INFLUENCE OF FIRST LANGUAGE ON PRODUCTION AND PERCEPTION OF SPEECH

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CERTIFICATE

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DECLARATION

This dissertation entitiled *"INFLUENCE OF FIRST LANGUAGE ON PRODUCTION AND PERCEPTION OF SPEECH"* is the result of my own study under the guidance of Dr. N.P. NATARAJA, Professor and Head, Department of Speech Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

Speech is a form of communication that employs a linguistic code (language), which may be thought of as a systematized code of arbitrary symbols, basically vocal, but reinforced by visible bodily activity (Gray and Wise, 1946).

Eisenson and Boase (1975) have described speech as a complex function, i.e. one's manifestation of attitude, purpose, feeling and thought. This manifestation is presented in a symbolic code and in a manner that is culturally determined yet individually formed and expressed orally.

The speech process can be divided into respiration, phonation, articulation, resonation and prosody or supra- - segmentals. Continuous speech involves the smooth functioning of these processes in an interactive manner.

Prosody or suprasegmentals are variations larger than individual segments of speech. Suprasegmentals organize speech into a particular format; and the segmental features are nestled within these segmental units. Suprasegmentals include intonation, rhythm, stress and juncture.

Intonation is the patterned variation of pitch over linguistic units of different lengths, or the perceived pattern of rise and fall of pitch over linguistic units.

Intonation marks syntactic contrasts, changes meaning and signals attitudes and feelings.

There is some evidence that early communication is essentially suprasegmental in nature (Lewis,1951; Lenneberg, 1967). The infant varies intonation patterns to express physiological and emotional needs. Although segmental development stabilizes at 8 years of age (Templin, 1953), the age at which suprasegmental development reaches a similar level is not certain (Shadden et al., 1980). At the age of six to seven 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 Yompol'skaya, 1969).

It has been found that various emotions and attitudes are conveyed by varying patterns of intonation (Crystal, 1969).

Intonation has been studied using subjective (perceptual) analysis. However, studies using perceptual judgements may reflect the listeners' attitudes and feelings. Hence acoustic analysis is used to study intonation. These studies have shown that fundamental frequency and intensity cue intonation (Denes, 1959; Mejewski and Blasdell, 1969).

"Meaning for speech is always two fold, it is not enough that a speaker uses a type of expression that carries only a logical meaning; he must show the hearer how he himself feels about the matter. He must not only let the hearer know what the idea is; but how well or ill he himself thinks of it. The expression of thought content varies little from one speaker to another, the difference in the personal attitude of different speakers or readers will result in quite different presentations of the same material" (Woolbert, 1927).

An individual's mother tongue influences his production and perception of speech in a second language. The mother tongue influences the production of voice onset time (Lisker and Abramson, 1964; Slis and Damste, 1967; Lindquist, 1972; Frokjair-Jensen et al., 1973; Bengurel et al., 1978; Keating, 1984; Brownman and Goldstein, 1986; Ravanan, 1993); vowel duration (Fledge, 1980; Molly Mark, 1982; Ravanan, 1993), and speech rhythm (Adams, 1979).

The mother tongue also influences production of suprasegmentals (Fry, 1966; Demrich, 1954). Perception of suprasegmentals has also been found to be influenced by the mother tongue (Singh, 1966; Singh and Black, 1966; Abramson and Lishker, 1970; Meyawaki et al., 1975; Sapon and Carrok, 1957; Arathi, 1983; Venkatesh, 1983).

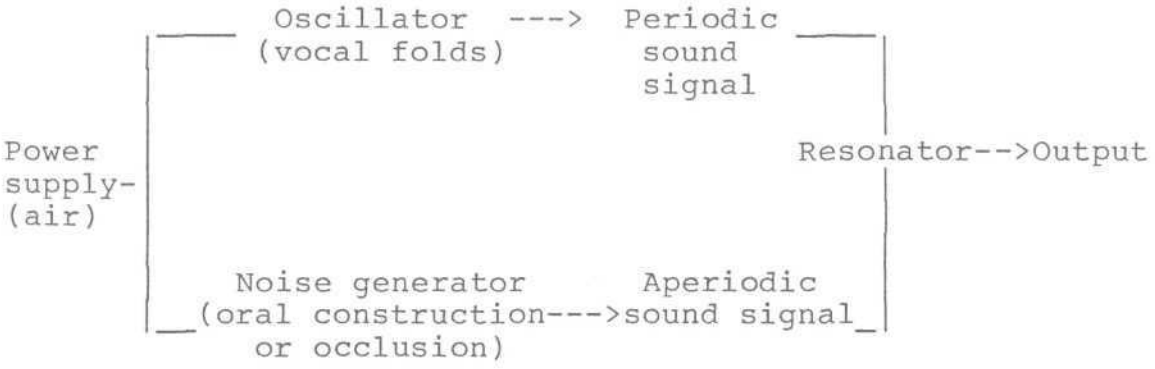
REVIEW OF LITERATURE

Speech is the superimposition of a number of actions in the upper respiratory tract upon the action of the larynx (in producing a fundamental tone) and lungs to result in audible phonations of the sounds in appropriate sequence. It may be viewed as a unique method of communication evolved by man to suit the uniqueness of his mind. By its great flexibility, it permits man to produce a variety of signals commensurate with the richness of his imagination (Eisenson, D'Amer, Irusin, 1963).

The goal in producing speech is to make certain meaningful sound combinations. It is an acoustic goal. To effect that goal, the speaker uses air to make a variety of sounds, which are further modified when they are produced in context with one another. The sounds are produced by regulating the airstream as it passes from the lungs to the atmosphere. This regulation is brought about by the movements of the jaw, lips, tongue, soft palate, pharynx and vocal folds to alter the shape of the vocal tract. The movements are mainly the result of muscle contractions, which are due to nerve impulses, and the whole process is controlled by the nervous system (Borden and Harris, 1980).

In English there are approximately 40 phonemes. They are all created by making exhaled air audible. The two

primary methods used for making air audible are to voice and to create consonant noises. Voicing is the creation of a somewhat periodic sound wave by the opening and closing of the vocal folds. The air from the lungs is thus chopped into tiny puffs of air which are audible. Consonant noise is created by the positioning of the parts of the speech mechanism in such a way that aperiodic sounds are created in the vocal tract, mostly in the mouth or oral cavity. Both the sounds of voicing and the sounds of consonant noise are resonated in the vocal tract.



Schematic illustration of the speech production mechanism

Speech sounds overlap and flow into one continuously changing stream of sounds, further bounded by slowing changing modifications overlaid upon it. These overlaid changes are the prosody or suprasegmentals - the rhythm and music of speech (Borden and Harris, 1980).

Prosodic systems may be defined as sets of mutually defining phonological features which have an essentially

variable relationship to the words selected, as opposed to those features (for example the segmental phonemes and the lexical meaning) which have a direct and identifying relationship to such words (Borden and Harris, 1980).

The primary prosodic parameters are the psychological attributes of sound - pitch, loudness and duration; which have a primary relationship with the physical dimensions of fundamental frequency, amplitude and time respectively. Prosodic systems comprise independently varying vocal effects based on combinations of these three parameters in specific ways (for example rhythmicity) or on contrast in silence (the system of silent pauses) (Crystal, 1969).

Suprasegmentals can be described as variations larger than individual segments, overlaid upon a word, phrase or sentence. They include intonation, stress, rhythm and juncture.

At a linguistic level, speech can be organized by stress and intonation into suprasegmental units, with the segmental units nestled within. This is the organizational formal for normal speech production and this organization significantly facilitates perception of the speaker's message (Harris, 1978).

Stress can be initiated by various combinations of these cues. It can be shifted for emphasis, to make change in meaning; and to change grammatical category (Fry, 1955, 1958).

Most often, an increase in pitch and loudness is used, but a sharp decrease can also mark stress. Slower tempo and longer perceived durations cue stress, whereas the same may be done by longer silent periods (pauses). Stressed segments are perceived as louder, longer and higher in pitch than unstressed segments (Fry, 1958). In English, stressed morphemes have a characteristic energy curve. The force of articulation rises sharply at the beginning, culminates in the stressed syllable and tapers off towards the end. Hence consonants preceding the stressed syllable are articulated with greater force than those following it (Kurath, 1964).

Intonation

Intonation is described as the patterned variation of pitch over linguistic units of different lengths; or the perceived patterns of rise and fall of pitch over linguistic units. The changing F_0 perceived as the intonation contour of a phrase or sentence is particularly effective in expressing differences in attitude and also differences in meaning. This intonation pattern can be imposed on a sentence, a phrase or even a word.

A 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 of the breath group (Liberman, 1967).

Intonation marks syntactic contrasts (phrase endings, interrogation versus declaration), changes meaning, and signals attitudes and feelings. Excitement, including some kinds of anger and states of enthusiasm is often accompanied by a large shift in intonation, while calm subdued states including some forms of anger, grief, peacefulness and boredom are characterized by a narrow range of intonation variation. We know how a person feels as often by how he says his message as by the message itself.

Ancient Sanskrit literature opined that different types of intonation should be used in different situations (from the Natya Sastra, quoted by Savithri, 1978).

Intonation is high, excited and fast in a rejoinder, confusion, harsh approach, representing sharpness and roughness, agitation, weeping, challenging one who is not present, threatening terrifying and calling one at a distance.

Intonation will be grave and slow in conditions of sickness, fever, grief, hunger, thirst, deliberations, deep

wound from a weapon, communicating confidential words and in states of anxiety. Intonation will be grave and fast in a woman's soothing words to a child and panic. It will be slow, excited and of low pitch following an object lost after being seen, hearing anything untoward about a desired object or person, mental deliberations, envy, censure, saying something which cannot be adequately expressed, telling stories, rejoinders, conclusions, on actions involving excess misery, grief, surprise, jealousy, anger, joy and lamentation. Grave and slow intonation can be used in words containing pleasant sense and happiness. Excited and high intonations can be used in words which express sharpness and roughness.

Huttar (1968) conducted a study wherein the emotional states of an adult male American speaker, as reflected in 30 utterances, were evaluated by 12 subjects on nine seven point semantic differential scales (Osgood, 1958). The emotional states of the person whose speech was studied were measured indirectly by means of listeners' responses, and the prosodic features of the utterances were studied perceptually (listeners' response) and acoustically (sound spectrograph).

The results showed significant correlations between acoustic variables and the judgements of some types of

emotions. Higher correlations were found between the acoustic variables and degree of emotion. Correlation coefficients between judgements of emotion and judgement of prosodic features were in general higher than the correlations involving the acoustic variables. Degree of perceived emotion was found to be highly and positively correlated with fundamental frequency range and intensity range.

Deva (1957, 1960) in a study on Telugu speakers, concluded that degree of emotion is correlated with raising of frequency, the rank order of emotions being sorrow (least change), anger and fear.

Denes (1959) checked whether information about intonation is maintained when listening to synthesized speech in which the fundamental frequency is controlled by the intensity variation of a normal humanly produced speech sequence. Results of the study showed that control of the F_0 of the synthesized sounds by the intensity of the input did provide uses for recognition of intonation.

According to Pullack, Ruberstein, Horowitz (1960), F_0 alone is not enough to determine intonation in whispered speech.

A study by Liberman and Michaels (1962) showed that when both intensity and F_0 cues were given in a perceptual

task, listeners performed better than when either intensity or frequency cues were given.

Majewski and Blasdell (1969) conducted a study involving forced choice of emotion using synthetic fundamental frequency contours; on Polish and American English listeners; and concluded that cues for F- control identification.

Rhythm

This can be described as the perception of a patterned time program underlying the sequences of speech (Pike, 1959). It has also be described as a repetitive event taking place at regular intervals of time.

Pike (1959) has divided rhythm as stress timed and syllable timed. In stress termed rhythm, stress occurs at regular intervals; whereas in syllable timed rhythm, each syllable has equal duration.

The natural rhythm of any given speech sequence is part of language competence.

Duration and juncture

Duration and juncture are two other aspects of suprasegmentals. Speech sounds vary in intrinsic duration; with diphthongs and long vowels being longer than the short

and the unstressed vowels. Continuous consonants are longer than the bursts of stops. There are duration relationships which extend over units larger than segments. Vowels are longer before voiced consonants than before voiceless consonants. They are also longer before continuants than before stops.

Juncture is a prosodic feature related to duration. Differences in juncture result from changes in duration combined with other sound changes. Junctural distinctions are being studied in an effort to produce more natural synthetic speech and to better understand speech production rules (Lehiste, 1970). Juncture also plays an important role in written language, with word junctions, spaces and marks of punctuation being used to mark major syntactic and semantic junctions.

Earlier suprasegmental features were frequently viewed as desirable, but not essential or something extra, which are to be considered only after more important dimensions like segmental production, phonological discrimination, syntax, auditory memory, grammar, semantics, etc. Their function was thought to be more of decorative ornamentation and was viewed to make speech more aesthetically pleasing. This view is now considered erroneous. Prosody is now thought to act as foundations or structural support for the organization of speech communication.

a. Chunking or parsing device for dividing the flow of speech into coherent auditory structures suitable for further processing.

b. Predictive device which allows listeners to anticipate the arrival of potentially important speech material.

Investigations have provided evidence that prosodic information is essential and is required at all levels of perceptual analysis, influencing segmental analysis (Summerfield, 1975; Martin, 1975, 1979), syntactic analysis (Darwin, 1975; Klatt, 1975, 1976, 1979; Wingfield, 1975; Collier and t'Hart, 1975; Lehiste et al., 1976; Streeter, 1978) and semantic analysis (Lieberman, 1967; Bolinger, 1972; Linblom and Rapp, 1973; Coker et al., 1973; Cooper, 1979; Cooper and Sorenson, 1977). Research also supports the use of prosodic information for grammatical analysis (Cooper and Sorenson, 1977) in identifying and delimiting elements of longer, discourse-level speech sequences such as paragraphs (Lehiste, 1975); in selectively attending to one voice among many (Darwin, 1975) and in interpreting a speaker's communicative intent (Hadding-Koch and Studdart-Kennedy, 1964).

Other studies have shown that production of the suprasegmentals is rooted in and may provide information

about neurophysiological organisation and physiological-anatomical constraints (Neisser, 1967; Lieberman, 1977; Allen, 1975; Nooteboom and Cohen, 1975; Fowler, 1977, 1979, 1980).

Prosody has also been found to influence the perceptual integration of speech (Huggins, 1974, 1975, 1977; Ladefoged and Broadbent, 1960; Warren, 1976; Dorman et al., 1979; Bastian, 1960; Darwin, 1975; Dallett, 1964; Nusser et al., 1969; Mills and Martin, 1974, 1975). Another function is the physiologically based segmentation of speech (Liberman, 1967; Goldman-Eisler, 1968; Grosjean, 1977, 1979). Successive events tend to be integrated in perception if the events are similar and follow each other rapidly. This integration depends on the intervening interval, similarity of the stimuli and whether the nature of the task requires that they be integrated.

The anticipatory function of prosody has been supported widely (Lieberman, 1963; Stowe and Hampton, 1961; Abrams and Bever, 1969; Vergugge et al., 1976; Summerfield, 1975; Martin, 1975, 1979; Sorensen and cooper, 1979; Lehiste, 1975; Nooteboom and Cohen, 1975; Goldman-Eisler, 1972; Martin, 1975). Suprasegmental acoustic cues function to enable the listener to expect or anticipate the rough outlines of speech not yet heard.

Speech, even the logical aspect of meaning itself, often depends largely on such vocal elements such as phrasing, emphasis and inflections (Woolbert, 1927). These elements can be described as follows:

a. Changes in quality or timbre is one of the most significant factors. Its use can change the meaning or implication of speech. Eg. Solemn, serious and weighty affairs are discussed in tones different from those in light, gay and inconsequential affairs.

b. Changes in intensity: This is another aspect which contributes to the understanding of speech. Emphasis may be either logical or emotional or both. A slight change in shading can affect meaning significantly. Intensity effects can be brought about in three ways:

i. Accent changes: Accent is constituted by an increase in loudness together with a rise in pitch given to a certain syllable of a word to satisfy convention of correctness in pronounciation. A shifting accent may change meaning.

ii. Emphasis: This is constituted by an increase in loudness and pitch. Emphasis always changes meaning. This is more concerned with meaning than correctness.

iii. Simply varying the loudness to soft or loud may express politeness, challenge, etc.

c. Changes in time: These convey both logical and emotional aspects. Rapid utterances may represent a different attitude in speaker or a different attitude in the listener.

This is achieved in three ways:

- Using shorter or longer phrases or thought units (varying the number of pauses between them).
- Varying the length of pauses.
- Varying the number of words per minute.

Emphasis is accompanied by lengthening of sounds.

d. Change in pitch: These are primarily instrumental in expression of the logical aspect of meaning. They have some emotional significance as well.

These carry some amount of emotional information, especially when extremely wide or narrow ranges are used (Woolbert, 1927). For example, the widest ranges are usually seen in anger and the narrowest in grief. Excitatory emotions show wide pitch ranges while inhibitory emotions show narrow pitch ranges. Eg. Anger has the widest pitch range, while grief has the narrowest.

The following studies throw light on the above mentioned influence of native language on production.

Voice onset time of speech sounds was found to vary significantly across and between subjects in the mother

tongue and other languages. However, when a subject spoke in his first language and other languages, there was no differences in voice onset time observed (Ravanan, 1993). The language in which one speaks was found to have an influence on voice onset time (Lisker and Abramson, 1964;' Slis and Damste, 1967; Lindquist, 1972; Frokjair-Jensen et al., 1973; Bengurel et al., 1978; Keating, 1984; Brownman and Goldstein, 1986). Perception of VOT was not found to differ with language by other studies (Basu, 1979; Ravishankar, 1981; Usha Rani, 1989).

Vowel duration: Fledge (1980), based on a study concluded that some Arabic-English bilinguals utilized different voicing-dependent vowel durations in Arabic and English.

Voicing dependent vowel duration was studied in English and French monolinguals and bilinguals (Molly Mack, 1982). A larger context dependent difference in preconsonantal vowel duration was found in English than in French; and it was found that English and French vowel duration ratios of French-English bilinguals were essentially like those of French monolinguals. However, bilingual English speakers produced longer vowels than French vowels.

Ravanan (1993) in a study on vowel duration in different languages (Hindi, Kannada, Tamil and English),

concluded that significant differences existed in vowel duration in utterances of subjects speaking a second language and third language.

Usha Rani (1989) studied the effect of preceding vowel duration, closure duration, transition duration of preceding and following vowels and voice onset time on perception of medial geminate unaspirated bilabial and velar stops consonants across Kannada and Hindi speakers. The study found no difference in perception of preceding vowel duration in Kannada and Hindi speakers.

Usha Rani (1989) found no significant difference in the percepts of closure duration, transition duration of preceding and following vowels by Kannada and Hindi speakers.

Speech rhythm

Adams (1979) carried out a study to establish the nature of differences in speech rhythm between native and non-native speakers of English. He came up with the following conclusions.

There was a significant difference between the two groups of subjects in the number and position of stressed syllables spoken in the test items; and also in the number, placement and duration of pauses used in the same utterance.

There was no difference between the two groups with respect to the parameters used to signal stress.

A review of prosodic patterns, their organisation and their occurrence in various languages would be useful.

Most of the studies on this aspect have concentrated on intonation patterns. The question here is whether intonation is produced and perceived in the same way across all languages or is it different from language to language ?

Fry (1966) opines that weightage given to various perceptual factors in intonation will vary from language to language. For example users of a tone language attach greater relative weightage to pitch variations than uses of non-tone languages.

According to Denirich (1954) native language interferes with other languages at different levels - phonemic, grammatical and radical Based on the aspect of linguistic tone, a tone language speaker can be easily identified from the speaker of a non-tone language. Studies have shown that the mother-tongue affected perception (Singh, 1966; Singh and Black, 1966; Abramson and Lishker, 1970; Meyawaki et al., 1975; Sapon and Carrok, 1957; Arathi, 1983; Venkatesh, 1983). Individual performance has been related to the amount of linguistic experience (Baglis,

1972), while Stevens et al. (1969) opine that linguistic experience had no effect.

"The changes in pitch which occur within a sentence are not haphazard. The pattern of variation and rules of changes are highly organized. Their intricacy is so great that although one speaks his language with little effort, their analysis is extremely difficult and may induce one to conclude that no actual organisation or rules are present, but the people use pitches by whim and fancy. In each language, however, the use of pitch fluctuations tends to become semistandardized or formalized, so that all speakers of the language use basic pitch sequences in similar ways under similar circumstances. These abstracted characteristic sentence melodies may be called 'intonation contours'" (Pike, 1945).

Intonation patterns, though fluctuating like the speaker's attitude are as strong in their implications as the attitudes that they represent. In actual speech there is a balance between intonation and the words chosen. Sometimes a lack of balance between intonation and word context may be brought in deliberately for special speech effects (Pike, 1945). Intonation can be roughly divided into two types.

a. Those contours which are completely colourless in meaning. This is known as intonational minimum of speech and

serves as a mould into which all sentences may be poured so that they achieve utterance.

b. Other intonation characteristics are affected or caused by the individal's physiological state like anger, happiness, excitement, age, sex, etc. These help to identify people and to ascertain how they are feeling. Whenever a certain sequence of relative pitch is heard, one may conclude that the speaker means certain things. One sentence may have several contours and a single contour may have several meaningful parts (Pike, 1945).

The general characteristics of intonation seem to be shared more broadly than those of any of the other phenomenon gathered under the label of language (Bolinger, 1972). The cause of universality is not linguistic inheritance, but more to do with the physiology of speech and with the central nervous system (Bolinger, 1972).

Intonation patterns in some of the languages of the world have been described.

1. In the English language the regular definable phonological boundaries for tone units are indicated by two factors:

a. There is a perceivable change in pitch; either stepping up or down depending on the direction of the nuclear tone movement.

b. Presence of juncture at the end of every tone unit. This usually is manifested as a very slight pause, but very often there are accompanying segmental phonetic modifications like variations in length, aspiration, etc. which strengthen this.

The nuclear unit (tone system) in English is categorized into three types - simple, compound and complex.

	Simple	Complex	Compound
Basic types	\, /, –	∨ , ∧	\+ / , /+\
Secondary types		≁ , ∨\	∧+ / , ∨+\ \+ –
Simple pitch range	↑↑, ↑ , → + tone ϕ, ↓, ↓	↑↑, ↑, ↑, → + tone ϕ , ↓, ↓	↑↑, ↑, ↑, → + both elements ϕ, ↓, ↓
Complex pitch range		n+∨, ∧, ∾, ∨\ ω+∨ , ∧ , ∾, ∨\ ∨n , ∧ω , ∨ω	n/ + \ etc ω/ + / etc \+n/ , /+n\ ω\ +/ , ω/+ \

ω : Wide pitch range

ϕ : Normal pitch range (stands for unmarked terms occurring in simple and complex pitch range systems)

n : Narrow pitch range

↑↑, ↑ : Refer to a relatively high tone height

↑, → : Medium tone height

ϕ, ↓, ↓ : Relatively low tone height

A tone unit consists of a syllable which causes a glide of a particular kind. This is called the nucleus of a

tone unit. This is also termed as tonic syllable (Halliday, 1966). A tone unit consists of three segments - head, prehead and tail.

