

"INTONATION IN BENGALI - SOME ASPECTS"

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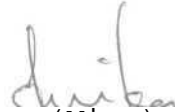
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DECLARATION

This dissertation entitled "Intonation in Bengali-Some aspects" 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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CHAPTER - 1

INTRODUCTION

"Language is a purely human and non - instinctive method of communicating ideas, emotions and desires by means of a system of voluntarily produced symbols" (Sapair, 1921).

Language is described as the transmission of utterances in an intelligible and meaningful fashion. These utterances are studied in units referred to as linguistic units. The properties of linguistic units are phonology, semantics, morphology, syntax.

Phonology is the study of the sound system of the language containing acoustical characteristic of speech. It is divided into segmental and suprasegmental phonemes. Phonemes are elements common to a group of sounds. Segmental phonemes are vowels, semivowels and consonants. The other portion of phonology involves the supra-segmental phonemes or the stress, intonation and juncture features of an utterance (Fry, 1978).

Intonation an aspect of prosody is an Important factor in normal speech. If this aspect of prosody is affected one can feel the aberration in speech. "Intonation, like every thing else in a language, is one instrument in an orchestra".

(Bolinger, 1972). Many times a sentence spoken to express a particular emotion with inappropriate intonation does not bring the wanted effect on the part of the listener and the speaker is misunderstood. One should know the different intonation patterns for different emotions before producing them.

Spoken sentences are strings of segments that vary not only in spectral quality, but in frequency, amplitude, and relative length. To understand what a speaker has communicated, a listener must identify the segments that is composing the utterance, and the order in which they occur; but a good deal of information is also encoded in the frequency, amplitude and timing variations, ie, the prosody of the utterance, and listeners makes good use of it. Prosodic processing can be so efficient that the listeners will attend to prosodic continuity at the expense of semantic continuity (Darwin, 1975).

Prosody has been viewed as decorative ornamentation, functioning to make speech mere aesthetically pleasing (Freeman, 1983). Intonation is one aspect of prosody. It is the salt of an utterance and without it a sentence can be understood but the message is colourless and tasteless.

Incorrect use of it can lead to embarrassing ambiguities (Delattre, 1962).

Stress is the feature of speech used to emphasis on accent. Relative stress is accounted for by measurable changes in intensity, duration and fundamental frequency. Stress can be phrase, sentence, word or also can be in form of contrastive stress. In English word stress operate phonetically on the syllable (Mackay, 1978) to aid us in distinguishing among word meanings. Subtler and synchronous changes in duration, loudness, and pitch allow us to perceive and attribute the proper meaning to the words. In phrases the semantic and syntactic relationship among words determine that some of them take the distinctive stress pattern. Sentence stress is distributed based on rules. Information bearing or content words receive greater stress than the functors in a sentence (Mackay, 1978)' Contrastive stress occurs in spoken English in relation to certain well specified conditions of discourse.

Intonation is one of the more endearing aspects of the suprasegmentals. Bolinger (1972.) stated "Intonation is the broad undulation of the pitch curve that carries the ripples of accent on its back. Sarcasm, irony and various types of humor are also dependent upon intonation changes. It is

important to emphasize that all of the consequences of prosody interact. Suprasegmentals like stress, rate and intonation are constantly used together in speech and combined in appropriate ways to produce the desired linguistic effect.

Bolinger (1972) stated that most important grammatical function of intonation in language is to tie the major parts together within the sentences and tie sentences together within the conversation. It gives information about where the division of the sentence comes, what is subordinate to what, and whether speaker is saying, asking or commanding.

People often get annoyed not by what has been said to them, but by the way it has been said. Pike (1945) stated that "often people react more violently to the intonational meanings than to the lexical ones". There are some researchers who claim that intonation plays only peripheral part (Bolinger, 1972), on the other hand there are those who show that intonation is the most 'central' aspect of our oral communication. (Lado, 1961; Pike, 1945; Lieberman, 1962).

Whether it is a form of 'central' aspect of oral communication or not, has been neglected in many languages. This neglect was noticed by Lado (1961) who said that "inspite of its importance in many languages, intonation

signals have been the last to be analyzed linguistically, and still remain somewhat controversial in the few languages which has been analyzed . A possible explanation of this may be the fact that intonation pattern seem to be learned at the earliest stages of language learning and are deeply embedded in the habit mechanism of our use of language.

OBJECTIVE OF THE STUDY

1. To analyze the listeners responses to the emotional utterances of the speakers.
2. To see the patterns of intonation in the sentences spoken by the speakers with various emotions.

NEED FOR THE STUDY

The literature of communication disorder is filled with diagnostic description of the dysprosodic speech. Every major category of disordered speech is chanelised by some degree of disrupted prosody. Abnormal prosody is a primary salient characteristics of the speech of the deaf. Further, deficiencies of speech perception and production of prosodic features are present in large number of language disordered children and adults.

Speech pathologists can readily recognize dysprosody and have attempted systematic description of some abnormal

dysprosodic patterns (Darley, 1979), but successful treatment methods aimed at the restoration or establishment of natural prosody are infrequent in literature. Therefore, the study of normal prosodic aspects is essential.

Intonation plays an important role in the understanding of speech, and it is essential to know the intonation pattern of a language. This in turn helps speech pathologists to plan and execute therapy of cases, as teaching intonation is a part of language therapy for deaf and other cases.

Very few studies on intonation have been done in Indian languages, and no information is available on intonation in Bengali language has not been given much attention. Thus there is a need for the study of intonation in Bengali.

HYPOTHESIS

1. In Bengali different intonation patterns are used in expressing different types of emotions ie., there is fundamental frequency variation with in the sentence as related to emotion expressed.
2. Intensity variations that occur in the sentences do not show difference between different types of emotions.
3. The native speakers can identify the intonation patterns better than non native speakers.

IMPLICATIONS OF THE STUDY

1. This study provides information regarding intonation in Bengali language.
2. The procedure developed by this study can be used to study the intonation in different languages.
3. The intonation patterns identified by this study, can be used for giving therapy to speech and language disordered cases.
4. To teach intonation in deaf children.
5. For further research.

LIMITATIONS

1. Randomly selected sentences have been taken, and the number of sentences for a particular emotion is not equal.
2. The dialogues from film stories depicting various emotions have been selected. These samples may not be equal to natural speech.
3. Spontaneous speech not considered in the study and no comparison was made between the intonation patterns in spontaneous speech and the sentence selected from the audio-tapes of film stories.
4. Synthesized speech was not used so the intonation patterns of the test sentences were not isolated from the other prosodic variables.

REVIEW

Speech is a form of a language that consists of sounds produced utilising the flow of air exhaled from the lungs. Speech is an established communicative system of arbitrary and conventionalized acoustic symbols, produced mainly by the action of muscle of the respiratory and upper respiratory tracts (Travis). Speech is a form of communication by which transmission of information takes place by means of sound waves which are in form of acoustic energy (Fant). Man's primary method of communication is speech. Speech may be viewed as the unique method of communication evolved by man. By its great flexibility, it permits man to produce a variety of signals to commensurate with the richness of his imagination. At the same time, the ability to think in terms of purposiveness and causality enables man to expand enormously his use of reciprocal communication for the coordination of social activities (Eisenson and Irwin, 1963).

When one analyses good speech, the speech that most adequately contributes to social interaction, it is discovered, that it possesses certain characteristics. Each of these characteristics makes its particular contribution to the total impression. Some of these important characteristics of speech are loudness, pitch, intonation and inflection,

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rhythm, voice quality, articulation, stress, accent style, level of language, kind of language.

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

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

Prosodic features may extend over varying domains. Sometimes over relatively short stretches of utterances, like one syllable or one morpheme or one word and sometimes over longer stretches of utterances, like one phrase, or one clause, or one sentence. Intonation is relatable to longer stretches of utterances (Cruttenden, 1986).

The prosody of connected speech may be analysed and described in terms of the variation of a large number of prosodic features. There are however, three features, which

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are most consistently used for linguistic purposes, either singly or jointly. These three features are pitch, length and loudness. Pitch concerns the varying height of the pitch of the voice over one syllable or over a number of successive syllables; length concerns the relative durations of a number of successive syllables or the duration of a given syllable in one environment relative to the duration of the same syllable in another environment; loudness concerns changes in loudness within one syllable or the relative loudness of a number of successive syllables. At linguistic level, speech can be viewed as organised by stress and intonation into suprasegmental units nested within. This is the organisation format for normal speech production and this organization significantly facilitates perception of the speakers "message". (Harris, 1978).

The pitch is an important characteristic of speech. For every voice there is a general pitch level known as optimum pitch at which the voice will be found to be most comfortable or most effective. This level will vary from person to person and each person will find it easily possible to make a considerable number of variations from this general level. The normal range of pitch variations depends upon sex, age, and several other factors. The voices of men are generally lower in average pitch than those of women. Under conditions

of excitement, many people have voices which break or show pitch breaks.

Loudness or intensity is another important aspect of speech. Loudness is the psychological correlate of intensity. Loudness depends on many factors. But the important factors which determine loudness are intensity and frequency of the sound.

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

Intonation and inflection are two other characteristics of speech which go hand in hand with pitch. Inflection is the shift in pitch during the utterance of a syllable. There are times when it is appropriate to speak with a minimum of inflection. But a person who consistently talks with a monopitch will find his listener either irritated or asleep. A true monotonous voice is comparatively rare, but it dominates any conversation by its difference. Intonation is an exclusive term referring to pitch as a function of time and may be applied to a simple inflexion or to long term

variation is phrases over numerous inflexional shifts (Greene 1964)-

"Intonation, like everything in language, is one instrument in an orchestra". (Bolinger, 1972). It is the variations of pitch as applied to the whole sentence. Bolinger (1972) considers intonation as only a "peripheral part of the oral communication". According to Bolinger (1972), "Intonation is not as 'central' to communication as some of the other components of language. If it were, we could not understand some one who speaks in a monotone, and in so far as our comprehension of written language is due to its being a faithful reproduction of speech, we could not read".

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

attitudes are conveyed such as doubt, agreement, questioning, affirmation, continuing interest etc.

"Intonation is the linguistic form in which the speaker organizes certain kinds of information" (Denes, 1959). "Intonation is the perception of changes in the fundamental frequency (Fo) of vocal cord vibration during speech production" (Minifie, 1973). The acoustic cues for prosodic features which have received the most extensive attention are fundamental frequency, intensity and temporal spacing of acoustic events.

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

Pisoni and Saweesh (1975), "Prosody may serve as the inter-face between low level segmental information and higher level grammatical structures in speech". Later this interfacing role of prosody was elaborated by stating that "Prosody carries direct phonetic cues to certain semantic and grammatical classes".

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

Prosodic features including intonation, rhythm and stress fulfil important functions in speech perception and production. Perceptually, prosodic information assists the listener in segmenting the flow of speech by contouring words. Syntactically, prosodic features help differentiate among different patterns. Lexically, prosodic features aid in differentiating grammatical categories, such as verbs and nouns. In addition, prosodic features also relate to specific pragmatic functions. For eg: contrastive stress is used to distinguish between topic and comment (Chafe, 1970). He also added that it is used to distinguish new and old

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information in discourse. The new information is generally stressed while the old information is not. Bolinger (1912.) explained the linguistic stress functions to set off elements which carry a heavier information load and which the speaker wishes to place into focus. In production speaker can speak rapidly and carelessly stress on unstressed elements controlling on careful articulation on only critical elements. Another major function of stress is to indicate the syntactic relationship between words or parts of word.

There are many noun-verb oppositions in English. The placement of stress indicates the syntactic function of the word. Similar oppositions occur in cases where two word phrases form compounds such as "a walk out", "to walk out" In these cases, there is a stress only on the first element of the compound for the nouns, but on both elements for the verbs.

Amplitude modulation is manifested in language by what is most commonly termed as stress it has however been observed that what is interpreted by the speaker or hearer has no simple correlation with loudness. Stress is marked by alternations of pitch, loudness, tempo and perceived segment duration.

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

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

Stress in speech is dependent upon increase in breath force or a fuller use of resonances. Inflection is accompanied by minute adjustment in length and a tension of the folds which produce expressive pitch glide. The meaning of speech is purely dependent upon the factors of stress, pitch, or pace, which are conceived intellectually as a rhythmic sequence of events or coherence of what would

otherwise be the utterance of a disconnected series of vowels and constants (Winckle, 1970).

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

Rhythm in speech is "a pattern of vocal change", draws attention to the need for regular lung ventilation or breathing pattern which underline pauses, stress, rate, pitch or intensity. Refers to the relative stress of syllable in a word. Rhythm also plays a important role in speech.

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

During the second half of the year, the intonational capacities were further augmented. The important observation made was that the new forms of intonational expressions appeared at greater intervals from third month onwards. Exclamatory delight, with a calmer, satisfied sound were not differentiated from the intonation of happiness until the 6th month. A requesting intonation developed from the seventh month and a questioning intonation did not appear until the second year. The above studies show the importance of intonation in the expression of emotions in speech in as young age as few months.

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

1. The prosody has a guide function, i.e. it helps the hearer
 - a) to extract the relevant signal from the noise
 - b) to direct the hearers attention to the most important element of an utterance.
2. It divides longer sentences into smaller units.
3. It signals the information focus of a sense and with a tonal accent on one of the words in the unit.
4. It expresses the interactional role of an utterances with in a complex sequence.
5. It indicates the speaker's attitude.

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

It becomes essential to differentiate intonation from the 'tone' of a tone language. In tone languages, pitch contours are located on single syllables and not on groups of syllables or on an entire sentence as in intonation. These words cannot exist until their phonemic tone exists along with its sounds. Tone also carries the basic lexical meaning of the word.

It is a well known fact that intonation patterns are acquired by children even before the actual acquisition of speech sounds. Even though no systematic studies were conducted, the importance of intonational variations in infant vocalizations and speech has been recognised and observations were noted down as early as in 1920's. The shift of intonation as a meaningful speech signal that has a

reference to specific social situations was comparatively rapid. Schafer (1922) reported that a nine month old infant who responded to the intonation of a phrase by looking at the clock also looked at the clock when similar phrases were spoken with the same intonation. Lowenfeld (1927); Buhler and Hetzer (1928) -reported that infants from the age of 2 months onwards, responded positively to the human voice, while infants from the age of 3 months onwards responded positively to friendly tone and negatively to angry tones of voice.

In another study conducted by Corlew (1968), to know the development of the recognition abilities of intonation contours in English, two series of experiments were conducted. These two series investigated the information conveyed by intonation from speaker to listener. A multiple choice test was devised to test the ability of 48 adults to recognize and label intonation when it was separated from all other meanings. Nine intonation contours whose labels were most agreed upon by adults were each matched with two English sentences (one with appropriate and one with inappropriate intonation and semantic content) to make a matching test for children. The matching test was tape recorded and given to children in the first, third and fifth grades. (32 subjects in each grade). The first grade children matched the

intonation with significantly fewer sentences than either the third or fifth graders. Some intonation contours were matched with significantly greater frequency than others. The performance of the girls were better than that of the boys on an 'impatient' question and 'simple command' which indicated that there was a significant interaction between sex and intonation. The suprasegmental features are a direct bridge to meaning, revealing as they do the attitudes and feelings of the speaker in ways the segmental information alone can never do. The use of changing F_0 , perceived as the pitch pattern or intonation contour of phrase/sentence is particularly effective in expressing difference in attitudes and also difference in meaning. American English sentences are often characterized by a rise-fall intonation curve. The pitch rises during the first part of an utterance and falls at the end. This is generally the declarative sentences and of questions which are impossible to answer with 'yes' or 'no'. Another intonation curve common in English is the end - of - utterance pitch rise. Pitch rise indicates a question to be answered with 'yes' or 'no'. It may also indicate that the sentence is incomplete (Lieberman, 1980).

Rising intonation results chiefly from increased cricothyroid muscle activity, lengthening the vocal folds for

faster vibration. Falling intonation accompanies the decrease in intensity at the end called the breath group. The decrease in subglotal pressure is accompanied by both intensity and F_0 declines. This pattern called an unmarked breath group. (Lieberman, 1980).

Intonation marks syntactic contrasts, changes meaning, and signals, attitudes and feeling. Excitement, including some kinds of anger and states of enthusiasm, is often accompanied by large shifts in intonation, with calm, subdued states, including some forms of grief, anger, peacefulness, and boredom characterized by a narrow range of intonation variation.

Perception of the prosodic aspects takes place by tracking the fundamental frequency and thereby perceive significant changes in fundamental frequency (F_0) resulting in various intonation contours. Listeners perceive the proper fundamental frequency even when it is absent, as long as they can hear the harmonic structure, formed by multiples of the F_0 (Fry, 1978). To perceive the prosodic feature of stress, listeners apparently use frequency, intensity, and duration as perceptual cues. Fry (1978) has stated that the fundamental frequency is the most powerful cue to stress. The prosodic feature of juncture can be cued by silence,

vowel lengthening, or by features such as presence of voicing or aspiration.

Intonation - groups align with larger syntactic constituents and most commonly it corresponds with clauses. But very often they also correspond with adverbials which are modifying a whole clause. Different descriptions of intonation have emphasised grammatical meanings, attitudinal meaning and discursal meanings. Emphasising grammatical meanings suggests that there are typical tones associated with syntactic structure like declaratives, interrogative and imperatives; and that the discursal meanings usually associated with these structures that is statements, questions, and commands will also have typical tones even when they are not marked syntactically. A discursal approach to the meaning of tones deals in concepts like shared mutual knowledge of speaker and listener, the desire of the speaker to dominate listeners and the sort of expectation which a speaker has about a listener's reply. (Cruttenden, 1986).

