ACOUSTIC PARAMETERS OF SPEECH OF STUTTERERS IN PRE AND POST-THERAPY CONDITIONS

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ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE - 570 006
MAY-1991

TO

My Revered Guide
Who is my
Source of Inspiration

DR. N.P.NATARAJA

CERTIFICATE

This is to certify that the dissertation entitled **"ACOUSTIC PARAMETERS OF SPEECH OF STUTTERERS IN PRE AND POST-THERAPY CONDITIONS"** *is the bonafide work in part fulfilment for the degree of Master of Science (Speech & Hearing), of the student with Register No M 8923.*

Director

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CERTIFICATE

This is to certify that the dissertation entitled

"ACOUSTIC PARAMETERS OF SPEECH OF STUTTERERS IN PRE AND POST-THERAPY CONDITIONS"

has teen prepared under my supervision and guidance.

nay 1991

DR.N.P.NATARAJA 13/6/91
Guide

DECLARATION

This dissertation is the result of my own study undertaken under the guidance of Dr.N.P.Nataraja, Prof. & HOD Speech Science, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

MYSORE
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INTRODUCTION

PART-1

COMPUTERISED SEVERITY RATING SCALE FOR STUTTERING

Research on stuttering has been concentrated on the areas like diagnosis, assessment and therapy of stuttering. The question as what should be regarded as stuttering and how it should be assessed has not been solved satisfactory. When a speech clinician evaluates the speech of a stutterer, he usually rates stuttering depending on his knowledge and previous experience. Thus the rating may vary from clinic to clinic. Though there have been many attempts, it is very difficult to define stuttering.

Verbal behaviours of stutterers are amenable to objective analysis. But formerly the severity of stuttering was assessed only through judgement which was obviously subjective ie., based on the perception of listeners. Rating scales differing in number of points of ratings were used. An improvement over this type of rating was of counting number of times a stutterer "stuttered" - which is usually denoted as a 'block'. Later it was realised that blocks alone will not do, but it should be related to the number of words he read or spoke during the time he had those blocks.

Lewis (1951) attempted to measure the judgement of severity utilizing a 9-point interval rating scale and they determined that the listeners could rank stuttering severity solely on the basis of audio sample of stuttering.

Sherman et al (1956), Young (1961) have shown a fairly strong relationship between the measures based on two methods, that is by counting moments of stuttering and by employing subjective rating scale methods.

While Prather & Willimas (1963), Martin (1965), Hoops and Wilkins (1973) reported that the judgement of severity of stuttering could be reliable if a large group of judges are used but not otherwise.

In recent years, researchers have tried using instruments in an attempt to define stuttering, as the use of glottographic recordings or use of spectrographic analysis (Stromsta, 1965).

NEED FOR THE STUDY

Thus the review of literature reveals that the results regarding severity rating of stuttering are not satisfactory.

This calls for development of a method which would determine the severity of stuttering with more accuracy and objectivity.

STATEMENT OF THE PROBLEM

Determine the method of measuring severity of stuttering, accurately and objectively and find out whether it is sensitive enough.

OBJECTIVES OF THE STUDY

The objectives of the study are -

1) To find out correlation between ratings by judges and measurement using computer by comparing the descriptions of disfluences, rate of speech and the rating of severity of stuttering in both ways of analysis.

2) To judge the intrajudge and interjudge reliability.

LIMITATIONS OF THE STUDY

1) Less number of subjects were used in the study.
2) Only postgraduate students of speech and hearing have been used as judges.

IMPLICATIONS OF THE STUDY

1) It provides a more accurate and objective way of rating severity of stuttering.

2) Provdies information regarding pre and posttherapy conditions of stuttering.

PART-11

ACOUSTIC PARAMETERS OF SPEECH OF STUTTERERS IN PRE AND POST THERAPY CONDITIONS

"Stuttering has been called a riddle_____Stuttering is more than a riddle. In at least a complicated, multi-dimensional jig-saw puzzle with many pieces still missing".

"Many good minds have attempted definitions of stuttering, but the variability among them makes clear, this complex and variable disorder is hard to delimit".

- Van Riper

In recent years, the field of stuttering has seen many turning points in lieu of interest surging to highlight the causation of stuttering. Laryngeal dynamics is one such field which has received vast and varied attention.