Head: Stretch of utterance from the first stressed and usually pitch prominent syllable but not including the nuclear tone. It consists of an unspecified number of stressed or unstressed syllables (at least one of stressed). Heads are classified as falling, rising, falling-rising-(falling), rising-falling-(rising), prehead/preonset. Any utterance which precedes the onset syllable within the same tone unit. It consists of an unspecified number of unstressed syllables with a slight degree of stress (not equivalent to the stress of the onset syllable and never with pitch prominence). Preheads are classified into high, extra high, mid and extra low.

Tail: Consists of an unspecified number of stressed/ unstressed syllables (at least one of either) following the nuclear syllable. This usually continues the pitch movement unbrokenly till the end of the tone unit.

Fo'nagy and Magdies (1963) did a comparative study of emotive intonation patterns in English, French and German. The results were as follows:

a. Joy : Increases the pitch range in all three languages. This is reflected in a higher pitch level with a melody ascending frequently at irregular intervals as well as in irregular stress distribution. In French, the voice rises at the end of phrase; whereas Hungarian sentences are characterised by a decrescendo.

b. Longing : Characterized by a slightly rising, descending and gently ascending pattern at the end of the sentences in all three languages.

c. Surprise : Characterised by increased pitch. In all three languages, the voice falls a fifth or sixth interval from a high level. In yes or no questions surprise is reflected in an increase of the rising interval.

d. Sudden fright : Differs from surprise in having a narrower pitch range in the checking of loudness and speed. Also characterised by a peculiar timbre. The pattern does not stay long on the high level; the greatest part of the phrase constitutes a straight melodic line on a low level.

e. Anguish : Characterised by an extremely narrow pitch range in all the three languages.

f. Scorn : Characterised by a narrow pitch range and in Hungarian, this is denoted by a compressed or grumbled voice production.,

g. Anger : In English and German, this is denoted by the 4th, 5th and 6th ascending intervals of the stressed syllables; which frequently interrupt the straight melodic line.

h. Sarcasm : Denoted by a checked, widely arched stressed off glide; in a creaky voice with nasal timbre. This arch is found to be wider in English and French than in Hungarian.

Crystal (1969) found different intonation patterns and features for various emotions and attitudes; such as excitement, anger, amusement, matter of factness, precision, etc. These are summed up as follows:

Feature	Emotion/Attitude
Number of tone units	Matter-of-factness, pleasure
Tonicity	Anger, question
Tonal subordination	
a. High frequency	Anger, matter of factness, irritation

b. Low frequency		Precision, question, apology
Nuclear tone type	\-	Conspiratorial
	\	Anger, matter of factness, vexation impatience, satisfaction grimness, irritation
	^-	Excitement, pleasure
	^	Dismay, haughtiness, amusement pleasure
	v-	Worry, pleasure
	v	Dismay, disappointment, apology, grimness
	+	Haughtiness, puzzlement, impatience
	/	Puzzlement, boredom, question
	-	Boredom
Strongly stressed syllable		Anger, disapproval, vexation, impatience
High unstressed syllable		Anger, boredom, question, impatience conspiracy, satisfaction, irritation
Clipped syllables		Anger, impatience, irritation
Drawled syllables		Boredom, vexation, grimness
Simple pitch range (syllabic)		
Large step up ↑/↑↑		xcit Excitement, puzzlement, pleasure, question, conspiracy, worry, satisfaction
Slight/no step up ↑/→		Apology, worry, grimness
Step down 0/↓		Dismay, anger, matter of factness, boredom, irritation
Flattened syllable in tail		Haughtiness, boredom, satisfaction
Complex pitch range: Narrow		Boredom, grimness
Wide		Excitement, puzzlement, question

Simple pitch range over a polysyllabic stretch

High: Haughtiness,puzzlement, amusement, pleasure, question, worry.

Low : Dismay, disapproval, vexation, conspiracy, impatience, satisfaction, grimness.

Loudness:

Loud: Excitement, anger, vexation, impatience, irritation

Soft: Dismay, puzzlement, amusement, question, apology, conspiracy, satisfaction.

Tempo:

Fast: Excitement, anger, pleasure, vexation, conspiracy, impatience, irritation.

Slow: Disappointment, puzzlement, precision, disapproved, boredom, question, apology, worry, satisfaction, grimness.

Rhythm:

Rhythmic: Precision, vexation

Tension:

Tense: Anger, disapproval, impatience, grimness

Lax : Boredom

Paralinguistic features: Excitement, amusement, conspiracy

Abe (1955) carried out a comparative study of English and Japanese intonation patterns. Both the languages were found to employ a gradually falling intonation pattern

for questions (of the information seeking type). A slight rise, when added (instead of the fall) to the sentence was found to have an effect of cordiality or curiosity. Intensified feelings such as animation, anger, irony, exultation, etc. were found to be effects of heightened tone; whereas accusation was denoted by an interrogative word pronounced with a rapid decrescends of voice with falling sentence-final intonation. Surprise or incredulity was denoted by a conspicuous rise of pitch at the end of the sentence.

American English intonation patterns were found to consist of three pitches and a terminal contour (Trager and Smith, 1951, 1957). The initial pitch was most often 'middle' but could be low, high or extra high. They found that in case of statements or questions, the central pitch accompanying the primary stress of the phrase or clause was most often high; but was frequently extra high (could be low or middle too) during emphasis. The final pitch was often low at the end of statements, middle at the end of clauses that did not end sentences, and high at the ends of certain kinds of questions. Other patterns not described were also seen.

The final pitch was found to be modified by the terminal contour; and could be sustained (-), rising (/) or

falling (\). Sustained was often found in clauses that did not end sentences, falling occurred in statements and interrogative word questions and rising occurred in other questions and in many non-final clauses. Wide variations in pitch as well as predominance of falling patterns were exceptional factors in British English; these distinguish it from American English as well as other European languages. Palmer (1922) and Jones (1964) found that British English has the same falling pitch in questions beginning with an interrogative word (eg. Where are you going) as well as those not beginning with an interrogative word (Are you going ?); whereas American English and most European languages use different patterns for the two. For questions beginning with an interrogative word, a falling contour was used, whereas in the questions not beginning with an interrogative word, a sharply rising intonation was used.

Hawaiian American English or Pidgin was found to differ from general American English in terms of the phonetic shape of the pitch accent. Statements and interrogative questions had similar patterns as in general American English. The intonation patterns in these languages differ for yes-no questions and tag questions.

It was agreed by a number of researchers that the earlier parts of the fundamental frequency contour may play

a role in the perception of intonation of sentences of differentiating function in Danish (Uldall, 1960, 1961; Von Essen, 1956; Garding and Abramson, 1965; Hadding-Koch and Studdart Kennedy, 1963, 1964, 1965, 1972, 1973, 1974). Importance of the terminal contour in perception was also checked (Danes, 1960; Isacenko and Schadlieh, 1963; Isacenko, 1965).

Thorsen (1978) analysed short sentences in Advanced Standard Copenhagen Danish, and found that intonation contours approached straight lines, slopes varying according to sentence type in a trade off relationship with syntax. The more the syntactic information about the non-declarative function contained in the sentence, the more declarative was its intonation contour. The speakers could identify such utterances solely on the basis of the fundamental frequency course without any contextual or syntactic information. It was found that the less falling the intonation contour, the more interrogative an utterance was heard. The more steeply falling the contour was, the more declarative an utterance was heard.

Chang (1958) in a study in Chengtu (Szechuan, China), categorized 10 principal allotones under four tonemes; which are described as follows:

Toneme I - 1. High rising

- 2. Mid Level

Toneme II - 3. Low falling

Toneme III - 4. High falling

5. High level

6. Half high falling

Toneme IV - 7. Low falling rising

8. Low low falling

9. Low level

- 10. neutral tone

He stated that intonation in the Chengtu dialect is superimposed on the sentence as a whole. It is this superimposed intonation that modifies the individual tones and not the tones themselves that decide the intonation of the sentence.

Fo'nagy and Magdics (1963) described emotive intonation patterns in Hungarian. They came to the following conclusions.

1. Joy was denoted by an increased pitch range.

2. Tenderness was expressed by a non-fluctuating higher pitch level.

3. Longing was denoted by a narrow pitch range.

4. A coquettish invitation was denoted by a melody in the mid level or lower range.

5. In the case of surprise, the voice suddenly glided up or up and down to a high level within the stressed syllable; then according to the kind of surprise fell

to a mid level (joyful surprise) or to a lower level (struefaction) leaving the sentence melody unclosed.

6. Fright had a similar pattern as surprise.

7. Anguish was denoted by an extremely narrow pitch range, the melody of the stressed syllable rising about a semitone and returning to a much higher level where it becomes static.

8. Horror was found to be pronounced on a chest tone; and complaint was characterised by a musical intonation (floating at one level and ascending a semitone at regular intervals).

9. Scorn was sounded in chest tone and was denoted by a more or less even and finally descending melodic line intoned on a very low level.

10. Anger was expressed on a mid pitch level and was denoted by a straight, rigid, melodic line which showed a sudden rise up to the 4th, 5th or 6th interval at the beginning of the phrases.

11. Sarcasm was denoted by a stressed syllable gliding to a low level in a wide arc.

Intonation patterns used in questions and during emphasis in Italian were studied by Chapellez (1964). It was found that short interrogative questions were denoted by falling and falling rising patterns. During emphasis (for

contrast), the pitch of the stressed syllable of the contrast word fell from a high to a low note. When emphasis was used for intensity, the pitch range was widened and the stressed syllables were pronounced with increased stress.

The three pitch levels (high, mid and low) or intonemes are the minimum units of the intonation system in Kunimarpa (New Guinea). These units combine to form sequences which are called pre-nuclear contours and nuclear contours. Four types of pre-nuclear contours were noted by Pence (1964).

1. Stepping (mid high) pre-nuclear contour as seen in a declarative sentence.
2. Rising (low high) pre-nuclear contour which causes a meaning of incompleteness.
3. Falling (high low) contour which indicates excitement.
4. Level contour which indicates suspense.

Pence (1964) also noted ten types of nuclear contours which are:

1. Higher nuclear contours - indicating impending incompleteness or normal question.
2. Mid nuclear contour of unknown meaning.
3. Low nuclear contour which indicates a normal or unemotional statement.

4. High low nuclear contour which indicates an announcement.

5. High mid nuclear contour which may indicate a polite statement.

6. Mid low nuclear contour which denotes an emphatic sentence/statement.

7. Mid high nuclear contour which denotes a polite question or a non-emphatic call.

8. Mid-high low nuclear contour which denotes deep feeling like intense sympathy or desire.

9. High high mid nuclear contour which is used for an intense or distant call.

10. Mid low mid nuclear contour; used as an excited sequence, both for listing items and also to denote hesitation.

It was found that unlike the non-Scandinavian languages and Icelandic, Finnish, Farsese and Swedish languages, Norwegian has two tonal stress accents.

In Welsh uniqueness in the suprasegmental systems was demonstrated by Williams (1985); Ladd, (1980). Detailed studies on emotive intonation patterns in Indian languages have been few. In Kannada, terminal contours have been found to be important in determining the type of sentence. Intonation permitted the identification of emotion or the

type of the sentence even when context sentences were not presented. Some aspects of intonation in Kannada were studied by Manjula (1979). The following patterns were observed:

1. Anger: Sentences ended in rise-fall, fall-use (slight), gradual fall, gradual rise, fall-rise and sustain-fall.

2. Fear: The terminal patterns demonstrated rise fall, sustain fall or fall rise.

3. Frustration: Terminal patterns exhibited sustain-fall, rise-fall and sustain-fall-fall.

4. Jealousy: Terminal patterns exhibited rise-fall, fall-slight rise, fall-rise, gradual-fall and sustained-fall.

5. Worry: Terminal patterns showed rise-fall, sustain-fall and gradual fall.

6. Surprise: Rise-fall pattern was seen.

7. Grief: Rise-fall, gradual-fall and sustain-fall were noticed.

8. Joy: Higher rise fall and gradual fall were observed.

9. Neutral (no emotion carried): Rise-fall and gradual fall patterns were noted.

A study by Nandini (1985) on speakers of Kannada showed that the intonation patterns seemed to depend more on

frequency variations than on intensity and other factors. Analysis revealed the following intonation patterns used to express various emotions:

Emotion	Intonation pattern
1. Surprise	- Rise-slight-rise/fall (gradual)
2. Anger	- Rise-slight-fall/rise
3. Anger associated with a question	- Slight-fall (gradual)-rise
4. Jealousy	- Rise (gradual)-slight-fall (gradual) -rise gradual
5. Frustration	- Slight-rise-rise (gradual)-slight-fall-rise
6. Accusation	- Rise (gradual)-fall (gradual)-rise (gradual)
7. Hesitation	- Slight-rise (gradual), slight-fall (gradual)
8. Request	- Slight fall (gradual)
9. Question	- Slight rise
10. Answer	- Slight fall
11. Neutral	- Rise slight fall (gradual)

'Slight' indicates a half rise and half fall, while 'gradual' indicates a slower degree of rise or fall. Another study in Kannada (Nataraja, 1981) found the following.

Emotion	Pattern seen
1. Anger	- Mid-high-low
2. Joy	- High-mid-high
3. Jealousy	- Mid-low-mid-low
4. Neutral	- High-mid-low
5. Mercy	- Mid-low-mid-high

Nataraja (1985) found the following patterns for emotions in Kannada:

1. Joy	- High-mid-high
2. Sarcasm	- Mid-low
3. Disappointment	- High-mid-high-mid
4. Fear	- Mid-low

Srivatsav (1985) studied emotive intonation patterns in Hindi speakers. The following observations were made:

1. Surprise was indicated by a fall-flat-rise-fall curve.

2. Fear was denoted by a fall-rise-fall-rise and fall type of frequency curve and a gradual decrease in intensity.

3. Frustration was represented by a fall-rise-fall type of frequency variation.

4. Jealousy was representedroughly by a rise-flat-fall type of frequency curve and a rise-fall-flat-fall type of intensity curve.

5. Joy was denoted by a flat-fall-rise-fall type of frequency curve and a flat-rise-fall type of intensity curve.

6. Grief was indicated by a rise-fall-rise-fall type of frequency pattern and a rise and gradual fall type of intensity curve.

7. Anger was expressed by a rise-fall-rise-fall and rise type of curve both for frequency as well as intensity.

8. Worry was indicated by a rise-fall-rise-fall-rise and fall type of frequency curve, with a rise-fall-flat and fall type of intensity curve.

9. A neutral sentence resulted from a rise fall-rise and fall type of frequency curve. There was an inconsistent gradual decrease in intensity with time.

Intonation patterns in Hindi studied by Nataraja (1981) gave the following results on analysis for emotions expressed.

Emotion		Pattern seen
1. Anger	-	Mid-low-mid
2. Joy	-	High-mid-high-mid
3. Jealousy	-	Mid-low
4. Neutral	-	Mid-low-low
5. Mercy	-	Mid-low-mid

Nataraja (1985) studied intonation patterns for emotions in Hindi and found the following:

1. Joy - High-mid-high-mid
2. Sarcasm - Mid-low
3. Disappointment - Mid-high-low

The same study also analyzed intonation patterns in two other Indian languages - Gujarathi and Tamil. Analysis gave the following patterns:

Emotion expressed	Pattern seen	
	Gujarathi	Tamil
1. Anger	- Mid-low-high-low	Mid-low-mid
2. Joy	- Mid-low-mid-low	High-mid-high-mid
3. Jealousy	- Mid-low	Mid-low
4. Neutral	- Mid-low-mid	Mid-low-low
5. Mercy -	- Mid-low	Mid-low-mid

Another study in Tamil (Nataraja, 1985) gave the following results:

1. Joy - High-mid-high-mid
2. Sarcasm - Mid-low-mid-low
3. Disappointment - High-mid-high
4. Fear - High-mid-low-mid
5. Surprise - High-mid-high

Intonation patterns for various emotions in Malayalam were studied by Nataraja (1985). The study gave the following results:

1. Joy - Mid-high-low-mid
2. Sarcasm - Mid-high-mid
3. Disappointment - Mid-low-mid
4. Fear - High-mid-high
5. Surprise - High-mid-high-mid
6. Statement - Mid-high-mid
7. Anger - Mid-low-mid

Even though data is limited, there seem to be definite emotive intonation patterns specific to each language. However, all these studies were conducted on speakers with the native language as material samples. Studies on the influence of native language on production of intonation patterns in a different language are few, if any. The present study aims at documenting the effect, if any; of native language on production of sentences with different emotions in English. It also aimed, along with studying of the effect on production, at studying the effect of the first language on perception of samples in English. This would be especially relevant in the Indian context where there exist at least 1654 separate languages; and also because most of the Indian urban population conduct a large part of their daily affairs in English. The information so obtained would be useful in therapy also.

METHODOLOGY

The present study was aimed at finding out differences in the way individuals with different first language produce and perceive speech in a foreign language. The specific parameter of speech studied was the prosodic feature intonation.

a. Production

In the production part of the study, it was investigated whether differences existed in the way people with different first languages produced intonation patterns in a foreign language. The foreign language choosen was English as it is one of the most widely used ones in Indian society. The study was carried out keeping in mind the emotive use of prosody.

Materials

A list of ten English sentences was prepared. Out of this, five sentences were finally chosen by a group of subjects who had at least ten years experience in speaking English, based on the familiarity of the sentences. The final five sentences were simple, commonly used in every day conversation. Care was also taken to see that each sentence

could be spoken in a wide variety of contexts with different intents and emotions. The sentences chosen were:

1. I am going home tomorrow.
2. That is your house.
3. Today we have bread for breakfast
4. He is coming here.
5. Sit down here.

Next, seven different emotions were considered. They were surprise, fear, joy, anger, disappointment, sarcasm and statement. These were chosen because they were considered commonly used ones and also because it was easier for the subjects to convey these emotions in speech. A list was then made with three emotions indicated against each sentence. Thus a particular sentence could be produced in three different ways.

Each sentence and the emotion indicated against it was written on flash card. Thus a set of 15 flash cards was prepared. They were as follows:

1. I am going home tomorrow: Statement
2. I am going home tomorrow: Joy
3. I am going home tomorrow: Disappointment
4. That is your house: Surprise
5. That is your house: Disappointment
6. That is your house: Statement

7. Today we have bread for breakfast: Joy
8. Today we have bread for breakfast: Anger
9. Today we have bread for breakfast: Disappointment
10. He is coming here: Surprise
11. He is coming here: Fear
12. He is coming here: Statement
13. Sit down here: Surprise
14. Sit down here: Anger
15. Sit down here: Sarcasm

They were randomized for the purpose of presentation to the subjects.

Subjects

Six subjects each from four Indian languages Hindi, Kannada, Tamil and Malayalam were chosen for the study. These languages were chosen because of availability of subjects with these as their first language. Each group of subjects included 3 males and 3 females, thus making a total of 24 subjects. All these subjects had normal hearing and had no speech and language impairment. These subjects ranged in age from 17 to 24 years; and each had schooling in English medium. Each had a minimum of 5 years of experience in speaking English.

Procedure

Each subject was seated comfortably in a sound treated room. He was then given the set of 15 flash cards with the randomized sentences with the emotions indicated on them. The subject was told to read the cards as many times as required for practice and to become familiar with the list. If the subjects had any questions regarding the sentences or emotions, they were explained to them first using a description of the meaning and then using an imaginary situation. Each sentence/emotion was described to all 24 subjects in exactly the same way, so as to eliminate any bias. After the subject was thoroughly familiar with the list, he was told to read out each sentence; expressing the emotion indicated.

As the subject uttered the sentences, they were recorded using a Meltrack CR-X90 chrome precision audio cassette and a Sony stereodeck TCFX170 with the unidirectional microphone kept at a distance of 6 inches from the speaker's mouth.

If a particular speaker felt that he hadn't spoken a sentence conveying the required emotion, either by the subject or by experimenter or both then the subject repeated the sentence until it was satisfactory.

In order to check whether the emotions conveyed were the required ones or not, a perceptual test was carried out. The subjects chosen for this part of the study were 8 speech language pathologists; including 4 males and 4 females; representing the four earlier mentioned Indian languages. These subjects ranged in age from 18 to 23 years and all of them had at least 5 years experience in speaking English. None of these subjects participated in the earlier study, or had knowledge about the purpose of the study.

The subjects were comfortably seated in the speech perception lab with the tape recorded samples (recorded earlier in the production study) amplified and given to each subject using a stereodeck, amplifier and individual headphones. A response sheet (given in appendix) was provided to each subject and the following instructions were given:

"You will hear recorded samples of sentences, spoken by different individuals. Listen to each sentence and try to identify the emotion expressed by the speaker. If you cannot identify it on the first try; ask for a repetition. Look at the list of emotions given at the top of your response sheet and choose the one which you feel the speaker has conveyed. If you feel none of the emotions match, leave the space blank. If you do identify a particular emotion; indicate it in the space provided.

The subjects were given as many repetitions of the sample as they wanted to judge.

Responses given by these subjects were compiled and tabulated. These responses were used to choose the set of sentences which would be used for analysis later. A particular sentence emotion combination was chosen for analysis only when six out of the eight listeners identified the emotion correctly.

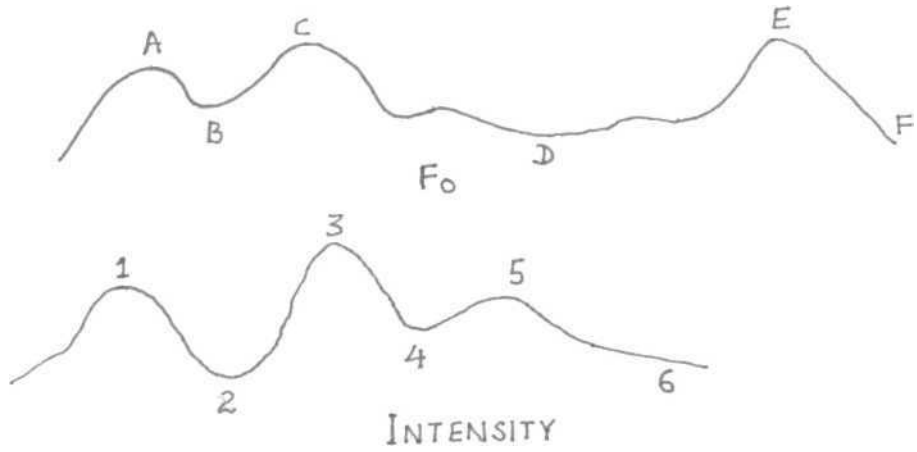
Analysis

These shortlisted tape recorded samples were digitized and stored on a computer (HCL Pentium) using an A-D converter and speech interface unit. These were then stored on computer harddisk and analyzed under the F_0A_0 off line program under VAGHMI. The sampling rate used was 16,000 Hz, with a block duration of 30 msec and a block shift of 10 msec.

The F_0A_0 off program uses LPC autocorrelation to analyse the speech waveform and the resulting display gives the frequency and the intensity contours of the speech signal.

The F and intensity contours for each sentence were thus obtained; and the peaks and troughs in the curves were

marked by moving the cursor. The frequency and intensity that point were noted down.



The cursor was moved from left to right and the frequency and intensity values at points A, B, C, D, E, F, 1, 2, 3, 4, 5 and 6 were noted down.

Analysis of these curves involved the following

- Noting the individual patterns of F and intensity curves for each particular emotion.