The linguistic features of intonation are determined by factors like the fundamental frequency, intensity and duration. Most of the investigators refer to the fundamental frequency as the essential ingredients of intonation but some

do not. "The intonational differences heard as high or low, rising or falling are primarily related to the frequency of the sound waves" (Lado, 1961).

Pike (1945), while describing the role of fundamental frequency says that "every sentence, every word and even every syllable is given some pitch when it is spoken". Even a sound is produced at certain pitch level. The changes in pitch which occur within a sentence are either semistandardized or standardized, so all speakers of the language use basic pitch sequences in similar ways under similar circumstances. However, it is difficult to analyse the language of a native speaker in order to find organisation and rules in terms of pitch variation".

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

The acoustic cues for prosodic features which have received the most extensive attention are fundamental frequency, intensity, and temporal spacing of acoustic events (most frequently expressed as duration and rate measurements). These cues may carry segmental information also. The acoustic cues of fundamental frequency (F_0) and intensity have been experimentally demonstrated to be closely related to perceptions of pitch and loudness. While F_0 and intensity are independent acoustic events in both production and perception, they are intimately linked. For example, in production, the rate of vocal fold vibration (F_0) is determined by glottal state (including degree of constriction and vocal fold tension) and by the transglottal pressure differentiated. Rate of vibration can be altered:

- 1) by increasing or decreasing subglottal air pressure,
- 2) by increasing or decreasing supraglottal air pressure.

Intensity which is a function of transfer of energy through the vocal tract, is determined by subglottal air pressure, degree of constriction and length of the vocal tract. Therefore there are a number of options for altering either parameters, independent variation of either parameter (ie., varying F_0 while holding intensity constant or vice-versa) which requires compensatory adjustments.

In general, while speakers can, and sometimes do vary F_0 and intensity independently, there is a strong tendency for changes in one parameter to be accompanied by some change in the other. For example, while increasing vocal intensity, most speakers also rise F_0 . Poor speech motor control is characterized by limited ability to vary these parameters independently, but trained speakers can produce precise independent variations.

Fundamental frequency (F_0), is a stronger cue than intensity, also tends to be used in conjunction with other cues and is in most circumstances a sufficient but not a necessary cue. In general the F_0 contour of a simple, declarative sentence or clause shows a F_0 peak on the first stressed syllable, with a gradual decline of F_0 on the final syllable of the utterance group. Faster, shorter rises and falls in F_0 , occurs during overall falling contour and coincides with the production of syllables perceived as stressed. Acoustic studies have shown that major clause and phrase boundaries of a variety of sentence type are typically characterized by a fall-rise pattern (Cooper and Soreson, 1977). The lowest point in the F_0 fall occurs just prior to the syntactic boundary. The F_0 rise may begin either just before the boundary or just after the boundary.

Series of experiments were conducted in order to see the relationship of intonation with as many different kinds of acoustic characteristics as possible. In these experiments speech analysis and speech synthesis methods were used and the analytical experiments were concerned with measuring the changes that occur in the acoustic characteristics of the speech wave when the various 'tones' of intonation are spoken. The aim of the synthesis experiments was to see the kind of intonation recognised by the listeners when they hear synthetic sounds generated according to various pre determined patterns. It was found that simple relationships existed between intonation and fundamental frequency - a straight forward fall in frequency for a falling "tone" or a simple rise in frequency for a rising intonation "tone". There was a rise for rising "tone" and a fall in fundamental frequency for a falling tone.

When the intensity graphs were inspected, it was found that on many occasions the shape of the intensity - time curves were similar to the fundamental frequency time curves. The exception was the high-rise "tone" for which two curves were consistently different. Also, the intensity curves always started and ended at zero while the frequency would start and end at any value. These effects would probably be less pronounced in speech over longer duration than when

syllables are considered. A study done by Denes (1959) confirmed that the movement of the third formant was related to the changes of intonation pattern.

Denes (1959), conducted a study to check whether the information about intonation is maintained while listening to synthesized speech in which the fundamental frequency is controlled by the intensity variation of a normal humanly produced speech sequence. The results showed that the control of the fundamental frequency of the synthesized sounds by the intensity of the input did provide cues for the recognition of intonation.

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

time. When only pitch information was presented, correct identification was made 44% of the time. When amplitude information was added to the pitch information, the identification rose to 47%.

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

In one of the experiments by Denes (1959), a vocoder was used. A vocoder is an analysis - synthesis telephone system in which a simplified version of the speech wave is transmitted. The output consisted of a sound wave with a spectrum that in broad outline corresponded with the spectrum of the speech wave produced by the speaker. This spectral

pattern could be excited at will with a periodic or a noise source, producing either voiced speech or whisper, and when present, the fundamental frequency of the output could be controlled separately. The vocoder was used in the following ways:

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

The input consisted of mostly words and very few sentences which were pronounced by expert phoneticians on a number of different tones ie., high-fall, low-fall, high-rise, low-rise, fall-rise and rise-fall. The corresponding output of the vocoder, which was adjusted in turn to all three conditions outlined above, was then interpreted by a few phonetically trained listeners.

The results showed that listeners had little difficulty in distinguishing the intonation "tones" when the vocoder was switched to whisper. The intonation was largely lost when monotone was used and the experiment was inconclusive when the fundamental frequency pattern of the output was varied arbitrarily.

Ross and Duffy (1973), conducted a study to find out which portion of the frequency curve contained sufficient prosodic features for listeners to correctly identify the intended emotions of speaker. An actor and actress simulated nine different emotions with the same passage in each of the nine different spoken paragraphs. The passage was edited from the tape (thus keeping the lexical information constant) and presented to listeners under five listening conditions:

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

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

In ancient Sanskrit literature, it is said that different types of intonation should be used in different situations (Savitri, 1978). "It is said that intonation will always be made high, excited and faster in a rejoinder, confusion, harsh approach, representing sharpness and roughness, agitation, weeping, threatening, terrifying and calling one at a distance".

Intonation will be grave and slow in conditions of sickness, fever, grief, hunger, thirst, deliberation, deep wound from a weapon, communicating, confidential words and in states of anxiety. Intonation will be grave and fast in women's soothing children, panic and attack of cold. Intonation will be slow, excited and of low pitch in following an object lost after being seen, hear in anything about a desired object or person. Communicating something desired, mental deliberation, envy, anything which cannot be adequately expressed, telling stories, rejoinder, conclusions, misery, grief, surprise, jealousy, anger, joy and lamentation. Grave and slow intonation can be used in words containing pleasant sense and bringing in happiness. Excited and high intonations can be used in words which express sharpness and roughness.

According to Fry (1968) any spoken message consists of a series of different stresses and the succession of these stresses make up a rhythm pattern. It is said that it is difficult to distinguish between rhythm and intonation, but one can find pairs of sentences which are similar in rhythm but differ in intonation and also vice-versa.

Ladefoged (1967) conducted a study by asking the subjects to read a series of phrases with both a falling intonation and a rising intonation and studied the relation between subglottal pressure and stress. He has concluded that there is a greater intonation rise in the question forms and a large increase in subglottal pressure accompanied this intonation rise. As a result, the final unstressed syllable in question forms had higher subglottal pressure than the previous stressed syllable.

In an experiment Majewski and Blasdell (1969) used synthetic fundamental frequency contours. The synthetic fundamental frequency contours were classified by Polish and American English listeners as indicating either statements or questions. Graphic analysis were applied to listener's responses, in order to isolate the most prominent fundamental frequency cues that served to differentiate statements from questions. Comparison between the response distributions for

the two language groups revealed both common and language specific cues for fundamental frequency contour identification.

"Infant vocalisation, convey meaning to the parent who hears them". Has been supported by Lowenfeld (1927), Buhler and Hetzer (1928), Seldloková (1964). In a study concerning recognition of infant vocalisations, Illingsworth (1955) noted that mothers in maternity wards of a hospital claimed that they awoke when their own infant cried but not when other children cried.

The purpose of the study by Mallard and Daniloff (1973), was to determine which acoustic parameters were important to a mothers judgement of her child's vocalisation along a "pleasure - distress" perceptual dimension. 24 vocalisations of a four month old child, were judged by the child's mother for emotional content. An acoustical analysis was performed on the samples. Multiple regression analysis revealed that glottal frequency best predicted judgments of emotional state, where as duration and intensity were of lesser importance. As the fundamental frequency increases the tendency to rate the vocalisation as distressed also increased. The authors concluded that "glottal activity, particularly glottal frequency may be a crucial parameter in

an infants signalling his emotional state to a listening parent". It is well known that intonation and stress, both of which are primarily glottally mediated, are rather well developed before the first word is spoken. It seems likely that a child uses the laryngeal system, in the early stage because it is better controlled and more highly developed than the articulatory system (Sheppard and Lane, 1968).

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

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

Nataraja (1982) compared the intonation contour in four Indian languages (Kannada, Tamil, Gujarati, Hindi) under five emotional conditions (a) Anger, (b) Joy, (c) Jealousy, (d) Neutral, (e) Mercy. He concluded that "same intonation may be used to express different emotional conditions and further, the same patterns/contours are seen across the language being used". There seems to be common or 'universal' intonation contours across the languages studied.

Stress may be defined as the perception of some linguistic units as emphasized or prominent in contrast to surrounding units (Freeman, 1983). Units of phonological syllable, word phrase, clause, sentences or paragraph length may be stressed in contrast to surrounding speech. Stress is marked by alteration of pitch, loudness, tempo and perceived segment duration. While increase in pitch and loudness are most frequently used to mark stress, sharp decreases will also signal stress. In contrast, only slowed tempo and longer perceived duration will mark stress. As might be expected increase in F_0 , intensity and segment durations have been found to accompany or cue stress (Fry, 1958), longer silent periods (pauses) may also mark and/or cue stress.

Stressed or accented syllables are perceived as louder, longer and higher in pitch than unstressed syllable. Rules

for syllable stress in English are exceedingly complex. At unit levels stress serves the universal purpose of marking that which is important or essential to the understanding of message. In production, this would allow the speaker to concentrate on careful articulation of critical elements. Perceptually the listener could reduce the processing load by ignoring (or only minimally attending to) the unstressed elements which the speaker has marked for him as redundant (since their identity can be deducted from the remaining stressed elements).

Pitch is one of the most important of several auditory cues for the perception of stress in standard Copenhagen Danish (Thorsen, 1978). Investigations of Rathna, et al., (1983,), showed that a relative increase in intensity, steepness of the intensity rise, a pause before the word and a large duration of the word are the features observed contributing to stress in Kannada language.

It is true to some extent that some of the intonation characteristics are shared by most of the languages in the world. This is called universality of intonation. Though many investigations were taken up by investigators of various corners of the world, comparing one language with the other, a definite and conclusive result could not be derived

regarding this aspect. There are some, who argue in favour of it and there are some others who argue against it.

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

Bolinger (1972) states that there are three features of intonation which have similar uses in all languages. They are

- 1) Range - The range conveys emotion when we are excited, our voice extends its pitch upwards. When we are depressed, we speak almost in a monotone. As this feature is not usually under voluntary control; it is another instance of instinctive gesture.
- 2) Direction - Usually connected with pause. The two together are the punctuation marks of speech. The tendency in all languages, in making statements, is to have a fairly high pitch toward the beginning of a sentence and then to drift down to the lowest pitch at the end. In questions that are answered by 'yes' or 'no', the direction often tends to be up all the way.

In both cases what is incomplete goes up and the completion comes down, an alternating tension and relaxation that again is basically gestural.

- 3) Relative height - It is associated with the importance given to particular word or words in a sentence.

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

An utterance may convey different meanings due to the changes in intonation even though the utterance contains the same segmental phonemes. The intonational meanings of a language are superimposed upon lexical meanings. Every word

in a language has some intrinsic meanings. These intrinsic meanings are called lexical meanings. These lexical meanings are indicated by the consonants, vowels, stress and to some extent, the context where such a meaning is possible. The intonation meaning is a temporarily added form or transitory pitch contour. It does not contribute to the intrinsic meaning of a word but merely gives a shade of meaning added to or superimposed upon the intrinsic level meaning, according to the attitude of the speaker.

People often react more to the intonational meanings than to a lexical one. "The intonation contours", though fluctuating, are as strong in their implication as the attitude which they represent, in actual speech. The listener is frequently more interested in the speaker attitude than in his words i.e., whether a sentence is spoken with a "smile" or "with a sneer". Usually there will be a balance between the intonation and the words chosen. But some times, a lack of balance between intonation and word content may be brought in deliberately for special speech effects.

Uldall (1960) stated "attitude measurement" which seemed to be a promising technique by which to attempt to find out whether a group of subjects from the same linguistic

community would agree on the "meanings" of intonations, and whether some few very general "dimensions of meaning" in the emotional area could be extracted.

In her experiment, the same sentences were presented with differing intonation contour (imposed upon it synthetically) to a set of subjects who rate each sentence plus intonation as to 'whether it conveyed the impression that the speaker was bored or interested, rude or polite, agreeable or disagreeable and write down a list of 10 paired opposition a seven point scale, using the "semantic differential technique (Osgood, Susi and Tannenbaum, 1957). Four sentences in English were used in this experiment and these four sentences were intended to be kept as colourless as possible so that, it would allow the intonation to add as much as possible to their meaning, so that it would represent as many situations as possible when combined with different intonations. Sixteen intonation contours were applied to these four sentences.

It was concluded that:

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

2. The 'smooth' contours preceding steadily in one direction (particularly downward) are found more pleasurable than broken contours with a change of direction or movement up and down of strong and weak syllables.
3. Statements can be pleasant when either falling or rising at the end, while on the questions and the command contours final rising tends to be the pleasant ones.
4. In determining the factor of 'interest' vs "lack of interest" the final rising or falling of the contour is not important.
5. In determining the 'authoritative' - 'submissive' factor, the range of pitch is more important than the final rise or fall.

Rathna et al., (1975) found that a pause before a word contributes to perception of stress in Kannada language. Morse (1972) has reported high amplitude sucking experiments which demonstrate the infants between 1.5 and 2 months of age discriminate between marked (rising) and unmarked (falling) breath group intonation pattern. Martin (1980), describes suprasegmental acoustic cues as functioning to 'enable the listener to expect or anticipate the rough outlines of speech not yet heard'.

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

Sorenson and Cooper (1979), reported that F_0 of the first stressed syllable is higher by 6 percent for longer (13.8 word) sentences than for shorter (7.5 word) sentences. Rathna et al., (1982), did a study to find the influence of intonation patterns of part sentences on the identification of the contexts in which those part sentences are spoken. The results showed that it was not possible for the subjects to identify the correct context sentences when either only part sentence was spoken, or part sentence and context sentence was given together.

Pollack, Rubenstein and Harowitz (1960) conducted a study where four talkers instructed to read neutral sentences and sound happy or sound bored etc. There were sixteen modes of expression. Listeners attempted to identify the intended mode of expression drawing their responses from a limited number of alternatives. Four factors on the identification of modes of expression was studied. They were:

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

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

Huttar (1968), conducted a study where in the emotional states of an adult American speaker, as reflected in 30 utterances, were evaluated by 12 subjects on 9, seven point semantic differential scales. The emotional states of the person whose speech was studied were measured indirectly by

means of listeners response, and the prosodic features of the utterances were studied by two means.

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

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

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

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

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

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

Nithun (1998) did a study to investigate the perception of emotion under conditions of masked fundamental frequency (F_0). Six different sentences were studied in which both perceptual and instrumental analysis was done. The results showed that;

1. The intonation permits the identification of emotion of sentences even when the F_0 information is masked.
2. The emotion 'surprise' was best identified and the poorest identified emotion was 'anger'.
3. Trained judges could identify the pitch contours occurring in sentences, reliably and validly.
4. Females use larger F_0 range for all emotions when compared to males.

Attempts have been made to study intonation and other prosodic aspects in pathological conditions of speech.

Darley (1979), in the diagnosis of articulation disorder includes assignment of prosodic production features. He describes 'ataxic dysarthria' as association with the deviant perceptual dimensions of prosodic excess and phonatory prosodic insufficiency. Acoustic analysis demonstrate that this perceptual cluster can be resolved primarily as a distortion of the temporal pattern of speech; with lengthening of normally reduced (unstressed) syllables and

the occurrence of intersyllabic pauses. They suggest that ataxic speech production involves a dissociation (as opposed to integration) of the syllables, with a tendency toward equal syllable duration, frequent abnormal pause intervals between syllables. This second description is clearly a preferable basis for treatment planning, even as an articulation analysis is preferable to the observation that the client does not say all his sounds correctly. Acoustic analysis offer a access to critical diagnostic information.

In subcortical dysarthrias, Kent (1979), describes three patterns of dysprosody each representing deterioration of relative syllable timing and a distortion of F_0 . 'Sweeping' is described as exaggerated F_0 , glides and is typical of some ataxic dysarthrias. 'Scanning' is the marked dissociation of syllables in time. Such syllables have a marked tendency toward equal durations, and a monotypic F_0 pattern. Scanning speech is characteristics of ataxic dysarthria.

Intonation problems in deaf may be divided into two major types:

- a) Monotonous voice
- b) Excessive erratic pitch variation.

A comparative study of intonation pattern was done between deaf and normal hearing subjects (Nandyal.,1981). Results showed that:

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

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

1. Hyper prosody - Excessive or exaggerated prosody observed in some types of Aphasia and Manical states.
2. Dysprosody - Distorted prosody observed in cerebellar ataxia and in conjunction with some aphasias or speech ataxia.
3. Aprosody-Attenuation, reduction, or lack of normal prosody observed in Parkinsons patients and in right hemispheric lesion patients.