Larynx has been thought to be the culprit even in very early days [Avicenna (1037), Hann (1736), Morgagni (1973), Arnott (1829)].

It has been thought that the laryngeal abnormalities result because the focal feature of stuttered speech involve aberrant properties of speech muscle activities, many of which are simply not readily available for the direct unaided human observation.

MacKenzie (1955) has found a complete reduction in stuttering for the stutterers who had used electrolaryx. Other reports have shown that laryngectomized stutterers who had learnt esophageal speech did not show any stuttering (Irving and Webb, 1961).

Wingate's (1970) view of improved fluency in several conditions due to change in phonatory function has spurred a number of investigations related to phonation in stutterers.

Findings of Conture, McCall, Brewer (1977) indicate that there are differences in laryngeal behaviour among various types of stuttering. They used the fiberoptic endoscope to visualize and record behaviours of the larynx during stuttered speech. These investigators reported that at times during speech the larynx was inappropriately and unpredictably open and that at other times it was inappropriately closed. It was indicated that different types of disfluencies were associated with different forms of laryngeal activity. Part-word repetitions were generally associated with abductory laryngeal activity during the time course of the perceived disfluencies while sound prolongations were generally associated with adductory laryngeal activity.

Freeman (1977), Freeman and Ushijima (1978), Shapiro (1980) carried out EMG measurement of intrinsic muscle activity with hooked wire electrode during stuttered and fluent speech. Finding showed that stuttered speech was associated with higher levels of muscle activity than fluent speech, that coordination between agonist-antagonist muscle was reduced and that sudden reductions in muscle activity occurred with the release of a stuttered word.

Freeman (1977), Shapiro (1980) noted that perceptually fluent utterances of stutterers were often accompanied by disruptions in the usual coordination of laryngeal muscles.

Articulation responses during standard speech was examined with high speed cinefluorography by Freeman and Ushijima (1978), Zimmerman (1980). Stutterers showed frequent repositioning of articulators preceding both fluent and disfluent utterances. Fewer synchronous relationships were found among articulators of stutterers in either fluent utterances or disfluent ones for stutterers than for fluent utterances of a normal speaker.

Conture (1984) suggested that EGG waveforms might be different for fluent utterances of children when accompanied with those of fluent utterances of normal speaking children. Peter and Boves (1984) reported that subglottal air pressure built up in fluent utterances of stutterers was often different from that observed in fluent utterances of normal speakers.

Thus the review of literature indicates that larynx does play an important role in stuttering behaviour.

"The inappropriate vigorous contraction of posterior cricoarytenoid" as suggested by Schwartz (1974) and the simultaneous contraction of intrinsic muscles of larynx as observed by Freeman and Ushijima (1975) during stuttering might result in a change in the temporal aspects of speech with respect to voicing. Voice Onset Time, Voice/Speech Initiation Time, Voice/Speech Termination Time are some parameters among the temporal aspects of speech.

Several studies have revealed that voice onset time (VOT), voice/speech initiation time (VIT/SIT), voice/speech termination time (VTT/STT) values for stutterers are different as compared to nonstutterers. They also show that laryngeal muscle activity of stutterers is different from nonstutterers during speech. But as reported by Peters and Hulstijn (1987) the evaluation of the outcome of stuttering therapy is very often restricted to the assessment of the disfluency percentage and speech rate. While in stuttering therapy gentle voice onset time (VOT) seems to be an important fluency generating target behaviour. However, objective physical description of voice onset characteristics in untreated and treated stutterers have not yet been obtained.

Researchers have used main two methods to study VOT, VIT/SIT, VTT/STT, they are wideband spectrograms and optical oscillograph method.

The present study has made use of a wide band spectrogram to study the voice onset time, PM 100 to study speech initiation time and speech termination time values for voiceless stop consonants of English and Kannada languages for stutterers in both pre and post therapy conditions and to compare them with those of nonstutterers. Fundamental frequency, rate of speech, total number of stuttering moments have also been found out.

NEED FOR THE STUDY

Thus the review of literature reveals that voice onset time, voice/speech initiation time, voice/speech termination time are different for stutterers than nonstutterers.

This calls for a study which would try to determine the relationship between the two variables ie., pretherapy and posttherapy voice onset time, speech initiation time and speech termination time and other parameters as rate of speech, fundamental frequency and total number of stuttering moments.

