evite /		
	F0-V	229-104	87-344	344-347		
	IO-V	43-35	35-59	59-36		
4.	Male	ഔോ!	ചേട്ടന്റെ	കൊമ്പന്തിയേ, ചേട്ടന്റെ		
		/ yyo!	ceettante	kombentiyee, ceettante kombentiyee /		
	F0-V	205-207	200-213	213-187	225-177	185-176
	IO-V	57-40	40-48	48-37	34-48	57-37

The frequency range and intensity range used by the subjects in the sentences expressing the emotion on 'Surprise' is displayed in Table 1.7.2. and Table 1.7.3. respectively.

Table 1.7.2: Showing frequency range in sentences expressing 'Surprise'

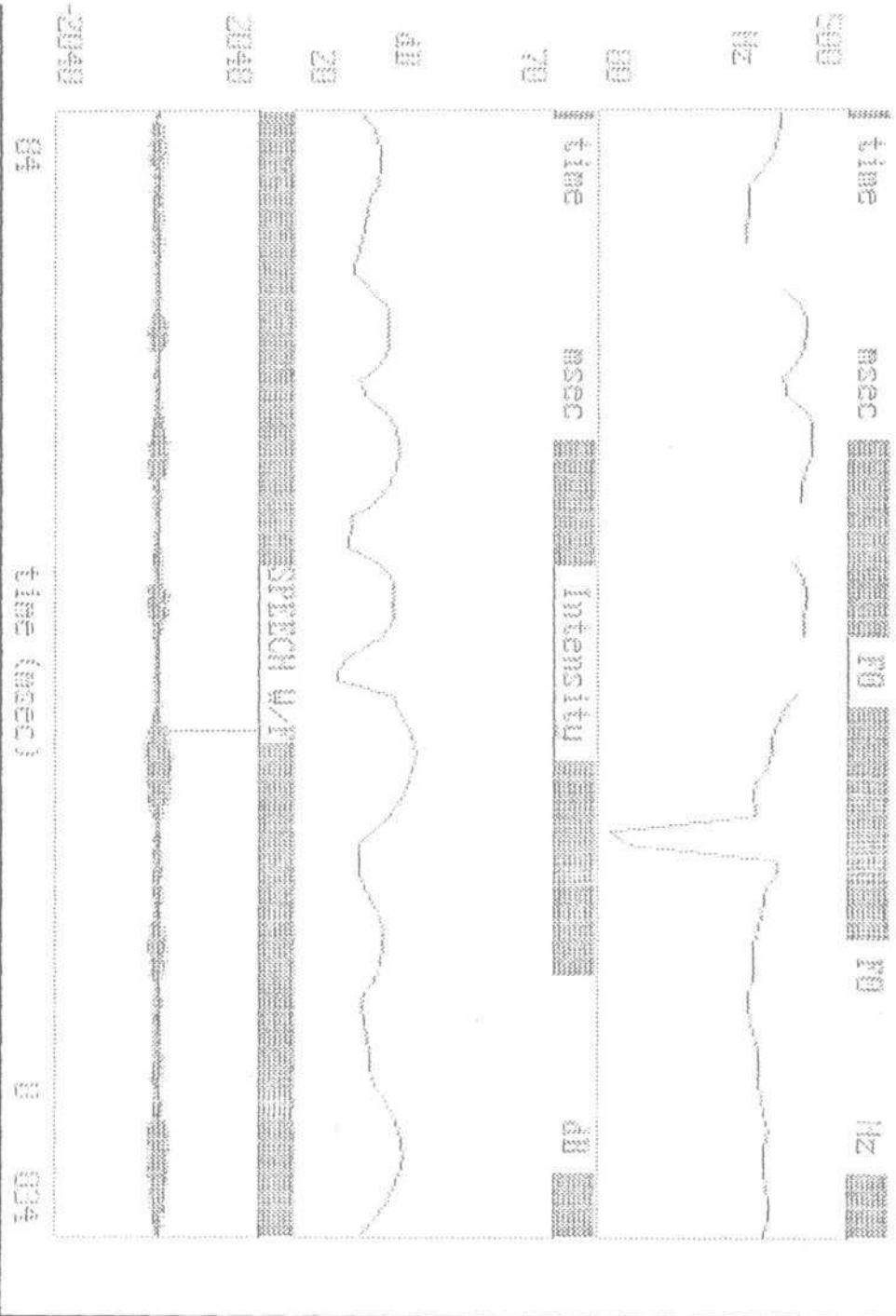
Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	450	236	214			
2.	F	441	129	314	232.0	263.0	201.0
3.	M	410	78	332			
4.	M	242	172	70			

Table 1.7.3: Showing intensity range in sentences expressing 'Surprise'.

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	52	36	16			
2.	F	43	29	14	20.25	15.0	25.5
3.	M	60	35	25			
4.	M	60	34	26			

It is seen from table 1.7.1. that Malayalam speakers while expressing surprise follow rise (gradual) - fall (gradual) - rise - fall intonational pattern. The terminal contour for 'Surprise' was a falling pattern. The intensity patterns were quite consistent when compared with the same sex.

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T: Intonation pattern in surprise :- rise (gradual) fall (gradual) rise - fall
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When the comparisons for fundamental frequency range and intensity range between males and females were done, it was found that females had a greater fundamental frequency range than males and the males had a greater intensity range than females. But these differences were not statistically significant.

Graph 7 shows the intonation pattern of rise (gradual) - fall (gradual) - rise - fall type which is used by Malayalam speakers in expressing 'Surprise'.

8. Worry:

Four sentences expressing the emotion 'Worry' was taken. Of these two were spoken by males and the other two by females. The Fo and Io variations of the four sentences analysed, are noted in Table 1.8.1.

Table 1.8.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Worry'.

Sl. No.		Sentences		
1.	Female	ഈശ്വരാ ശരിക്കടല്ല കിട്ടിയോ		
		/iiswara	serikkatalla	kittiyoo/
	F0-V	383-316	457-356	355-329
	IO-V	57-41	58-55	54-36
2.	Female	യ്യോ വല്ലവരും കണ്ടാലോ		
		/yyoo	vallavarum	kantalo/
	F0-V	156-340	347-377	377-184
	IO-V	32-33	38-50	50-32