Lieberman (1968), comments that "although relevant phonetic or instrumental analyses are not available at present for most languages, it is possible to generalize about intonation to the extent of stating that short declarative sentence usually ends with a falling fundamental frequency contour".

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

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

Hird (1993) acoustically analysed 'emotional tone' of nondominant hemisphere damaged subjects. The purpose of his study was to investigate the effect of right hemispihere

damage on the perception and production of emotional prosody. Eight male patients with altered prosody following strokes in the region of middle cerebral artery of the right cerebral hemispheres and four normal subjects with no history of neurological damage participated in the study. Results showed no significant differences between the two groups on receptive scores. Right cerebral vascular accident subjects produced significantly shorter utterances than the controls in all conditions. There was also a significant standard deviation between fundamental frequency and group.

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

In the field of speech and hearing, knowledge regarding intonation forms a useful tool in the therapeutic work and also, to some extent in the diagnostic field. This study is an attempt to determine the intonation pattern of a set of sentences in Bengali and to analyze the responses of a group of listeners to the emotions expressed by the speakers.

CHAPTER - 3

METHODOLOGY

The aim of the present study is to find the various intonation patterns, that are used by Bengali speakers in expressing different emotions. For this study it was decided to use taped audio recorded speech samples from popular Bengali films and note the following emotion.

1. Anger
2. Grief
3. Joy
4. Fear
5. Jealousy
6. Surprise
7. Worry
8. Frustration
9. Neutral

The study was carried out in the following steps :

1. Selection of material
2. Preparation of material
3. Perceptual evaluation
4. Acoustic analysis
5. Relating results of perceptual evaluation with acoustic analysis.

Selection of the material:

Sentences were selected from audio recordings of popular films in Bengali, which are available in cassettes. It was decided to use dialogues from audio cassettes of films on the following basis.

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

Therefore it was considered that the independent variable has been operated to the maximum possible extent specifically, the intonation, has occurred in such a way so as to convey the required emotion. Hence it was decided to select sentences occurring in two popular film-audio cassettes, expressing different emotions. The films which have been considered as popular and acted by well known artists were

1. Debota (de : boṭa)
2. Boro Bou (bo:ro bou)

3.3

In total thirty six sentences expressing various emotions, were randomly selected from two film audio cassettes. These sentences were selected on the basis of emotions indentified by the experimenter and three Bengali native speakers. The experimenter and the three Bengali native speakers had a mean age of 25 years with mother tongue as Bengali and all were well versed in Bengali language. The selection was done after testing the tapes fully i.e. the expressed emotion was deecided on the basis of context and content of the sentences.

Preparations of Material :

Nine different emotions were considered. They were suprise, fear, joy, anger, jealousy, worry, frustration, grief and neutral. These emotions were chosen because they are the primary emotions, commonly used by humans and commonly conveyed in speech.

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

Emotion	No. of sentences	Male	Female
1. Anger	4	2	2
2. Grief	4	2	2
3. Joy	4	2	2

3.4

Emotion	No. of sentences	Hale	Female
4. Fear	4	4	
5. Jealousy	4	2	2
6. Suprise	4	2	2
7. Worry	4	2	2
8. Frustration	4	4	
9. Neutral	4	2	2
		22	14
Total number of sentences = 36			

Four sentences for each emotion was selected. These sentences expressed different emotions to the maximum possible extent and could be easily identified as expressing a particular emotion by the native speakers of Bengali. The sentences selected with the emotions expressed in each sentence are given in Appendix 'A'.

The thirty six sentences selected by the Bengali native speakers, as conveying various emotions were extracted from the two audio cassettes of films (actual film cassette) to a Meltrack CR-X90 chrome precision audio cassette in a sony stereo deck (CFS-W445S).

Perceptual evaluation :

A perceptual test was done to check whether the emotions conveyed by these sentences were perceived by the native Bengali speakers and non native speakers in the same manner. The subjects of both groups ranged in age from 18 to 25 years. The native speakers chosen had good command of Bengali language and using that for their day to day speech, and the non-native speakers were never exposed to Bengali language or had contact with Bengali speakers. The subjects had no knowledge of the purpose of the study.

The subjects were comfortably seated and the recorded sentences were presented to the subjects using stereo deck. A response sheet was provided to each subject and the following instructions were given.

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

3.6

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

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

1. It was studied whether non-native speakers could identify the various emotions from the thirty six sentences in a similar manner as native Bengali speakers.
2. It was also studied whether the context and the content of the sentences were important for perceiving the emotion.

Acoustic Analysis:

The tape-recorded samples were analyzed using the DSP sonograph - 5000. The following instrumental set up was used for acoustic analysis.

Tape Recorder—————> DSP Sonograph—————> Printer

The fundamental frequency (F_0) and intensity contours for each sentence were obtained. The frequency and Intensity of the points on the curve were determined by moving the cursor.



DSP-SONOGRAPH: Instrument used for analysis.

3.7

Analysis of these curves involved the following:

1. Mean F_0 for the thirty six sentences were calculated.
2. Noting the individual pattern of F_0 and Intensity curves for each particular emotion.
3. The curves for different emotions expressed by males and females were separated. For example all the curves of sentences expressing "fear" in males were grouped together. Thus different patterns of curves produced were tabulated. Ex: Rise - Fall - Rise etc . It was observed whether there was only one kind of pattern prevalent for a particular emotion conveyed by the Bengali speakers.
4. The frequency and intensity at the beginning and end of a particular word of a sentence was noted.
5. For each sentence, the range of frequency variations was calculated by subtracting the lowest frequency from the highest frequency. The average range of fundamental frequency (F_0) for a particular emotion; produced by speakers of Bengali language was calculated by dividing the sum of ranges of a particular emotion by the number of a sentences chosen by experimenter for each emotion. These ranges were then tabulated.

The patterns were analyzed and then compared with the perceptual evaluation.

Thus the identification of emotion by native and non-native speakers of Bengali, based on perceptual evaluation was obtained. The same sentences were subjected to acoustic analysis to note the intonation curve with reference to each emotion expressed by both males and females.

CHAPTER - 4
RESULTS AND DISCUSSION

Intonation, an aspect of prosody is an important factor in normal speech. "Intonation like every thing else in a language, is one instrument in an orchestra". (Bolinger, 1972).

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

Greene, (1964) has stated that intonation is an exclusive term referring to pitch as a function of time and may be applied to a simple inflexion or to long term variation in phrases over a numerous inflexional shifts, whereas others consider that Intonation is determined by factors like fundamental frequency (F_0), Intensity and duration (Minifie, 1973; Lleberman, 1980; Fry, 1978; Lado, 1961; Sorenson and Cooper, 1977).

In this study four sentences, for each of the nine emotions have been randomly selected from Bengali film audio cassettes and analysed both acoustically and perceptually.

4.2

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

Emotion	No. of sentences	Male	Female
1. Anger	4	2	2
2. Grief	4	2	2
3. Joy	4	2	2
4. Fear	4	4	-
5. Jealousy	4	2	2
6. Surprise	4	2	2
7. Worry	4	2	2
8. Frustration	4	4	-
9. Neutral	4	2	2
		22	14
Total number of sentences = 36			

Thus, thirty six sentences, 22 spoken by males and 14 spoken by females were analyzed to note the intonation patterns used in different emotions by Bengali speakers. The number of sentences selected for male and female speakers were not the same for the emotion "Fear" and "Frustration".

The fundamental frequency (Fo) variations and the Intensity (Io) variations in a particular sentence was

obtained using inton programme. The intensities noted for each sentences is based on the reference value in the DSP sonograph (Appendix B) . The Fo curves and intensity curves for the various emotions are obtained.

The terms "steep", "gradual" and "flat" have been used to depict the intonation patterns. The concept "steep" is used to indicate a sharp rise and sharp fall, "gradual" used to indicate a slower degree of rise or fall and "flat" to indicate minimal variations in Fo and intensity.

1. Anger:

Out of the four sentences depicting the emotion "anger", two were spoken by males, and rest two by the female speakers. The Fo and Io variations of the four sentences are presented in Table - 2.1.1.

Table 2.1.1: Showing Fo variations (Fo-V) and Intensity variation (Io-V) in "Anger" type of sentences.

Sl. No.	Speaker	Sentence		
1. Female :	হুগা dɔ:j^	দেখাচ্ছ dak^h^tj^o	আমাকে ? a:ma:ke	
F o - V	146-217	246-193	250-320	
I o - V	81-88	82-88	85-57	

4.4

2. Female :	মানে	গোমার	কর্গ	ফোন	কর্বে	না ?	
	ma:ne	goma:r	ko:rʈa	fo:n	korbe	na:	
Fo - V	249-220	207-243	100-210	276-341	186-227	201-330	
Io - V	52-81	74-87	80-70	80-79	71-85	84-73	
3. Male :	বেড়িয়ে	ফাও	এখান	শ্রোবে			
	beri:je	dʒa:o	ekʰa:n	ʃʰe:ke			
Fo - V	150-101	129-256	320-128	262-182			
Io - V	79-92	90-91	81-92	80-67			
4. Male :	আমি	গোমার	কোন	কথা	সুন্দর	চর্ক	না ।
	a:mi	gomar	ko: no	koʰʌ	ʃuntɔ	ʃʰa:ɽ	na:
Fo-V	266-249	256-284	297-250	227-176	256-284	276-196	193-111
Io-V	71-81	85-81	90-88	88-85	80-75	74-89	84-75

The frequency range and the Io range used by the subjects in the sentences expressing the emotion "Anger" is displayed in Table 2.1.2. and Table 2.1.3. respectively.

Table 2.1.2. Showing frequency range in sentences expressing "anger".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	F	485	146	339			
2.	F	465	100	365			
3.	M	337	101	236	321.25	352	290
4.	M	456	111	345			

Table 2.1.3. Showing Intensity range in sentences expressing "anger".

Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	F	88	57	31			
2.	F	87	52	35	27.5	33	22
3.	M	92	67	25			
4.	M	90	71	19			

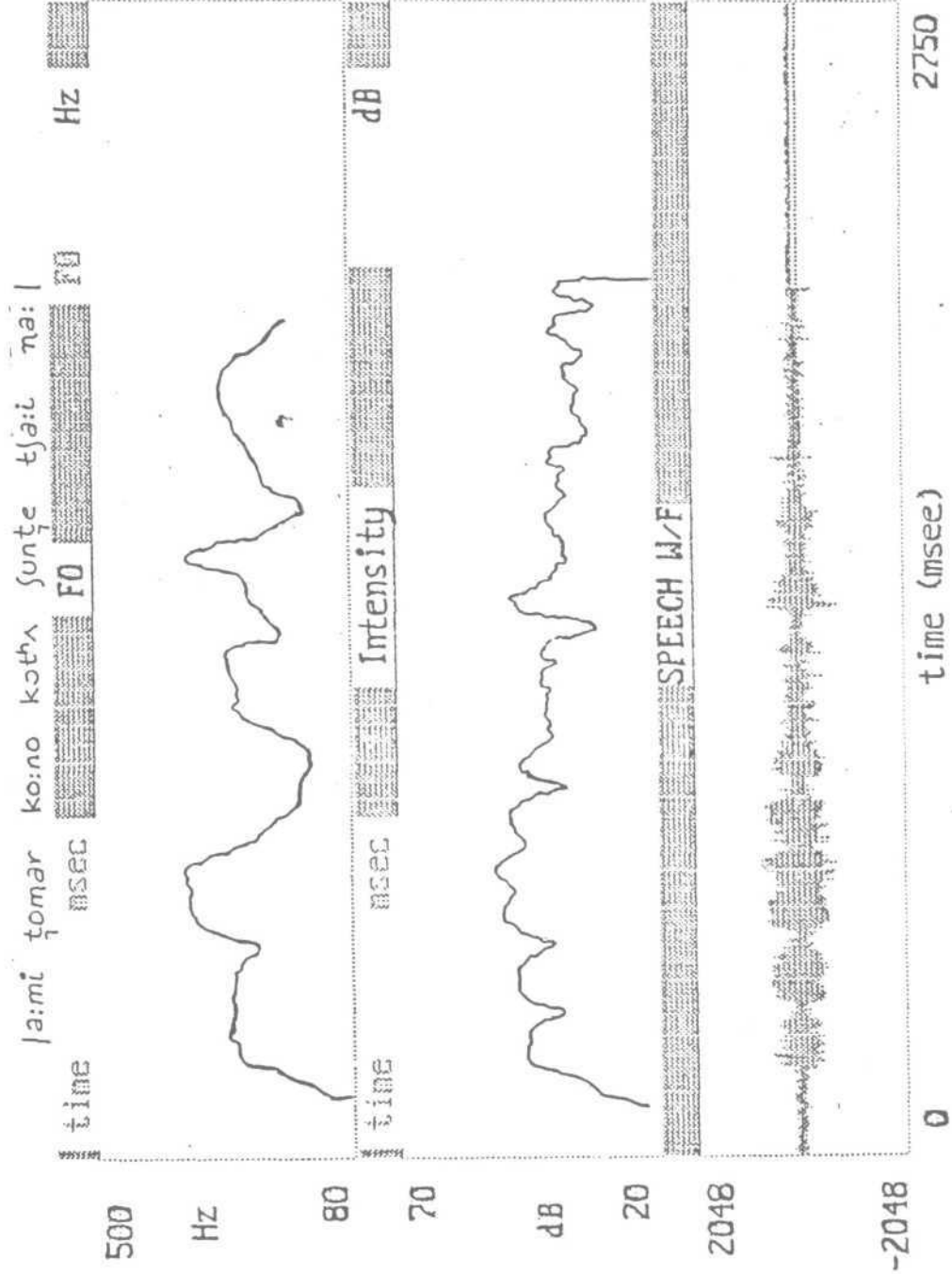
It can be seen from table 2.1.1. that the sentences expressing "Anger" in the form of question i.e. Anger-Question, which is represented in the first two sentences show an intonation pattern of Rise - fall - Rise - fall -rise (steep). The sentences expressing "anger" in the form of statement, i.e. the third and fourth sentences showed an intonation pattern of Rise - fall - Rise -fall (gradual). The terminal contour of the "Anger-Question" pattern depicted a rising pattern where as the statement form showed a falling final contour, thus terminal contour helps in determining sentence type. The intensity variations were inconsistent and showed a decrease in energy at the end of the sentences-

Comparing the fundamental frequency range and intensity range in females and males it was found that the females used a greater Fo and Io range when compared to the males.

4.5.a

Graph:1 Intonation contour: "Anger."

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

2. Grief:

Four sentences expressing the emotion "Grief" have been analyzed, out of which two sentences were spoken by males and two by females. The Fo and Io variations of the four sentences are given in Table - 2.2.1.

Table 2.2.1: Showing (Fo-V) and (Io-V) in sentences expressing "grief".

Sl. No.	Speaker	Sentence			
1. Female :	এইভাবে lei b ^h a:be	অপমান ɔ:poma:n	হুত hoʈe	হলো । ho:lo	
Fo - V	124-330	325-301	298-301	284-124	
Io - V	88-84	81-84	59-85	86-60	
2. Female :	বিক bo:ki	কি ki	আর a:r	আর্ষে । ʃa:d ^h e	
Fo - V	365-340	330-150	280-311	320-186	
Io - V	86-74	80-83	67-86	88-68	

4.7

3. Male:	বোকাৰ bɔka:r	মোটা mɔtɔ	আপনাকে a:pna:ke	আত্মত a:gha:t	দিয়া d̪ije	ফেললাম phella:m
Fo - V	247-217	230-117	222-126	227-184	137-249	220-193
Io - V	68-74	66-73	57-70	76-66	80-82	63-70

4. Male:	আমি a:mi	বিনে bine	পয়সায় paɪsɑ:i	অব ɔb	কাৰু ka:dj	কৰে ko:re	দেব de:bo
Fo-V	148-95	138-249	144-193	193-208	217-249	249-116	132-116
Io-V	73-85	67-84	65-79	81-89	72-64	64-68	69-61

The frequency range and the intensity range used by the subjects in expressing "grief" is represented in Table 2.2.2. and 2.2.3. respectively.

Table 2.2.2: Showing frequency range in sentences expressing "Grief".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	F	370	124	246			
2.	F	571	150	421	264.55	333.5	195.5
3.	M	354	117	237			
4.	M	249	95	154			

Table 2.2.3. Showing Intensity range in sentences expressing "Grief".

Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	F	88	59	29			
2.	F	88	67	21	25.75	25	26.5
3.	M	82	57	25			
4.	M	89	61	28			

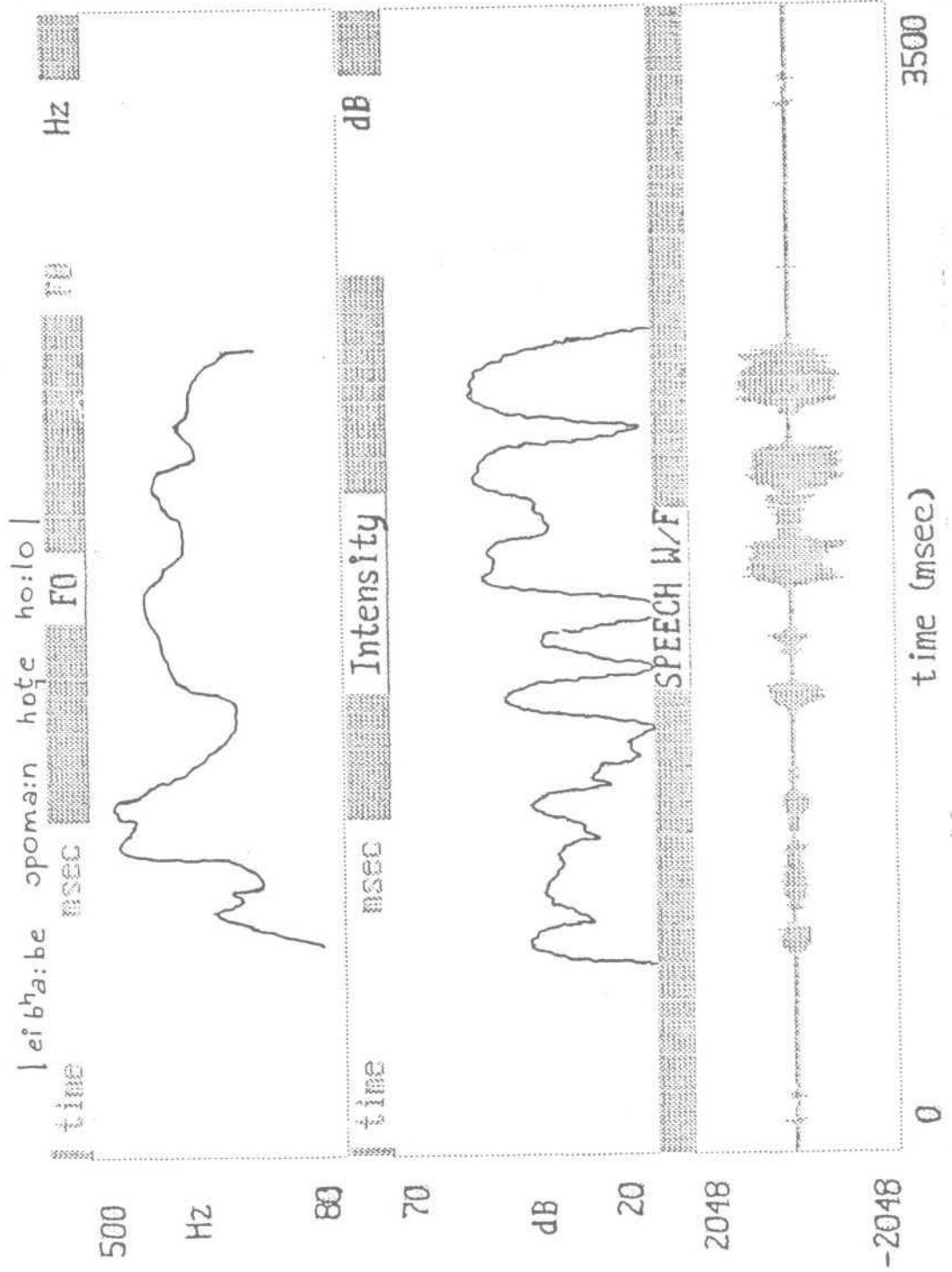
It can be concluded from the Table 2.2.1. that speakers uttering sentences of emotion "grief" follow a Rise-fall (gradual) - rise-fall (steep) intonational pattern. Though there was a variation in the first sentence, the other sentences showed a similar pattern. All the four sentences showed a final or terminal contour of a sudden fall in the Fo. The intensity variation was not consistent, however in the end of the sentences there was a decrease in the energy i.e. there was a "steep fall" in intensity at the end of all the four sentences.

Comparing the fundamental frequency range and intensity range it was found that females used a greater Fo range than males. However the intensity range in males and females in expressing "grief" didn't show a difference.

4.8.a.

Graph: 2 Intonation contour: "Grief"

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Thus it can be concluded that Bengali speakers use Rise-fall (Gradual)-Rise-fall (steep) type of intonation pattern in expressing "grief" as shown in graph 2.

3. Joy:

Out of the four sentences expressing the emotion "joy", two have been spoken by males and the other two by females. The Fo and Io variations of the four sentences are noted in Table - 2.3.1.

Table 2.3.1: Showing (Fo-V) and (Io-V) in sentences expressing "joy".

Sl. No.	Speaker	Sentence		
1. Female :	আমি	খুলবে	হয় ?	
	a:mi	kʰulbo	t̪o	
Fo - V	310-262	251-367	243-330	
Io - V	86-84	74-81	80-71	
2. Female :	দাঁড়	চাৰিটা	দাঁড় ।	
	d̪a:ɔ	t̪a:bita:	d̪a:ɔ	
Fo - V	337-278	225-222	268-189	
Io - V	71-84	62-75	64-76	

4.10

3. Male:	চাকরি tʃa:kviv	ইন্টারভিউ intarvju	লেটার letar	এসেছে। ese:tʃe
Fo - V	280-249	262-243	249-211	227-128
Io - V	67-83	83-89	71-83	77-63

4. Male:	চিক tʃik	আছে a:tʃe	অ্যার। sar
Fo-V	129-107	194-233	301-107
Io-V	73-81	76-87	79-74

The frequency range and the intensity range used by the subjects in expressing "Joy" is represented in Table 2.3.2. and 2.3.3. respectively.

Table 2.3.2: Showing frequency range in sentences expressing "Joy".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	F	367	243	124			
2.	F	337	189	148	154.5	136	173
3.	M	280	128	152			
4.	M	301	107	194			

Table 2.3.3. Showing Intensity range in sentences expressing "Joy".

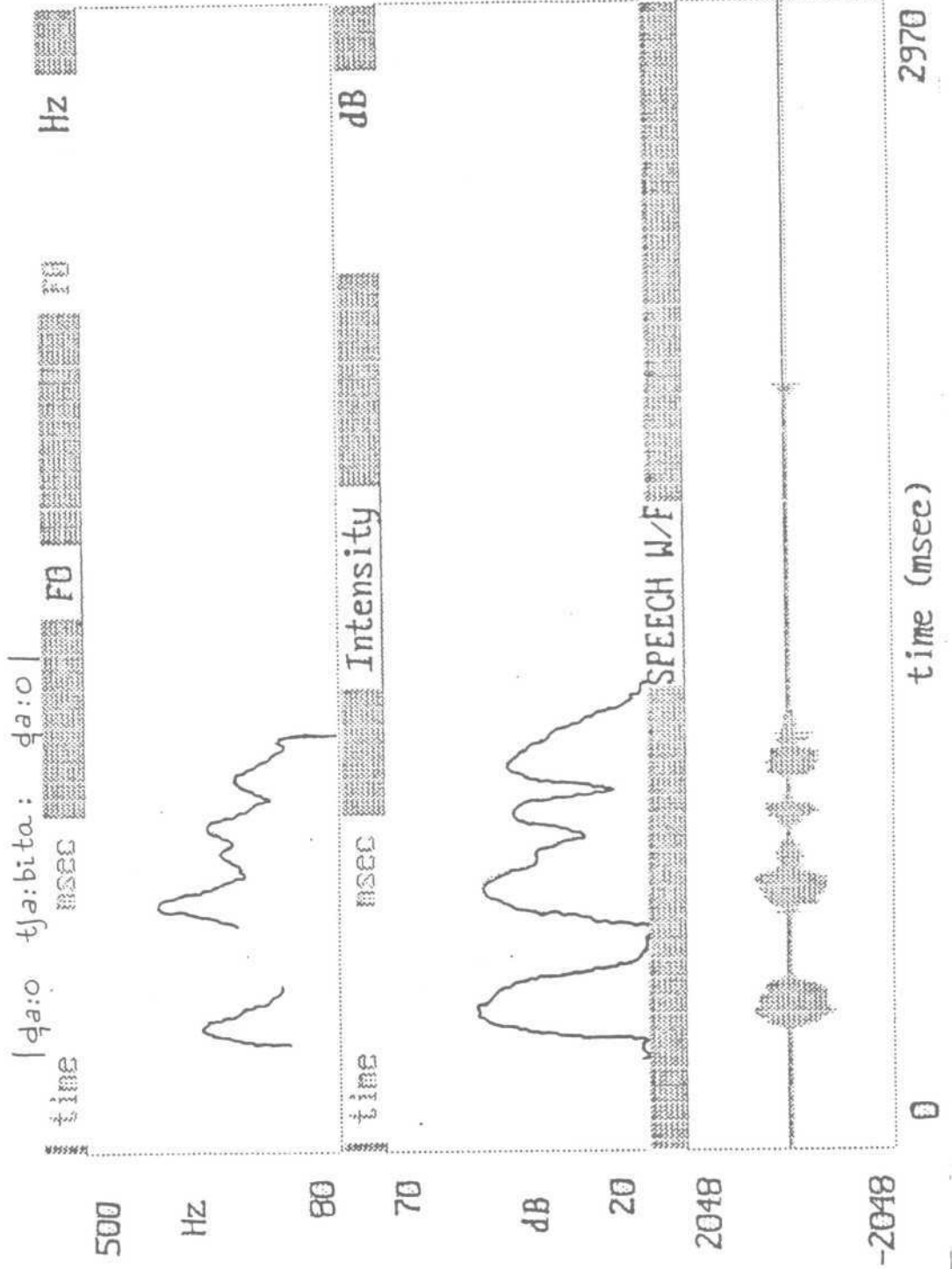
Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	F	86	71	15			
2.	F	84	62	22	19.25	18.5	20
3.	M	89	63	26			
4.	M	87	73	14			

It can be seen from Table 2.3.1., that the intonational pattern used for "joy" by the Bengali speakers was Rise-fall-Rise (gradual)-fall (steep). The first sentence showed rising pattern as the terminal contour. This is because of the fact that the first sentence was a yes-no question depicting the emotion "Joy" where as the other sentences were statements. The intensity variations were not consistent, but in all the four sentences there was fall in intensity at the end of the sentence.

The comparison of fundamental frequency range and intensity range showed that males used a greater frequency range than females. It was also found that males used slightly higher intensity range when compared to females while expressing "joy".

Graph: 3 Intonation contour: "Joy"

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It can be concluded that Bengali speakers use Rise-fall-Rise (gradual)-fall (steep) type of intonation pattern in expressing "joy" as shown in Graph-3.

4. Fear:

All the four sentences selected to express the emotion "Fear" have been spoken by males. The Fo and Io variations of the four sentences are noted down in Table 2.4.1.

Table 2.4.1.: Showing (Fo-V) and (Io-V) in sentences expressing "fear"

Sl. No.	Speaker	Sentence		
1. Male:	আমায়	ডেকেছেন	আর ?	
	a:ma:i	deketj ^h e:n	sar	
Fo - V	102-217	194-248	137-249	
Io - V	70-86	78-82	79-69	
2. Male:	ভয়ন	আর	ত ?	
	bhi:son	ma:rbe	t _o :	
Fo - V	232-176	98-173	165-256	
Io - V	63-84	79-84	79-74	
3. Male:	বাবা	দেখতে	পার ।	
	ba:ba:	dek ^h t _e	pa:be	
Fo - V	242-138	111-170	387-143	
Io - V	57-86	84-80	77-84	

4. Male :	आभास a:mai	भैरा me:vo	ना । na:
Fo-V	238-164	101-178	140-236
Io-V	68-88	85-80	75-64

The frequency range and the Intensity range used by the subjects in expressing "fear" are represented in Table 2.4.2. and Table 2.4.3. respectively.

Table 2.4.2.: Showing frequency range in sentences expressing "fear"

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	M	249	102	147	232		
2.	M	256	98	158			
3.	M	494	78	416			
4.	v	315	108	207			

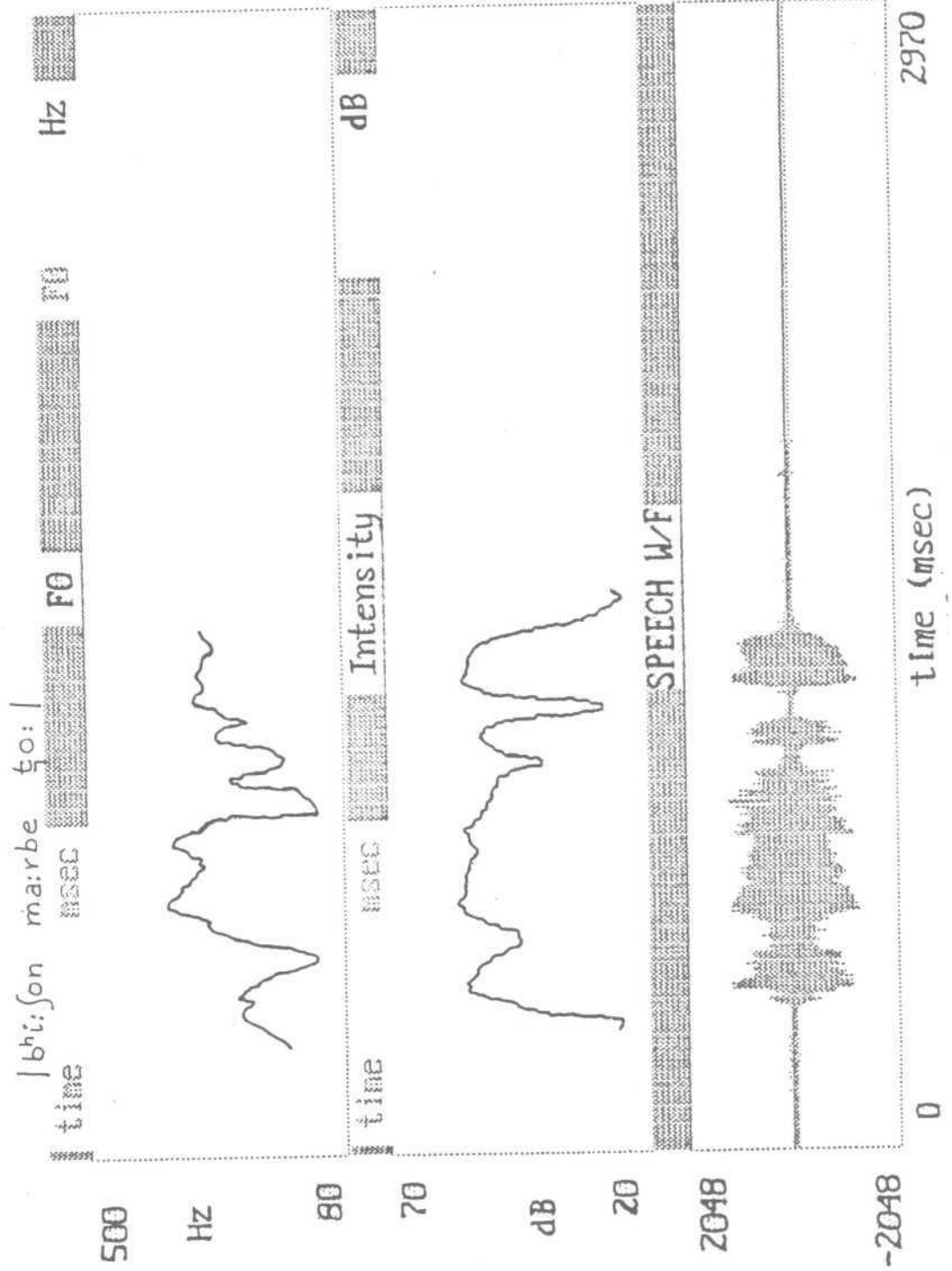
Table 2.4.3. Showing Intensity range in sentences expressing "fear".

Sent Mo.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	86	69	17	24.75		
2.	M	88	63	25			
3.	M	86	57	29			
4.	M	89	61	28			

4.13.a.

Graph: 4 Intonation contour: "Fear"

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It can be concluded from the Table 2.4.1. that Bengali speakers in expressing sentences of emotion "fear" showed a Rise (gradual) -fall (steep) - rise-fall - rise (steep) intonational pattern. The terminal contour in all the sentences showed a rising type pattern. The intensity variations were not same and in consistent in all the sentences.

All the sentences were uttered by male speakers, due to which comparison of the ranges of frequency and intensity could not be done.

Thus it is found that Bengali speakers use Rise (gradual) - fall (steep) - rise-fall - rise (steep) type of intonation pattern in expressing 'fear' as shown in Graph 4.

5. Jealousy:

Out of the four sentences depicting the emotion "Jealousy", two have been spoken by males, and rest two by the female Bengali speakers. The fundamental frequency and intensity variations of the four sentences are noted in Table 2.5.1.

Table 2.5.1. Showing (Fo-V) and (Io-V) in sentences expressing "Jealousy".

Sl. No.	Speaker	Sentence					
1. Male:	দাদাৰ	কথা	খুলে	জিহ্মেছিলে	আই	বলো।	
	e	da:da:r	ko ₇ ha:	b ^h ule	gi:jetʃile	ʈa:i	bolo
Fo - V	115-123	200-227	102-138	90-152	260-179	121-101	222-101
Io - V	72-86	84-81	74-84	77-82	79-86	77-89	89-75
2. Male:	দাদকে	লুচি	হালওয়া	খাওয়ালেই	চলবে।		
	e	da:da:ke	lu:ʈʃi	halwa:	k ^h a:wa:lei	ʈolbe	
Fo - V	124-115	134-167	150-97	126-142	136-126	221-149	
Io - V	71-91	88-87	84-87	82-81	83-86	88-69	
3. Female:	বাবা	বাবাৰদে	একুট	বহুছোলেৰ	দিকে	টেনে	
	ba:ba:	bo:ra:bo:ri	ektu	bo:ro:ʈʃeler	ʈike	te:ne	
Fo-V	111-264	222-341	341-262	280-232	243-276	227-196	
Io-V	77-86	70-81	70-75	72-80	66-72	66-82	
	কথা	বলেন।					
	ko ₇ ha:	bolen					
Fo-V	170-186	310-160					
Io-V	77-69	63-64					
4. Female:	স্বামীৰ	চাকৰী	নেই	পু	দাখ	ওয়া	আজ
	Sa:miv	ʈa:kvi	nei	ʈobu	da ₇ k ^h o	o:ra:	a:dj
Fo-V	262-350	185-106	131-165	227-249	249-128	213-238	310-255
Io-V	71-81	66-85	81-72	69-71	71-84	64-87	70-75

	ছকমন kxmon	সুখী। sukhi
Fo-V	269-276	276-243
Io-V	64-84	87-67

Table 2.5.2. Showing the frequency range in sentences expressing "Jealousy".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	M	260	90	170			
2.	M	318	98	220	221.75	249.5	195
3.	F	341	111	230			
4.	F	373	106	267			

Table 2.5.3. Showing Intensity range in sentences expressing "Jealousy".