STATEMENT OF THE PROBLEM

The present study attempts to find out the relationship between pretherapy and posttherapy variables in stuttering.

PURPOSE OF THE STUDY

The purpose of the study was to test the following hypotheses:

1) "There will be no difference between stutterers in pretherapy condition and matched nonstutterers for both Kannada and English speakers" for:

i) Voice onset time of voiceless stop sounds

   a) in syllables (pa, ta, ṭa, ka in Kannada and pa, ta, ka in English).

   b) in words in isolation (pakkada, ṭaar, ṭam, kamala in Kannada and pen, ṭeeth, kite in English).

ii) Speech initiation time

iii) Speech Termination time

iv) Fundamental frequency

v) Rate of speech (using standard passage in Kannada and Rainbow passage in English)

vi) Total number of stuttering moments.

2) "There will be no difference between stutterers in posttherapy condition and matched nonstutterers for both Kannada and English speakers" for :

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka in Kannada and pa, ta, ka in English)

b) in words in isolation (pakkada, taar, tarn, kamala in Kannada and pen, ṭeeth, kite in English)

ii) Speech initiation time

iii) Speech termination time

iv) Fundamental frequency

v) Rate of speech (using standard passage in Kannada and Rainbow Passage in English),

vi) Total number of stuttering moments.

2) "There will be no difference between stutterers in posttherapy condition and matched nonstutterers for both Kannada and English speakers" for :

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka in Kannada and pa, ṭa, ka in English)

b) in words in isolation (pakkada, taar, tam, kamala in Kannada and pen, ṭeeth, kite in English)

ii) Speech initiation time

iii) Speech termination time

iv) Fundamental frequency

v) Rate of speech (using standard passage in Kannada and Rainbow Passage in English),

vi) Total number of stuttering moments.

3) "There will be no difference between stutterers in pretherapy and posttherapy condition for both Kannada and English speakers" for:

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka in Kannada and pa, ṭa, ka in English).

b) in words in isolation (pakkada, taar, tam, kamala in Kannada and pen, ṭeeth, kite in English).

ii) Speech initiation time

iii) Speech Termination time

iv) Fundamental frequency

v) Rate of speech (using standard passage in Kannada and Rainbow passage in English)

vi) Total number of stuttering moments.

LIMITATIONS OF THE STUDY

1) The study was done using only Kannada and English languages.

2) The study was done using only five stutterers and five nonstutterers with limited age group.

3) Only one female stutterer was used as subject.

4) Investigator was not involved in therapy and no specifications were provided to the therapist by the investigator.

IMPLICATIONS OF THE STUDY

1) This study helps in knowing the variations in different parameters of stuttering in posttherapy and pretharapy conditions.

2) It helps to find out the similarities and differences between stutterer's pretherapy condition and nonstutterers* posttherapy condition and nonstutterers.

3) Helps in knowing the effectiveness of therapy procedures used with the help of some objective measure.

DEFINITIONS OF SOME OF THE KEY WORDS USED IN THE STUDY

STUTTERING:

"The term stuttering means: I (a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary, audible or silent repetitions or prolongations in the utterance of short speech elements namely sounds, syllables and words of one syllable. These disruptions (c) usually occur frequently or are marked in character (d) are not readily controllable. II Sometimes the disruptions are (e) accompanied by accessory activities involving the speech apparatus, related or unrelated body structures or stereotyped speech utterances. These activities give the appearance of being speech-related struggle. III Also, there are not infrequently (f) indications or report of the presence of an emotional state, ranging from a general condition of 'excitement* or 'tension' to more specific emotions of a negative nature such as the fear, embarrassment, irritation or the like. (g) The immediate source of stuttering is some incoordination expressed in the peripheral speech mechanism, the ultimate cause is presently unknown and may be complex or compound" (Wingate 1964).

VOICE ONSET TIME (VOT):

The duration between the release of a complete articulatory constriction or burst transient and the onset of phonation (Lisker and Abramson 1964, 1967).

VOICELESS STOP:

A voiceless stop is a speech sound produced by -

1) a complete oral closure
2) a velic closure and
3) absence of voicing during complete oral closure.