- Each group of speakers (language specific) was taken separately. In each of these groups; the curves for different emotions were grouped separately. For example, all the curves of sentences expressing fear in the Hindi speakers were grouped together. Thus different patterns of curves produced were tabulated. Eg. Rise-fall-rise, rise-flat-fall-flat-rise, etc. The number of subjects producing

each pattern was also observed. It was also observed whether there was any one kind of pattern prevalent for a particular emotion conveyed by speakers of the same language.

This was done for all emotions, for all the subjects in all four languages.

The different patterns obtained for different emotions was tabulated across all four languages in the following.

Emotion	Patterns observed			
	Hindi	Malayalam	Tamil	Kannada
Fear				
Sarcasm				
Surprise				
Statement				
Joy				
Disappointment				
Anger				

It was then observed whether there was any overlap across languages, i.e. whether similar patterns were obtained in the four languages for the same emotions; or were individual patterns obtained for each specific emotion in a specific language. It was also observed whether

patterns found in the production in the native language and productions in English were similar or different. This was done by comparing the patterns obtained from the present study to studies (Manjula, 1979; Nandini, 1985; Nataraja, 1981, 1985; Srivatsav, 1985) on patterns in each of these four languages.

For each fundamental frequency curve, the range of frequency was calculated by subtracting the lowest frequency from the highest frequency. The average range of fundamental frequency for a particular emotion, produced by speakers of a particular language, was calculated by dividing the sum of the individual ranges by the number of sentences. These ranges were then tabulated.

Analysis of the perception part of the experiment involved the following.

The subjects identification responses were compiled and it was observed whether these were common patterns within the same language group for a particular emotion. For example, all the sentences expressing fear (taken from utterances of all the 24 speakers) were collected and the different patterns for fear were taken in groups. This distribution was studied across subjects from different languages. It was studied whether subjects speaking

different languages perceived all of these patterns as fear; or they perceived only particular patterns as fear. This analysis was done for all emotions across subjects speaking each language.

It was also studied whether subjects could identify an emotion better when the speaker and the subject had the same first language; or did universality existed in perception across the speaker's first language. For example, can a Hindi speaker perceive emotions more correctly when they are produced by a Hindi speaker rather than a Tamil speaker.

These patterns were analysed and then conclusions were drawn.

RESULTS AND DISCUSSION

This study aimed at finding out any differences in the way individuals with different first languages (Hindi, Kannada, Malayalam and Tamil) perceived and produced the suprasegmental feature, intonation, using a second language, English. This study was carried out with the emotive use of intonation.

The results obtained were as follows:

- There was no single pattern observed for a particular emotion. The same emotion could be conveyed using different intonation patterns.

- Different patterns of intonation were used to express a particular emotion by speakers of the same language.

- The general patterns of frequency and intensity used to convey various emotions in these languages (as concluded by previously cited studies by Manjula, 1979; Nandini, 1985; Nataraja, 1981, 1985; Srivatsav, C.P., 1985) tended to be reflected in the English productions of each first language speaker.

Each emotion was analyzed for the range of fundamental frequency. The average range for speakers in each language was calculated (Table 1).

First language	Range in Hz for different emotions						
	Statement	Joy	Disapp-ointment	Fear	Sarcasm	Surprise	Anger
Hindi	283.3	293.9	210.8	365.02	45.3	368.9	205.6
Malayalam	273.13	385.7	381.7	322.2	322.4	299.62	317.5
Kannada	230.3	259.0	239.46	290.7	197.6	310.0	185.4
Tamil	289.2	288.16	250.2	268.5	176.8	337.7	172.1

Table 1: Average range of fundamental frequency across emotions in speakers with different first languages

speaker (250.2 Hz and 239.5 Hz respectively), 210.8 Hz being the lowest range; produced by Hindi speakers.

For fear, Hindi speakers produced the largest range of F_0 (365.02 Hz), with Malayalam, Kannada and Tamil speakers following (with 322.2 Hz, 290.7 Hz and 268.5 Hz respectively).

For sarcasm, Malayalam speakers showed the largest range of F_0 (322.4 Hz) and were followed by Kannada (197.6 Hz) and Tamil speakers (176.8 Hz) with Hindi speakers showing the least range (45.3 Hz).

For surprise, Hindi speakers showed the largest range of F_0 (368.9 Hz), with Tamil, Kannada and Malayalam speakers following with ranges of 337.7 Hz, 310 Hz and 299.62 Hz respectively.

For anger, Malayalam speakers showed the maximum range of F_0 (317.5 Hz), followed by Hindi, Kannada and Tamil speakers (205.6 Hz, 185.4 Hz and 172.1 Hz respectively).

The patterns used to denote various emotions in each language were also studied.

Fifteen sentences spoken by Kannada speakers were correctly identified as statements by subjects in the perceptual experiment. The frequency and intensity of these

fifteen statements were analyzed. Three sentences showed a rise-fall-flat pattern, two showed a fall-flat pattern, while two showed a flat-rise-fall-flat pattern and two showed a gradual fall pattern for frequency. The other patterns seen were i) fall-rise-fall, ii) fall-flat-rise-fall, and iii) flat-rise-fall-flat rise. All the intensity curves showed a rise-fall-rise-flat gradual fall pattern (Figure 1.1a, b).

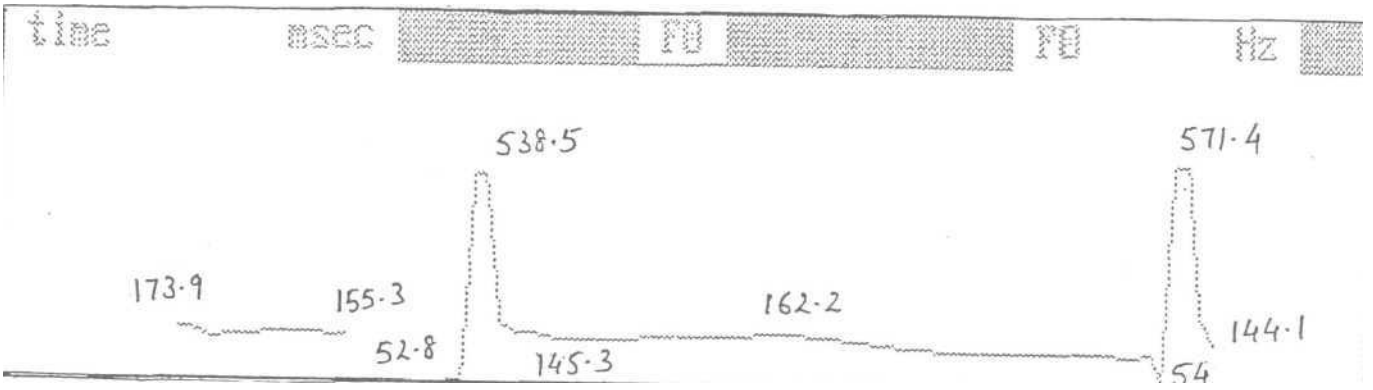


Fig. 1.1a: Typical F_0 curve for statements produced by Kannada speakers

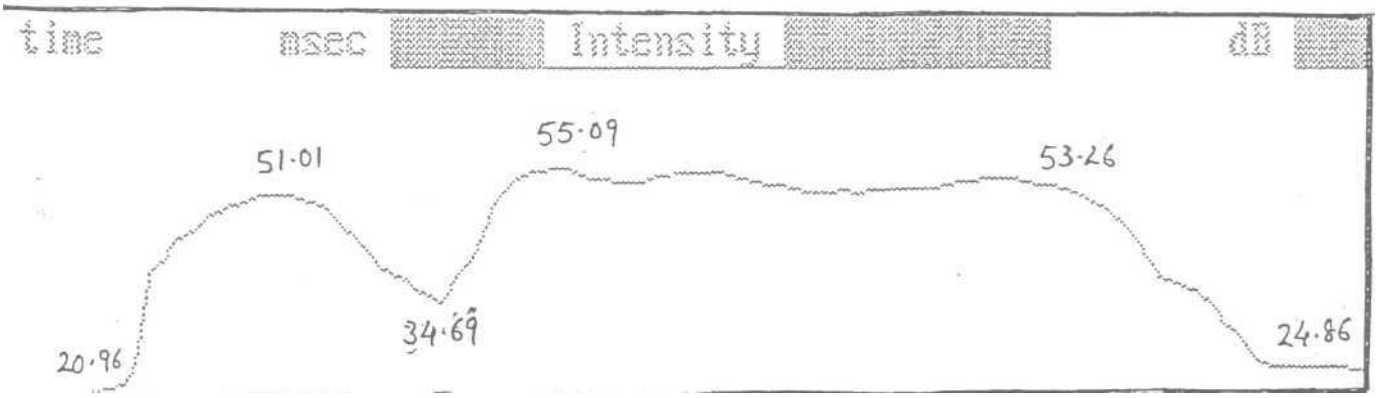


Fig. 1.1b: Typical intensity curve for statements produced by Kannada speakers

Thus, a rise-fall-flat pattern of F_0 was used by majority of Kannada speakers to produce a statement. The

Kannada speakers produced a statement using a rise-fall-rise-fall-gradual fall intensity pattern. Studies by Manjula (1979), Nandini (1985) and Nataraja (1981) have found that Kannada speakers speaking in Kannada use rise-gradual fall, gradual fall and high-mid-low type of frequency patterns to produce statements. As these patterns were seen in the present study also, it can be concluded that Kannada speakers use similar patterns of frequency for statements in their mother tongue and in English.

Seven sentences in which Kannada speakers expressed joy were analyzed. Five showed a flat, gradually falling pattern; and two showed a gradual rise-gradual fall pattern for frequency the intensity curves showed a rise-fall-rise-fall pattern (Figure 1.2a,b).

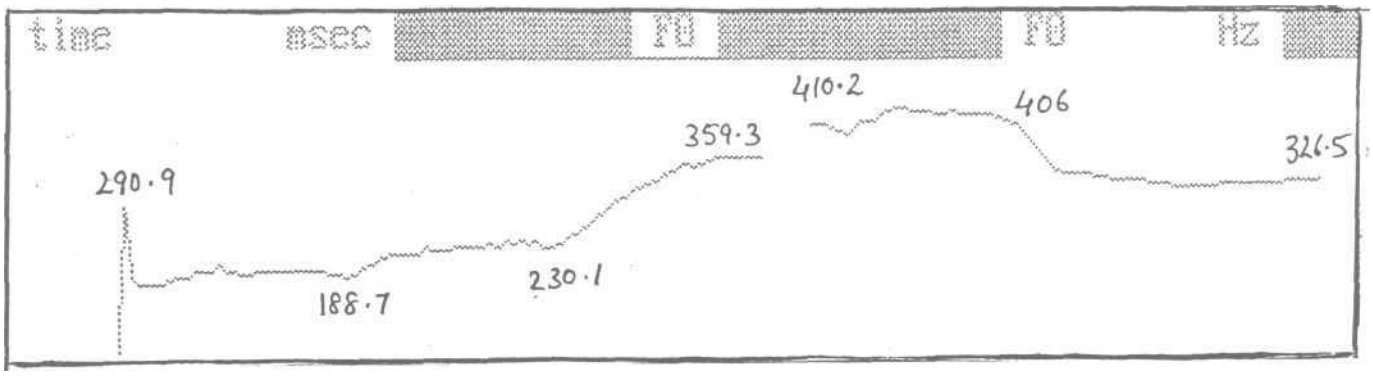


Fig. 1.2a: Typical F_0 curve for joy expressed by Kannada speakers

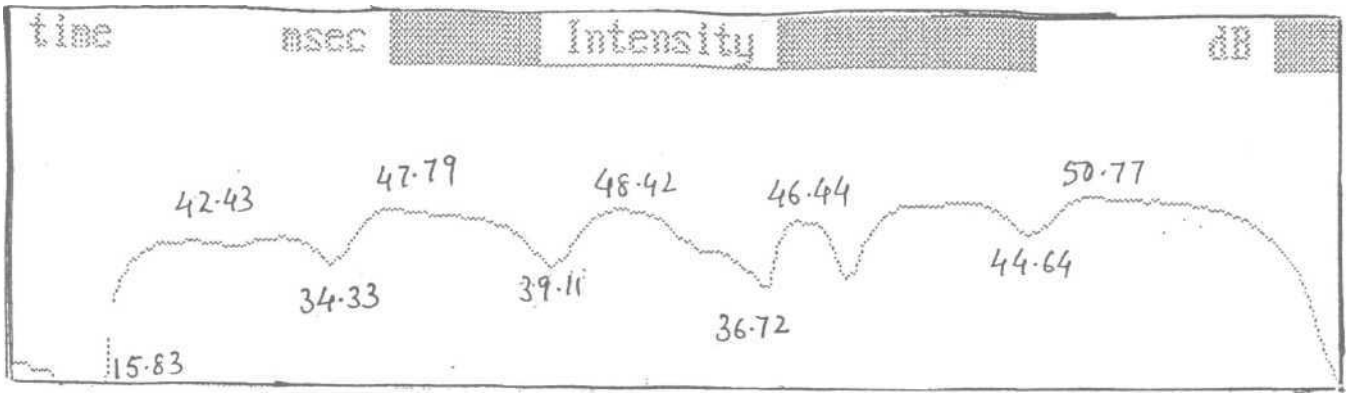


Fig. 1.2b: Typical intensity curve for joy expressed by Kannada speakers

Thus it was concluded that a majority of Kannada speakers used a flat gradually falling pattern of frequency and a rise-fall-rise-fall pattern of intensity to express joy.

Studies by Manjula (1979) and Nataraja (1981,1985) showed that Kannada speakers use frequency patterns of rise-fall, gradual fall and high-mid-low for expressing joy in Kannada. Thus it can be concluded that patterns used by Kannada speakers to express joy in Kannada are seen when they speak in English.

Nine sentences which Kannada speakers used to express disappointment were analyzed. Out of these three sentences showed a flat pattern, while two showed a gradual fall in frequency. The other patterns observed were i) flat-fall-rise-fall-flat, ii) flat-fall-rise-flat,iii) fall-flat-rise-flat-rise-fall and iv) fall-rise-fall-flat. Of the nine intensity curves, four showed a flat-fall-rise-flat pattern and five showed flat pattern for intensity (Figure 1.3a,b).

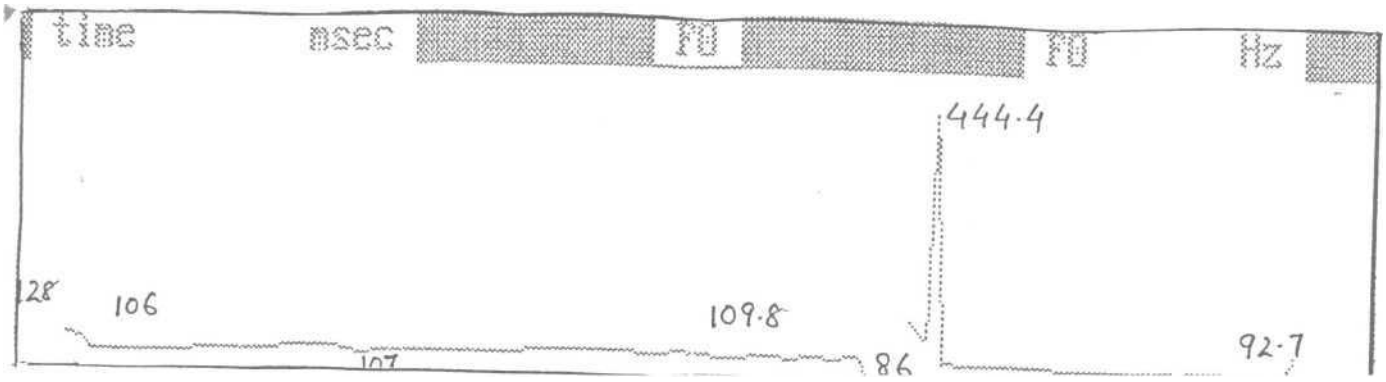


Fig. 1.3a: Typical F_0 curve for disappointment expressed by Kannada speakers

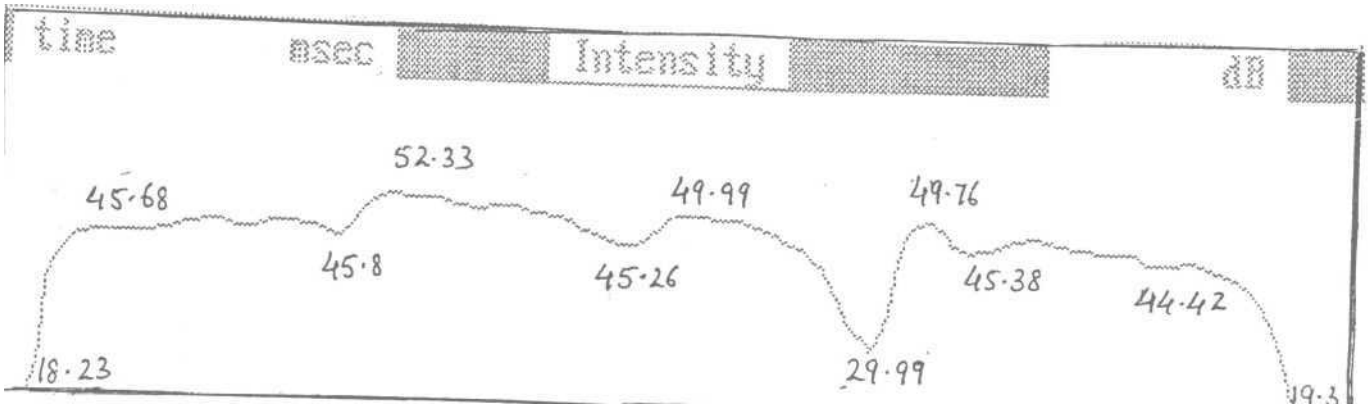


Fig. 1.3b: Typical intensity curve for disappointment expressed by Kannada speakers

Thus it can be concluded that the majority of the subjects studied showed a flat fundamental frequency pattern and a flat-fall-rise-flat intensity pattern for disappointment.

Nataraja (1985) found that Kannada speakers speaking in Kannada used a high-mid-high-mid pattern of frequency to express disappointment. As this pattern was found in the present study, it can be concluded that Kannada speakers use similar frequency patterns to express disappointment in their mother tongue and in English.

Four of the five frequency curves which were used by Kannada speakers to express fear showed a flat pattern with gradually falling ends; while one showed a rise-fall pattern of frequency. All the intensity curves showed a gradual fall pattern (Figure 1.4a, b).

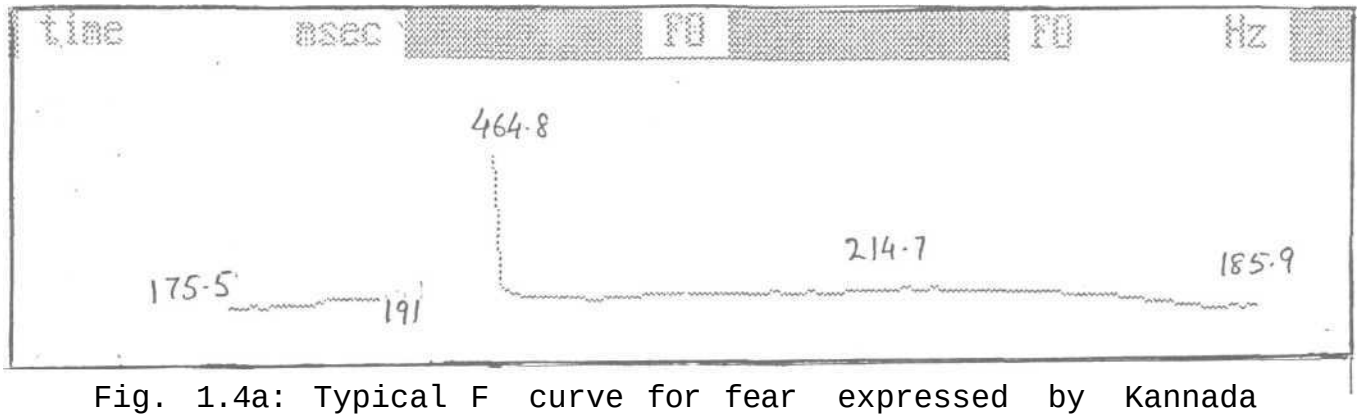


Fig. 1.4a: Typical F curve for fear expressed by Kannada speakers

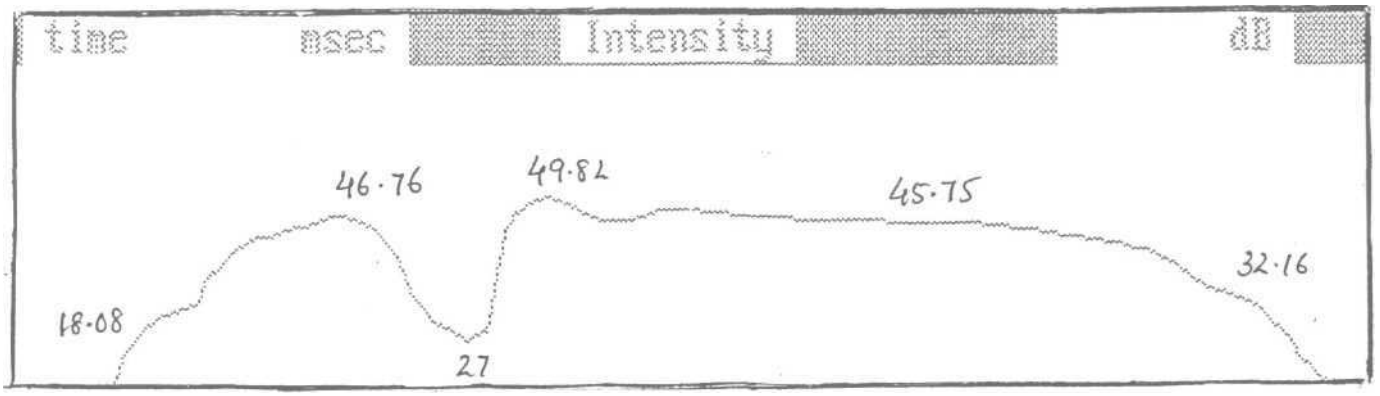


Fig. 1.4b: Typical intensity curve for fear expressed by Kannada speakers

Therefore it was concluded that majority of the Kannada speakers used flat-fall type of intonation pattern to express the emotion, fear. Kannada speakers used a

Nataraja (1985) found that Kannada speakers used mid-low frequency pattern to express sarcasm while speaking in Kannada. As this pattern is similar to the one observed in the present study, it can be concluded that Kannada speakers use similar frequency patterns to express sarcasm while speaking in their mother tongue and in English.

Out of the ten sentences in which Kannada speakers expressed surprise, five showed a gradually falling frequency curve, while four showed a gradually rising curve. One of the sentences showed a steeply falling pattern. All the ten sentences showed a rise-fall-gradual fall type of intensity pattern (Figure 1.6a,b).