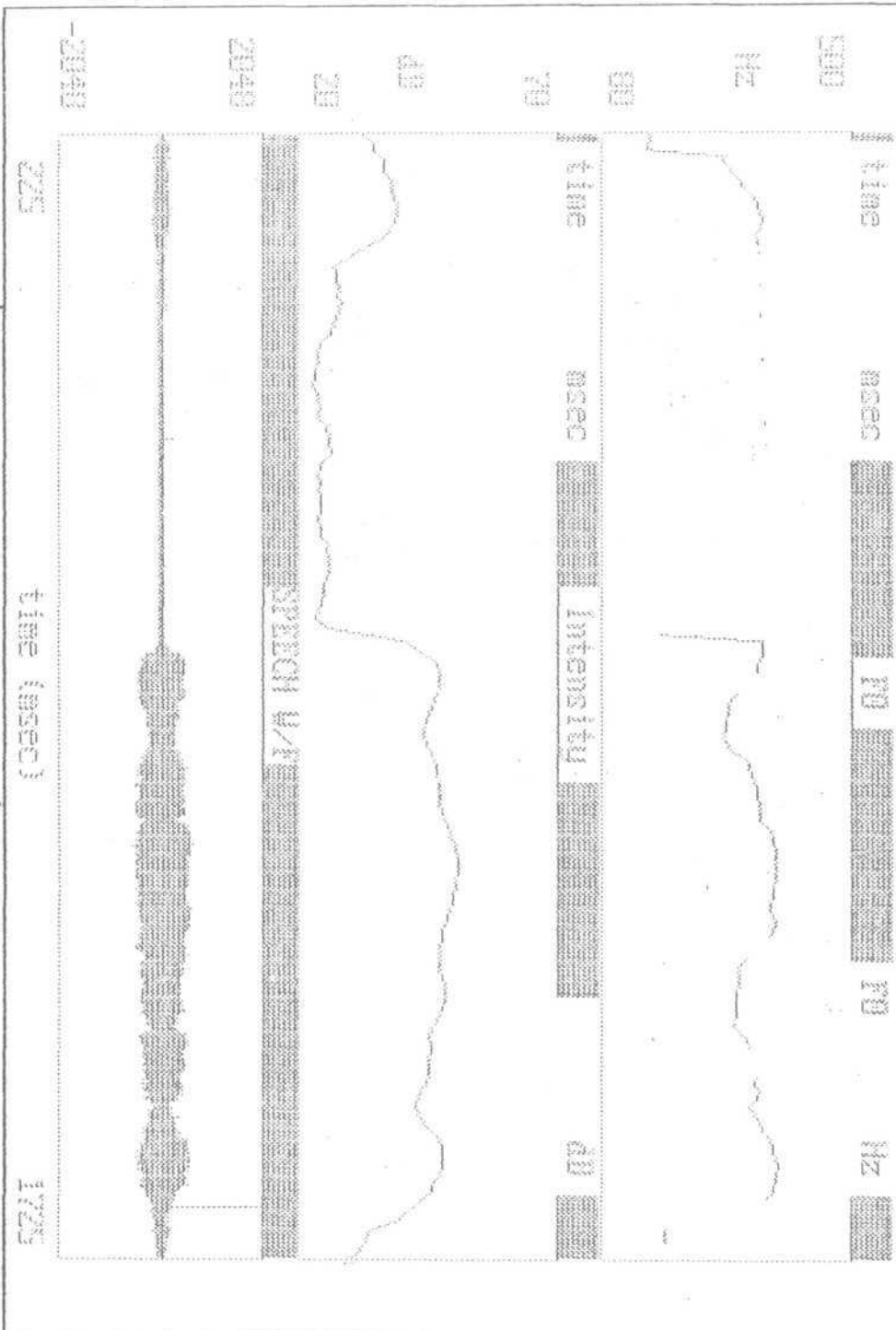
3.	Male	ആരോട് /aaroota/	എങ്ങനെ en'ne	പറയുന്നു parayunna	അറിയാതെ ariyaate	വിശമിക്കുകയായിരുന്നു. visamikkukayayirunnu/
	F0-V	90-400	333-100	78-80	80-95	95-78
	I0-V	48-36	34-45	44-46	46-44	46-44
4.	Male	അത് /naana/	കുറയ്ക്കുക kuraccu	തെറ്റായിരിക്കുന്നു ten'sanilaana/		
	F0-V	188-390	202-280	401-347		
	I0-V	37-36	36-35	44-33		

The frequency range and intensity range used by the subjects in the sentences expressing the emotion on 'Worry' is displayed in Table 1.8.2. and Table 1.8.3. respectively.

Table 1.2.2: Showing frequency range in sentences expressing 'Worry'

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	457	288	169			
2.	F	377	152	225	286.0	197.0	375.0
3.	M	484	80	404			
4.	M	423	77	346			

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8: Intonation pattern in worry :- rise (steep) - fall - rise - fall
 Display Cursor Others

Table 1.8.3: Showing intensity range in sentences expressing 'Worry'.

SI. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	61	36	25			
2.	F	39	32	7	17.5	16.0	19.0
3.	M	62	35	27			
4.	M	40	29	11			

It can be concluded from Table 1.8.1 that Malayalam speakers while expressing 'Worry' follow a rise (steep) - fall - rise - fall pattern of intonation. The first sentence had a pattern of fall - rise - fall and this might be because the sentence was in question form which elicits a yes no response. The other three sentences had a statement form. All the sentences had a falling pattern of terminal contour. Intensity variation was not consistent and the pattern varies from sentence to sentence.

Males were found to use a greater fundamental frequency range than females and it was statistically significant at the 0.05 level. The intensity range when compared to females, males had greater variation expressing 'Worry' but it was not statistically significant. Graph 8 shows the intonation pattern of rise (steep) - fall - rise - fall pattern of intonation used by Malayalam speakers in expressing 'Worry'.

9. Neutral:

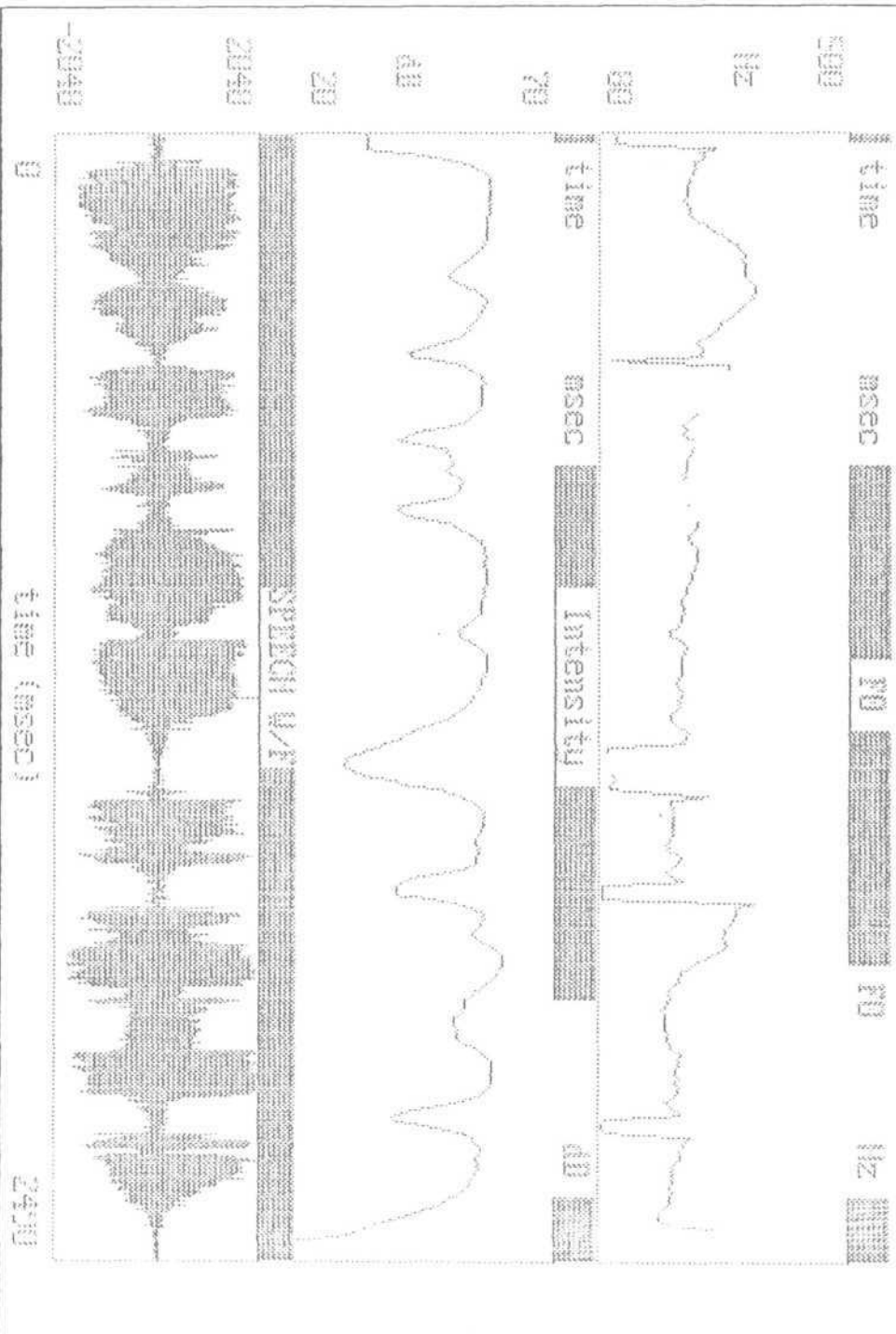
Four neutral sentences were spoken by two males and two females. The Fo and I₀ variations of the four sentences analysed, are noted in Table 1.9.1.