SPEECH INITIATION TIME:

Speech initiation time is defined as the time lapse between the appearance of some experimenter controlled external stimulus (eg: a tap on the table) and subject's initiation of glottal vibration for the act of speaking.

SPEECH TERMINATION TIME:

Speech termination time is defined as the time lapse between the appearance of some experimenter controlled external stimulus (eg: a tap on the table) and subjects termination of spontaneous speech.

FUNDAMENTAL FREQUENCY:

Fundamental frequency is the frequency of the speech signal, as shown by the 'PM 100' expressed in terms of Hertzs.

RATE OF SPEECH:

Rate of speech is defined as the total number of syllables produced by the individual per second.

REVIEW OF LITERATURE

PART-1

Stuttering occurs when the forward flow of speech is interrupted abnormally by repetitions or prolongations of a sound, syllable or articulatory posture, or by avoidance and struggle behavior (Van Riper 1982).

Though there have been many attempts, it has been difficult to define stuttering. The ratings of severity vary from clinic to clinic. A more efficient and accurate scale for obtaining reliable measurement of severity of individual moments of stuttering is needed. The severity of stuttering was assessed only through judgement which was obviously subjective, that is based on the perception of listeners by making use of rating scales. An improvement over this type of rating was counting number of times a stutterer 'stuttered* - which is usually denoted as a block. A fairly positive relationship between measures based on the two methods, that is by counting moments of stuttering and by employing subjective rating scale method has been shown. (Sherman, Dorothy and Young 1956, 1958). Researchers have also used measures such as clinician's ratings, self ratings, non-fluency rate or rate of speech in a single speaking or reading situation. Thus, over the years different techniques have been used to measure the severity of stuttering.

I. LISTENER JUDGEMENTS

Lewis and Sherman (1951) were the first to devise a scale based on listener judgement of recorded samples of stuttering . They attempted to measure the consistency of 'judgement of severity* utilising a 9-point interval rating scale and they determined that their listeners could rank stuttering severity solely on the basis of audio samples of stuttering. Sherman and McDermott (1958) compared the results given by different judges as against a single judge and they found that different judges gave different ratings although a single judge could be consistent in his own ratings whether the sample included 5,10,15 or 20 moments of stuttering. Young, Prather (1962) concluded from a study by using a 9 point scale for rating severity of stuttering for three types of samples a) total sample b) randomly selected segments from the total sample (segment duration being 20 seconds) c) consistently selected segments (20 seconds duration) from the total sample. Fifty male stutterers were used as subjects and fourty listeners were appointed for the judgement. Results indicated that the ratings of stuttering severity of short speech segments were comparable to ratings of the total sample from which the short segments were selected.

Cullinan and Williams (1963) conducted a study to compare the results obtained using a five point, seven point and nine point scale of stuttering severity. Rating of

speech samples for 'likeness to normal speech' and 'easiness to listen to' on a seven point interval scale by using the direct magnitude estimation procedure was also carried out. Results indicated that there was a fair correlation among group means of all procedures. Cullinan, Prather and Williams (1963) also compared ratings of severity on 4,5,8,10 point scales using different instructions. They found that the reliability of rating scale was not good enough to use in individual prediction, even when a judge used his own standard sample as a yardstick (direct magnitude estimation). A group of judges, however using several judgements of the same sample can achieve reliable mean scale values. Hoops and Wilkins (1973) made use of three groups of judges (Teachers, speech pathology students and others) and a 9 point scale of severity. They found poor reliability in judgements of severity for half of the taped stuttering samples.

II. SEVERITY RATING USING OTHER DIMENSIONS

Different investigators have tried to explore the measurable dimensions of stuttering. Scales developed by Johnson et al (1963), Riley (1972, 1980) deal with the following dimensions:

a) Frequency of stuttering

b) Duration of stuttering

c) Physical concomitants.

Pat (1986) reported two more dimensions as

d) Rate of speech

e) Prosodic features.

While Bloodstein (1975) has reported five ways of finding out severity, degree and amount of stuttering. They are:

a) Frequency of stuttering: It is expressed as a number of percentage of moments of stuttering or of stuttered words. It was first used by Johnson and his associates at the University of Iowa in the 1930's. Bloodstein (1944) studied thirty adult stutterers reading "average factual prose' to two listeners. The mean of stuttered words was reported to be 10.8% of the total words but the mean ranged from 0.0% to 47%.