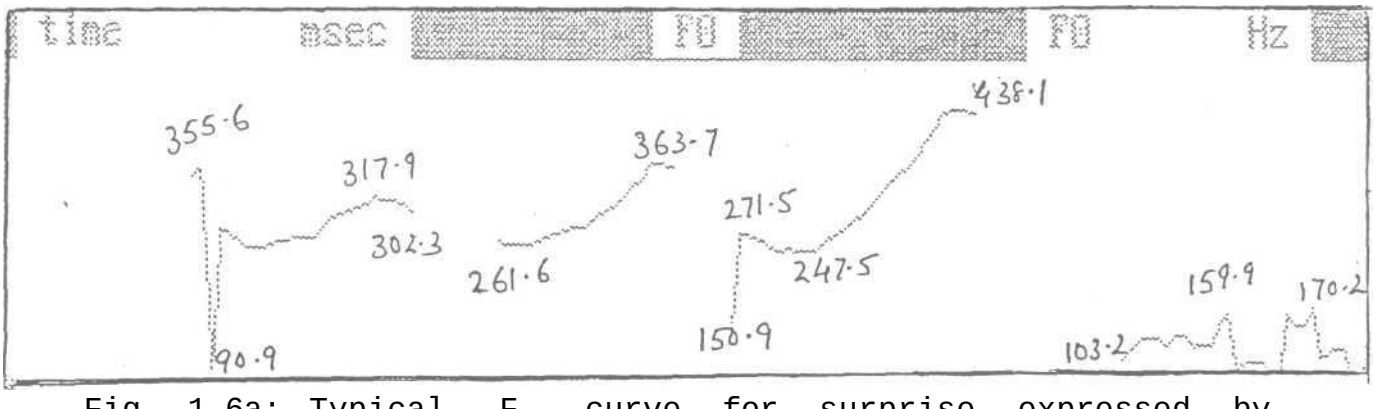


Fig. 1.6a: Typical F_0 curve for surprise expressed by Kannada speakers

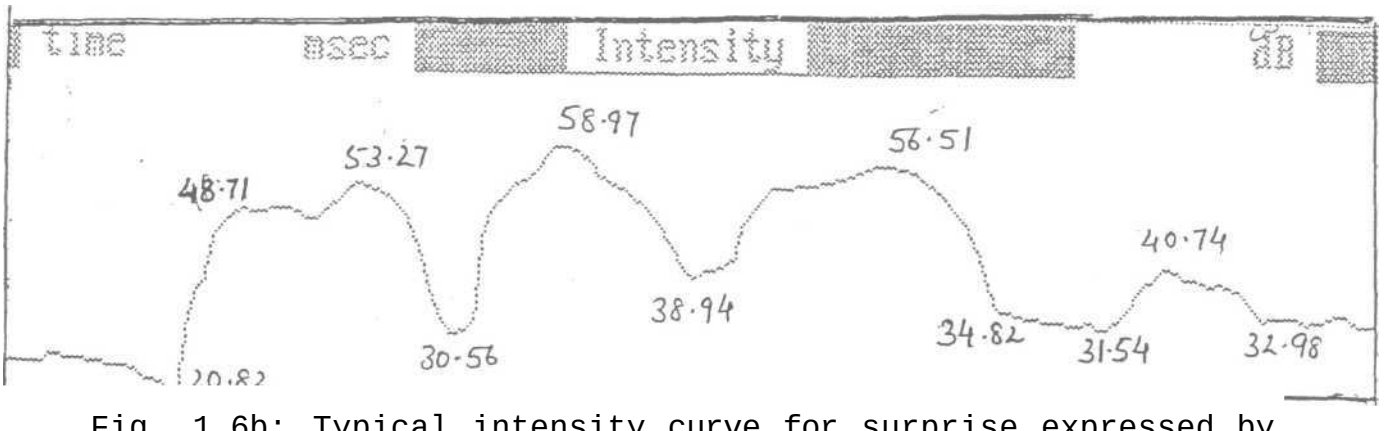


Fig. 1.6b: Typical intensity curve for surprise expressed by Kannada speakers

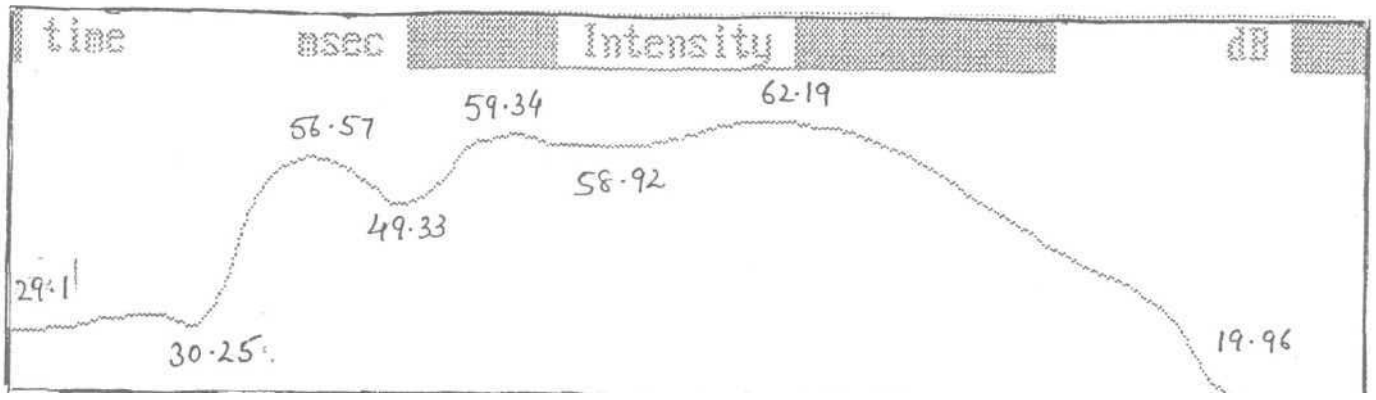


Fig. 1.7b: Typical intensity curve for anger expressed by Kannada speakers

It was concluded that majority of Kannada speakers used a fall-rise-fall pattern of frequency and a rise-fall-rise-fall-rise-fall pattern of intensity to express anger. According to studies by Manjula (1979), Nataraja (1981) and Nandini (1985), Kannada speakers speaking in Kannada used rise-fall, flat-rise, gradual fall, gradual rise, flat-rise, sustain fall, mid-high-low and rise-slight fall patterns to express anger. It was thus concluded that patterns used to express anger in Kannada were seen in English also.

To conclude, there were similarities between frequency patterns used by speakers with Kannada as their mother tongue to express various emotions in Kannada and English. Hence it can be said that the mother tongue of Kannada speakers influences their productions in English. Intensity patterns do not seem to be a factor for identification of emotions in Kannada.

Fifteen statements produced by Hindi speakers were identified as statements in the perceptual task. These were analyzed for frequency and intensity. Four of the sentences showed a flat pattern, six showed a flat-fall pattern. The other frequency patterns observed were i) flat-rise, ii) rise-flat-rise, iii) flat-fall-rise-fall, iv) flat-fall-rise and v) flat-fall-rise-fall-rise; each shown by one sentence. All the intensity curves showed a rise-gradual fall pattern (Figure 2.1a,b).

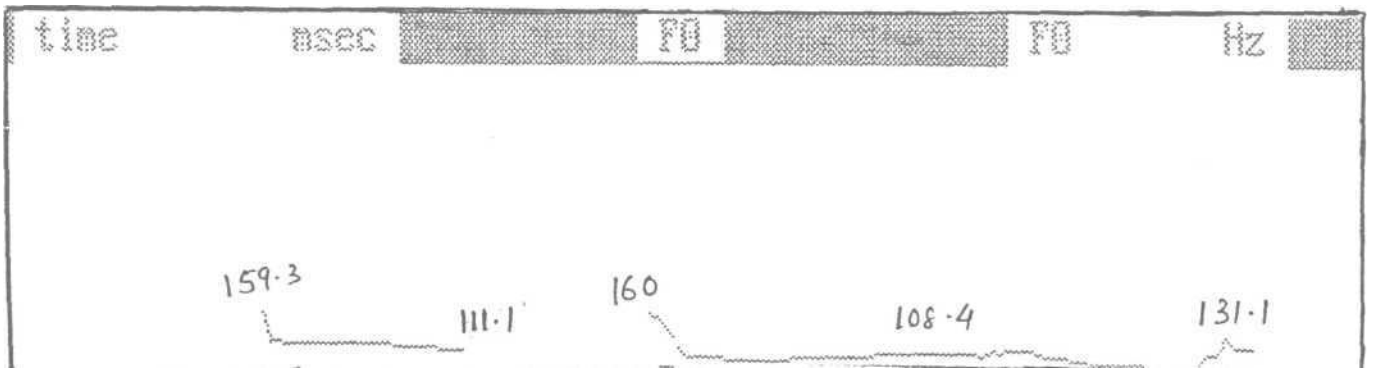


Fig. 2.1a: Typical F_0 curve for statements produced by Hindi speakers

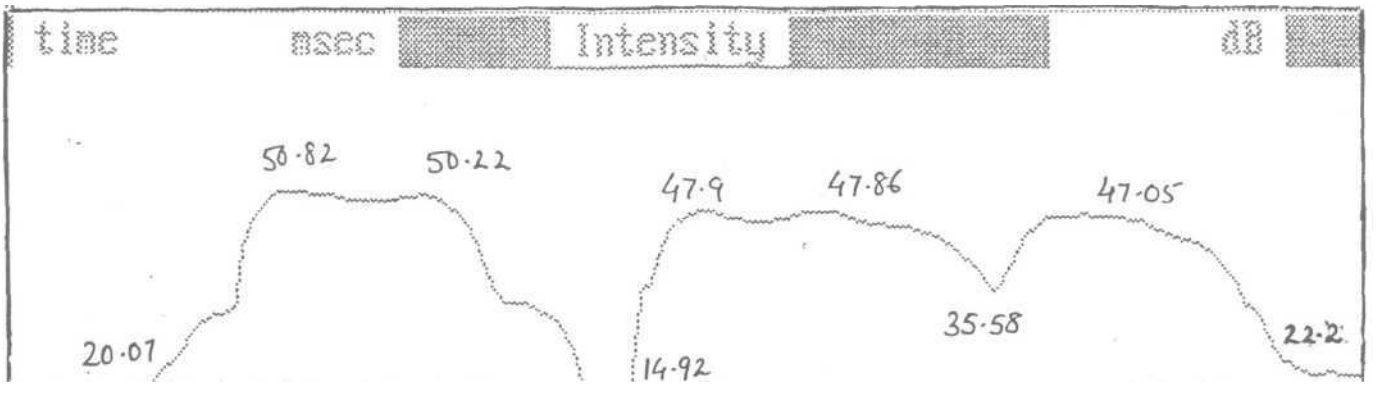


Fig. 2.1b: Typical intensity curve for statements produced by Hindi speakers

Thus it was concluded that majority of the Hindi speakers used a flat-fall pattern of frequency and a six gradual fall pattern of intensity to produce a statement in English. Studies by Nataraja (1981) and Srivatsav (1985) found that Hindi speakers used mid-low, rise-fall-rise and fall type of frequency patterns to produce statements in Hindi. As these patterns are similar to those seen in the present study, it was concluded that Hindi speakers use similar patterns of frequency to produce statements in Hindi and in a second language, English.

Nine sentences produced by Hindi speakers were identified as expressing joy in the perceptual experiment. These sentences were analyzed for frequency and intensity. Three of them showed a flat-fall pattern of frequency. The other patterns seen were i) fall-rise-flat-gradual rise, ii) rise-fall-flat-fall, iii) rise-fall-flat-fall, iv) rise-fall-rise-fall, v) rise-fall-rise, vi) rise-fall-flat-fall-rise and vii) flat; each shown by one sentence. Five of the intensity curves showed a rise-fall-rise-fall pattern and four showed a flat-gradual fall pattern. Figure 2.2a and 2.2b give typical frequency and intensity curves for a sentence spoken by a Hindi speaker, expressing joy.

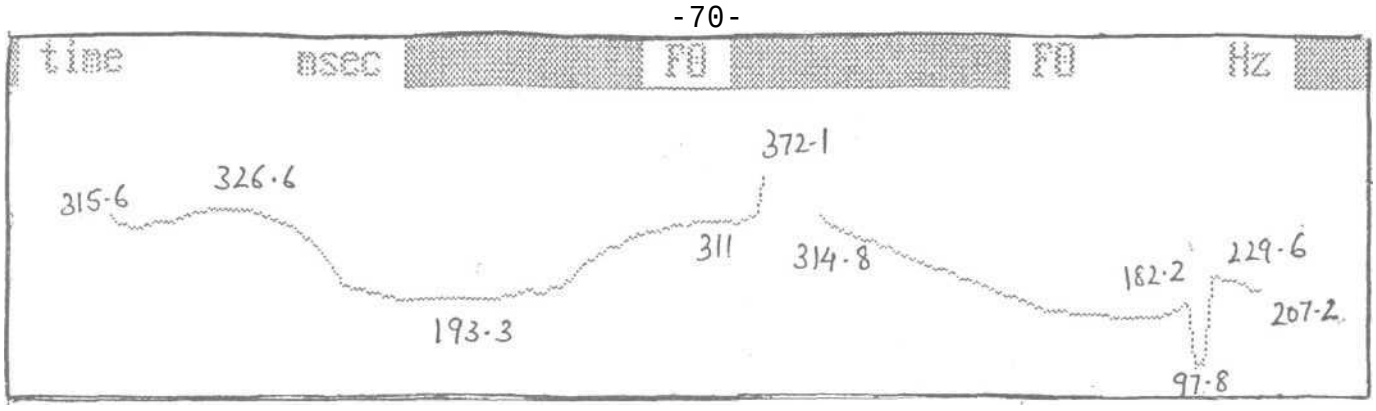


Fig. 2.2a: Typical F_0 curve for joy expressed by Hindi speakers

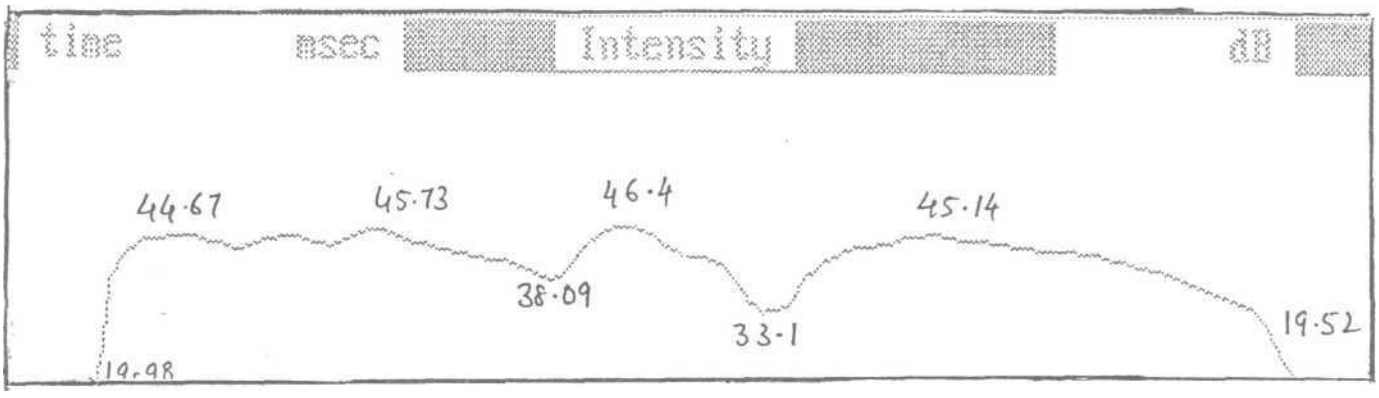


Fig. 2.2b: Typical intensity curve for joy expressed by Hindi speakers

It was concluded that majority of Hindi speakers used a flat-fall pattern of frequency and a rise-fall pattern of intensity while producing a sentence to express joy. Studies by Nataraja (1981, 1985) and Srivatsav (1985) showed that Hindi speakers speaking Hindi used high-mid-high-mid and flat-fall-rise-fall patterns of frequency to express joy. As these patterns were not seen in the present study, it was concluded that Hindi speakers use different frequency patterns to express joy in their mother tongue and a second language, i.e. English.

Ten sentences in which Hindi speakers expressed disappointment were analyzed for frequency and intensity. Three of these sentences showed a flat pattern of frequency. The other patterns; each shown by one sentence, were i) fall-rise-flat-fall-rise-fall, (ii) flat-rise-fall, iii) fall, iv) rise-fall, v) fall-rise-fall, vi) flat-fall-flat and vii) fall-rise-flat-rise-fall. Six of the intensity curves showed a rise-fall pattern and four showed a rise-flat-fall pattern. Figure 2.3a and 2.3b give typical patterns of frequency and intensity for sentences produced by Hindi speakers to express disappointment.

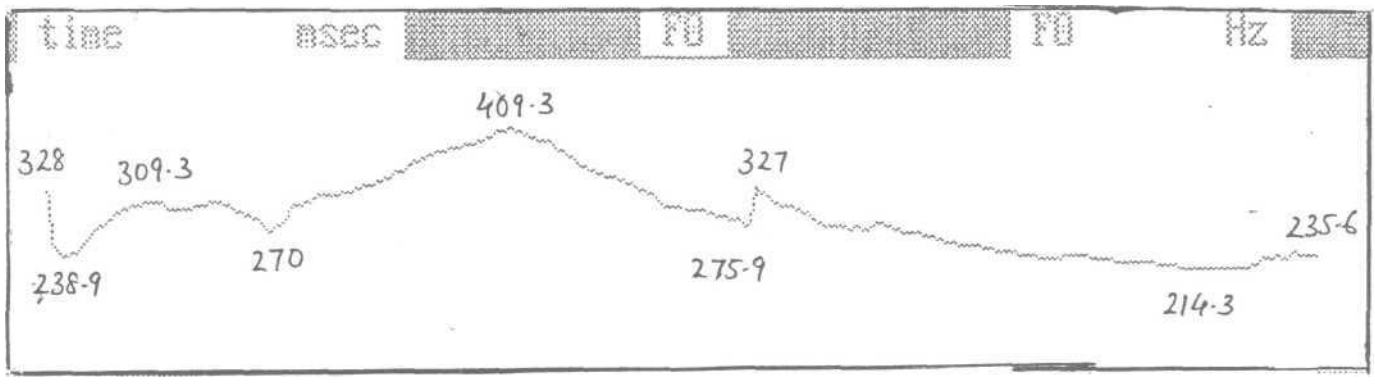


Fig. 2.3a: Typical F_0 curve for disappointment expressed by Hindi speakers

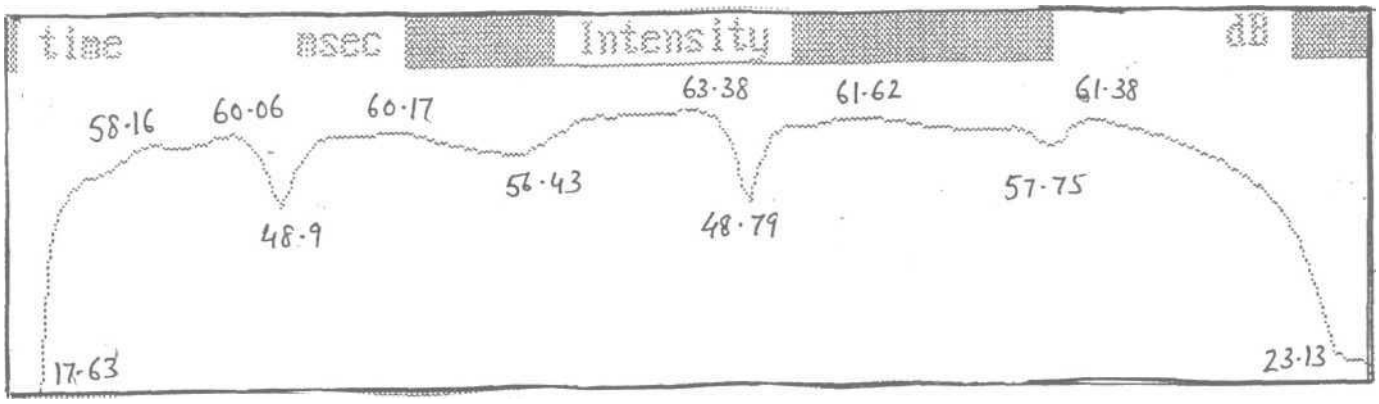


Fig. 2.3b: Typical intensity curve for disappointment expressed by Hindi speakers

It was concluded that a flat curve of frequency and a rise-fall pattern of intensity was used by majority of Hindi speakers to express disappointment in English. Nataraja (1985) found that Hindi speakers used mid-high-low patterns of frequency to express disappointment while speaking in Hindi. As this pattern is not seen in the present study, it was concluded that Hindi speakers use different frequency patterns to express disappointment while speaking in Hindi and in a second language English.

Five sentences in which Hindi speakers expressed fear were analyzed for frequency and intensity. Two of these showed a rise-flat and two showed a rise-fall pattern of frequency; while one showed a fall-rise-fall-rise pattern. Four of the intensity curves showed a rise-fall-rise-flat pattern and one showed a flat-fall pattern. Typical patterns for sentences expressing fear are shown in Figures 2.4a and 2.4b.

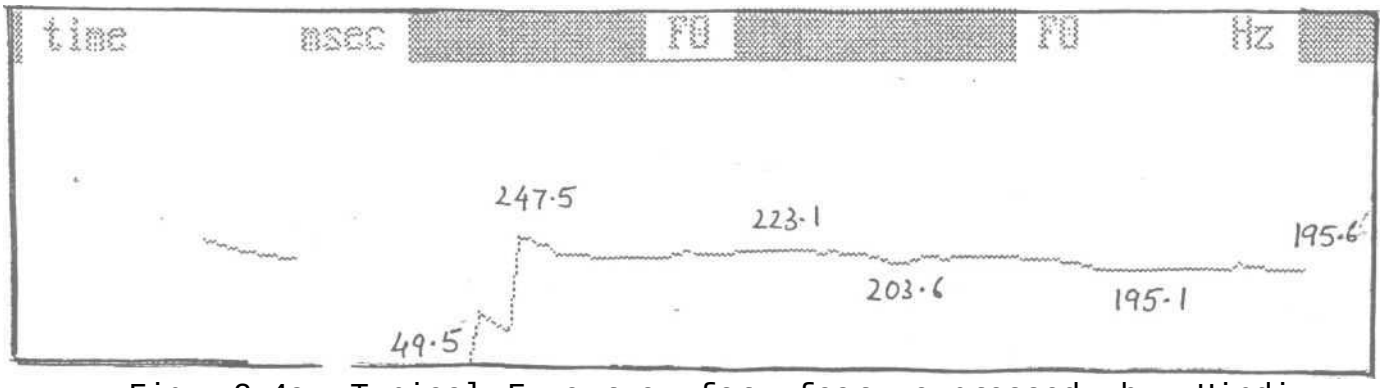


Fig. 2.4a: Typical F_0 curve for fear expressed by Hindi speakers

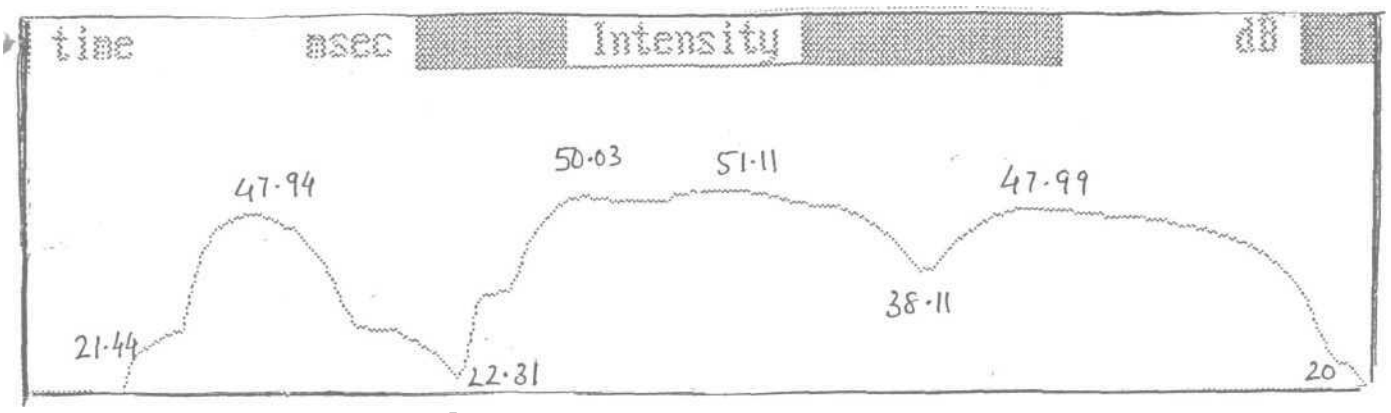


Fig. 2.4b: Typical intensity curve for fear expressed by Hindi speakers

It was concluded that a rise-flat or rise-fall pattern of frequency and a rise-fall-rise-flat pattern of intensity was used by a majority of Hindi speakers to express fear while speaking English. Srivatsav (1985) found that Hindi speakers speaking Hindi used frequency patterns of fall-rise or fall to express fear. As these patterns were found in the present study also, it was concluded that Hindi speakers use similar frequency patterns to express fear in their mother tongue and English.