Table 1.9.1.: Showing (FO-V) and (IO-V) in sentences expressing 'Neutral'

Sl. No.	Sentences				
1.	Female	ചിന്തിക്കുകൾ കണ്ടുപറയാമായിരുന്നു. /cinaunne kuute kontuvaraamaayirunnu/ 484-315 254-223 231-186			
		IO-V	40-53	50-46	49-34
2.	Female	തിരുവിളിയിരിക്കുന്ന കിരണങ്ങൾ അടുത്ത് വരില്ലാതെ . /tiikuviliyitirikkanu karntaal atuttu varillaatre/ 254-232 232-221 98-287 287-181			
		IO-V	47-57	57-36	33-55 55-38
3.	Male	സർ അദ്ധ്യക്ഷന്റെ അദ്ധ്യക്ഷതയ്ക്കുമാർ കിരണങ്ങൾ വന്നിരിക്കുന്നു . /saar advakkerraaśvatimeenoon kaaranu vannirikkunnu/ 159-153 163-145 183-129 129-78			
		IO-V	56-39	41-46	46-50 50-33
4.	Male	നിങ്ങളുടെ സേവനം വിചാരിച്ചുകൊണ്ടിരിക്കുമ്പോൾ അതിനോടടുത്തുവന്നുപോകാൻ /ninnalute seevanam dipparittimentinga veenti ñaanaavaśyappetukayana/ 85-109 110-219 200-245 245-94 96-191			
		IO-V	49-52	51-40	41-54 54-52 53-33

The frequency range and intensity range used by the subjects in the sentences expressing the emotion 'Neutral' is displayed in Table 1.9.2. and Table 1.9.3. respectively.

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 Dr. Anand Kumar Aravindan

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Table 1.9.2: Showing frequency range in sentences expressing 'Neutral'

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	484	144	340			
2.	F	340	78	262	262.75	301.0	224.5
3.	M	216	78	128			
4.	M	410	79	321			

Table 1.9.3: Showing intensity range in sentences expressing 'Neutral'.

Sl. No.	M/F	Max. Freq.	Min. Freq.	Range	Avg. Range	Range in females	Range in males
1.	F	59	34	25			
2.	F	60	33	27	25.5	26.0	25.0
3.	M	57	33	24			
4.	M	59	33	26			

It can be concluded from Table 1.9.1 that Malayalam speakers used fall (gradual) - rise (gradual) - fall - rise - fall (gradual) intonation pattern in expressing neutral! sentences. The intensity contour was quite similar in all the four sentences.

Comparing the fundamental frequency range between males and females showed that the females had a greater fundamental frequency range than males but it was not statistically significant. The intensity range between males and females

are quite similar. The intensity variations were also quite consistent in the four sentences.

Graph 9 shows the intonation pattern of fall (gradual) - rise (gradual) - fall - rise - fall (gradual) type which was used by Malayalam speakers in expressing 'Neutral' sentences.

After studying the various fundamental and intensity variations for each emotion, the intonation pattern of each emotion that was used by Malayalam speakers could be well determined. All the male and female subjects had a comparatively higher frequency than the normal range.

It can be concluded that different types of intonation patterns are used by Malayalam speakers under various emotional conditions as shown in Table 2.

Table 2: Showing the intonation patterns under various emotional condition

SI. No.	Emotion	Terminal contour	Intonation pattern
1.	Anger	Fall (gradual)	Fall (gradual) - rise - fall - rise - fall (gradual)
2.	Fear	Fall (gradual)	Rise (steep) - fall - rise - flat - fall (gradual)
3.	Frustration	Fall (gradual)	Fall - rise - fall - rise - fall (gradual)
4.	Grief	Fall	Fall (steep) - rise - fall - rise - fall
5.	Jealousy	Fall	Fall (gradual)-Rise(steep)-fall- rise-fall
6.	Joy	Fall (steep)	Rise (steep) - fall - rise - fall (steep)
7.	Surprise	Fall	Rise (gradual) - fall (gradual) - rise- fall
8.	Worry	Fall	Rise (steep) - fall - rise - fall
9.	Neutral	Fall (gradual)	Fall (gradual) - rise - fall - rise - (gradual) - fall (gradual)

Nandini (1985) conducted a study to find out the intonation patterns used by Kannada speakers and the results indicated that in Kannada different intonation patterns are used expressing different emotions.

Chandrashekar (1985), conducted a similar study to find out the intonation pattern used by Hindi speakers for different emotions and he found that Hindi speakers use different intonation patterns to express different emotion.

Shrabanti (1999) also conducted a similar study to find out intonation patterns used by Bengali speakers and she concluded that in Bengali, different intonation patterns are used expressing different emotions.

According to the objective analysis, of the present study, the hypothesis stating that, "In Malayalam, different intonation patterns are used in expressing different types of emotions" has been accepted, as seen from Table 2. The present study also does not show any difference in intonation pattern used by males and females.

No difference in intonation patterns among males and females have also been reported by Chandrashekar, (1985) and Nithun (1998) in Hindi language, Nataraja (1982), Manjula (1979), Nandini (1985) in Kannada language and Shrabanti (1998) in Bengali language, intonation patterns used in different emotions was the same in both males and females.

It can be concluded that intonation patterns observed differ with emotions. But, not much difference is found in the intonation patterns between 'frustration' and 'anger'. Thus it may be that the same kind of intonation pattern may be used to express different types of emotions. This result partly in agreement with the

findings of Manjula (1979), Rathna et.al. (1982), Shrabanti (1999) that "same intonation pattern can be used to express different emotions".