Thus, if no moments of stuttering occurred, the severity of stuttering would be nil. The relationship between frequency and listener judgements of severity is not much high as reported by the following:

Authors	Correlation
Shulman (1945)	0.57
Sherman & Trotter (1956)	0.61
Rousey (1958)	0.51
Young (1961)	0.76 (part word disfluencies)
Aron (1967)	0.46 to 0.71

Variability in frequency counts in reading and speaking tasks has also been reported.

b) Mean duration of stuttering" The average duration of stuttering block is about one second. Blocks tend to vary in duration only within a few seconds, although some of the severe stutters may occasionally be observed to continue for longer than a minute. Bloodstein (1944) showed that thirty subjects ranged in mean duration of stutterings from less than 0.05 seconds to 3.7 seconds in oral reading, the median subjects had a mean duration of 0.9 seconds. Only 25% had a mean duration of more than 1.4 seconds, this shows that the mean duration of stutterings, employed as a measure of amount of difficulty on a given reading or speaking task, varies. Mean duration of stutterings does not appear to be related in any notable degree to other measures of severity of stuttering, which may be because of its restricted range of variability.

c) Frequency of specified disfluencies: Johnson (1945) reported that in stutterers as well as in non-stutterers, speech produced on most occasions contained a considerable variety of interruptions or hesitancies. Though every disfluency should not be regarded as an example of the disorder, there is no satisfactory objective measure of differentiating the moments of stuttering from other instances of disfluences, it always depends on the judgement of a listener. He gave a normative data on the disfluencies of stutterers and non-stutterers and stated that stutterers proved to have much more disfluencies than non-stutterers.

With respect to some categories (as revisions, incomplete phrases, interjections) the difference was small and results were overlapping with respect to others (as part word repetitions and prolonged sounds). Sander (1961) provided an index to classify stutterer's type of disfluencies from others. It is a count of disfluent words for which disfluency was defined as a sound syllable or word repetition, a sound prolongation, a broken word, an interjection with a word.

d) Rate of speech: One important type of objective measure is rate of speech production. For example, oral reading rate in words/ syllables per minute or speaking time in the utterance of a given number of words. Stuttering, of course, tends to retard the speakers speed of verbal output. Darley (1940) stated that normal oral reading rate ranges from 129 to 222 words per minute with a mean rate of 148 words per minute. Bloodstein (1944) found that the oral reading rate of adult stutterers was 123 words per minute, range being 42 to 191 words per minute. But extensive normative data by Johnson (1961a) for both reading and speaking shows comparable differences and overlapping between stutterers and non-stutterers. According to Pat (1986) speech and language pathologists should attempt to establish speaking rate above 129 words per minute in successfully treated stutterers.

e) Bating of severity: Listener's ratings of severity of stuttering constitutes a subjective measure. With the help of this method, stuttering is classified as mild, moderate or severe. The severity ratings of this type have been improved by using tape recorded speech samples, multiple judges, and refined psychological scaling techniques.

III. SPECIAL TECHNIQUES IN SEVERITY BATING MEASUREMENT

Tuthill (1946), Holler (1957) found no differences in rated severity by judges who saw and heard the subjects and those who heard the tape-recorded samples of the stutterers. Luper (1959) found that his judges rated movies of stuttering samples as more severe than when the same samples were shown with sound. Williams, Wark, Minife (1963) found that audiosamples and combined audio-visual samples were judged similarly either on the rating scales or frequency counts. Martin (1965) showed that groups of speech clinicians, stutterers and native students rated audiovisual samples of stuttering higher in severity than the audio samples of stuttering.

Stromsta (1965) and Agnello (as cited by Van Riper 1971) have made use of spectrographs in analysis of stuttering samples. Gautheron et al (1972) have studied laryngeal tensions in stuttering by using glottographic recordings. Vijayalaxmi (1973) has tried to quantify stuttering by using duration of blocks and ward output, using a 'Kymogram' and by

finding out a 'stuttering quotient' which is the ratio of duration of blocks to word output. She concluded that it was reliable in measuring stuttering. Myers (1978) has made an attempt to correlate scale values of stuttering severity with 8 phyisological variables including heart rate, skin conductance, EMG activity etc. She found that "different subjects have different physiological variables that best correlate with the severity of their stuttering".