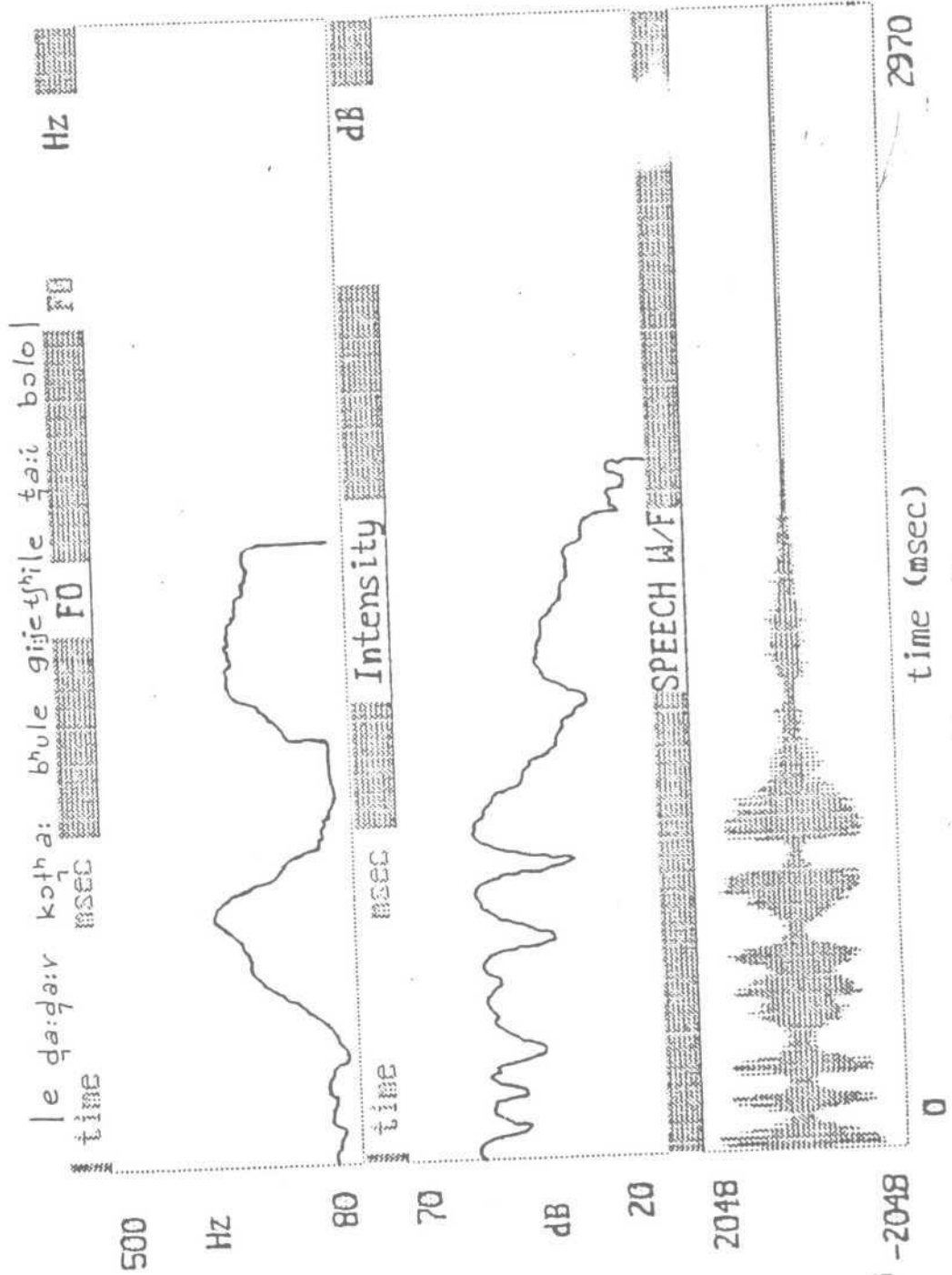
Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	89	72	17			
2.	M	91	69	22	21.25	23	19.5
3.	F	86	63	23			
4.	F	87	64	23			

It can be seen from Table 2.5.1. that Bengali speakers while expressing 'Jealousy' follow a Rise (steep) -fall -

4-16-00

Graph: 5 Intonation contour: Jealousy

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rise - fall intonation pattern. The final contour as a falling pattern. Intensity variations did not coincide with the frequency variations and were inconsistent in sentences. Intensity contour showed a steep falling pattern at the end of sentences.

Females used a greater range of frequency and also intensity when compared to the males while expressing "Jealousy".

Graph - 5 shows the intonation pattern of Rise (steep) - fall - rise- fall type which is used by Bengali speakers in expressing "Jealousy".

6. Surprise:

Out of the four sentences expressing surprise, two were spoken by males and other two by females. The Fo and Io variations of the four sentences analyzed, are noted in Table 2.6.1.

Table 2.6.1. Showing (Fo-V) and (Io-V) in sentences expressing "Surprise".

Sl. No.	Speaker	Sentence			
1. Male:	ଧୁରୁ t̥u:i	ଅନ୍ mod̥	କେତେଦିଅଁ? khejet̥hi:ʃ		
Fo - V	181-121	202-148	165-222		
Io - V	61-80	82-86	84-66		
2. Male :	ଏ e	ଧୁମ୍ମି t̥u:mi	କାକେ ka:ke	କି ki	କାହୁଁ । bo:lt̥h'o
Fo - V	354-167	222-220	193-250	205-94	117-142
Io - V	79-89	80-81	79-76	73-82	74-77
3. Female:	ଧୁନ୍ଦର ŋundo:r	ଧୁନ୍ଦରା t̥h'ora	ଲିକେଦିଅଁ likhe:t̥h'o	ତୋ । t̥o:	
Fo - V	292-180	350-150	217-92	152-160	
Io - V	74-84	67-88	88-78	57-64	
4. Female:	ଅକ୍ଷୟ ak̥h'o:no:	ଦାକ୍ଷିଣୀ t̥d̥a:kvi	ଅଧିକ । ho:ini		
Fo-V	238-290	330-353	238-300		
Io-V	60-72	68-79	61-67		

The fundamental frequency range and intensity range for "surprise" is represented in Table 2.6.2. and 2.6.3. respectively.

Table 2.6.2. Showing Fo range in sentences expressing "surprise".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	M	467	121	346			
2.	M	354	94	260			
3.	F	380	92	288	252.25	303	201.5
4.	F	353	238	115			

Table 2.6.3. Showing Intensity range in sentences expressing "surprise".

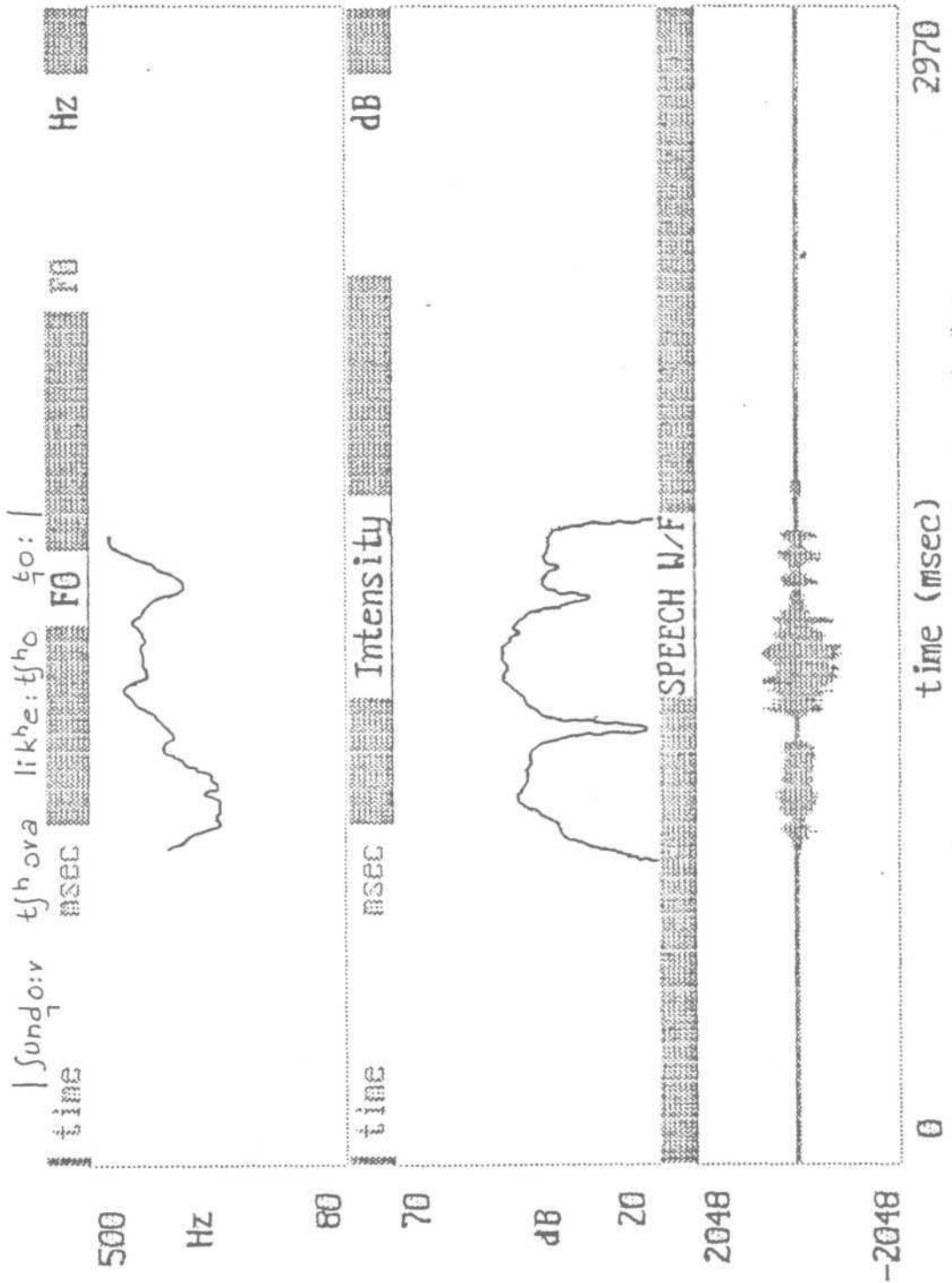
Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	86	61	25			
2.	M	89	73	16			
3.	F	88	57	31	22.75	25	20.5
4.	F	79	60	19			

It is seen from Table 2.6.1. that Bengali speakers while expressing surprise follow a Fall (gradual) - rise (steep) -fall - rise (gradual) intonational pattern. The terminal contour for 'suprise' was a gradual rising pattern.

4.19.a.

Graph: 6 Intonation contour: "Surprise"

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Intensity variations were inconsistent and did not follow a particular pattern.

Males were found to use a greater fundamental frequency range when compared to females in expressing surprise. However females used a greater intensity range when compared to males.

Graph - 6 shows the intonation pattern of Fall (gradual) - rise (steep) - fall - rise (gradual) type which is used by Bengali speakers in expressing 'surprise'.

7. Worry:

Out of the four sentences expressing worry, two were spoken by males and other two by females. The Fo and Io variations of the four analyzed sentences are noted in Table 2.7.1.

Table 2.7.1. Showing (Fo-V) and (Io-V) in sentences expressing "Worry".

Sl. No.	Speaker	Sentence		
1. Male ;	চাৰি	ভাব	কেন ?	
	tʃa:bi	de bo	kæno	
Fo - V	250-173	196-187	222-112	
Io - V	84-85	86-88	86-67	

2. Male:	আপনার	বাবা	মা	কখন	খিঁববেন?
	a:pna:r	ba:ba:	ma:	kokʰo:n	phivbe:n
Fo - V	264-161	165-238	142-150	164-281	252-155
Io - V	70-79	74-84	79-87	87-73	72-77
<hr/>					
3. Female:	তাল্লে	এতো	অত্যাগচ্ছি	চলে	এলে ।
	t̪a:hole	aʈo:	t̪ava:t̪a:ni	t̪o:le	e:le
Fo-V	301-341	341-310	287-189	256-353	322-189
Io-V	76-86	84-67	81-83	79-89	89-78
<hr/>					
4. Female:	তখন	আবার	কিছু	বলবে	নাগো ।
	t̪o po:n	a:ba:r	kitʃʰu:	bo:lbe	na:t̪o:
Fo - V	242-330	243-301	327-353	128-232	152-284
Io - V	71-79	85-84	68-83	71-86	82-74

The Fo and Io range used by subjects in expressing "worry" is represented in Table 2.7.2 and Table 2.7.3. respectively.

Table 2.7.2: Showing Fo range in sentences expressing "worry"

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in female	Range in males
1.	M	348	112	236			
2.	M	433	130	303			
3.	F	453	169	284	262	254.5	269.5
4.	F	353	128	225			

Table 2.7.3. Showing Intensity range in sentences expressing "Worry".

Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	88	67	21			
2.	M	87	70	17	19.45	20	19
3.	F	89	67	22			
4.	F	86	68	18			

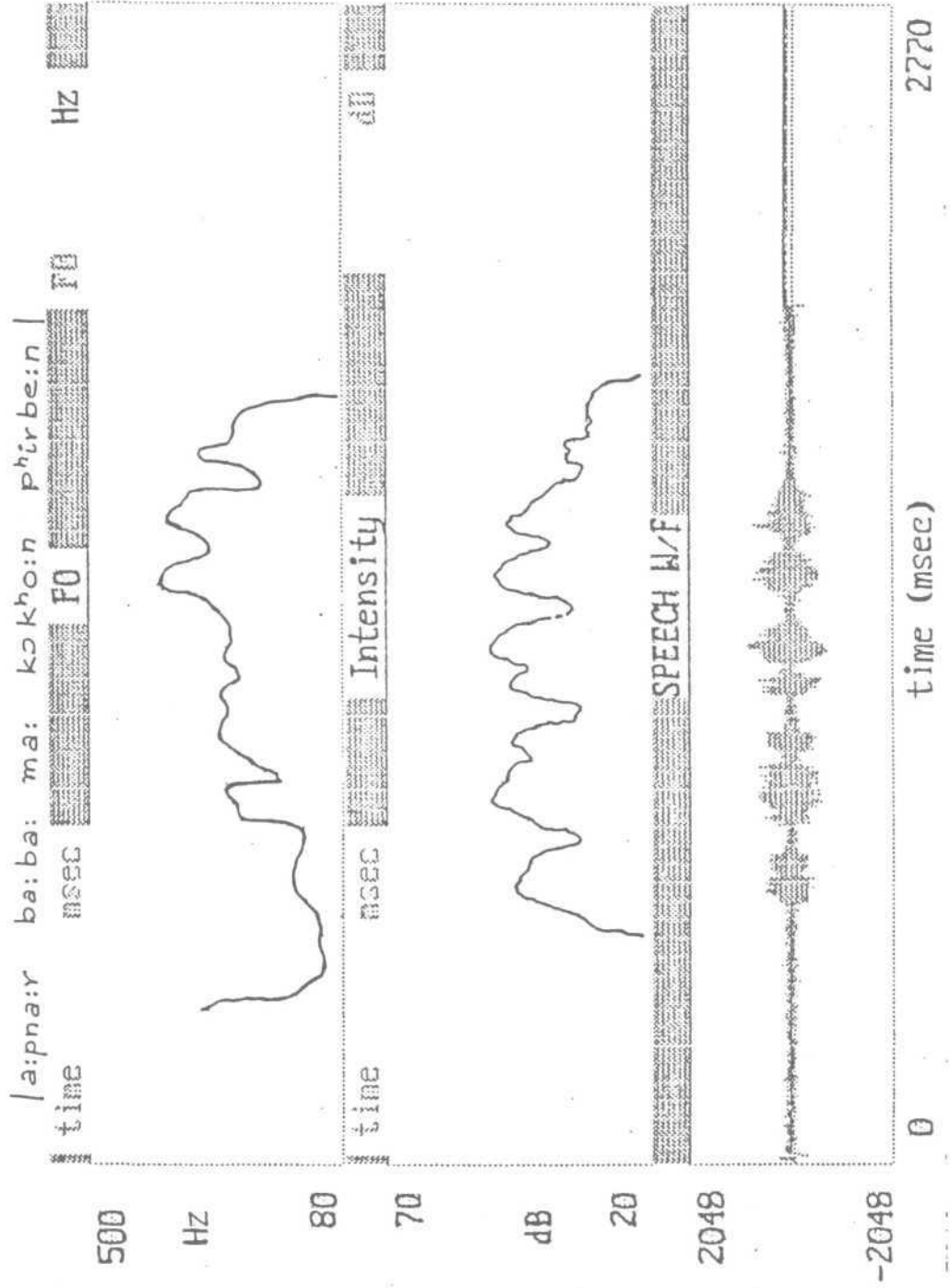
It can be concluded from Table 2.7.1. that Bengali speakers while expressing 'worry' follow a Fall-falt-rise-fall (steep) intonational pattern. There was a variation in the pattern of the fourth sentence which was a 'yes-no' question form depicting 'worry'. The sentence follows Fall-flat-rise-rise (gradual) intonational pattern. The terminal contour in the statement form of sentence was a falling pattern where as in the yes-no question sentence their terminal contour is a rising pattern. Intensity variation was not consistent and the pattern varies from sentence to sentence.