It has been seen in the present study that the intensity variations in the four sentences of a particular emotion are inconsistent i.e. they did not follow the same pattern. But sentences expressing emotions such as Fear and Worry shows that there was consistent intensity variation between the sexes. The neutral sentences also showed that there was quite constant variations. But since all the other emotions did not have a consistent intensity variations, it can be stated that the perception of the intonation contour depends on the fundamental frequency variation that takes place during the utterance, than on intensity variations. Small variations in frequency may not be identified by subjective analysis but well detected by objective analysis. The results of the present study support the view of Pike (1945) and Labo (1961) that the variation in fundamental frequency of voice is the basis for perception of intonation contours. Further the result of this study do not agree with the results of Dener (1959) which states that it is not always the variations in fundamental frequency that contributes for intonation contour. Studies done by Chandrashekar (1985) on intonation patterns in Hindi, Nandini (1985) in Kannada, Shrabanti (1999) in Bengali also support the result of the present study that variation in fundamental frequency is the basis for perception of intonation contours. Thus it can be concluded, that the hypothesis stating that 'intensity variation do not indicate specific pattern in different emotions' has been accepted.

In the present study all the intonation contour show a falling pattern at the end of the sentence except for one or two sentences. It has been found that there was lowering of fundamental frequency or falling pattern at the end of the sentences in expressing five emotions studied by Nataraja (1982). A falling

pattern of terminal contour has also been suggested by Chandrashekar (1985) in intonation contour of Hindi language and also in Kannada language by Nandini (1985). Leiberman (1980), Soreson and Cooper (1977) stated that American English sentences were often characterized by fall in intonation curve. From the present study it is found that all types of sentences have a falling pattern as the terminal contour. Thus it may be possible that the final or terminal contour may be same for different emotional conditions, but the difference may be found in other parts of the contour, as it is seen in the present study.

The study of the fundamental frequency range in males and females showed that among Malayalam speakers female speakers used a greater frequency range in emotions of anger, grief, jealousy, joy, surprise and neutral, where as males use a greater range for fear, frustration and worry. Frequency range used in sentences expressing 'Anger' was the maximum, and minimum in sentences expressing 'Surprise', followed by neutral, fear, worry. But only 'Joy' and 'Worry' showed statistically significant difference.

Intensity range was maximum in sentences expressing 'neutral' and minimum for sentences expressing 'worry'. Females used a greater intensity range for expressing anger, grief and joy and males used a greater intensity range for fear, frustration, jealousy, surprise and worry. Statistically significant difference was found only for 'Fear' and 'Joy'.

Nithun (1998) did a study on intonation used by Hindi speakers and his result showed that the females used a greater frequency range and intensity range than males in expression of all the emotions. In the present study, it is seen that males had greater intensity range for more emotions than males that is (5/9) and females had a greater fundamental frequency range for more emotions (i.e 6/9) than males.

Table 3: Showing the FO range and 10 range in various emotions and also comparison of ranges between males and females

Emotion	Freq. range	Comparison in M/F	Intensity range	Comparison in M/F
Anger	356.75	F>M	18.25	F=M
Fear	285	M>F	*18.75	M>F
Frustration	313.25	M>F	20.5	M>F
Grief	242.75	F>M	20	F>M
Jealousy	306	F>M	21	M>F
Joy	*346	F>M	*21.5	F>M
Surprise	232	F>M	20.25	M>F
Worry	*286	M>F	17.5	M>F
Neutral	262	F>M	25.5	F=M

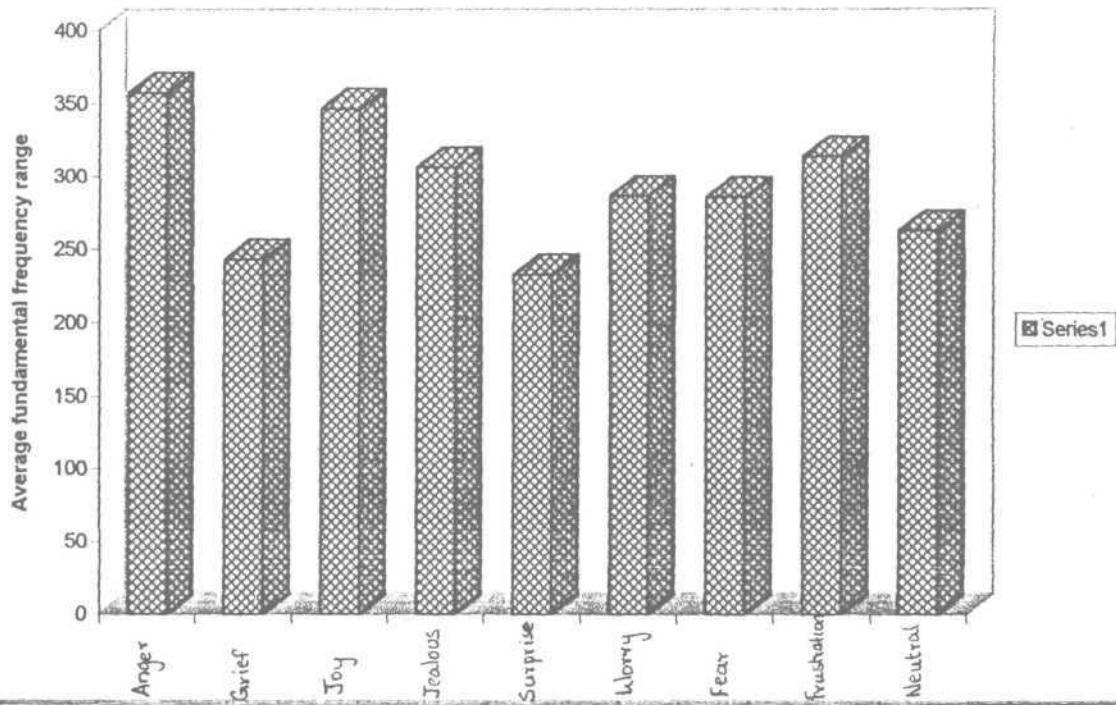
* —> Stastically significant

Perceptual analysis was done to find out whether that non native Malayalam speakers could perceive the intonation similarly to that of native Malayalam speakers. Bolinger (1972) has stated that it is the perceptual analysis that is important in understanding the intonation, as it is the ultimate determiner of meaning. The results of the present study i.e the perceptual scores (Appendix C) differentiating different emotions by non-native and native speakers are presented in Table 4.

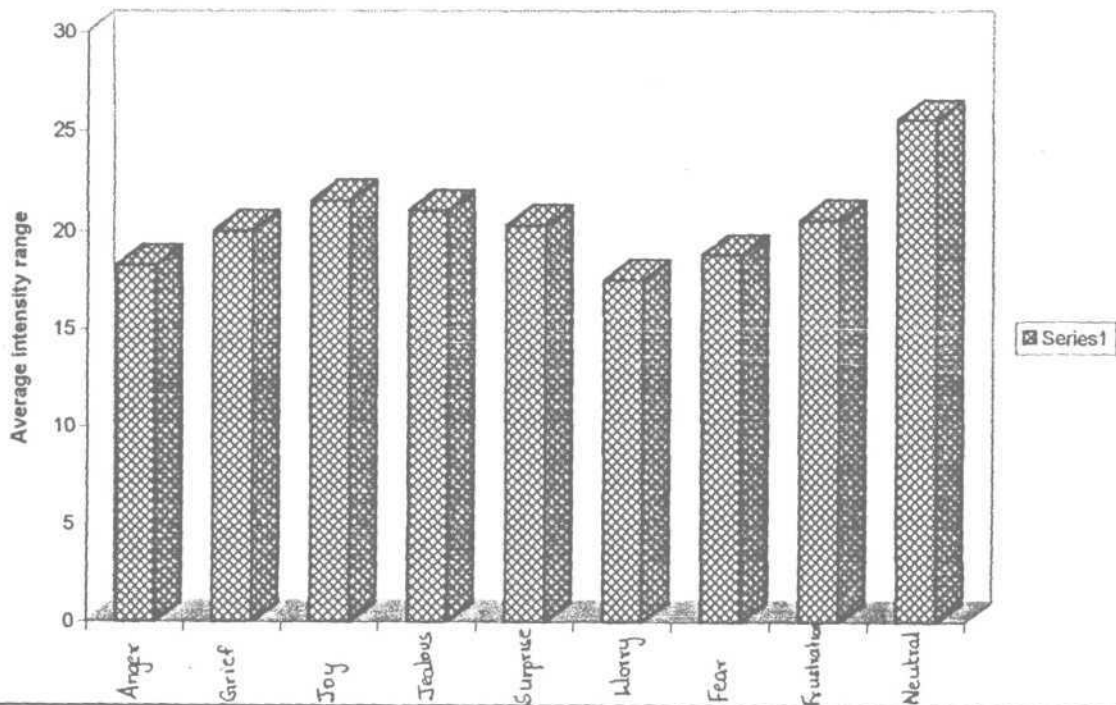
Table 4: Showing the perceptual scores in percentage for different emotion in native and non native speakers