One sentence spoken by Hindi speakers was identified as expressing sarcasm in the perceptual experiment. This sentence was analyzed and it showed a flat-fall-rise-fall for frequency and a rise-fall-rise-flat-fall-flat-fall pattern of intensity. Figure 2.5a and 2.5b give the frequency and intensity curve for this sentence.

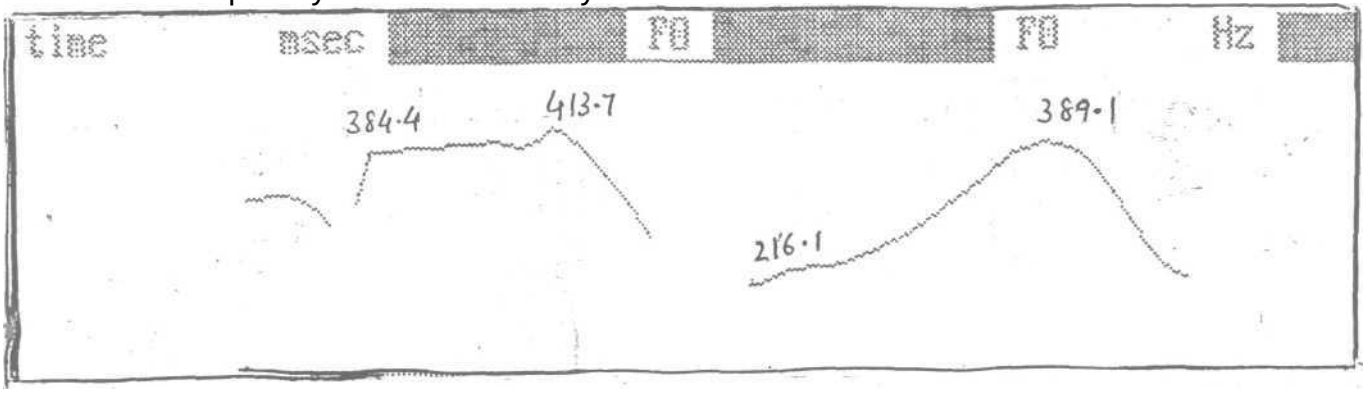


Fig. 2.5a: Typical F_0 curve for sarcasm expressed by Hindi speakers

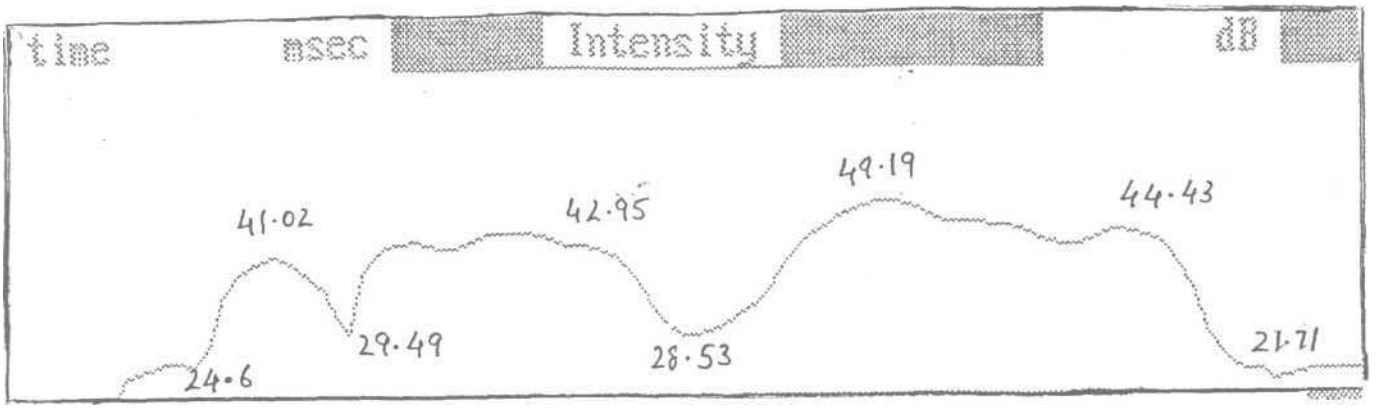


Fig. 2.5b: Typical intensity curve for sarcasm expressed by Hindi speakers

Nataraja (1985) found that Hindi speakers expressing sarcasm used a mid-low pattern for frequency, while speaking in Hindi. As this pattern is not seen in the present study, it can be concluded that Hindi speakers use different frequency patterns to express sarcasm in their mother tongue and in a second language English.

Eleven sentences in which Hindi speakers expressed surprise were analyzed for frequency and intensity patterns. Two of these showed a gradually rising pattern while two others showed a rise-fall-rise pattern of frequency. The other frequency patterns, each shown by one sentence, were i) flat-gradual rise; ii) rise-fall-rise-fall, iii) gradual fall-rise, iv) rise-flat, v) fall-rise-fall, vi) rise-fall-flat, vii) flat-rise-fall-gradual rise. Eight of the sentences showed a gradually falling pattern of intensity, while three showed a rise-fall-rise-gradual fall pattern. (Figure 2.6a and 2.6b).

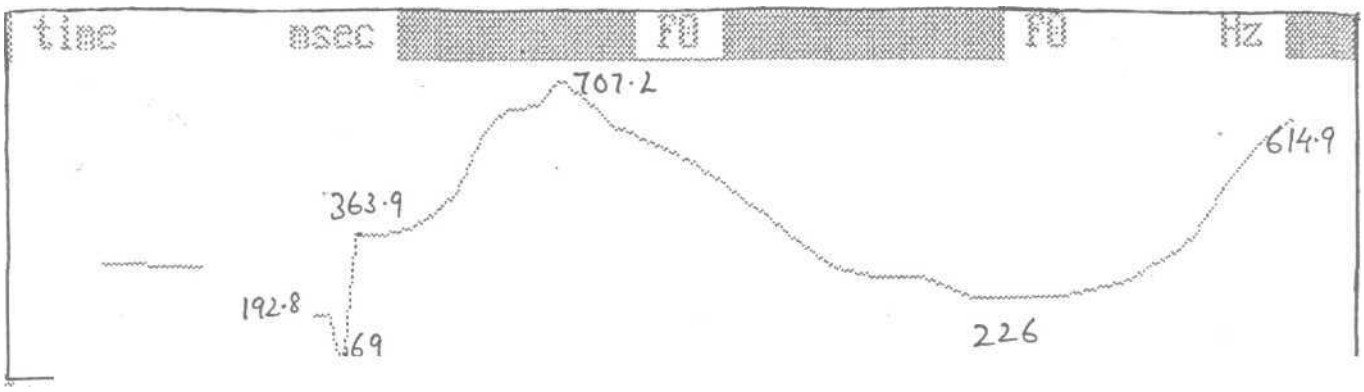


Fig. 2.6a: Typical F_0 curve for surprise expressed by Hindi speakers

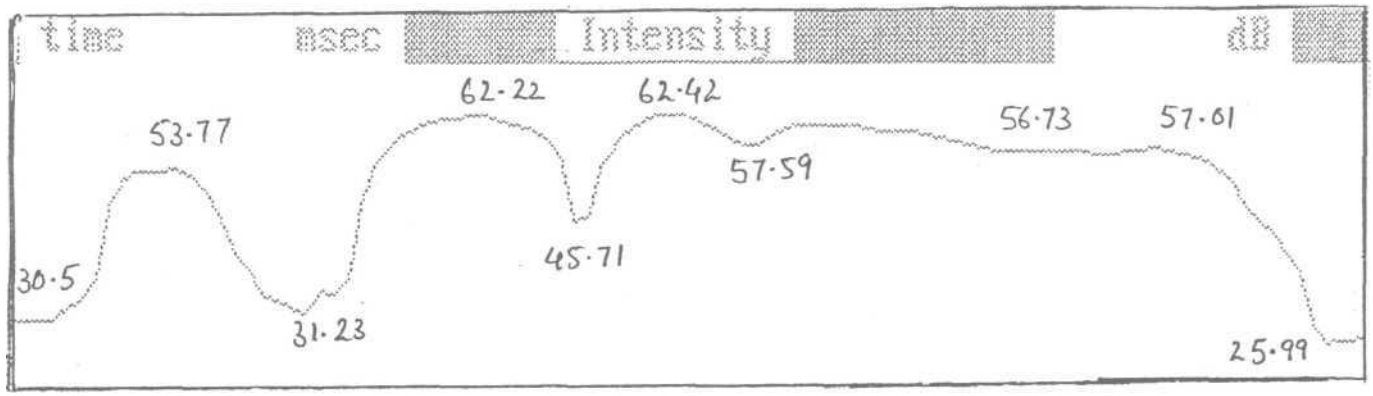


Fig. 2.6b: Typical intensity curve for surprise expressed by Hindi speakers

It was concluded that majority of Hindi speakers used a gradually rising or rise-fall-rise pattern of frequency and a gradually falling pattern of intensity to express surprise. Srivatsav (1985) found that Hindi speakers used a fall-flat-rise-fall pattern of frequency to express surprise in Hindi. As these patterns were not found in the present study, it was concluded that Hindi speakers use different frequency patterns to express surprise while speaking in Hindi and English.

Nine sentences produced by Hindi speakers were identified as expressing anger in the perceptual task. The frequency and intensity patterns of these sentences were analyzed. Five of the sentences showed gradually falling patterns; and the other patterns seen were; i) flat-fall-rise, ii) flat-fall, iii) flat-rise-fall, iv) flat-gradual rise; each shown by one sentence. Five of the intensity curves showed a rise-fall pattern and three showed a gradual fall pattern. Figure 2.7a and 2.7b show typical frequency and intensity patterns for anger expressed by a Hindi speaker.

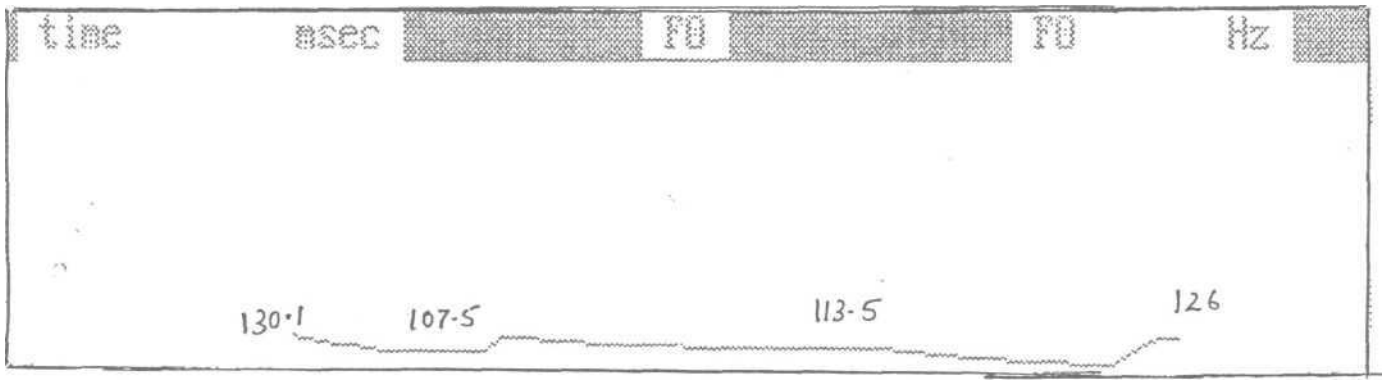


Fig. 2.7a: Typical F_0 curve for anger expressed by Hindi speakers

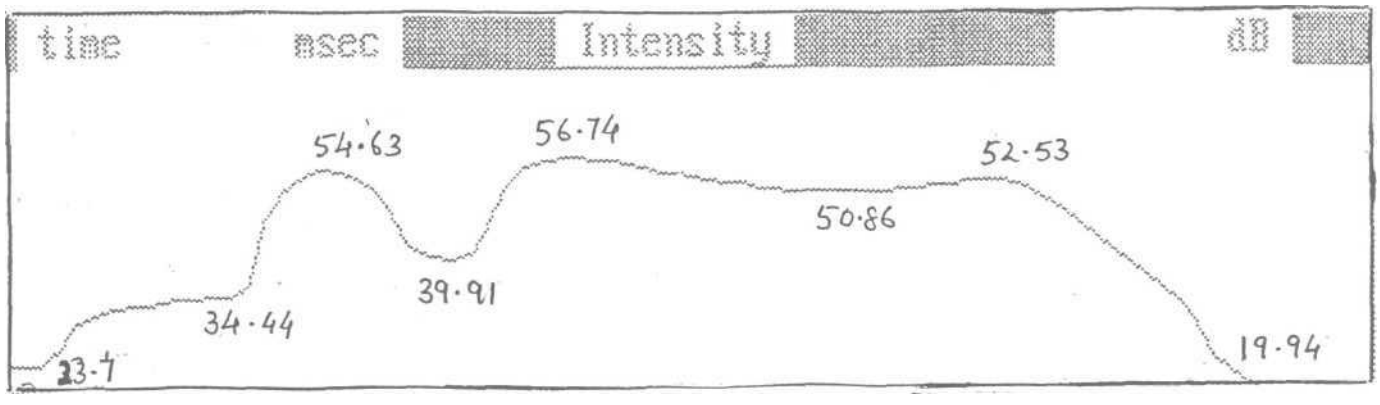


Fig. 2.7b: Typical intensity curve for anger expressed by Hindi speakers

It was concluded that majority of Hindi speakers expressed anger using a gradually falling pattern of frequency and a rise -fall pattern of intensity. Nataraja (1981) and Srivatsav (1985) found that Hindi speakers used rise-fall-rise, rise-fall and rise frequency patterns to express anger while speaking in Hindi. As these patterns were not seen in the present study, it was concluded that Hindi speakers use different frequency patterns to express anger while speaking in their mother tongue and second language English.

To conclude, the frequency patterns used by Hindi speakers to express emotions seem to be different (except for statements and fear) when they speak in their mother tongue Hindi and in English. Thus it can be concluded that the mother tongue has only limited influence on the productions of Hindi speakers in a second language, i.e. English. Intensity patterns do not seem to be a factor critical to identification of emotions in Hindi.

Fourteen sentences produced by Malayalam speakers were identified as statements in the perceptual task. These were analyzed for frequency and intensity. Four of these showed a flat pattern of frequency, while two showed a gradual fall-rise-flat-fall pattern; and two showed a flat-fall-flat pattern. The other frequency patterns observed

each in one sentence, were i) rise-fall-flat, ii) fall-rise, iii) gradual fall, iv) fall-rise-fall, v) flat-rise, vi) flat-rise-fall. Five of the intensity curves showed a flat-gradually falling pattern, while nine showed a rise-fall-rise-flat-fall-rise-fall pattern. Typical frequency and intensity curves for statements produced by Malayalam speakers are given in Figure 3.1a and 3.1b.

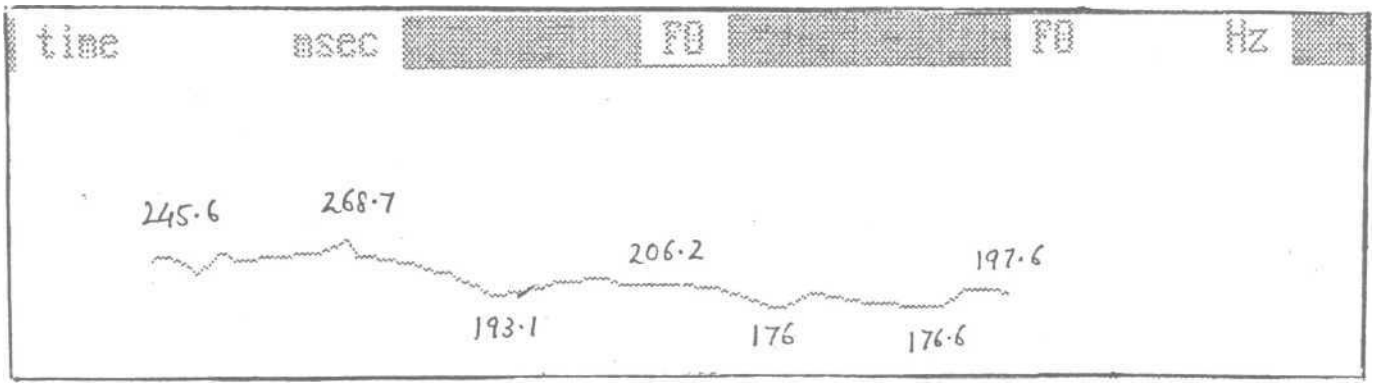


Fig. 3.1a: Typical F_0 curve for statements produced by Malayalam speakers

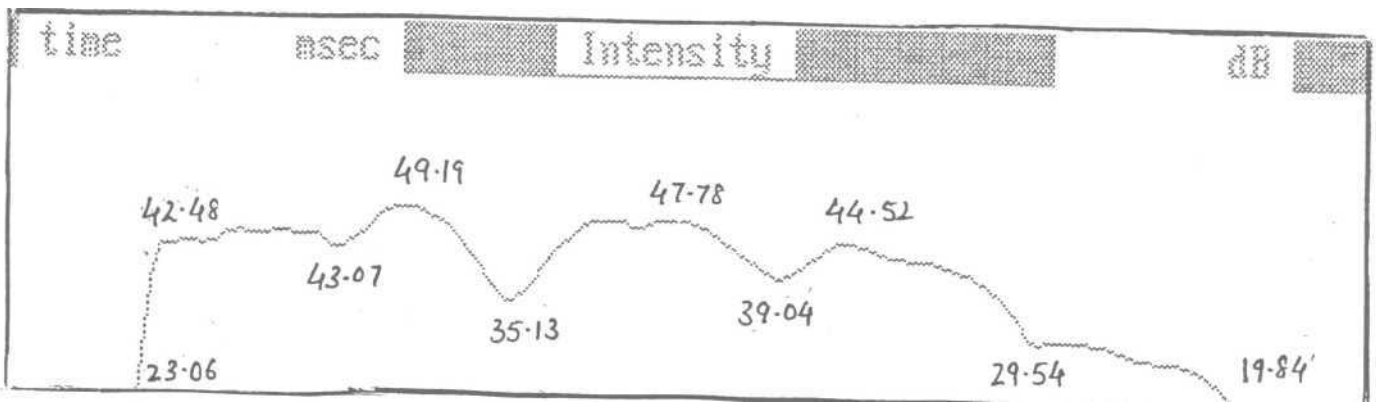


Fig. 3.1b: Typical intensity curve for statements produced by Malayalam speakers

It was concluded that majority of Malayalam speakers used a flat pattern of frequency and a flat gradually falling pattern of intensity to produce statements in English. Nataraja (1985) found that Malayalam speakers used high-mid-high patterns of frequency to produce statements in Malayalam. As similar patterns were observed in the present study, it can be concluded that Malayalam speakers use similar patterns to produce statements in Malayalam and in a second language English.

Eight sentences in which Malayalam speakers expressed joy were analyzed. No common pattern was found for frequency. The various patterns found were i) rise-fall, ii) flat, iii) fall-rise-fall, iv) fall-rise-flat-fall, v) rise-fall-flat-rise, vi) flat-rise-fall-flat-rise, vii) rise-fall-flat and viii) fall-flat-fall-rise-flat-rise-fall. The intensity curves showed a rise-gradual fall pattern. Typical frequency and intensity patterns for joy produced by Malayalam speakers are shown in Figure 3.2a and 3.2b.

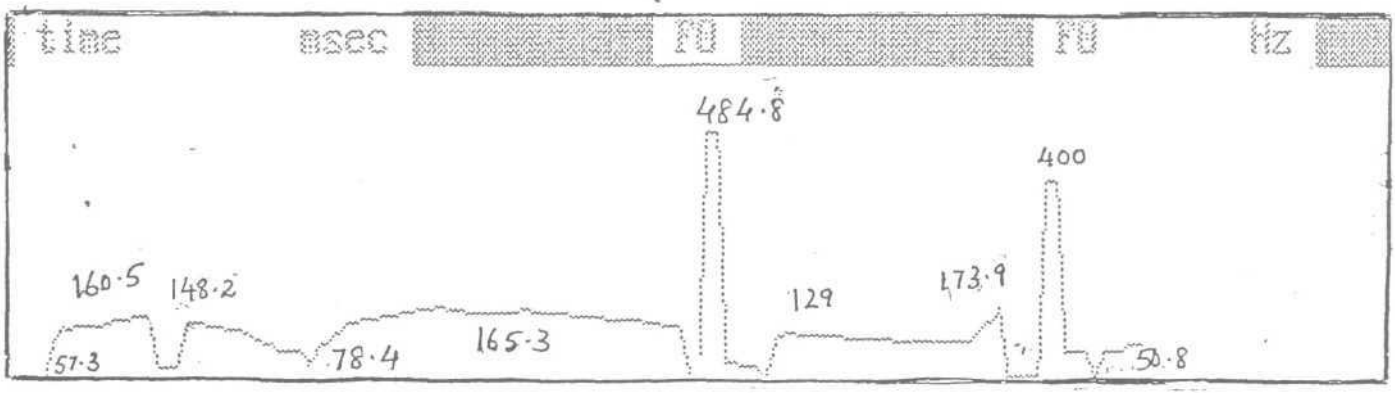


Fig. 3.2a: Typical F_0 curve for joy expressed by Malayalam speakers

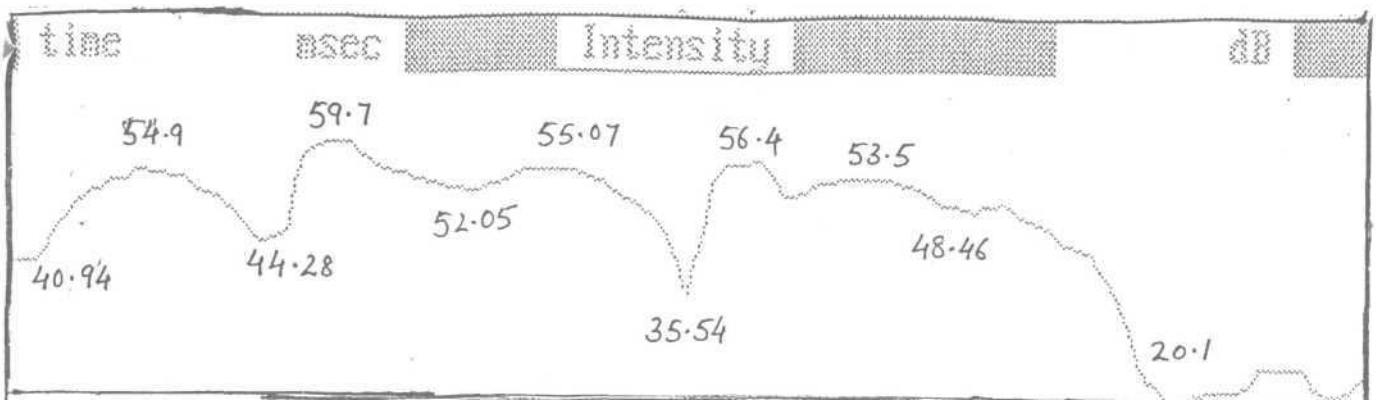


Fig- 3.2b: Typical intensity curve for joy expressed by Malayalam speakers

It was concluded that Malayalam speakers used different of frequency patterns; and a rise-fall intensity pattern to express joy in English. Nataraja (1985) found that Malayalam speakers expressing joy used frequency patterns of mid-high-low-mid while speaking in Malayalam. As similar patterns were observed in the present study, it can be concluded that Malayalam speakers use similar frequency patterns to express joy in Malayalam and English.