Males were found to use a greater Fo range when compared to females while expressing worry. However the intensity range used by males and females was nearly the same.

4.22.a

Graph: 7 Intonation contour: Worey

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Graph - 7 shows the intonation pattern of Fall-flat-rise-fall (steep) type which was used by Bengali speakers in expressing 'worry'.

8. Frustration:

All the four sentences expressing 'frustration' were spoken by male Bengali speakers. The Fo and Io variation of the four analyzed sentences are presented in Table 2.8.1.

Table 2.8.1. Showing (Fo-V) and (Io-V) in sentences expressing "frustration".

Sl. No.	Speaker	Sentence					
1. Male :	আর	কি	ব্যবসার	বা	করব ?		
	a:r	ki:	babʃa:i	ba:	korbo		
Fo - V	100-195	100-106	100-132	128-136	116-98		
Io - V	60-80	60-72	77-84	84-83	65-70		
2. Male :	আজ	তিনপাত্ত	ঘরে	আপনার	অফিস	বন্ধু ।	
	a:dʒ	t̪ima:ʃ	ʋho:re	t̪opone:r	ʋfis	bondho	
Fo - V	98-256	269-144	196-111	249-128	123-106	144-103	
Io - V	75-77	74-84	88-89	74-81	84-87	144-103	
3. Male :	এর	আজ	আমার	স্বস্তি	হলো	না	কেন ।
	er	a:ʒe	a:ma:r	mrit̪t̪u	ho:lo	na:	kæno
Fo-V	115-179	179-335	162-102	249-173	146-95	107-144	179-94
Io-V	89-84	89-87	84-88	90-77	84-83	86-81	66-74

Graph - 7 shows the intonation pattern of Fall-flat-rise-fall (steep) type which was used by Bengali speakers in expressing 'worry'.

8. Frustration:

All the four sentences expressing 'frustration' were spoken by male Bengali speakers. The Fo and Io variation of the four analyzed sentences are presented in Table 2.8.1.

Table 2.8.1. Showing (Fo-V) and (Io-V) in sentences expressing "frustration".

Sl. No.	Speaker	Sentence					
1. Male :	আর	কি	ব্যবসায়	বা	করব ?		
	a:r	ki:	babʃa:i	ba:	korbo		
Fo - V	100-195	100-106	100-132	128-136	116-98		
Io - V	60-80	60-72	77-84	84-83	65-70		
2. Male :	আজ	তিনমাস	যে	অপের	অফিস	বন্ধ ।	
	a:dʒ	t̪ima:ʃ	ʃe:ve	ʔopone:r	ʔf̪is	bɔndʰo	
Fo - V	98-256	269-144	196-111	249-128	123-106	144-103	
Io - V	75-77	74-84	88-89	74-81	84-87	144-103	
3. Male :	এর	আজ	আমার	স্বপ্ন	হলে	না	কেন ।
	er	a:ʒe	a:ma:r	mriʈʈu	ho:lo	na:	kæno
Fo-V	115-179	179-335	162-102	249-173	146-95	107-144	179-94
Io-V	89-84	89-87	84-88	90-77	84-83	86-81	66-74

4. Male:	ওটা o:ta	আমি a:mi	ভুলে bʰulʰe:	চারে tʃa:i
Fo-V	90-111	96-128	160-288	254-196
Io-V	77-75	71-69	65-70	70-66

The Fo and Io range used by subjects in expressing "frustration" in Bengali speakers is represented in Table 2.8.2. and Table 2.8.3. respectively.

Table 2.8.2.: Showing Fo range in sentences expressing "frustration".

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in female	Range in males
1.	M	221	98	123	194.5		
2.	M	269	98	171			
3.	M	381	95	286			
4.	M	288	90	198			

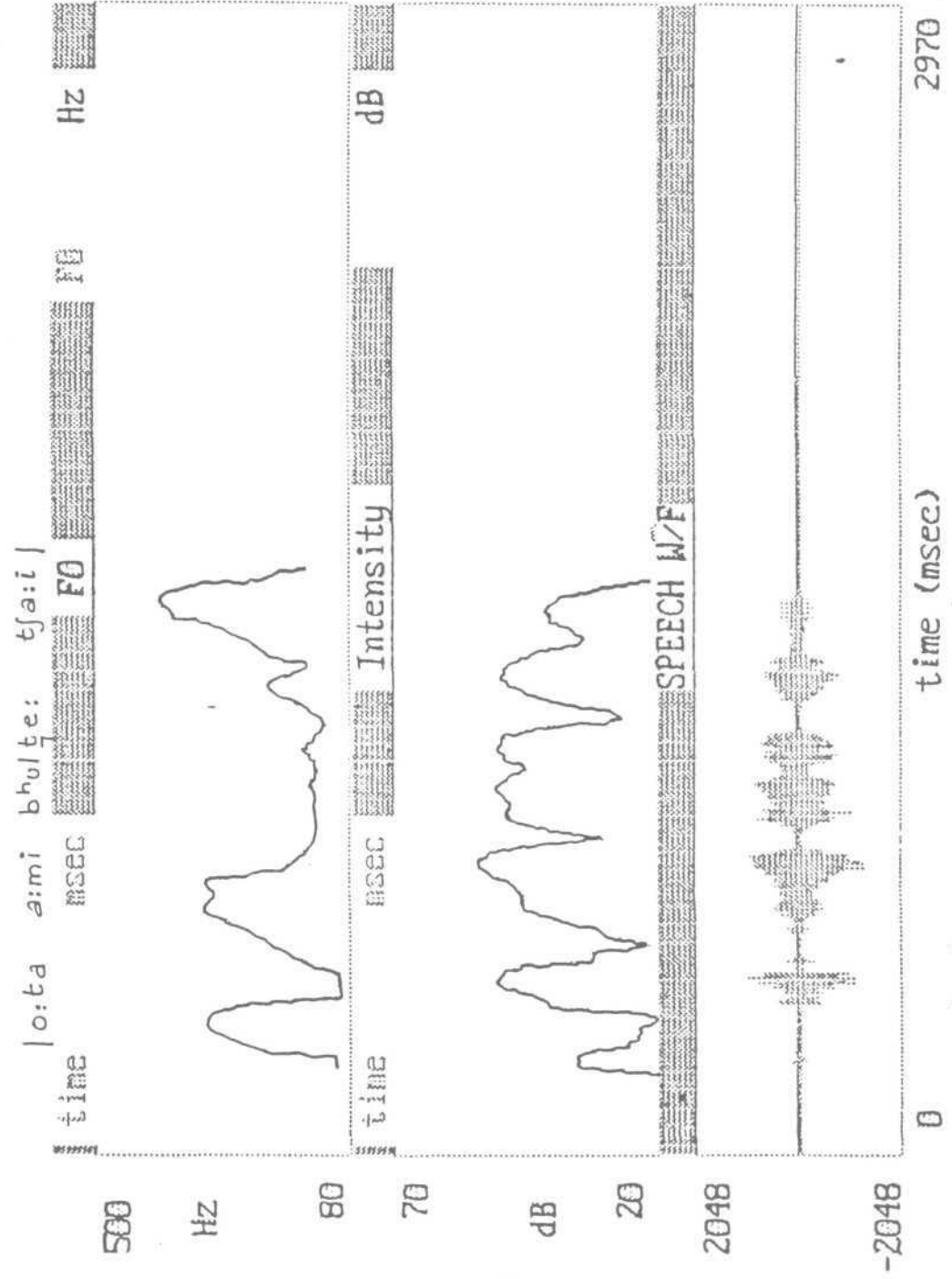
Table 2.8.3. Showing Intensity range in sentences expressing "Frustration".

Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	84	60	24	20		
2.	M	89	69	20			
3.	M	90	66	24			
4.	M	77	65	12			

4.24.a

Graph: 8 Intonation contour: Frustration

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It can be concluded from Table 2.8.1. that Bengali speakers while expressing 'frustration' followed a Rise (steep) -fall-flat-rise-fall (steep) intonational pattern. The terminal contour of all the four sentences expressing "frustration" showed a falling pattern. Intensity variation is not consistent and the pattern varied in each sentence.

Fundamental frequency range and intensity range could not be compared between males and females because all the speakers were males.

Graph - 8 shows the intonation pattern of Rise(steep)-fall-flat-rise-fall(steep) type which was used by Bengali speakers in expressing frustration.

9. Neutral:

Out of the four neutral sentences, two were spoken by males and other two by females. The Fo and Io variation of the four analyzed sentences are noted in Table 2.9.1.

It can be concluded from Table 2.8.1. that Bengali speakers while expressing 'frustration' followed a Rise (steep) -fall-flat-rise-fall (steep) intonational pattern. The terminal contour of all the four sentences expressing "frustration" showed a falling pattern. Intensity variation is not consistent and the pattern varied in each sentence.

Fundamental frequency range and intensity range could not be compared between males and females because all the speakers were males.

Graph - 8 shows the intonation pattern of Rise(steep)-fall-flat-rise-fall(steep) type which was used by Bengali speakers in expressing frustration.

9. Neutral:

Out of the four neutral sentences, two were spoken by males and other two by females. The Fo and Io variation of the four analyzed sentences are noted in Table 2.9.1.

Table 2.9.1. Showing (Fo-V) and (Io-V) in expressing neutral sentences.

Sl. No.	Speaker	Sentence				
1. Male :	এ	বাড়ির	জেট	আমি	জুলব ।	
	e	ba:viv	ge:t	a:mi	khulbo	
Fo - V	120-103	100-186	99-182	124-126	123-91	
Io - V	69-77	75-82	75-77	74-69	74-70	
2. Male:	এটার	আমার	অপসারি ।			
	eta:i	a:ma:r	o:pova:dh			
Fo - V	107-125	102-89	91-111			
Io - V	75-81	79-82	81-67			
3. Female:	এরিকে	একটু	জাকানে	পাঠিয়েছি	মা ।	
	ho:vike	ektu	do:ka:ne	pa:th'ijethi	ma:	
Fo-V	301-330	284-301	342-262	249-232	243-212	
Io-V	65-84	71-80	66-82	67-79	78-79	
4. Female:	এরির	মতো	কাছের	লোক	পাওয়া	
	ho:viv	mot _o	ka:djev	lo:k	pa:wa:	
Fo-V	256-276	292-310	238-238	243-252	269-301	
Io-V	64-82	83-69	60-80	75-74	57-78	
	ভাগ্যের	কমা				
Fo-V	284-238	246-211				
Io-V	66-78	80-76				
	bha:gger	ko:ha:				

The Fo and Io range used by subjects expressing 'neutral' sentences is represented in Table 2.9.2. and Table 2.9.3. respectively.

Table 2.9.2.: Showing Fo range in "neutral" sentences.

Sent No.	M/F	Max.Freq	Min.Freq	Range	Avg. range	Range in females	Range in males
1.	M	186	91	95			
2.	M	125	89	36			
3.	F	342	232	110	85	104.5	65.5
4.	F	310	211	91			

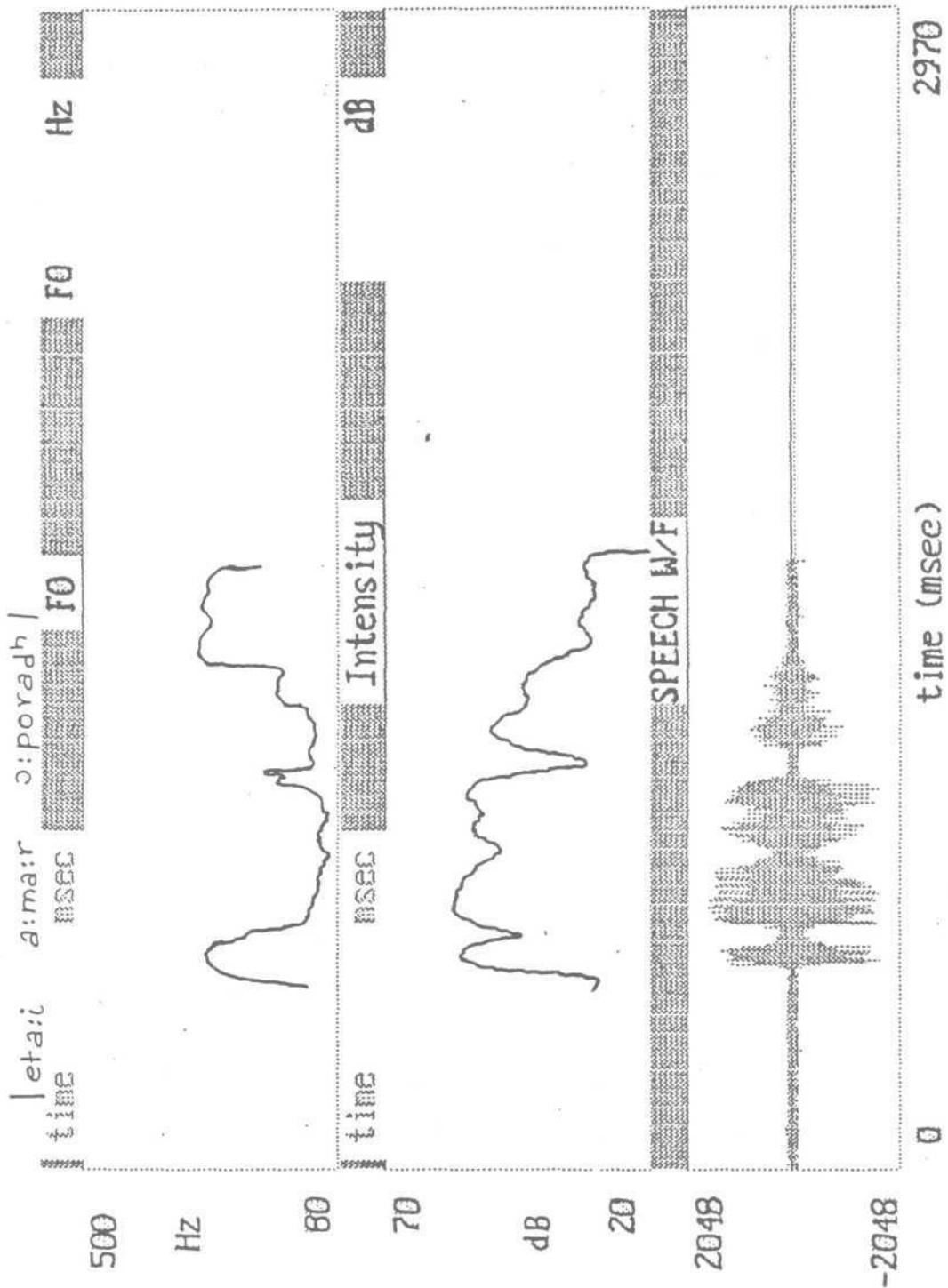
Table 2.9 .3. Showing Io range in 'Neutral ' sentences.

Sent No.	M/F	Max.I	Min.I	Range	Avg. range	Range in females	Range in males
1.	M	82	69	13			
2.	M	82	67	15			
3.	F	84	65	19	18.25	22.5	14
4.	F	83	57	26			

It can be concluded from table 2.9.1. that Bengali speakers used Rise(gradual) - fall-rise-fall(gradual), intonation pattern in expressing neutral sentences. Intensity contour was not similar in the four sentences.

4.27.0.

Graph: 9 Intonation contour: "Neutral"



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Comparing the Fo and Io range in males and females, it was found that females used a greater range in both Fo range and Io range in expressing neutral sentences.

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

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

It can be concluded that different types of intonation patterns was used by Bengali speakers under various emotional conditions as shown in Table-3.

Table 3: Showing the intonation patterns under various emotional conditions.

Emotion	Terminal Contour	Intonation pattern
1. Anger	fall(gradual)	Rise-fall-rise-fall(gradual)
2. Grief	fall(steep)	Rise-fall(gradual)-rise-fall(steep)
3. Joy	fall(steep)	Rise-fall-rise(gradual)-fall-(steep)

Emotion	Terminal Contour	Intonation pattern
4. Fear	rise(steep)	Rise(gradual)-fall(steep)-Rise-Fall-rise(steep)
5. Jealousy	fall	Rise(steep)-fall-rise-fall
6. Surprise	rise(gradual)	Fall(gradual)-rise(steep)-fall-rise(gradual)
7. Worry	fall(steep)	Fall-flat-rise-fall(steep)
8. Frustration	fall(steep)	Rise(steep)-fall-that-rise-fall(steep)
9. Neutral	fall(gradual)	Rise(gradual)-fall-rise-fall(gradual)

Chandrashekhar (1985), did a study on intonation patterns used by Hindi speakers for different emotions and he found that Hindi speakers use different intonation patterns to express different emotion.

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

Thus according to the objective analysis, of the present study, the hypothesis stating that "In Bengali, different intonation patterns are used in expressing different types of emotions" has been accepted, as seen from Table - 3.

The present study does not show any difference in intonation pattern used by males and females. There is no evidence of different intonation pattern being used by males or females in any of the emotions as seen from the present study done using Bengali speakers.

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

Though it can be concluded that intonation patterns observed differ with emotions, however not much difference is found in the intonation patterns between "Frustration" and "grief". Thus it may be that the same kind of intonation pattern may be used to express different types of emotions. Except for the sentences expressing emotion 'frustration' and 'grief' all other types of sentences have shown intonation pattern specific for each type. These results are partly in agreement with the findings of Manjula (1979) and Rathna et al. (1982) "that same intonation pattern can be used to express different emotions".