EMOTION	NATIVE SPEAKERS	NON-NATIVE SPEAKERS
Anger	87.5	55.0
Fear	40.0	32.5
Frustration	42.5	27.5
Grief	95.0	82.5
Jealousy	50	22.5
Joy	85	65.0
Surprise	77.5	42.5
Worry	57.5	42.5
Neutral	92.5	62.5

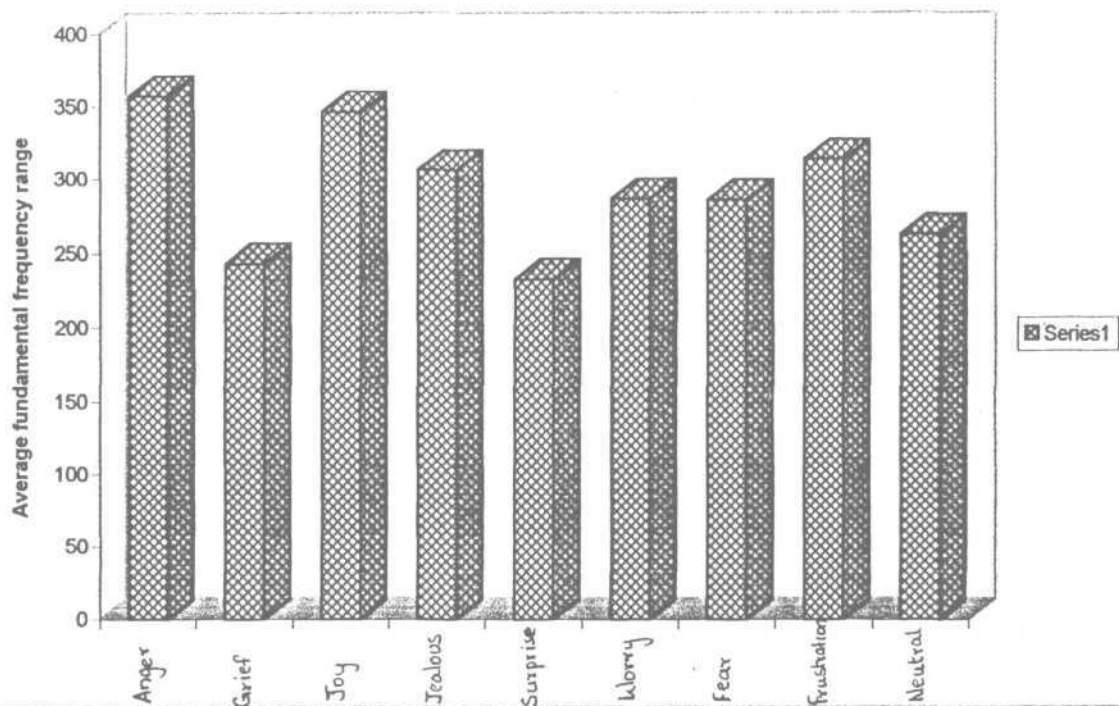
SHOWING F0 RANGE IN DIFFERENT EMOTIONS



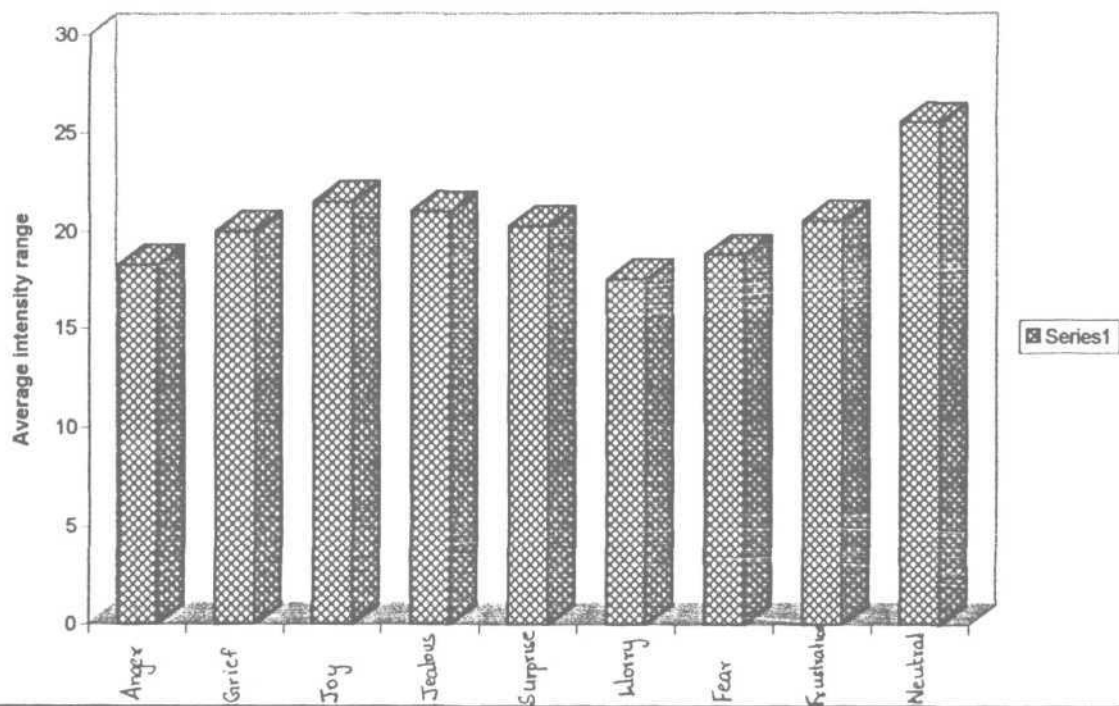
SHOWING INTENSITY RANGE IN DIFFERENT EMOTIONS



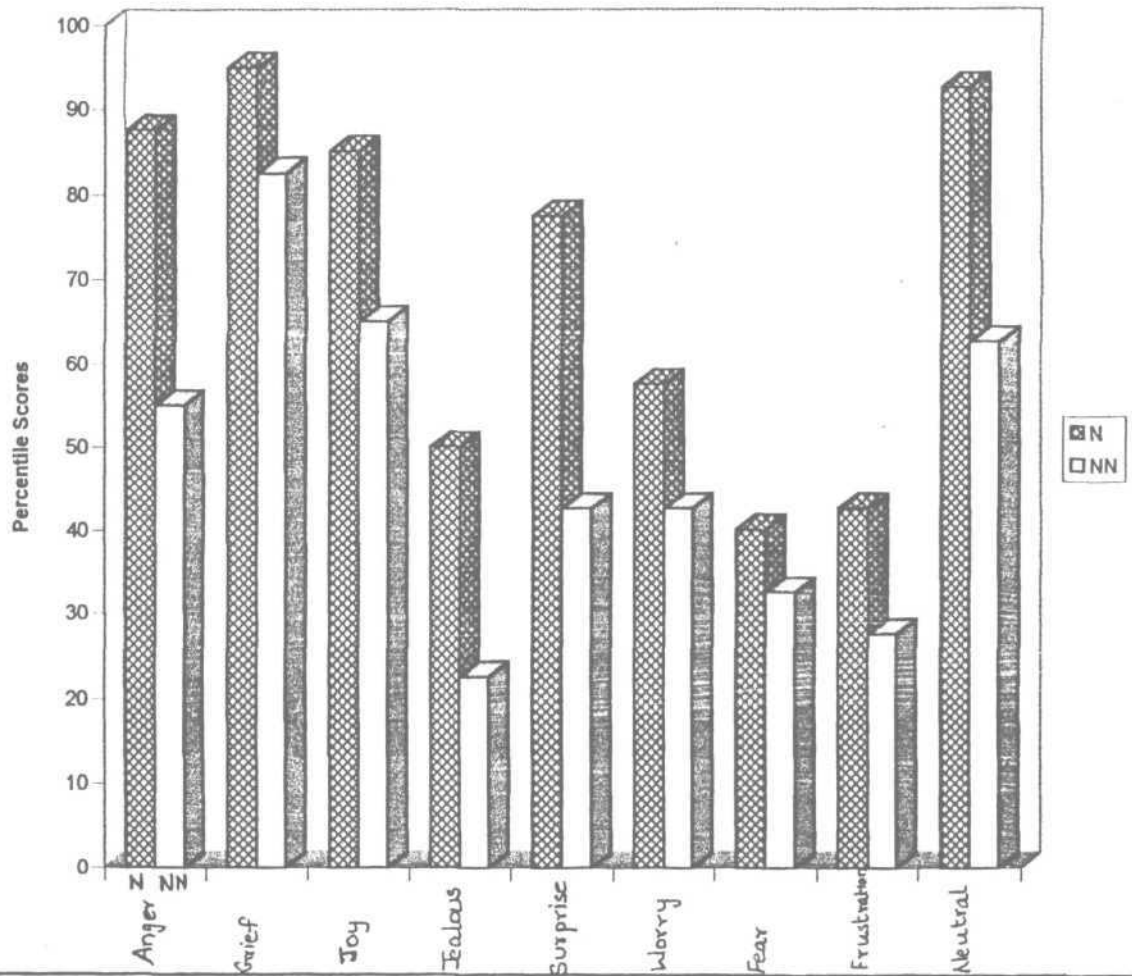
SHOWING F0 RANGE IN DIFFERENT EMOTIONS



SHOWING INTENSITY RANGE IN DIFFERENT EMOTIONS



SHOWING COMPARISON OF PERCEPTUAL SCORES BETWEEN NON-NATIVE AND NATIVE SPEAKERS



The study of table 4 shows that the native speakers had identified the different sentences expressing emotions ranging from 95% to 40% (Grief 95% and Fear 40%). The non native speakers had identified the emotion Grief 82.5% i.e., the emotion 'Grief has been expressed well in terms of intonation compared to others, so that even the non native speakers have been able to identify. Following grief, comes neutral, anger, joy, surprise, worry, jealousy, frustration and fear. The expression of fear seems to be not very clear, as both native and non native speaker have shown least scores of identification i.e. 40% and 32.5% respectively. The least identified sentence by non native speakers is emotion of jealousy (22.5%). It can be concluded that the sentences selected were actually representing the emotions i.e. they were selected for both, as identified by both native and non native speakers. Emotions of grief, joy, neutral and anger have been expressed well using intonation patterns as they could be identified by both native and non native speakers well. Emotions of fear, frustration, jealousy and worry were not well expressed using intonation patterns. In general native speakers could perceive the intonation pattern of different emotions than the non native speakers.

Thus it can be concluded that the hypothesis stating that 'native speakers can identify the intonation pattern better than non native speakers', is accepted as the identification scores of various emotions by the native speakers is more than the non native speakers (Table 4).

Better perception of the emotions by native speakers as seen in the table 4 can be contributed to contextual clues and comprehension of meaning of the words in sentences to some extent.

Thus, it may be concluded, based on the result of the present study that Malayalam speakers use different intonation patterns to express different emotions

and the intonation contours depend more upon the fundamental frequency variations rather than the intensity variations or other factors. Further it may also be concluded that native Malayalam speakers can identify the intonational patterns much better when compared to the non native speakers.