Seven sentences spoken by Malayalam speakers were identified as expressing disappointment in the perceptual task and these were analyzed. Two of these showed a flat-rise-fall-flat frequency pattern and two showed a fall-flat-rise-flat-rise pattern. The other frequency patterns seen were i) flat-rise-fall-rise-fall, ii) fall-rise-flat, iii) flat-rise-fall-flat. Four of the intensity curves showed a rise-fall pattern and the other three showed a rise-flat-fall pattern. Typical frequency and intensity curves used by Malayalam speakers to express disappointment are given in Figure 3.3a and 3.3b.

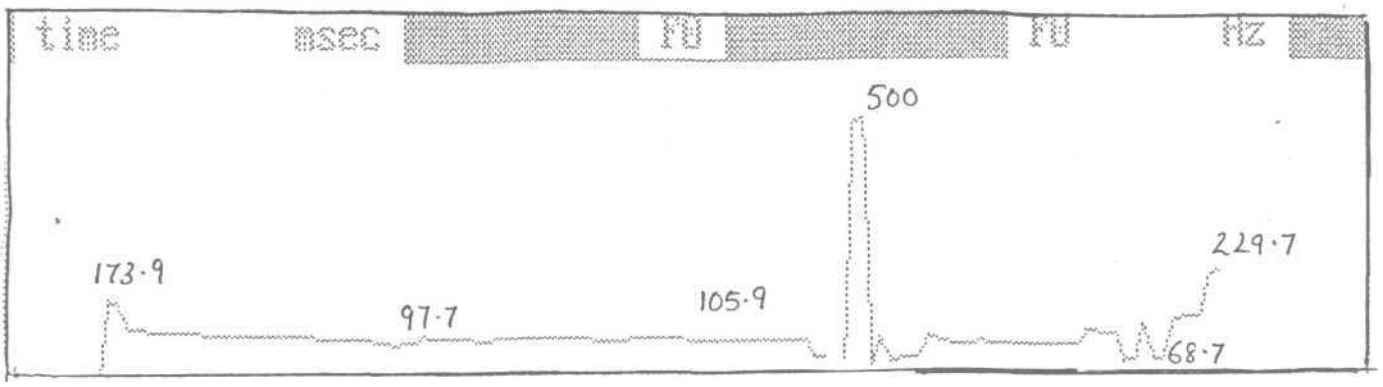


Fig. 3.3a: Typical F_0 curve for disappointment expressed by Malayalam speakers

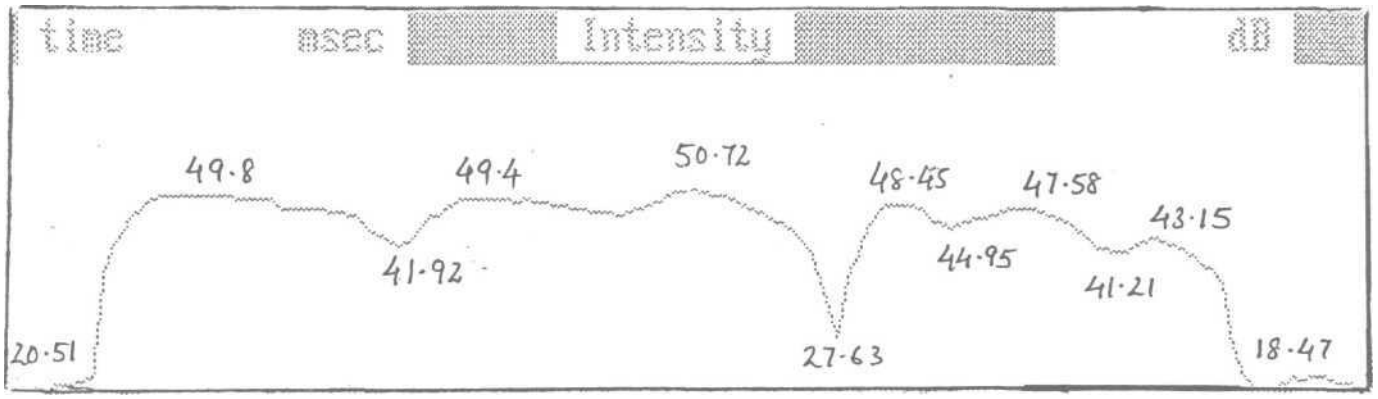


Fig. 3.3b: Typical intensity curve for disappointment expressed by Malayalam speakers

It was concluded that majority of Malayalam speakers used flat-rise-fall-flat and fall-flat-rise-flat-rise patterns of frequency and a rise-fall pattern of intensity to express disappointment. Nataraja (1985) found that Malayalam speakers used mid-low-mid frequency patterns to express disappointment while speaking in Malayalam. As similar patterns were found in the present study, it can be concluded that Malayalam speakers use similar patterns to express disappointment in Malayalam and English.

Four sentences in which Malayalam speakers expressed fear were analyzed. The sentences showed varying frequency patterns. These were i) rise-fall-rise, ii) rise-fall-rise-flat, iii) rise-fall-rise-fall, iv) fall-flat-rise. The intensity curves showed a gradual rise-gradual fall pattern. Figure 3.4a and 3.4b give the frequency and intensity patterns used by Malayalam speakers to express fear in English.

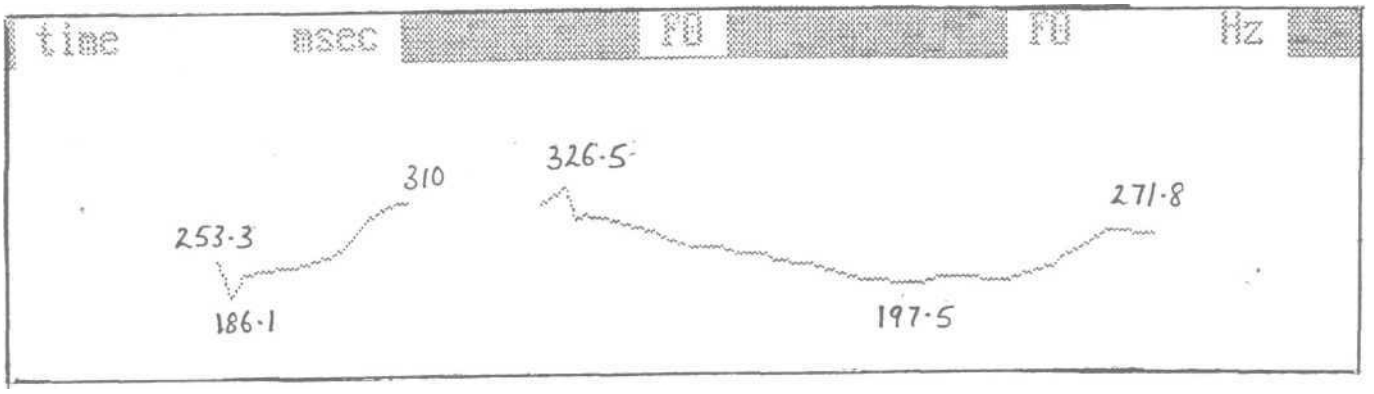


Fig. 3.4a: Typical F_0 curve for fear expressed by Malayalam sneakers

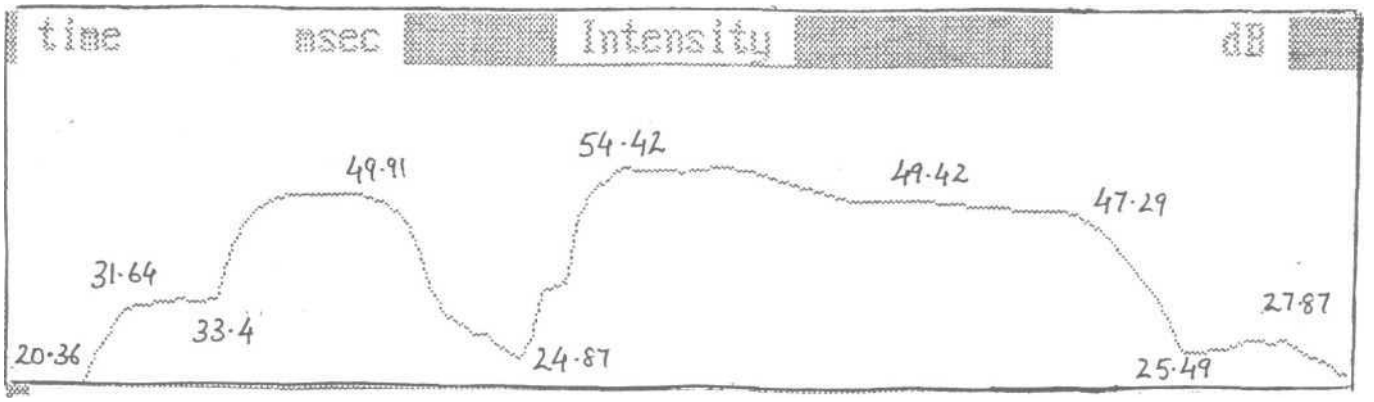


Fig. 3.4b: Typical intensity curve for fear expressed by Malayalam speakers

It was concluded that Malayalam speakers used different frequency patterns and a gradual rise-gradual fall pattern of intensity to express fear. Nataraja (1985) found that Malayalam speakers used high-mid-high patterns to express fear while speaking in Malayalam. As similar patterns were found in the present study,it can be concluded that Malayalam speakers used similar patterns to express fear in Malayalam and English.

One sentence spoken by Malayalam speakers was identified as expressing sarcasm in the perceptual task. This sentence was analyzed and showed a fall-rise-fall frequency pattern and a rise-flat-fall pattern of intensity. Figure 3.5a and 3.5b give the frequency and intensity pattern of this sentence.

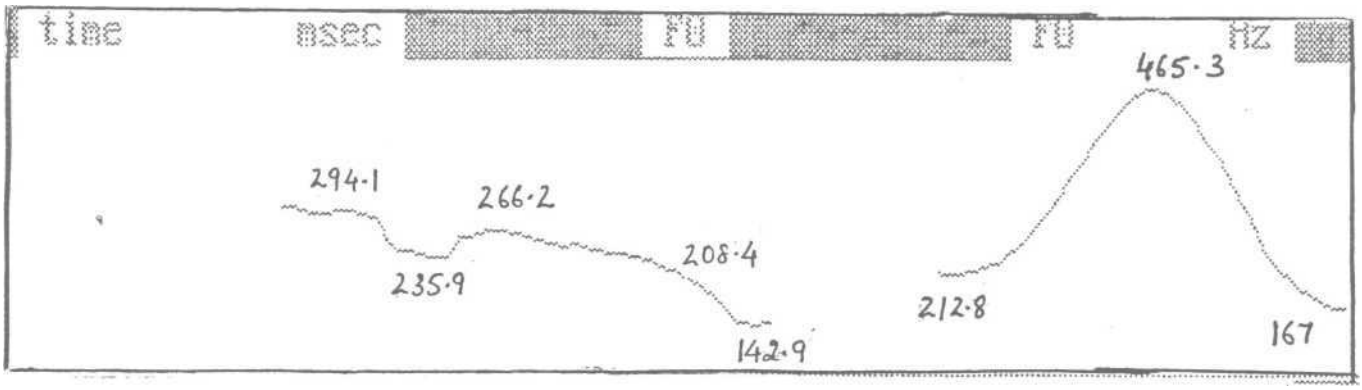


Fig. 3.5a: Typical F_0 curve for sarcasm expressed by Malayalam speakers

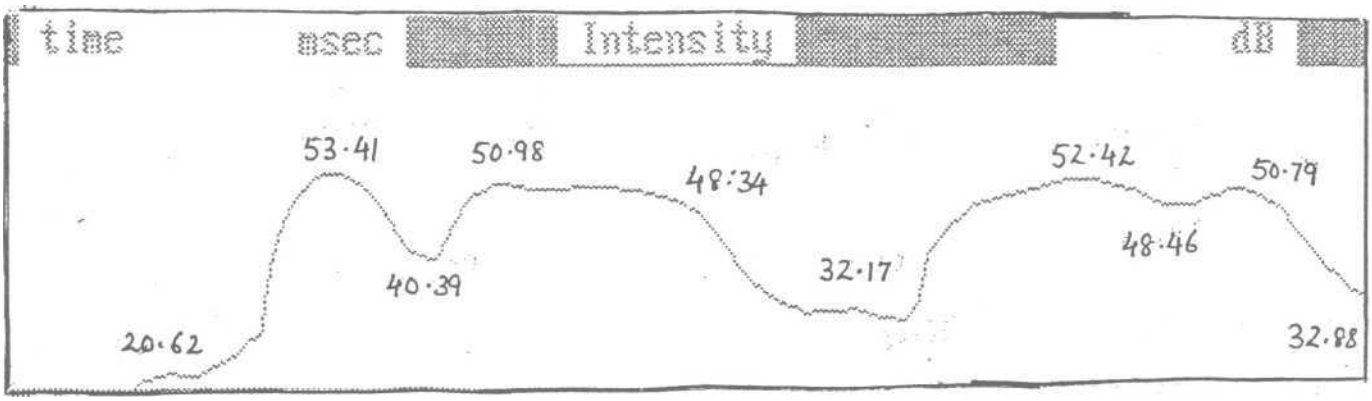


Fig. 3.5b: Typical intensity curve for sarcasm expressed by Malayalam speakers

Nataraja (1985) found that Malayalam speakers used a mid-high-mid pattern of frequency to express sarcasm while talking in Malayalam. As this pattern was not found in the present study, it can be concluded that Malayalam speakers may use different frequency patterns to express sarcasm in Malayalam and English.

Seven sentences in which Malayalam speakers expressed surprise were analyzed. Two of them showed a gradual rise pattern of frequency. The other frequency patterns, each shown by one sentence were i) fall-rise-fall, ii) rise-fall-flat, iii) rise-fall, iv) rise-fall-rise, v) fall-flat-rise-fall. Five of the intensity curves showed a rise-flat-fall pattern and two showed a rise-fall pattern. The typical patterns of frequency and intensity for surprise are shown in Figure 3.6a and 3.6b.

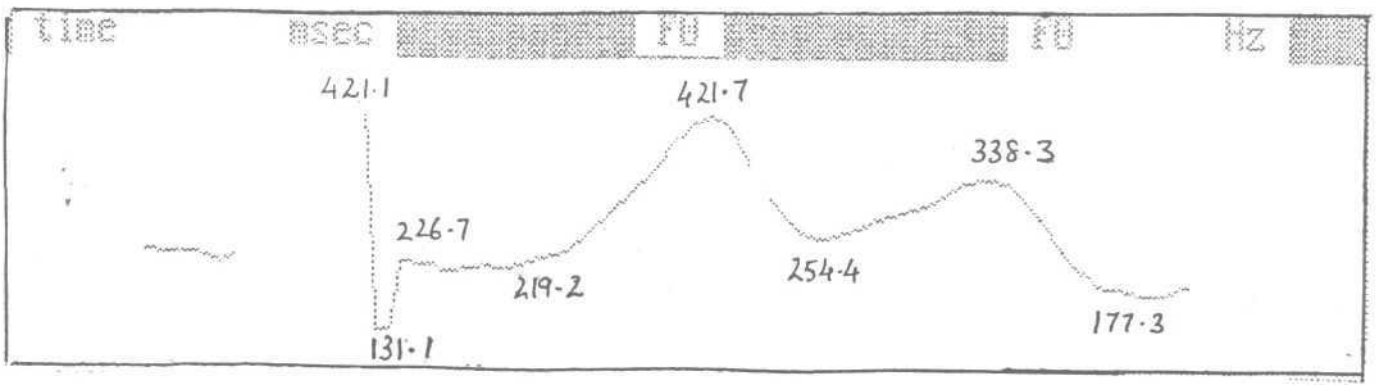


Fig. 3.6a: Typical F_0 curve for surprise expressed by Malayalam speakers

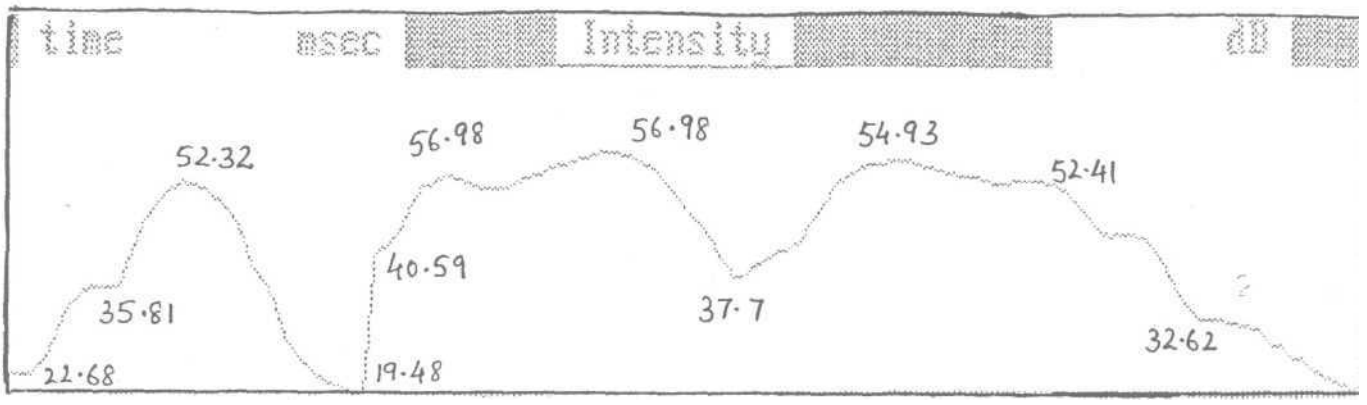


Fig. 3.6b: Typical intensity curve for surprise expressed by Malayalam speakers

It was concluded that a majority of Malayalam speakers use a gradual rise pattern of frequency while expressing surprise; though other patterns were also seen. Majority of Malayalam speakers expressed surprise using a rise-flat-fall pattern of intensity. Nataraja (1985) found that Malayalam speakers used high-mid-high-mid patterns of frequency to express surprise while speaking in Malayalam. As similar patterns were seen in the present study, it can be concluded that Malayalam speakers use similar patterns to express surprise in Malayalam and English.

Nine sentences in which Malayalam speakers expressed anger were analyzed. Four of them showed a flat-rise-fall-flat pattern of frequency and two showed a flat-rise-fall pattern. The other frequency patterns observed were i) fall-rise, ii) gradual fall and iii) flat-rise. The intensity curves showed rise-fall pattern. Typical frequency and intensity patterns for anger are shown in Figure 3.7a and 3.7b.

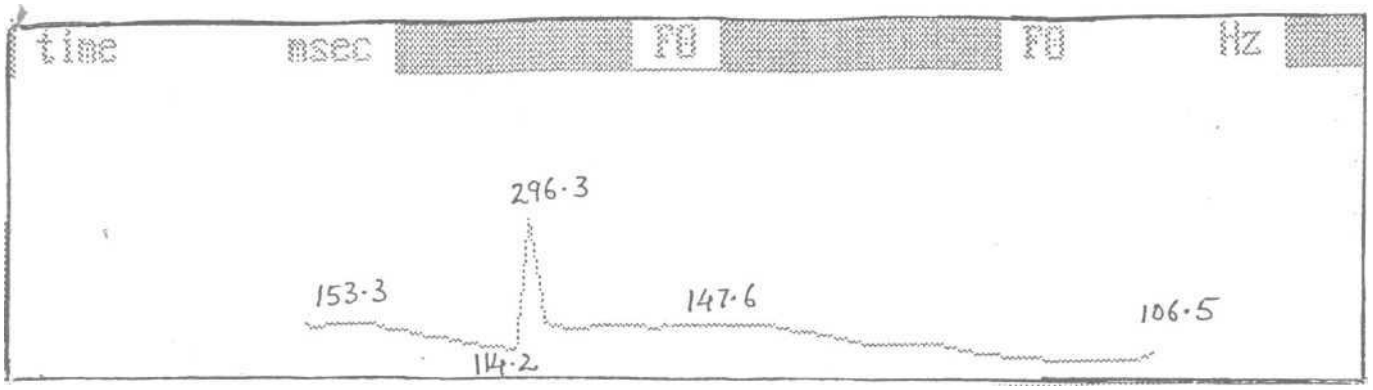


Fig. 3.7a: Typical F_0 curve for anger expressed by Malayalam speakers

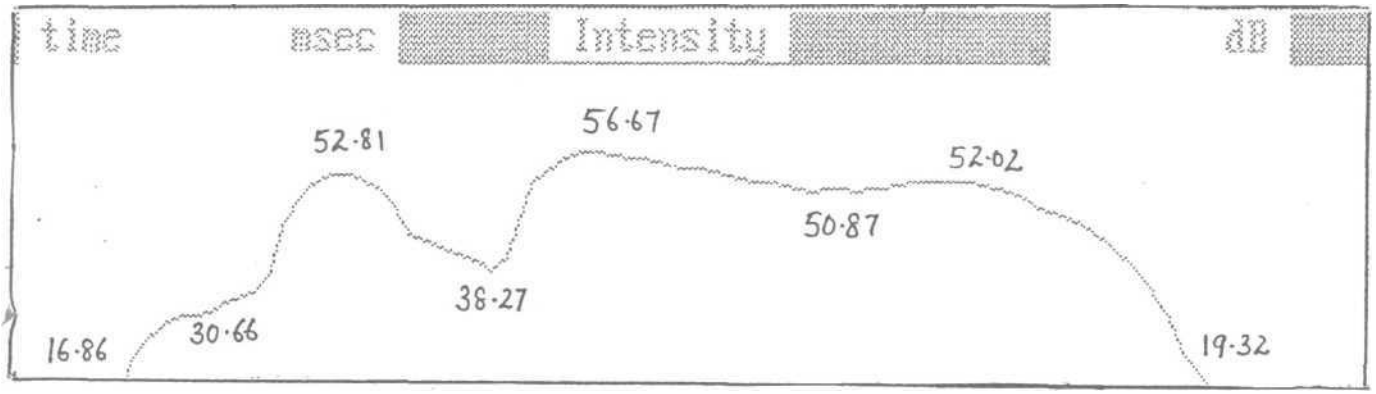


Fig. 3.7b: Typical intensity curve for anger expressed by Malayalam speakers

It was concluded that a majority of Malayalam speakers expressed anger using a flat-rise-fall-flat pattern of frequency and a rise-fall pattern of intensity. Nataraja (1985) found that Malayalam speakers used a mid-low-mid patterns of frequency to express anger while speaking in Malayalam. As similar patterns were observed in the present study, it was concluded that Malayalam speakers used similar patterns to express anger in Malayalam and in a second language, English. To conclude, there are similarities between frequency patterns used by speakers with Malayalam

as their mother tongue to express various emotions (except sarcasm) in Malayalam and English. Hence it was concluded that the mother tongue of Malayalam speakers influences their productions in English.