In the present study it has been seen that the intensity variations in the four sentences of a particular emotion are inconsistent i.e. they did not follow the same pattern. It can be stated that the perception of the intonation contour depends on the fundamental frequency variation that takes place during the utterance, than on intensity variation. Small variations in frequency may not be identified by subjective analysis but well detected by objective analysis. The results of the present study support the view of Pike (1945) and Lado (1961) that the variation in fundamental frequency of voice is the basis for perception of intonation contours. Further the results of this study do not agree with the results of Denes (1951) which states that it is not always the variations in fundamental frequency that contributes for intonation contour. Studies done by Chandrashekar (1985) on intonation patterns in Hindi and Nandini (1985) in Kannada, also support the result of the present study that variation in fundamental frequency is the basis for perception of intonation contours.

Thus it can be concluded, that the hypothesis stating that 'intensity variations do not indicate specific pattern in different emotions' has been accepted.

In the present study most of the intonation contours show a falling pattern at the end of the sentence except for few emotions. 'Fear' and 'surprise' showed a rising pattern in the final contour, where as anger, grief, Joy, jealousy, worry, frustration, neutral showed a falling pattern at the end of the sentences.

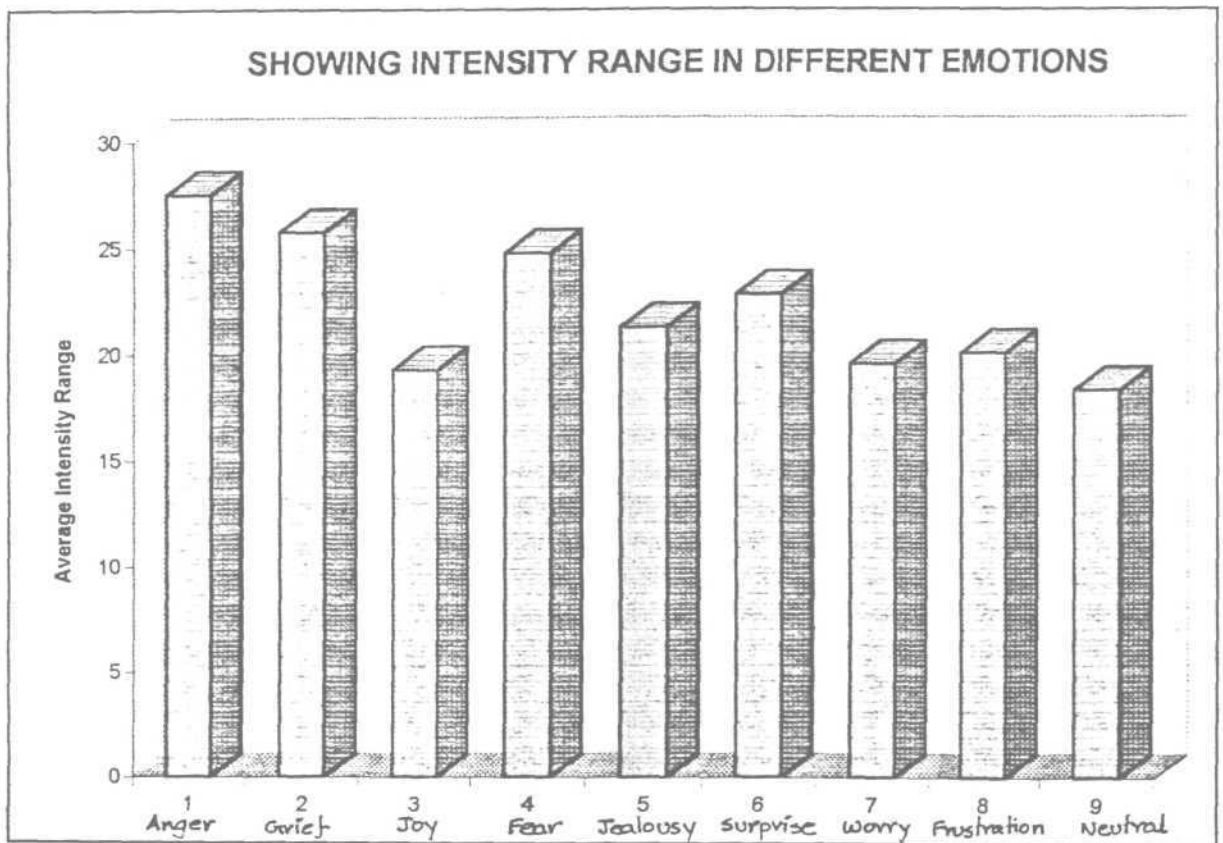
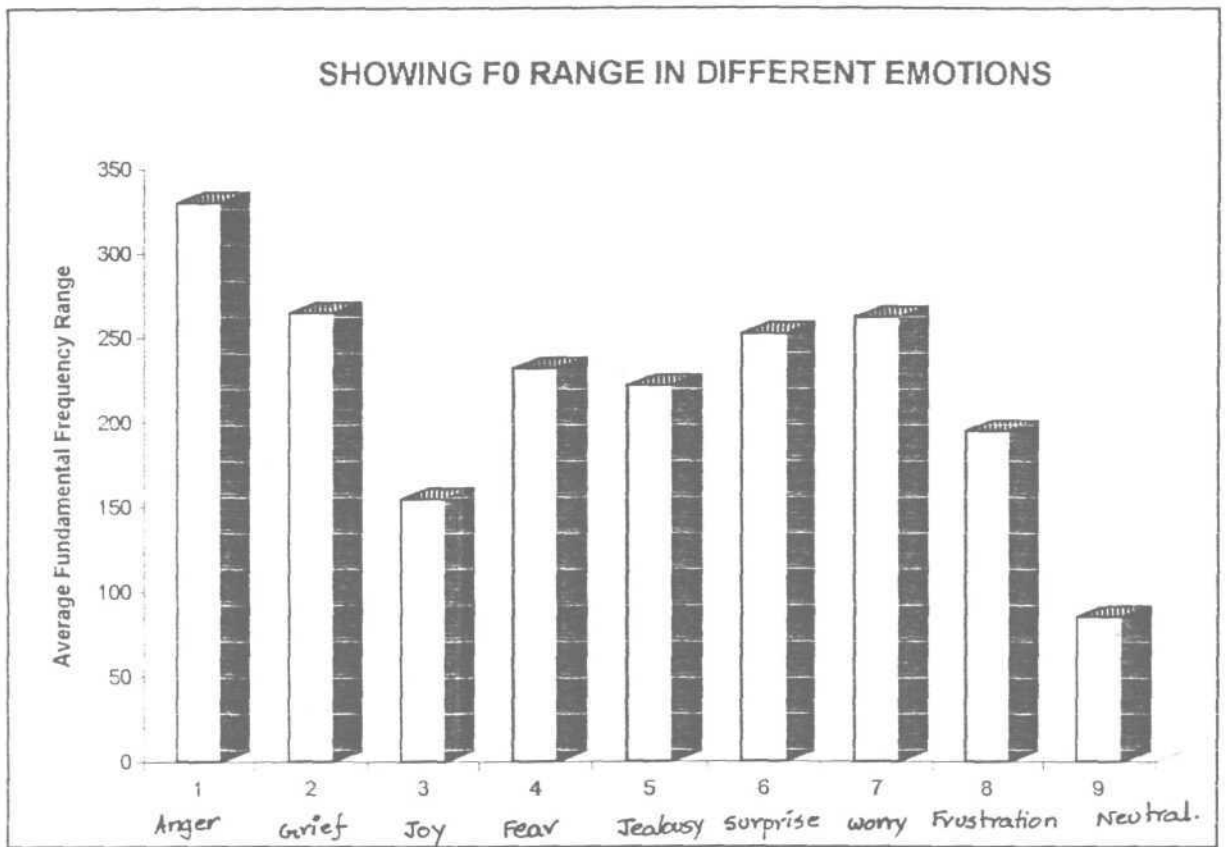
It has been found that there was lowering of fundamental frequency or falling type of intonation at the end of the sentences in expressing five emotions studied by Nataraja (1982). A falling pattern of terminal contour has also been suggested by Chandrashekhar (1985) in Intonation contour of Hindi language and also in Kannada language by Nandini (1985). Lieberman (1980), Soreson and Cooper (1977) stated that American English sentences are often characterized by fall in intonation curve. Falling pattern was observed in declarative sentences and in questions which were impossible to answer with yes-no. From the present study it is found that 'yes-no' questions irrespective of the emotion expressed showed a rising pattern type in the terminal contour. This view has been supported by study done by Lieberman (1980) who stated that pitch rise indicates a question to be answered with 'yes or no' and also sentences which are Incomplete.

Thus it may be possible that the final or terminal contour may be same for different emotional conditions, but the differences may be found in other parts of the contour, as it is seen in the present study.

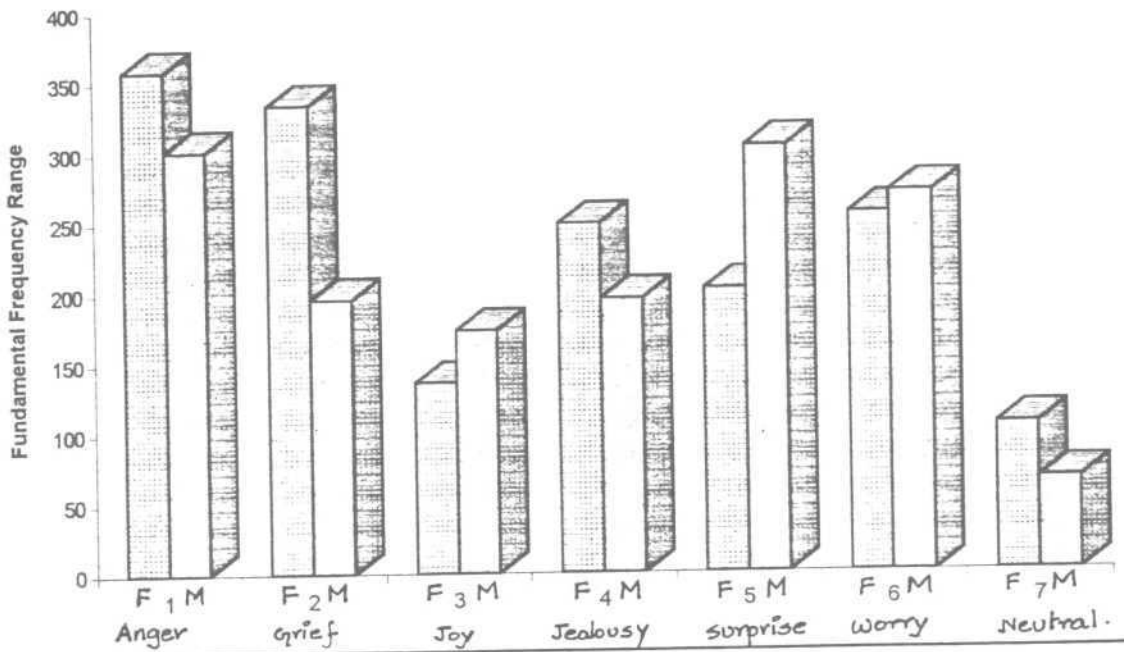
The study of the fundamental frequency range and intensity range in males and females it was found that among Bengali speakers females use a greater frequency range in emotions anger, grief, Jealousy, neutral, where as males use a greater range for 'worry and surprise'. Frequency range used in sentences expressing 'Anger' was the maximum and minimum in 'neutral' sentences. ^Grief''suprise' and 'worry' a reduced range when compared to anger and the range used was nearly the same.

Intensity range was maximum in sentences expressing 'anger' and minimum for neutral 'sentences'. Females used a greater, intensity range when compared to males in mostly all the emotions.

Nithun (1998) did a study on intonation used by Hindi speakers and his results partly support the results of the present study stating that the Females used a greater Fo range and intensity range than males in expression of all the emotions.



SHOWING COMPARISON OF F0 RANGE BETWEEN MALES AND FEMALES



SHOWING COMPARISON OF INTENSITY RANGE BETWEEN MALES AND FEMALES

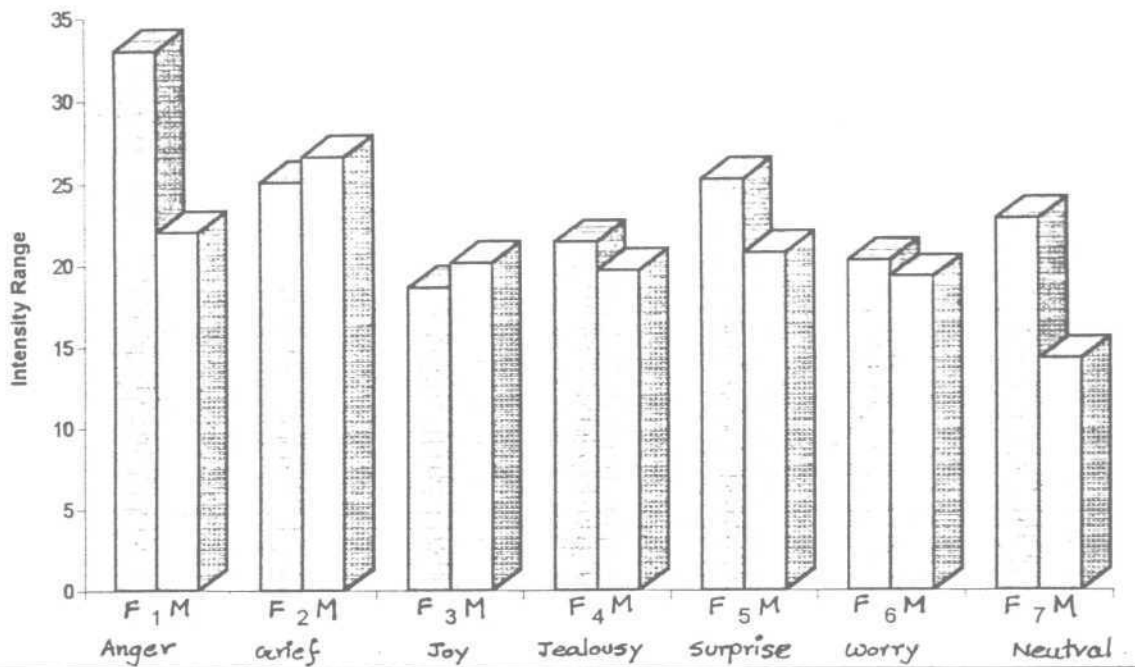


Table 4: Showing the Fo range and Intensity range in various emotions and also comparison of ranges between males and females.

Emotion	Freq. range	Comparison in M/F	Intensity range	Comparison in male and female
Anger	321.5	F>M	27.5	F>M
Grief	264.5	F>M	25.75	F<M
Joy	154.5	M>F	19.25	F<M
Fear	232.0	-	24.75	-
Jealousy	221.75	F>M	21.25	F>M
Surprise	252.25	M>F	22.75	F>M
Worry	262.0	M>F	19.5	F>M
Frustration	194.5	-	20.0	-
Neutral	85.0	F>M	18.25	F>M

Perceptual analysis was done to find out whether the non-native Bengali speakers could perceive the intonation similarly to that of native Bengali speakers. Bolinger (1973,) has stated that it is the perceptual analysis that is important in understanding the intonation, as it is the ultimate determiner of meaning. The results of the present study i.e. the perceptual scores (Appendix-C) differentiating different emotions by non-native and native speakers are presented in table 5.

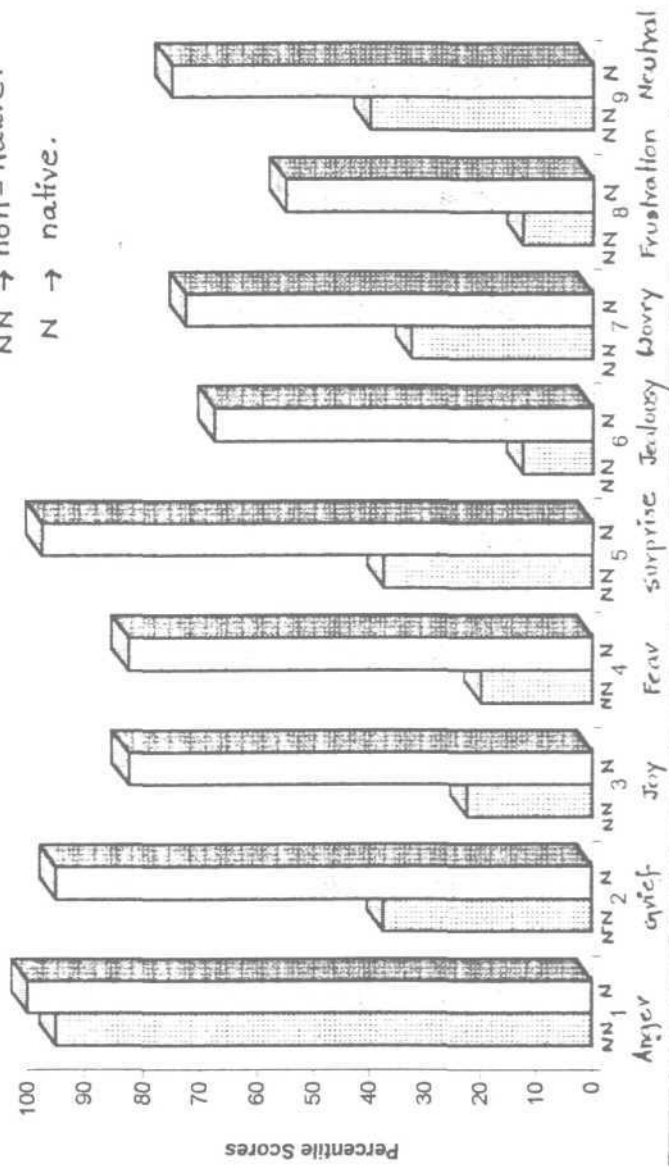
Table 5: Showing the perceptual scores in percentage for different emotion in native and non-native speakers.