Thus the results of the present study indicates;

1. In Malayalam, different intonation patterns are used in expressing various types of emotions.

2. The perception of intonation mainly depends upon the fundamental frequency variation.

3. The intonational pattern used by males and females do not differ.

4. The females used a greater frequency range in more number of emotions when compared to males, but it was stastically significant only for emotions of 'Joy' and 'Worry'.

5. The males used a greater intensity range in more number of emotions when compared to females. 'Joy' and 'Frustration' showed statistically significant differences.

6. The native Malayalam speakers were able to identify the intonation much better when compared to non native Malayalam speakers.

The result of the present study can be used for several purposes like speech synthesis, teaching the deaf, therapy for aphasia etc. Further studies using larger samples and population are recommended.

SUMMARY AND CONCLUSION

When one analyses good speech, the speech that most adequately contributes to social interaction, it is discovered that it possess certain characteristics. Each of these characteristics make their particular contribution to the total impression. Some of the important characteristics of speech are loudness, pitch, intonation, inflection, rhythm, voice quality, articulation, stress, accent style, level of language and kind of language. (Bolinger 1972).

Prosody has been viewed as decorative ornamentation, functioning to make speech more aesthetically pleasing, but prosody functions as the foundation or structural support for the organisation of speech communication (Freeman, 1983).

Intonation is an exclusive term referring to pitch as a function of time and may be applied to a simple inflexion or to long term variation in phrases over a numerous inflectional shifts (Greene, 1964). Intonation has been considered to be functioning at different levels of language, i.e. syntactic, lexical, phonological and also in providing information regarding the condition of the speaker's, emotion and others.

Abnormal prosody is a characteristic of deaf children and is also affected in language disordered children and adults. Therapy for deaf and aphasics include teaching intonation as it has been found to facilitate acquisition of language.

Study of intonation in a given language permits better understanding of the language and also helps in the intervention programmes. Thus there is need for knowing the intonation used in language for the purpose of teaching language.