PART-II

Stuttering is "_____a disturbance of rhythm and fluency of speech by an intermittent blocking, a convulsive repetition or prolongation of sounds, syllables, words, phrases, or posture of speech organs" (Wood, 1971).

This problem is not very well understood because no systematic attention has been paid to some of the basic questions, for example, concerning the definitions. Hegde (1978) has grouped the available definitions into following categories and has made an attempt to evaluate these definitions:

1) Perceptual - judgemental definitions that restrict the term stuttering to certain forms of disfluencies.
2) Experimental theoretical definitions that also restrict the term to certain forms of disfluencies.

3) Definitions that do not consider disfluencies to be crucial, and are based on avoidance behaviors.
4) Definitions in terms of unspecified molar movements; and
5) Definitions couched in terms of hypothetical variables.

Further he concludes that the definitions of stuttering are results of various theoretical positions on that behaviour. The validity of these theoretical positions is itself a controversial matter. In addition to being too theoretical, the available definitions of stuttering are either too restrictive or somewhat irrelevant. Therefore it becomes difficult to find an appropriate definition of stuttering. However, descriptive definition of stuttering, proposed by Wingate (1964), which has been found to be used most often, is used in the present study.

According to Wingate (1964), "The term stuttering means - 1) a) Disruption in the fluency of verbal expression which is b) characterized by involuntary audible or silent repetitions or prolongations in the utterance of short speech elements, namely sounds, syllables and words of one syllable. The disruptions c) usually occur frequently or are marked in character and d) are not readily controllable. 2) Sometimes these disruptions are e) accompanied by accessory activities involving the speech apparatus related or unrelated body structures or stereo-typed speech utterances. These activities give the appearance of being speech related

struggle. 3) Also, there are not infrequently f) indications or report of the presence of an emotional state, ranging from a general condition of 'excitement' or 'tension' to more specific emotions of a negative nature such as fear, embarrassment, irritation or the like g) the immediate source of stuttering is some incoordination expressed in the peripheral speech mechanism, the ultimate cause is presently unknown and may be complex or compound.

While Van Riper (1971) has stated that when a stutterer stutters a word, ".. there is a temporal disruption of the simultaneous and successive programming of muscle movements required to produce one of the word's integrated sounds, or to emit one of its syllables appropriately or to accomplish the precise linking of sounds and syllables that constitutes its motor pattern.

Literature indicates that several attempts have been made to locate the causative factor of stuttering but none of them have definitely indicated the factor which causes the stuttering behavior. From the time of Aristotle (384 BC) till today many have attributed stuttering as an organic condition. Some have considered stuttering is due to the dysfunction of some articulatory organs as lips, jaw, palate. Serre D' Alais and Arnott (1828) thought that stuttering is due to glottic spasm. Sir Charles Bell (1832) believed that cauastive factors of stuttaring is some respiratory

abnormality and hence several breathing exercises for improving the speech of stutterers were suggested. Orton (1928), Travis (1931) have advocated the cerebral dominance theory, according to which the stutterers have been thought to have lower margins of cerebral dominance which could result in desynchronization between the paired structure of speech and leads to stuttering blocks. Kopp (1934) found the difference in biochemical factors for the stutterers, whereas others have shown that there is no such difference. West (1943) thought stuttering was either due to a mild form of epilepsy (called Pyknolepsy) or a mild form of subclinical cerebral palsy. Attempts have been to explain stuttering behaviour on the basis of Wischner's anticipatory theory of stuttering, Lee and Black's (1947, 1950) delayed auditory feedback theory (1951) diagnosogenic theory of stuttering by Johnson (1957), learning theories (Johnson 1958, Brutten and Shoemaker 1967).

Wingate (1970) has found stutterers to be more fluent when they sing, speak in chorous, whisper, speak under masking noise or adopt a foreign accent. He considers that the fluency achieved by the stutterers during singing, chorus speech, whispered speech, speaking under masking noise or during speaking with a foreign accent may be due to a change in the phonatory function during those acts. Van Riper (1971) has stated that there is a marked reduction in stuttering during whispering and its elimination during

pantomimed speech could be attributed to the high degree of conscious articulation of slower speech rates that permits synchronization of phonatory, articulatory and respiratory mechanism. Van Riper (1971) has concluded that the core of the disorder is a disruption of timing of the motor sequence of sound, syllable and word production. Brenner, Perkins, Soderberg (1972) have compared the effect of rehearsing a passage out loud with those of rehearsing it in whisper. Only the rehearsal that included phonation produced the customary adaptation effect.