Intensity does not seem to be a factor important for identification of emotions in Malayalam as similar intensity patterns are seen in many different emotions.

Fifteen statements produced by Tamil speakers were analyzed. Eight of them showed a flat-gradually falling pattern for frequency. The other patterns, each shown by one sentence were i) rise-fall-flat, ii) flat-rise, iii) fall, iv) flat-fall-rise, v) rise-flat-fall, vi) fall-rise-flat, vii flat-rise-fall-flat. The intensity curves showed a flat gradually falling pattern. Figure 4.1a and 4.1b show typical frequency and intensity patterns for statements produced by Tamil speakers.

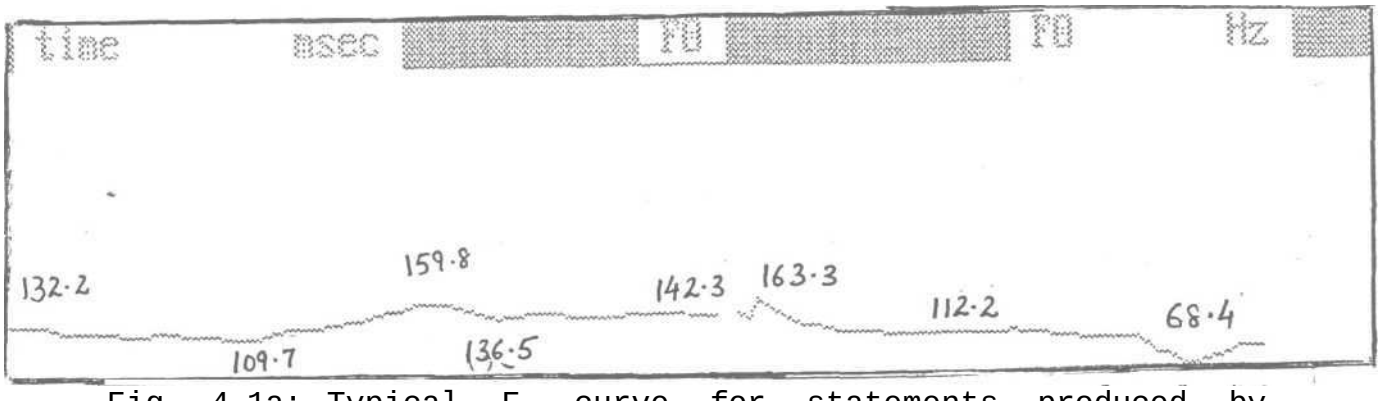


Fig. 4.1a: Typical F_0 curve for statements produced by Tamil speakers

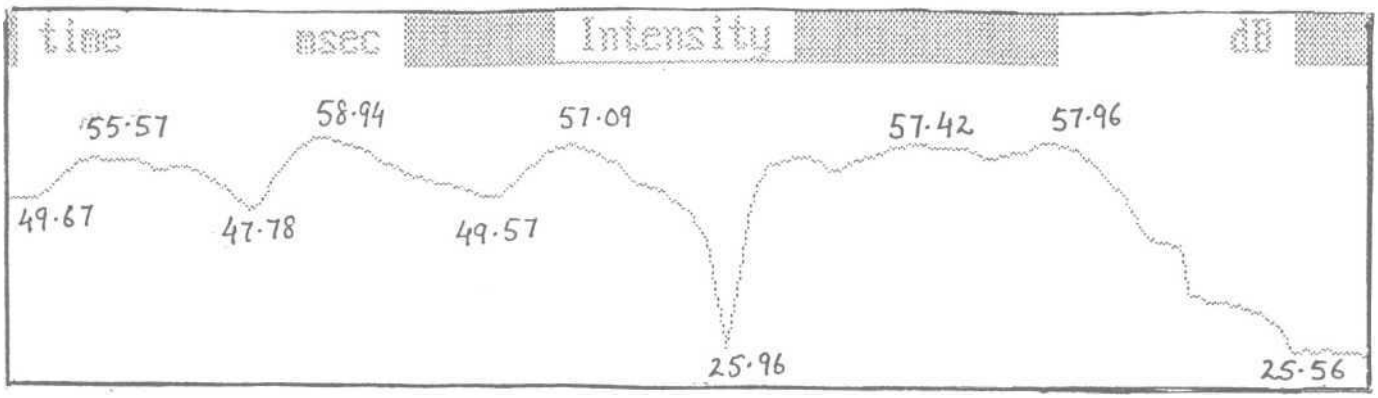
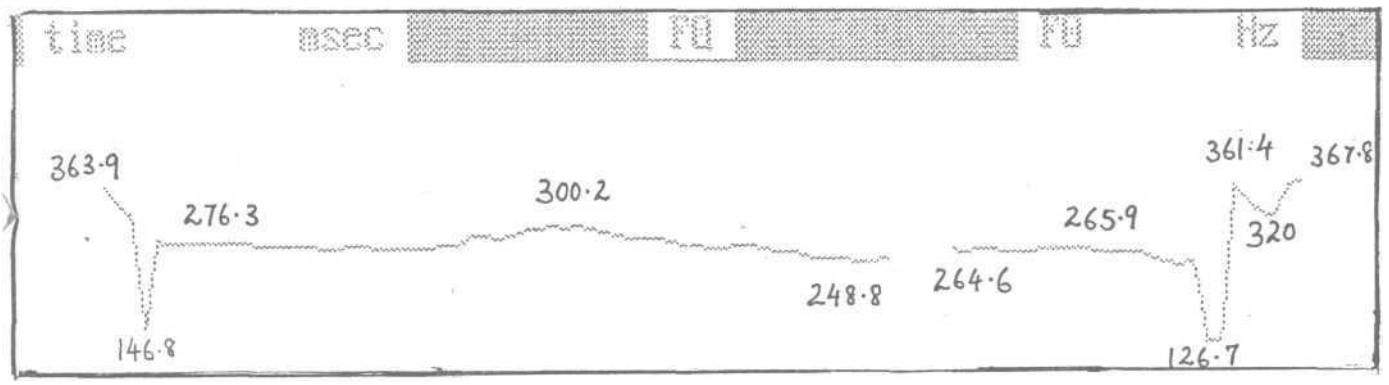


Fig. 4.1b: Typical intensity curve for statements produced by Tamil speakers

It was concluded that majority of Tamil speakers used a flat-gradually falling patterns of frequency and intensity to produce statements in English. Nataraja (1981) found that Tamil speakers used a mid-low-mid pattern of frequency while producing statements in Tamil. As similar patterns were seen in the present study, it can be concluded that Tamil speakers use similar patterns for statements in their mother tongue and in English.

Ten sentences in which Tamil speakers expressed joy were analyzed. Several patterns were seen for frequency. These were i) rise-fall-rise-flat, ii) flat-fall-rise, iii) fall-rise-fall, iv) flat-rise-fall-flat and v) rise-fall; each seen in two sentences. The intensity curves showed a rise-fall-rise pattern. Figure 4.2a and 4.2b show the typical frequency and intensity patterns for joy.

Ten sentences spoken by Tamil speakers were identified as expressing disappointment in the perceptual task and these were analyzed. Four of them showed a fall-rise-flat pattern of frequency, three showed a flat-rise-flat pattern and three showed fall-flat-rise pattern. Eight of the intensity curves showed a rise-fall pattern, and two showed a rise-flat-fall pattern. Figure 4.3a and 4.3b give the typical frequency and intensity patterns for disappointment.



4.3a: Typical F_0 curve for disappointment expressed by Tamil speakers

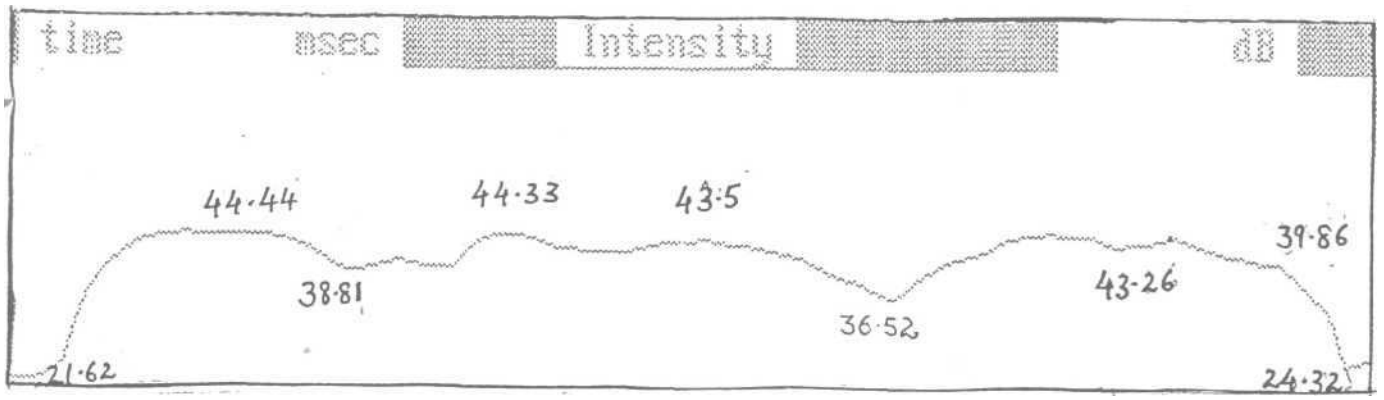


Fig. 4.3b: Typical intensity curve for disappointment expressed by Tamil speakers

It was concluded that the majority of Tamil speakers used a fall-rise-flat pattern of frequency and a rise-fall pattern of intensity to express disappointment. Intensity does not seem to reflect any variation with emotion in these speakers. Nataraja (1985) found that Tamil speakers speaking in Tamil used a high-mid-high pattern of frequency to express disappointment. As similar patterns were found in the present study, it can be concluded that Tamil speakers use similar frequency patterns to express disappointment in Tamil and English.

Three sentences spoken by the Tamil speakers were identified as expressing fear in the perceptual task. These were analysed. The three patterns of frequency obtained were i) flat, ii) fall-rise-fall-flat-rise and iii) fall-rise-flat-fall-rise. Two of the intensity curves showed a rise-fall-rise-flat-fall pattern while one showed a rise-flat-fall-flat pattern. Figure 4.4a and 4.4b show the typical frequency and intensity patterns for fear.

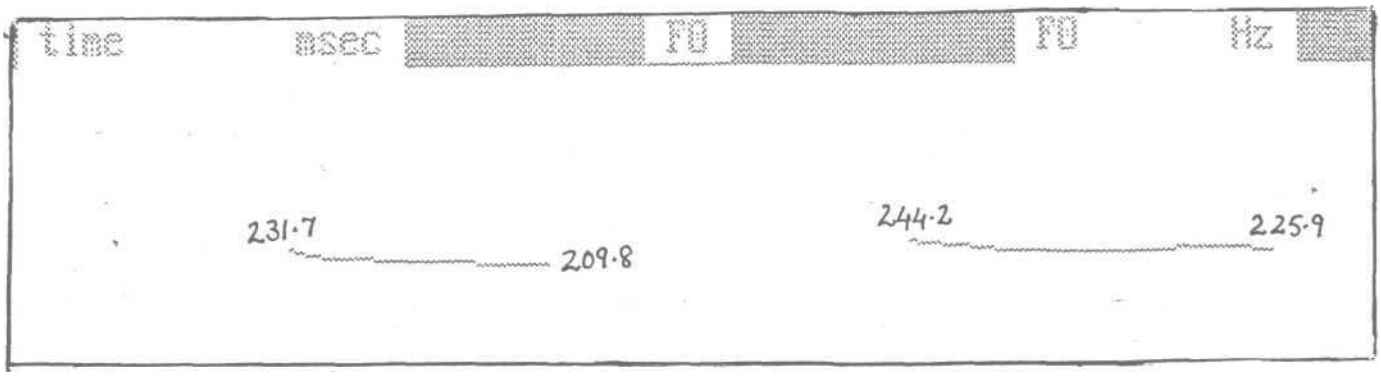


Fig. 4.4a: Typical F_0 curve for fear expressed by Tamil speakers

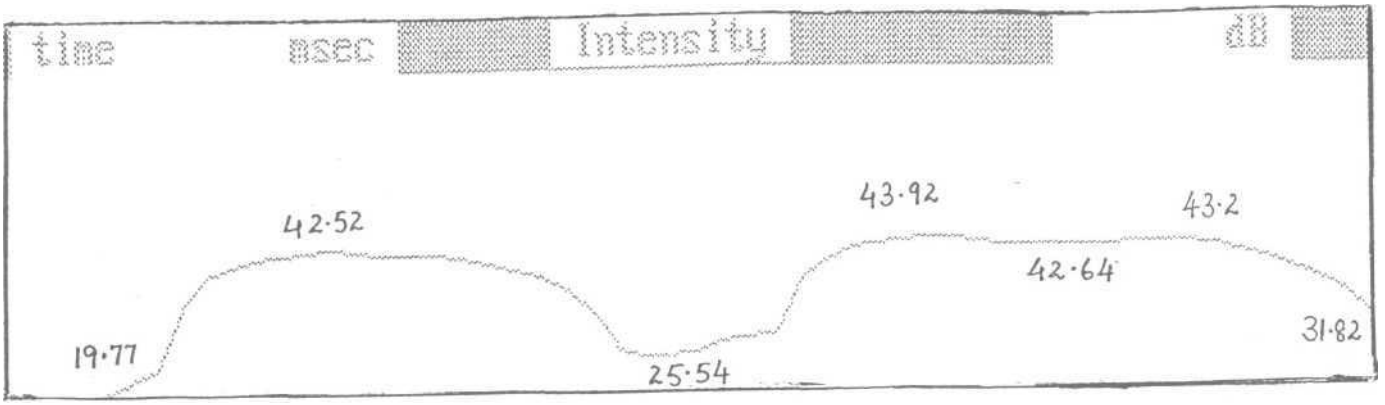


Fig. 4.4b: Typical intensity curve for tear expressed by Tamil speakers

It was concluded that Tamil speakers used a variety of frequency patterns to express fear. A majority of Tamil speakers used a rise-fall-rise-flat-fall intensity pattern while producing a sentence expressing fear. Nataraja (1985) found that Tamil speakers used a high-mid-low-mid pattern to express fear while speaking in Tamil. As similar patterns were seen in the present study, it can be concluded that Tamil speakers use similar patterns to express fear in their mother tongue and in a second language English.

Two sentences produced by Tamil speakers were identified as expressing sarcasm in the perceptual analysis. These sentences were analyzed for frequency and intensity. One of them showed a flat pattern of frequency; while the other showed a flat-fall-rise-fall pattern. The intensity curves showed rise-flat-fall and rise-fall-rise-fall patterns. Figure 4.5a and 4.5b show the typical frequency and intensity patterns for sarcasm.

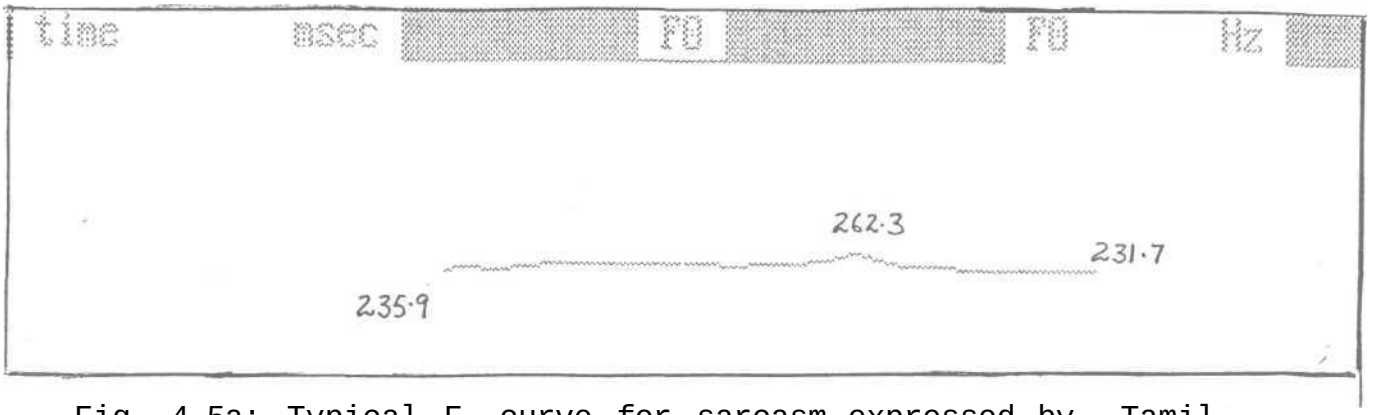


Fig. 4.5a: Typical F_0 curve for sarcasm expressed by Tamil speakers

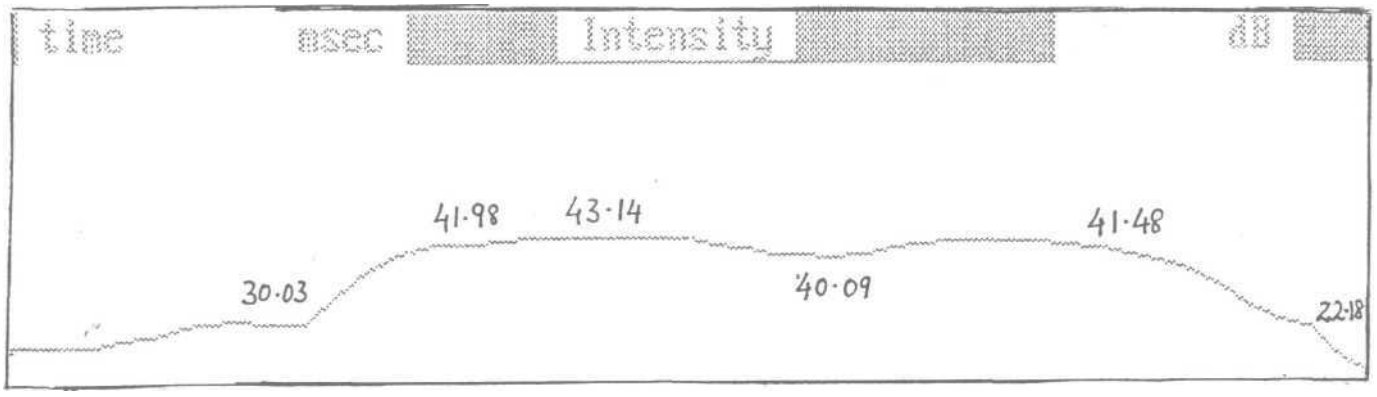
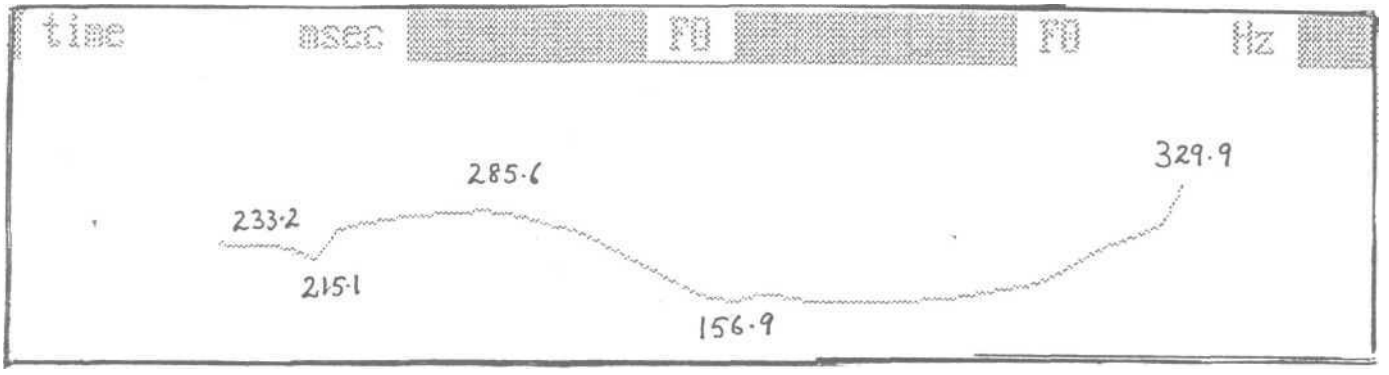


Fig. 4.5b: Typical intensity curve for sarcasm expressed by Tamil speakers

It was concluded that Tamil speakers use different patterns of F and intensity to express sarcasm. No specific pattern could be identified. Nataraja (1985) found that Tamil speakers used mid-low-mid-low patterns to express sarcasm while speaking in Tamil. As similar patterns were seen in the present study, it can be concluded that Tamil speakers use similar patterns to express sarcasm while speaking in Tamil and English.

Seven sentences produced by Tamil speakers were identified as expressing surprise in the perceptual task. Two of these sentences showed a rise-fall pattern of frequency. The other patterns, each observed in one sentence were i) flat-fall-flat-rise, ii) fall-rise, iii) rise-flat-rise-flat, iv) fall-rise-fall, v) rise-fall. Five of the intensity curves showed a rise-fall-rise-flat pattern; while two showed a rise-flat-fall pattern. Typical frequency and intensity patterns for surprise are shown in Figure 4.6a and 4.6b.