The present study aimed at finding out the intonation patterns used by native Malayalam speakers under different emotional conditions. Thirty six sentences were selected randomly from seven Malayalam film audio cassettes. Nine emotions, i.e. anger, grief, fear, frustration jealousy, joy, worry, surprise, neutral were considered as the basic emotions for the purpose of the study. Four sentences were chosen randomly to express each emotion. Both male and female subjects were considered. The emotions expressed were produced as natural as possible. It was conveyed by speakers to the listeners only through speech, i.e., without any visual clues. Ten native Malayalam speakers and ten non- native speakers in the age range——served as subjects for perceptual evaluation.

In the present study both objective and perceptual analysis of intonation have been done. The objective analysis was done using the **FOINT module** of **Vaghmi program**. In perceptual analysis both the groups i.e., native Malayalam speakers and non-native speakers were asked to listen to the 36 sentences and to identify the emotions expressed in the sentences.

The results obtained by objective and perceptual analysis were as follows:

1. In Malayalam, different intonation patterns were used in expressing different emotions.
2. The perception of intonation mainly depends upon the fundamental frequency variations in the sentence.
3. The intonation pattern used by males and females do not differ.

4. Females used a greater frequency range in expressing the emotions and more frequently when compared to males, but it was statistically significant only for the emotions of 'Joy' and 'Worry'
5. Males used a greater intensity range in expressing the emotions and more frequently when compared to females. Only the expression of 'Joy' and 'Frustration' showed statistically significant differences.
6. The native Malayalam speakers were able to identify the intonations much better when compared to non-native Malayalam speakers.

Recommendations

1. A more detailed study with more speech samples may be taken up
2. Natural speech can be used to study the intonation pattern in Malayalam
3. Other prosodic aspects in Malayalam can be studied using the same methodology
4. Other emotions can be studied using the same methodology
5. Emotions expressed by the disordered population (deaf, aphasics, etc.) can be studied, by keeping the present study as normative data
6. Intonation in other languages can be studied using same methodology.

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APPENDIX - A

<p>ചേട്ടന്റെ കൂട്ടുകാരൻ വന്നിട്ടുണ്ട് ബോംബേന്റ് എട്ടൻ പറഞ്ഞിട്ടു /ceettante kuuttukaaran vannittuṅṅa boombenna eṅṅan paraṅṅittu</p>	<p>Joy F</p>
<p>വന്നതാ . ഭാസ്കരപ്പിള്ളിക്ക് ഭാഗം വരൻ പറഞ്ഞു . vannataa bhaṅṅuvecciyoota veegam varaṅṅ paraṅṅu/</p>	
<p>ചേച്ചി സമ്മതിച്ചു വാങ്ങിക്കൊടുത്തു /ceecci sammaticcu vaṅṅnikkollaan/</p>	<p>Joy F</p>
<p>കൊച്ചും ഉണ്ണും നല്ല കൂട്ടാൻ കൂടി ഞാനിതിനെ ഉണ്ടിട്ടില്ല . /kollaam itrayum nalla kuuttān kuutti naanitivare uṅṅittillaa/</p>	<p>Joy M</p>
<p>നമുക്ക് മന്നാർപ്പാല ഉത്സവം കാണാൻ പോകാനിടയാ . /namukka manṅaarsaale ulsavam kaṅṅaan pookaṅṅullataa/</p>	<p>Joy M</p>
<p>ഇത്ര കിഷ്ടപ്പെട്ടു ഇതൊക്കെ കൊടുത്തിട്ടു പിന്നെ ഉണ്ടു ഉടുത്താൻ /itra kaṅṅappetta itokke koṅṅuttuviṅṅaan ivite uṅṅkaan</p>	<p>Frustration F</p>
<p>തന്നിയില്ല എങ്കിൽ കഷ്ടമാണ് . tuṅṅiyillaṅṅ irikkukyaṅṅoo/</p>	
<p>ഇങ്ങനെയൊരു മാറ്റമില്ലാത്തതാണ് ജീവിക്കുന്നതിന് കഷ്ടിട്ടില്ല . /iṅṅanoru marattalayane naan jiivitatti/ kaṅṅittillaa/</p>	<p>Frustration F</p>
<p>ഇവർ കാര്യമൊന്നും ഉണ്ടാകാതെ പോയിരിക്കുന്നു . /ivate kaaryamonnum ipam eṅṅatutta coodikkaṅṅa</p>	<p>Frustration M</p>
<p>പിറ്റേകുറിച്ചു വാർത്തയ്ക്ക് ചിലപ്പോ മതി . piṅṅcukayarriyavarṅṅatutta coodiccaa mati/</p>	
<p>എല്ലാ വിട്ടു മനുഷ്യന്മാർക്കും ജീവിക്കാനാണു /ellaam viṅṅa manuṅyanepoole jiivikkaṅṅamenna</p>	<p>Frustration M</p>
<p>വിചാരിച്ചു ജീവിക്കാനില്ലെന്നു വെച്ചു . vicaaricca jiivipikkillenno vecca/</p>	

അവൾ പെണ്ണിനെതിരെയുള്ള മീൻമേടിക്കാൻ ആണുണ്ടാകുക
 /ava! cellunnatum kaata miinmeetikkaan aañuññalalle
 കുട്ടിയിരിക്കുന്നത് .
 kuttiiyirikkunnata/

Jealous F

അയലോക്കത്തെ പോക്കുകൊണ്ടുണിപ്പെണ്ണു ചിത്ത
 /ayalookatte pookkukontaani penna cittayaavanata/

Jealous F

അവന്റെ മരണത്തിനെ പേറാല ഒരു പെണ്ണിനെ ജിന്മേൽ
 /avante marakkaattine poole oru pennunṭeriki ñaan
 കപ്പൽ മേടിക്കും .
 kappal meetikkum/

Jealous M

വരുത്താൻ കൂടാതെ സീറ്റോളോ നാട്ടുകാരും
 /varuttunmaarkkumaatre siirrolloo naattukaarum
 ചിലരെങ്കിലും ഇവിടെ .
 cilarokke ivitontee/

Jealous M

അമ്മേനേം പെണ്ണേയും തിരിച്ചറിയാത്ത ചെറുകൾ
 /ammeeneem peññaleem tiricariyaatta cerrakal/

Anger F

നിർത്തണം നിന്നാതെ ഇപ്രസാഹം
 /nirttanam niññate ii prasañham/

Anger F

ഒരു തേവിട്ടിയി പെണ്ണിനുവേണ്ടി എന്റെ തമ്പ്രാന
 /oru teevitiṣṣi penninuveenti nii ente tambraane
 കൊന്നു അല്ലേ .
 konnu allee/

Anger M

മിസ്റ്റർ അബ്ദുൾ റഹീം സുക്ഷിച്ഛ സാസാരിക്കാനം
 /mistar abdul rahiim suksiccha samsaarikkañam/

Anger M

ചേട്ടൻ എന്തെങ്കിലും പറ്റിയോ?
/ceettan enterikilum parriyoo ?/

Fear F

എന്താ പറ്റിയത് അച്ഛൻ
/enta parriyata accanna/

Fear F

പിൻമാനിയോ! എന്താവിതിന്റെ അർത്ഥം
/pinmaariyoo/entaayitinte artham/

Fear M

എല്ലാ വക്കിലെ എന്റെ കഴുത്തിൽ താലതലർ വിഴുമോ.
/etoo vakkiile ente kalutti/ kolakkayar viilumoo/