Emotion	Native Speakers	Non-native speakers
Anger	100%	95%
Grief	95%	37.5%
Joy	82.5%	22.5%
Fear	82.5%	20%
Jealousy	67.5%	12.5%
Surprise	97.5%	37.5%
Worry	72.5%	32.5%
Frestration	55%	12.5%
Neutral	75%	40%

The study of table-5 shows that the native speakers had identified the different sentences expressing emotions ranging from 100% to 55%. (Anger 100% and Frustration 55%). The non-native speakers had identified the emotion Anger 95% i.e.. the 'anger' has been expressed well in terms of intonation compared to others, so that even the non-native speakers have been able to identify. Whereas Grief, surprise and worry have not been expressed well by the speakers using intonation in other words, the non-native speakers/listeners had difficulty in identifying the emotions solely based on intonation. The expression of frustration seems to be not

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

NN → non-native.
N → native.



very clear, as both native as well as non-native speakers have shown least scores of identification that is 55% and 12.5% respectively. The sentences expressing Jealousy also has lead to poor identification scores (12.5%) in case of non-native speakers. The remaining sentences also fall between these scores. Thus it can be concluded that the sentences selected were actually representing the emotions ie., they were selected for both, as identified by both native and non-native speakers. Emotions anger, grief, surprise, worry and neutral have been expressed well using intonation patterns as they could be identified by both native and non-native speakers well. Emotions like frustrations, jealousy and fear were not well expressed using intonation patterns

However, in perceiving 'anger' the non-native speakers also showed a high score this may be due to high Fo range and intensity range in anger. 'Frustration' and 'jealousy' was poorly perceived by the non-native Bengali speakers. It is found that even native speakers perceived sentences expressing 'frustration' mostly as 'Grief' inspite of the presence of contextual clues. This may be due to the similar intonation pattern used by Bengali speakers while expressing 'Grief' and 'Frustration'. But in general native speakers could perceive the intonation pattern of different emotions better than the non-native speakers. (Appendix- C)

Thus it can be concluded that the hypothesis stating that "Native speakers can identify the intonation pattern better than non-native speakers", is accepted, as the identification scores of various emotions by the native speakers is more than the non-native speakers (Table-5).

Better perception of the emotions by native speakers as seen in Table-5 can be contributed to contextual clues and comprehension of meaning of the words in a sentence to some extent.

Thus it may be concluded, based on the results of the present study that Bengali speakers use different intonation patterns to express different emotions and the intonation contours depend more upon the fundamental frequency variations rather than on intensity variations or other factors. Further it may also be concluded that native Bengali speakers can identify the intonational patterns much better when compared to the non-native speakers.

Thus the results of the present study indicate;

1. In Bengali different intonation patterns are used in expressing various types of emotions.
2. The intensity variations do not show difference in pattern under different emotions.

3. The perception of Intonation mainly depends upon the fundamental frequency variation.
4. Terminal contours are important in determining the form of the sentence, i.e., statements and 'Yes-No' questions.
5. The intonational pattern used by males and females do not differ.
6. The frequency and the intensity range used by the females were greater in more number of emotions when compared to males.
7. The native Bengali speakers were able to identify the Intonation much better when compared to non-native Bengali speakers.

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

CHAPTER- S

SUMMARY AND CONCLUSION

Speech is an established communicative system of arbitrary and conventionalized acoustic symbols, produced mainly by the action of muscles of the respiratory and upper respiratory tracts (Travis).

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

"Intonation like everything else in language is one instrument in an orchestra" (Bolinger, 1972).

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

Intonation is an exclusive term referring to pitch as a function of time and may be applied to a simple inflexion or

to long term variation in phrases over a numerous inflectional shifts (Greene, 1964)-

Intonation has been considered to be functioning at different levels of language, i.e. syntactic, lexical, phonological and also in providing information regarding condition of the speakers, emotion and others.

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

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

The present study aimed at finding out the intonation patterns used by native Bengali speakers under different emotional conditions.

Thirty six sentences were selected randomly from two Bengali films audio cassettes as:

1. The emotions expressed , are produced as natural as possible.
2. The emotions are conveyed by speakers to the listeners only through speech, i.e., without any visual clues.

Ten native Bengali speakers and ten non-native speakers of age range 18-25 years served as subjects for perceptual study.

Nine emotions, i.e., surprise, fear, frustration, jealousy, joy, anger, worry, grief, neutral were considered as the basic emotions for the study. Four sentences were chosen randomly to express each emotion. Both male and female subjects were considered.

In the present study both objective and perceptual analysis were done. The objective analysis was done using the D.S.P. Sonograph - 5000. In perceptual analysis both the groups i.e., native Bengali speakers and nonnative speakers were made to listen to the thirty six sentences, that were randomly chosen from the two audio film cassettes, and asked to identify the emotions expressed in the sentences.

The results obtained by objective and perceptual analysis follows:

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

5.4

2. The intensity variations do not show difference in pattern under different emotions.
3. The perception of Intonation mainly depends upon the fundamental frequency variation.
4. Terminal contours are important in determining the form of the sentence, i.e., statements and 'Yes-No' questions.
5. The intonational pattern used by males and females do not differ.
6. The frequency and the intensity range used by the females were greater in more number of emotions when compared to males.
7. The native Bengali speakers were able to identify the Intonation much better when compared to non-native Bengali speakers.

RECOMMENDATIONS:

1. A more detailed study with more speech samples may be taken up.
2. Natural speech can be used to study the intonation pattern in Bengali.
3. Using the procedure developed by this study the intonation in other languages may be studied.
4. Other prosodic aspects in Bengali can be studied using the same methodology.

CHAPTER- 6

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APPENDIX - A

দয়া দেখাচ্ছ আন্মাকে

1. d̪ɔ:jʌ d̪akʰʌtʃʰo a:ma:ke? ANGER

মানে তোমার কটা ফোন করবে না ?

2. ma:ne t̪oma:r ko:rta fo:n korbe na: ? ANGER

বেড়িয়ে যাও এখন থেকে ।

3. beri:je dja:o ekʰa:n t̪ʰe:ke. ANGER

আমি তোমার কোন কথা শুনতে চাই না ।

4. a:mi t̪omar ko:no kotʰʌ ʃunt̪e tʃa:i na:. ANGER

এইভাবে অপমান হতে হলো ।

5. ei bʰa:be o:poma:n hot̪e ho:lo. GRIEF

বকি কি আর সাধে ।

6. bo:ki ki a:r ʃa:d̪ʰe. GRIEF

বোকার মতো আপনাকে আঘাত দিয়ে ফেললাম ।

7. boka:r mɔt̪o a:pna:ke a:gʰa:t̪ d̪ije pʰella:m. GRIEF

আমি বিনে পয়স্য সব কাজ করে দেব ।

8. a:mi bi:ne poiʃa:i ʃɔb ka:d̪j ko:re de:bo. GRIEF

আমি খুলবো তো ?

9. a:mi kʰulbo t̪o ? JOY

দাও চাবিটা দাও ।

10. da:o tʃa:bita: da:o. JOY

চাকরির ইন্টারভিউ লেটার এসেছে ।

11. tʃa:krir int̪ərvju let̪ər eʃe:tʃe. JOY

- ঠিক আছে sir.
12. t^hik a:t^he sər. JOY
- আমায় ডেকেছেন sir?
13. a:mai deket^he:n sar. FEAR
- ডীষন মারবে তো ?
14. bhi:ʃon ma:rbe t₇: ? FEAR
- বাবা দেখতে পাবে।
15. ba:ba: dek^hte pa:be. FEAR
- আমায় মেরো না।
16. a:mai me:ro na:. FEAR.
- এ দাদার কথা তুলে গিয়েছিলে তাই বলা।
17. e da:da:r ko t^ha: b^hule gi:jet^hile t₇:i bolo. JEALOUSY
- এ দাদাকে লুচি - হালওয়া খাওয়ালেই চলবে ?
18. e da:da:ke lu:t^hi ha:lwə: k^ha:wa:lei t^holbe. JEALOUSY
- বাবা বরাবরই একটু বড়ছেলের দিকে টেনে কথা বলেন।
19. ba:ba: bora:bo:ri: ektu boro:t^heler dike te:ne ko t^ha: bolen. JEALOUSY
- স্বামীর চাকরী নেই তবু দেখা ওরা আজ কেমন সুখী।
20. ʃa:mir t^ha:kri nei tobu da^ho o:ra: a:dj ka^hmon ʃuk^hi. JEALOUSY
- তুই মদ খেয়েছিস ?
21. tu:i mo^hd^h k^hejet^hiʃ. SUPRISE
- এ তুমি কাকে কি বলছ ?
22. e tu:mi ka:ke ki bo:lt^ho. SUPRISE

- সুন্দর ছটা লিখেছ তো ?
23. ʃundo:r tʃ^hɔra lik^he:tʃ^ho tɔ: SUPRISE
- এখনো চাকরি হয়নি ?
24. ak^ho: no: tʃa:kri hoini. SUPRISE
- এ বাড়ির জ্যেট আমি খুললো।
25. e ba:rɪr ge:t a:mi k^hulbo. NEUTRAL
- এটাই আমার জলরার্থ।
26. eta:i a:ma:r ɔ:pɔra:d^h. NEUTRAL
- হরিকে একটু দোকানে পাঠিয়েছি।
27. ho:rike ektu do:ka:ne pa:t^hijetʃ^hi ma:. NEUTRAL
- হরির মোটো কাজের লোক পাওয়া ডাঙের কথা।
28. ho:rɪr mo^hɔ ka:dʒer lo:k pa:wa: b^ha:gger ko t^ha: NEUTRAL
- চাৰি দেব কেন ?
29. tʃa:bi de^hbo kɛno ? WORRY
- আপনার ম্মা বাবা কখন ফিরবেন ?
30. a:pna:r ba:ba: ma: ko k^ho:n p^hirbe:n ? WORRY
- তাহলে এতো ডাড়াডাড়ি চলে এলে ?
31. ta:hole a^hɔ: ta:ra:ta:ri tʃo:le e:le. WORRY
- চলন আবার কিছু বলবে না তো ?
32. tɔpo:n a:ba:r kitʃ^hu: bo:lbe na: tɔ: WORRY
- আর কি ব্যবসায় বা করণা ?
33. a:r ki: babʃa:i ba: ko rbo. FRUSTRATION

আজ তিন মাস ধরে উপনের অফিস বন্ধ
34. a:dj t̪inma:ʃ d̪ʰo:re t̪ɔpone:r ɔfis bɔ n̪d̪ho FRUSTRATION

এর আগে আমার মৃত্যু হলো না কেন
35. er a:ge a:ma:r mrit̪tu ho:lo na: kænɔ FRUSTRATION

এটা আমি ভুলতে চাই।
36. o:ta a:mi b̪ʰult̪e: t̪ʃa:i. FRUSTRATION

APPENDIX B

Indicating conversion of reference intensity in DSP-
sonograph to dB scale.

On DSP	dB
- 47	47
- 46	48
- 45	49
- 44	50
- 43	51
- 42	52
- 41	53
- 40	54
- 39	55
- 38	56
- 37	57
- 36	58
- 35	59
- 34	60
- 33	61
- 32	62
- 31	63
- 30	64
- 29	65
- 28	66
- 27	67
- 26	68
- 25	69

On DSP	dB
- 24	70
- 23	71
- 22	72
- 21	73
- 20	74
- 19	75
- 18	76
- 17	77
- 16	78
- 15	79
- 14	80
- 13	81
- 12	82
- 11	83
- 10	84
- 9	85
- 8	86
- 7	87
- 6	88
- 5	89
- 4	90
- 3	91
- 2	92
- 1	93
- 0	94

APPENDIX - C
PERCEPTUAL SCORES IN NON-NATIVE SPEAKERS

SENT NO.	EMOTION	ANGER	GRIEF & SURPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
<hr/>									
1.	ANGER	10	-	-	-	-	-	-	-
2.		9	-	-	-	-	-	1	-
3.		10	-	-	-	-	-	-	-
4.		9	-	-	1	-	-	-	-
<hr/>									
1.	GRIEF	-	5	-	2	-	2	1	-
2.		-	2	1	3	-	2	2	-
3.		-	8	-	1	-	-	1	-
4.		-	-	-	2	3	-	1	1
<hr/>									
1.	JOY	1	-	3	1	2	-	-	2
2.		4	1	-	1	1	1	2	-
3.		-	2	-	2	1	1	3	1
4.		-	-	2	1	5	-	1	-
<hr/>									

PERCEPTUAL SCORES IN NON-NATIVE SPEAKERS

EMOTION	ANGER	GRIEF	SURPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
<hr/>									
FEAR									
1.	1	-	-	-	-	5	2	-	2
2.	-	1	4	1	-	1	3	-	-
3.	1	-	2	2	-	2	1	-	2
4.	2	-	-	-	4	1	2	-	1
<hr/>									
SURPRISE									
1.	-	2	1	-	2	3	-	-	2
2.	-	9	-	-	-	1	-	-	-
3.	-	-	7	1	-	-	-	2	-
4.	-	-	7	-	-	-	-	3	-
<hr/>									
JEALOUSY									
1.	-	2	-	1	-	2	-	-	5
2.	-	2	-	-	2	2	-	1	3
3.	-	1	-	4	-	-	1	1	3
4.	-	1	-	1	1	1	1	3	2
<hr/>									

PERCEPTUAL SCORES IN NON-NATIVE SPEAKERS

EMOTION	ANGER	GRIEF	SURPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
<hr/>									
1.	1	1	1	2		2	1	2	-
2.	-	-	4	-		2	-	-	4
3.	-	1	-	1		4	-	2	2
4.	1	-	-	-		5	1	1	2
<hr/>									
1.	1	3	-	-		3	-	-	3
2.	-	4	-	2	-	-	-	1	3
3.	-	6	-	2	-	-	-	-	2
4.	2	2	-	1		1	2	-	2
<hr/>									
1.	1	-	-	-	-	-	-	2	7
2.	-	2	-	-		6	-	-	2
3.	-	-	2	-		1	-	1	6
4.	-	2	-	1		4	-	2	1
<hr/>									

PERCEPTUAL SCORES IN NATIVE SPEAKERS

SEMI MO.	EMOTION	ANGER	GRIEF	SURPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
1.	ANGER	10	-	-	-	-	-	-	-	-
2.		10	-		-	-	-	-	-	-
3.		10	-	-	-	-	-	-	-	-
4.		10	-	-	-	-	-	-	-	-
1.	GRIEF	-	10		-	-	-	-	-	-
2.		-	10			-	-	-	-	-
3.		-	10			-	-	-	-	-
4.		-	8			-	-			2
1.	JOY					10		-	-	-
2.		-	-	-		7				3
3.		-	-	-		10		-	-	-
4.		-	-	-		6	1			3

PERCEPTUAL SCORES IN NATIVE SPEAKERS

SENT MO.	EMOTION	ANGER	GRIEF	SURPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
<hr/>										
1.	FEAR	-	-	-		-	2	6	-	2
2.		-	-		-	-	-	10	-	-
3.		-	-			-	2	7	-	1
4.		-	-	-	-	-	-	10	-	-
<hr/>										
1.	SURPRISE			10	-	-	-	-	-	-
2.				10	-	-	-	-	-	-
3.				10	-	-	-	-	-	-
4.				g			1	-	-	-
<hr/>										
1.	JEALOUSY		2		-	-	-	-	5	3
2.			2		-	-	-	-	5	3
3.		-	-	-	-	-	-	-	7	3
4.		-	-		-	-	-	-	10	-
<hr/>										

PERCEPTUAL SCORES IN NATIVE SPEAKERS

SENT WO.	EMOTION	ANGER	GRIEF	SUPRISE	FRUSTRATION	JOY	WORRY	FEAR	JEALOUSY	NEUTRAL
WORRY										
1.				1	-		9	-	-	-
2.		-	-		-		5	2	-	3
3.		-	-		-		6	-	1	-
4.		-	-	-	-		9	1		-
FRUSTRATION										
1.		-	-	-	8		2	-	-	-
2.		-	2	-	5	-	-	-	-	3
3.		-	6	-	4	-	-	-		-
4.			1		5	-	-	-	-	4
NEUTRAL										
1.		-	-	-	-	-	-	-	-	10
2.			4		-	-	-	-		6
3.		-	-	-	-		1			9
4.		-	3	-	-	2	-	-		5

**SHOWING THE PERCEPTUAL SCORES IN PERCENTAGE FOR DIFFERENT EMOTIONS IN NATIVE AND
NON-NATIVE SPEAKERS**

Responses

Emotion	Anger		Grief		Joy		Fear		Jealousy		Surprise		Worry		Frustration		Neutral	
	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN
Anger	100%	95%								2.5%						2.5%		
Grief			95%	37.5%		7.5%		12.5%		2.5%		2.5%		10%		20%		7.5%
Joy					82.5%	22.5%		15%		7.5%		12.5%		2.5%		12.5%		5%
Fear							10%	82.5%	20%			15%		10%		7.5%		12.5%
Surprise														2.5%		2.5%		5%
Jealousy										12.5%	97.5%	37.5%		10%		2.5%		5%
Worry										67.5%	12.5%			12.5%		15%		32.5%
Frustration							7.5%		5%	2.5%	12.5%	10%	12.5%	72.5%	32.5%	7.5%		20%
Neutral														5%		12.5%		25%
										12.5%				2.5%		2.5%		40%

N - native speakers

NN - non-native speakers