4.6a: Typical F_0 curve for surprise expressed by Tamil speakers

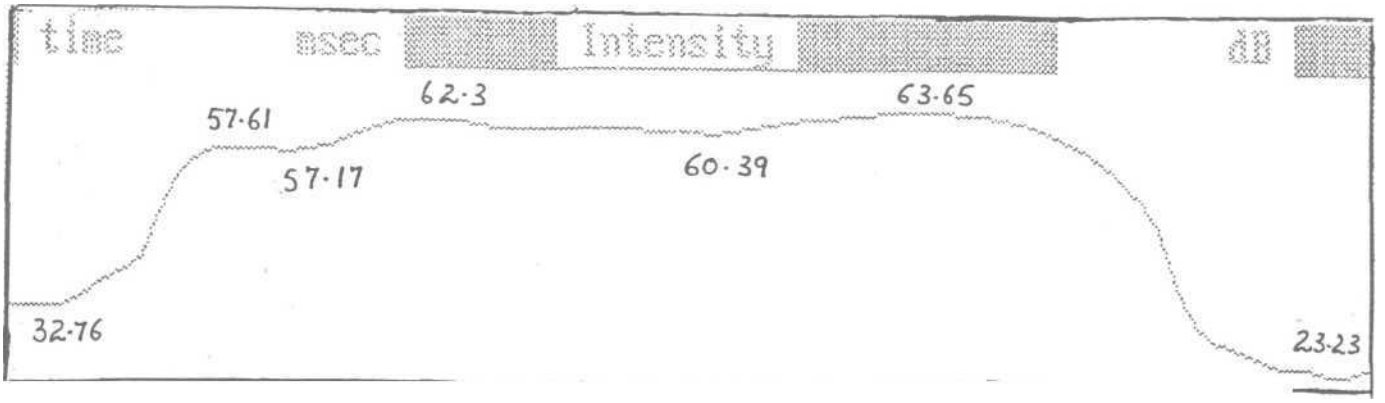


Fig. 4.6b: Typical intensity curve for surprise expressed by Tamil speakers

It was concluded that Tamil speakers use a variety of frequency patterns to express surprise. A majority of Tamil speakers expressed surprise using a rise-fall-rise-flat pattern of intensity. Nataraja (1985) found that Tamil speakers used a high-mid-high frequency pattern to express surprise while speaking in Tamil. As similar patterns were observed in the present study, it was concluded that Tamil speakers use similar patterns to express surprise while speaking in their mother tongue and in a second language English.

Ten sentences produced by Tamil speakers were identified as expressing anger in the perceptual analysis. These sentences were analyzed for frequency and intensity. Seven of them showed a gradually falling frequency pattern. The other three patterns observed were i) rise-fall, ii) fall-rise-fall and iii) flat-rise-fall. All the intensity curves showed a rise-fall type of pattern. Figure 4.7a and 4.7b show typical frequency and intensity for anger.

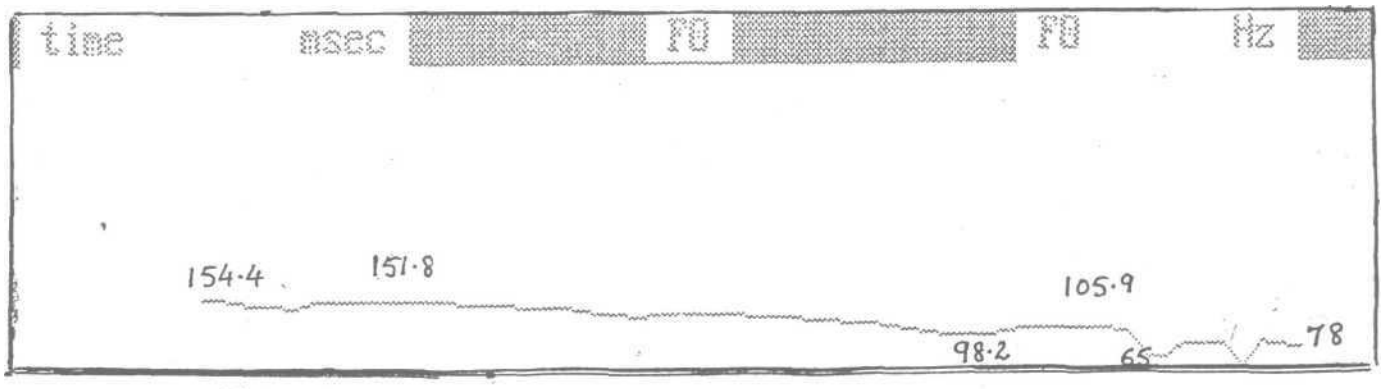


FIG 4.7a

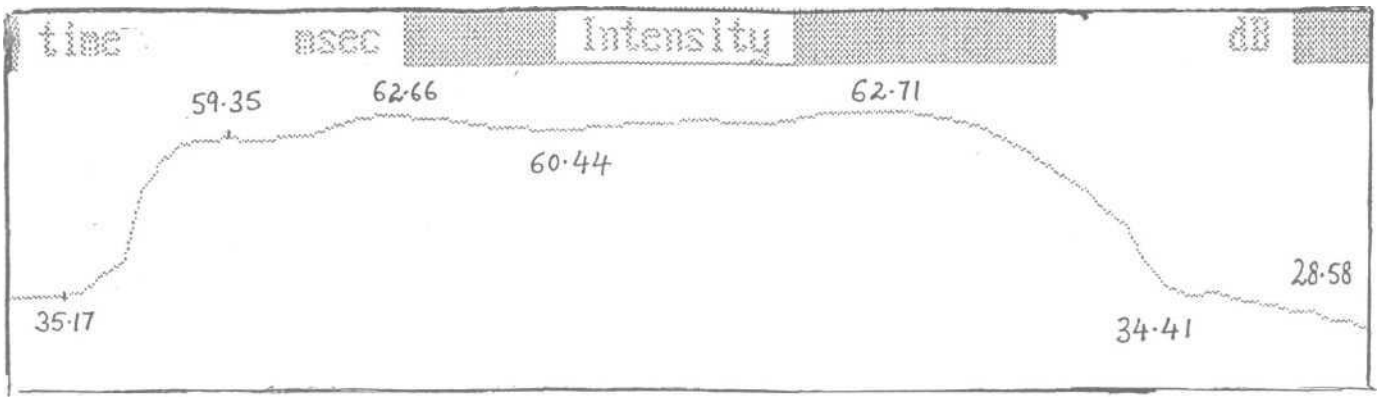


Fig. 4.7b: Typical intensity curve for anger expressed by Tamil speakers

It was concluded that majority of Tamil speakers expressed anger using a gradually falling frequency pattern and a rise-fall type of intensity pattern. Nataraja (1981) found that speakers with Tamil as their mother tongue used a mid-low-mid pattern of frequency to express anger while speaking Tamil. As this pattern was seen in the present study, it was concluded that Tamil speakers use similar frequency patterns to express anger while speaking in their mother tongue and in English.

To conclude, frequency patterns used by Tamil speakers to express emotions in Tamil are similar to those they use in English. Intensity patterns do not seem to be a determining factor for identification of emotion in Tamil.

To conclude, individual patterns do exist in each of the four languages. These are described in Table 2. However, the great degree of overlap between these patterns makes it difficult to draw strict lines and conclude that a

Kannada	Hindi	Malayalam	Tamil
Statement			
Frequency patterns:	Frequency patterns:	Frequency patterns:	Frequency patterns:
Rise-fall-flat, fall-flat, flat-rise-fall-flat, gradual fall, fall-rise-fall, fall-flat-rise-fall, flat-rise-fall, flal-rise	flat, flat-fall, flat-rise rise-flat-rise, flat-fall-rise-fall, flat-fall-rise and flat-fall, rise-fall-rise	flat, gradual fall-rise-flat-fall, flat-fall-flat,rise-fall-flat, flat-rise, gradual fall, fall-rise-fall, flat-rise, flat-rise-fall	flat-gradual fall, rise-fall-flat, flat-rise, fall, flat-fall-rise, rise-flat-fall, fall-rise-flat, flat-rise-fall-flat
Intensity patterns: Rise-fall-rise-flat-gradual fall	Intensity patterns: rise-gradual fall	Intensity patterns: flat-gradually falling, rise-fall-rise-flat-fall-rise-fall	Intensity patterns: flat-gradually falling
Joy			
Frequency patterns:	Frequency patterns:	Frequency patterns:	Frequency patterns:
Flat, gradual falling, gradual rise-gradual-fall	flat-fall, fall-rise-flat gradual-rise, rise-fall-flat-fall, rise-fall-rise-fall, rise-fall-rise, rise-fall-flat-fall-rise, flat	rise-fall, flat, fall-rise-fall, fall-rise-flat-fall, rise-fall-flat-rise, flat-rise-fall-fiat-rise, rise-fall-flat, fall-flat-fall-rise-flat-rise-fall	rise-fall-rise-flat, flat-fall-rise, fall-rise-fall, flat-rise-fall-flat, rise-fall
Intensity patterns:	Intensity patterns:	Intensity patterns:	Intensity patterns:
Rise-fall-rise-fall	rise-fall-rise-fall, flat-gradual fall	rise-fall	rise-fall-rise
Disappointment			
Frequency patterns:	Frequency patterns:	Frequency patterns:	Freguency patterns:
Flat, gradual fall, flat-fall-rise-fall-flat, flat-rise-flat, fall-flat-rise-flat-rise-fall, fall-rise-fall-flat	flat-fall-rise-fall, flat-fall-rise-fall, flat-rise-fall, fall-rise-fall, fall, rise-fall, flat-fall-flat, fall-rise-flat-rise-fall	flat-rise-fall-flat, fall-flat-rise-flat-rise, flat-rise-fall-rise-fall, fall-rise-flat, flat-rise-fall-flat	fall-rise-flat, fall-rise-flat, flat-rise-flat, fali-flat-rise
Intensity patterns:	Intensity patterns	Intensity patterns:	Intensity patterns;
Flat-fall-rise-flat, flat	rise-fall, rise-flat-fall	rise-fall, rise-flat-fall	rise-fall, rise-flat-fall

Kannada	Hindi	Malayalam	Tamil
Fear			
Frequency pattens	Frequency patterns	Freguency patterns:	Freguency patterns;
Flat gradually falling, rise-fall	rise-flat, rise-fall, fall-rise-fall-rise	rise-fall-rise, rise-fall-rise-flat, rise-fall-rise-fall, fall-flat-rise	flat, fall-rise-fall-flat-rise, fall-rise-flat-fall-rise
Intensity patterns:	Intensity patterns:	Intensity patterns:	Intensity patterns:
Gradual fall	rise-fall-rise-flat, flat-fall	rise-fall	rise-flat-fall-flat, rise-fall-rise-flat-fall
Sarcasm			
Frequency pattern	Frequency pattern:	Frequency pattern:	Freguency patterns:
Gradual fall	flat-fall-rise-fall	fall-rise-fall	flat, flat-fall-rise-fall
Intensity pattern	Intensity pattern:	Intensity patterns:	Intensity patterns:
rise-fall-rise-fall	rise-fall-rise-flat-fall-flat-fall	rise-flat-fall	rise-flat-fall, rise-fall-rise-fall
Surprise			
Frequency pattern	Freguency patterns:	Freguency patterns:	Freguency patterns;
Gradual fall, gradual rise, steep fall	gradual rise, rise-fall-rise, flat-gradual rise, rise-fall-rise-fall, gradual fall-rise, rise-flat, fall-rise-fall, rise-fall-flat, flat-rise-fall-gradual rise	gradual rise, fall-rise-fall, rise-fall-flat, rise-fall, rise-fall-rise, fall-flat-rise-fall	rise-fall, flat-fall-flat-rise, fall-rise, rise-flat-rise-flat, falil-rise-fall, rise-fall
Intensity pattern	Intensity pattern:	Intensity patterns:	Intensity patterns:
Rise-fall-gradual fall	gradual fall, rise-fall-rise-gradual fall	Rise-flat-fall, rise-fall	rise-flat-fall, rise-fall-rise-flat

Kannada	Hindi	Malayalam	Tamil
Anger			
Frequency patterns	Frequency patterns	Frequency patterns	Frequency patterns
fall-rise-fall, flat-rise-fall-flat, fall,fall-rise-fall-rise-flat-fall, rise-fall-rise-fall, flat	gradualfall, flat-fall-rise, flat-fall, flat-rise-fall, flat-gradual-rise	flat-rise-fall-flat, rise-fall, fall-rise, gradual fall, flat-rise	gradual fall, rise-fall, fall-rise-fall, flat-rise-fall
Intensity pattern:	Intensity patterns:	Intensity patterns:	Intensity patterns:
rise-fall-rise-fall	rise-fall, gradual fall	rise-fall	rise-fall

Table 2: Patterns observed for various emotions expressed by individuals with different mother tongue

particular pattern exists only in a particular language. There are similarities in patterns of intonation for emotion produced by speakers of different languages while speaking a second language English.

The individual patterns produced by male and female speakers with the same first language were analyzed. No significant difference was found between patterns of male and female speakers for the same emotion.

Speakers with the same mother tongue used different patterns to express a particular emotion. Eg. the emotion 'anger' was expressed using different patterns by different Kannada speakers. Hence the hypothesis that all speakers with the same mother tongue used the same pattern of intonation to express a particular emotion was rejected.

The hypothesis that speakers with different languages as their mother tongue use different patterns to express emotions was rejected; as most of the patterns for a particular emotion were seen in more than one language.

There were similarities between frequency patterns used by speakers with Kannada as their mother tongue to express various emotions in Kannada and English. Thus, the hypothesis that mother tongue has no influence over the productions of Kannada speakers in a second language English was rejected.

The intonation patterns used by Hindi speakers to express emotions were different (except for statements and fear) when they spoke in their mother tongue and in a second language English. Hence the hypothesis stating that mother tongue has no influence on the productions of Hindi speakers in a second language English was accepted.

The intonation patterns used by Malayalam speakers to express emotions when they spoke in their mother tongue and in a second language English were similar (except for sarcasm). Hence the hypothesis stating that mother tongue does not have influence on the productions of a Malayalam speaker in the use of a second language was rejected.

There are similarities between the intonation patterns used by Tamil speakers to express emotions in Tamil and in English. Hence the hypothesis that mother tongue does not influence the productions of a Tamil speaker on his productions in a second language English was rejected.

A perceptual study was carried out in which subjects were asked to identify emotions behind sentences they heard. This study gave the following results:

- All the subjects showed wide variation in identifying emotions. The same emotion was identified correctly in one sentence and as another emotion in other

sentences. For eg: They correctly identified the sentence. 'Today we have bread for breakfast' as expressing disappointment, but judged the sentence 'That is your house' as expressing a statement rather than disappointment. This again varied between the samples. Each subject identified the emotions behind some subjects sentences better than those of others, but there was no fixed pattern.

- The subjects did not show any preference for language - they did not identify the emotions which the speaker intended even when the speaker belonged to his own mother tongue. For eg: A Tamil speaker identified emotions expressed wrongly, even when the sentences were produced by a speaker with mother tongue Tamil.

- Subjects identified the emotions better in the productions of some speakers. This was common across all the subjects (Table 3).

- The number of emotions identified correctly from each speaker's productions by each listener is given in Table 3.

	M_H	F_H	M_M	F_M	M_T	F_T	M_K	
H_{M1}	10	13	13	9	9	10	10	9
H_{M2}	14	12	13	10	11	9	10	11
H_{M3}	11	13	8	6	9	9	9	9
H_{F1}	10	14	9	11	8	12	9	8
H_{F2}	10	14	14	8	10	13	11	7
H_{F3}	13	14	15	12	12	14	12	14
K_{M1}	12	13	10	11	8	12	11	11
K_{M2}	11	12	13	9	10	8	12	7
K_{M3}	12	10	12	9	9	11	11	10
K_{F1}	12	10	13	8	11	9	9	7
K_{F2}	12	14	11	10	9	12	11	11
K_{F3}	14	14	14	12	14	13	11	13
M_{M1}	12	13	4	6	9	9	7	11
M_{M2}	14	13	12	9	11	15	11	12
M_{M3}	13	13	13	10	11	14	8	12
M_{F1}	10	8	8	7	8	5	10	7
M_{F2}	13	11	11	7	9	10	9	8
M_{F3}	12	12	11	9	10	13	8	12
T_{M1}	13	13	12	12	11	11	12	11
T_{M2}	11	12	11	9	10	11	12	9
T_{M3}	14	12	12	10	13	12	11	11
T_{Fl}	3	9	8	6	6	7	5	7
T_{F2}	13	12	9	7	10	13	9	13
T_{F3}	15	13	15	12	13	15	12	15

Table 3: Number of English sentences out of fifteen identified correctly for emotion by subjects representing four first languages across speakers with different first languages

MH : Male Hindi speaking subject

FH : Female Hindi speaking subject

MM : Male Malayalam speaking subject

FM : Female Malayalam speaking subject

MT : Male Tamil speaking subject

FT : Female Tamil speaking subject

MK : Male Kannada speaking subject

FK : Female Kannada speaking subject

H_{M1}, H_{M2} , H_{M3} : Male Hindi speakers

H_{M1}, H_{M2} , H_{M3} : Female Hindi speakers

K_{Ml} K_{M2} K_{M3} : Male Kannada speakers

K_{F1}, K_{F2} K_{F3} : Female Kannada speakers

M_{M1}, M_{M2}, M_{M3} : Male Malayalam speakers

M_{F1}, M_{F2}, M_{F3} : Female Malayalam speakers

T_{M1}' T_{M2}, T_{M3} : Male Tamil speakers

T_{F1} , T_{F2}, T_{F3} : Female Tamil speakers

SUMMARY AND CONCLUSION

Speech is a form of communication that employs a linguistic code (language), which may be thought of as a systematized code of arbitrary symbols, basically vocal, but reinforced by visible bodily activity (Gray and Wise, 1946).

Continuous speech is the smooth functioning of respiration, phonation, articulation, resonation and prosody or suprasegmentals in an interactive manner.

Suprasegmentals or prosody; which are variations larger than individual segments of speech, include intonation, rhythm, stress and juncture.

Studies on intonation using acoustic analysis have concluded that frequency and intensity cue intonation.

The present study was carried out with the aim of investigating the effects, if any, of an individuals first language on speech production and perception; to be precise, the production and perception of intonation in its emotive use.

24 speakers representing the four languages were required to produce sentences in English, expressing

different emotions. These recorded samples were perceptually analyzed for identification of the emotions, by 8 subjects, again representing these four languages. The sentences which were correctly identified for emotion by at least 6 of these subjects were taken for analysis. These intonation patterns were analyzed using their fundamental frequency (F_0) and intensity curves. These curves were analyzed for their overall shape, individual patterns of F_0 and intensity curves for each particular emotion, patterns for a single emotion across speakers representing different first languages and the range of F_0 and intensity across languages.

The following results were obtained:

- There was no single pattern of intonation used by speakers with the same mother tongue to express a particular emotion.

- Speakers with different mother tongues used similar patterns to express emotions.

- Intonation patterns used for expressing emotions in productions in the first language ware seen in productions in English also. This similarity was seen in Kannada, Malayalam and Tamil. Thus it can be concluded that in these languages the mother tongue influences production of emotions in a second language English. Intonation patterns used by Hindi speakers however, were different when they spoke in Hindi and English. Thus it was concluded that

mother tongue of Hindi speakers did not have any influence on their productions in a second language English.

The range of fundamental frequency used to express emotions was also found to differ between speakers with different mother tongues. Malayalam speakers tended to show the maximum range for all emotions except surprise. Tamil speakers have shown lowest F_0 range for fear, sarcasm and anger, whereas Kannada speakers have shown the lowest F_0 range on the remaining emotions, i.e. Statement, Joy, Disappointment. The highest range of F_0 was produced by Malayalam speakers whereas the lowest range of F_0 was produced by Hindi speakers.

Speakers with different mother tongues did not perceive emotions in the same way, leading to the conclusion that mother tongue influences the perception of emotions in a second language.

Implications of the study

The results of the study can be used for therapy in intonation patterns for different language disorded individuals like aphasics and the hearing impaired. The results can also be used in second language learning. Information regarding the influence of mother tongue on perception of intonation in second language can also be obtained from the results.

BIBLIOGRAPHY

Balasubramanian, T. (1981): Duration of vowels in Tamil, Journal of Phonetics, Vol. 9, pp. 151-161.

Borden, G.J. and Harris, K.S. (1980):Speech Science Primer. Physiology,Acoustics and Perception of Speech. Williams and Wilkins. Baltimore/London.

Crystal, D. (1969): Prosodic systems and intonation in English, Cambridge University Press.

Crystal, D. (1971): Linguistics, Penguin Books Ltd.,England.

Elizabeth (1983): Effect of training and native language on scoring the responses on a speech discrimination test in English.

Freeman, F.J. (1982): "Prosody in perception, production and pathologies". Lass, N.J. et al., Speech, Language and Hearing - Normal Processes, Vol. 1, W.B. Saunders Company.

Gray and Wise (1959): Bases of speech, 3rd edn. Harper and Row Publishers, New York, Evanston and London.

Hege, J.E. and Efting, W. (1987): Production and perception of English stops by native Spanish speaker, Journal of Phonetics, Vol. 15, pp. 67-84.

Hege, J.E. and Wang, C. (1989): Native language phonotactic constraints affect how well Chinese subjects perceive the word final English t-d contrast. Journal of Phonetics, Vol. 17, pp. 299-315.

Kurath (1964): A phonology and prosody of modern English. University of Michigan Press.

Manjula, R. (1979): Intonation in Kannada, Some Aspects. A dissertation submitted to the University of Mysore in part fulfilment of Master's Degree.

Nandini, H.N. (1985): Some prosodic aspects in Kannada - A Dissertation submitted to the University of Mysore in part fulfilment of Master's degree.

Nataraja, N.P. (1981): Intonation in four Indian languages under five emotional conditions. Journal of AIISH, Vol. 12, pp. 22-28.

Nataraja, N.P. (1985): Intonation in Indian languages under different emotional conditions. An unpublished study.

Pike, K.L. (1945): "General characteristics of intonation", Bollinger, D.

Rakesh, V. (1989): Cross language study of velar and bilabial stop perception. Journal of AIISH, Vol. 22-23; pp. 70-72.

Rathna, N..(1974): The challenge of languages to speech therapists in India. Journal of AIISH, Vol. 5, pp. 1-6.

Rathna, N. Bharadwaj (1977): Rate of speech in diferent Indian languages, Joural of AIISH, Vol. 8, pp. 57-61.

Rathna, N.; Nataraja, N.P., Subramanjaiah, M.G. (1981): A study on prosodic aspects of Kannada language. Journal of AIISH, Vol. 12, pp. 1-7.

Srivatsav, C.P. (1985): Some prosodic aspects in Hindi, A dissertation submitted to the Univerisy of Mysore in part fulfilment of Master's Degree.

Swarnalatha,K.C. (1972): The development and standardisation of speech test material in English for Indians. Journal of AIISH, Vol. 3, pp. 165-170.

Ravanan, M.P. (1993): Cross linguistic study of some temporal parameters. Dissertation submitted as partial fulfilment for degree of M.Sc. (Speach and Hearing), University of Mysore.

Usha Rani (1989): Temporal perceptual cues of velar and bilabial stop consonents. A dissertation submitted as partial fulfilment of Master's Degree to the University of Mysore.

APPENDIX

A. Materials

List of sentences and emotions:

1. I am going home tomorrow: Statement, Joy, Disappointment

2. That is your house: Surprise, Disappointment, Statement

3. Today we have bread for breakfast: Joy, Anger, Disappointment

4. He is coming here: Surprise, Fear, Statement

5. Sit down here: Surprise, Anger, Sarcasm

B. Responses

Sample of response sheet:

Name of subject:

First language

List of emotions: Joy, Anger, Fear, Statement, Sarcasm, Disappointment, Surprise

Sample 1

	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 2

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 3:

1	2	3 1
4	5	6
7	8	9
10	11	12
13	14	15

Sample 4:

	2	3
	5	6
	8	9
	11	12
	14	15

Sample 5:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 6:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 7:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 8:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 9:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 10:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 11:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 12:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 13:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 14:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 15:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 16:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 17:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 18:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 19:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 20:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 21:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 22:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 23:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Sample 24:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15