Fear M

അശ്വരാ ശരീകുട് തല്പ് തിട്ടിയോ.
/iiswara, serikka talb kittiyoo/

Worry F

യ്യോ വല്ലവരും കണ്ടാല്ലോ.
/yyoo vallavarum kantaaloo/

Worry F

ആരോട് ഏങ്ങനെ പറയൂന്ന് അറിയാതെ വിഷ്വിഷ്കയായിരുന്നു.
/aarooḍa ennaṇe parayunnṇa ariyaate viṣamikkukayaayirunnu/

Worry M

ഞാൻ കുറച്ച് തെൻഷനിൽ ആണ് .
/naan kuraccḥ tenṣanilaana/

Worry M

സാധാരണ ഒരു കുട്ടി ചെയ്യുന്ന കാര്യമാണോ നീ ചെയ്തത്.
/saadhaaraṇa oru kuṭṭi ceyyaṇa kaaryamaaṇoo nii ceytata/

Grief F

ഇങ്ങനെയാതെ ആവുമെന്ന് ഞാനും കണ്ടിയില്ല .
/innaṇeyokke aavumennaṇaṇum karutiyailla/

Grief F

ആരാഉടവാൾ ഏറ്റുവാങ്ങിട്ടി
/aaraa uṭavaal̥ eruvaaṅṅuka/ Grief M

സ്നേഹം പലർക്കായിട്ട് പോന്നത് തന്നപ്പോൾ ഭ്രാന്തപിടിച്ചു
/sneham palarkkaayitta poonata kaṅṅappoo! bhraantupit̥ṭṭu Grief M

പോയ ഒരു കുട്ടി.
pooyoru kutti/

ചിന്തനെ കൂടെ കൊണ്ടു വരാമായിരുന്നു.
/cinnuune kuute koṅṅu varaamaayirunnu/ Neutral F

തീ കൂട്ടിയിട്ടിരിക്കുന്നത് തന്നാൽ അത്ത് വരില്ലാത്രേ
/tii kuṭṭittirikkunnatu kaṅṅaal aṭuttu varillaatre/ Neutral F

A. സാർ അഡ്വക്കേറ്റു അശ്വതിമേനോൻ തന്നാൽ വന്നിരിക്കുന്നു.
/saar advakkeerru aśvati meenoṅṅ kaṅṅaan vanniṅṅunnu/ Neutral M

നിങ്ങളുടെ സേവനം ഡിപ്പാർട്ടുമെന്റിനു വേണ്ടി ന്നാൻ
/niṅṅalūṭe seevanam ḍippaart̥ṭṭument̥ṭṭin̥ṅ veenti ṅṅaan Neutral M

അവശ്യപ്പെട്ടുകയാണു.
aaṅṅaśyappēṭṭukayaāṅṅ/

ഇത്ര പെട്ടെന്ന് വാങ്ങിയോ.
/itra peṭṭenna vaāṅṅiyoo/ Surprise F

എന്ത് പറ്റിപെട്ടെന്ന് .
/enta parri peṭṭenna/ Surprise F

ഔം തമ്പ്രാൻ ചേട്ടൻ എവിടെ .
/yyoo tambraan ceṭṭan eviṭe/ Surprise M

ഔം ചേട്ടൻ കമ്പന്തിയേ, ചേട്ടൻ കമ്പന്തിയേ .
/yyoo ceṭṭante kambentiyeē ceṭṭante kambentiyeē/ Surprise M

APPENDIX-B

SAMPLE OF THE SCORE SHEET GIVEN TO SUBJECTS FOR PERCEPTUAL ANALYSIS

Name	Age/Sex	Native Speaker: Yes/No
1.	19.	
2.	20.	
3.	21.	
4.	22.	
5.	23.	
6.	24.	Emotions
7.	25.	A - Anger
8.	26.	G - Grief
9.	27.	Fe - Fear
10.	28.	Fr - Frustration
11.	29.	Jo - Joy
12.	30.	Je - Jealous
13.	31.	S - Surprise
14.	32.	W - Worry
15.	33.	N - Neutral
16.	34.	
17.	35.	
18.	36.	

APPENDIX- C

NATIVE SPEAKERS

Sent No.	Emotion	Anger	Gr	Sur	Fru	Jo	Wo	Fe	Jea	Neu
Anger										
1.		9			1					
2.		7	2		1					
3.		10								
4.		9			1					
Fear										
1.							4	5		
2.			2				3	5		
3.			1	5			2	2		
4.							5	5		
Frustr.										
1.		6			4					
2.		2			6		1			1
3.		7			3					
4.		1	1		6		2			
Grief										
1.			10							
2.			9				1			
3.			10							
4.			9				1			
Jealous										
1.					1	3	1		4	1
2.		3			2				5	
3.		3	1		3		1		2	
4.									9	1
Joy										
1.				1		9				
2.						9				1
3.						10				
4.						6			1	3
Surprise										
1.				10						
2.				6			1	3		
3.				5			2	3		
4.				10						
Worry										
1.			3				1			
2.							4	6		
3.			2		2		6			
4.			1		3		6			
Neutral										
1.										10
2.				1			2			7
3.										10
4.										10

C

NON-NATIVE SPEAKERS

Sent No.	Emotion	Anger	Gr	Sur	Fru	Jo	Wo	Fe	Jea	Neu
Anger										
1.		5			2			1	2	
2.		5	1		2			1	1	
3.		9								1
4.		3		1			2		3	1
Fear										
1.					1		5	4		
2.			2		2		2	4		
3.			1	1	2		3	4		
4.			4		2		3	1		
Frustr.										
1.		8			2					
2.			1		2				2	5
3.		6			3					1
4.					4					6
Grief										
1.			7				1			2
2.			8				2			
3.			9	1						
4.			9				1			
Jealous										
1.						7			1	2
2.		4		1	1				4	
3.				-		6			2	2
4.		4			1				4	1
Joy										
1.				1		4	3	1	1	
2.						9	1			-
3.						7				3
4.		1				6			3	
Surprise										
1.				9		1				
2.				3	1		5	1		
3.				6	1	2	1			
4.				1			1	1	1	6
Worry										
1.				1			5	3		1
2.				1		1	6	2		
3.				2			2	1		5
4.						3	4		1	2
Neutral										
1.		1		1						8
2.			1			1		3		5
3.								2		8
4.								2		8

r

The Perceptual Scores in Percentage for different emotions in native and non-native speakers

Emotion	Anger		Grief		Joy		IFear		Jealous		Surprise		Worry		Frustration		Neutral	
	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN
Anger	87.5	55.0	5.5	2.7				5.5	16.6		2.7		5.5	8.3	11.1			2.7
Grief			95.5	82.5							2.7	5.5	11.1					5.5
Joy		2.7			85	65.5		2.7	2.7	11.1	2.7	2.7		11.1			11.1	8.3
Fear			8.3	19.4			40.0	32.5			13.8	2.7	38.8	36.1	2.7	19.4		
Surprise							11.1	25	5.5			77.5	42.5	8.3	19.4	5.5		16.6
Jealous	16.6	11.1	2.7		8.3		36.1		50	22.5		2.7	5.5		16.6	2.7	5.5	11.1
Worry			16.6	11.1		2.7	16.6	13.8		2.7			57.5	42.5	13.8	11.1		22.2
Frustration	44.4	38.8	2.7	2.7						5.5			8.3		42.5	27.5	2.7	33.3
Neutral		2.7		2.7		2.7					2.7	2.7	5.5	19.4			92.5	62.5

N = Native Speakers

NN = Non-Native Speakers