Rathna and Nataraja (1972) have reported a case where stuttering was found even in whispered and silent reading. This observation is contradictory to that of Wingate (1970) and Van Riper (1971).

Van Riper (1973) has stated that there are stutterers whose stuttering appears to be focussed at the laryngeal area. Based on analysis of recent research studies of the neurological mechanisms controlling laryngeal muscle activity, Wyke (1974) has suggested that some categories of stuttering may involve temporal incoordination of activity in one or more of these neurological systems. He also stated that "stuttering of laryngeal origin may be a form of phonatory ataxia arising either because of disordered voluntary prephonatory tuning of the vocal fold musculature or from incoordinated reflex modulation of the activity of

this musculature, during actual utterance". Hanna, Wilfling, McNeill (1975) have reported a single case study of a stutterer. They observed a marked reduction in stuttering when the laryngeal muscle tension of the subject was fed auditorily. Both the amplitude of the EMG signal and stuttering block were reduced 'dramatically' which suggests that some kind of stuttering might involve larynx.

Except one contradictory finding (Rathna and Nataraja 1972), all other studies point out that stuttering could be due to faulty functioning of the phonatory mechanism.

One of the factors that has been pointed out as an evidence of faulty phonatory function in stutterers during stuttering is the increase in 'voice onset time' (VOT) in stop consonants in stutterers as compared to nonstutterers.

Lisker and Abramson (1964, 1967) defined voice onset time (VOT) as the interval of time measured from the release of an initial stop to onset of vowel periodicity. They have opined that VOT is the critical acoustic cue underlying voicing distinctions, whereas Winitz (1975) stated that aspiration is the primary perceptual cue in the detection of voicing and VOT operates as a relatively important secondary cue.

Adams and Hayden (1974), Starkweather et al (1976) have reported that voice onset time, voice initiation time and

voice termination time are longer in stutterers as compared to non-stutterers.

Considering the studies that have been conducted in the above aspects;

VOICE ONSET TIME

Measurements and comparisons of the voice onset time of stutterers and nonstutterers began in early 1970's. With the use of a sound spectrograph or an equivalent device, investigators were able to assess stutterer's and nonstutterer's voice onset time during the fluent productions of simple, isolated CV syllables, during the generation of longer syllable sequences and during the production of stop consonants plus vowel combinations in continuous oral reading.

Voice onset time has been defined as "the duration between the release of a complete articulatory constriction or burst transient and the onset of phonation" (Lisker and Abramson 1964, 1967).

Agnello (1970), has found that the voice onset time in .fluent' speech of stutterers were longer than that of the nonstutterers.

Adams and Reis (1971, 1974)), have compared the frequency of stuttering and adaptation rate of stutterers while reading two passages that were constructed to differ in

the number of off/on vocal adjustments. One passage was composed entirely of voiced speech sounds (voiced passage) and the other contained both voiceless and voiced sounds (combined passage). They have found a higher frequency and slower adaptation rate for the passage containing the greater number of off/on adjustments (ie, the combined passage).

Agnello and Wingate (1972) compared voice onset time of stutterers and nonstutterers in CV utterances and found that voice onset times were longer in stutterers than nonstutterers. Wendall (1973) studied electroglottographic analysis of CV syllables in child stutterers and nonstuttering children. He concluded that stutterers had longer voice onset time than nonstutterers.

Lisker and Abramson (1974) reported that voiceless and voiced sounds are different by voice onset time differences ie, voicing lead or negative voice onset time for voiced sounds and voicing lag ie., positive voice onset time for voiceless sounds.

Schwartz (1974) has explained 'The core of stuttering block' as there is inappropriate and vigorous contraction of posterior-cricoarytenoid. Neurophysiologically voice onset time can be defined as the amount of time required to inhibit the activity of posterior cricoarytenoid during phonation. When a subject is asked to say /pa/, the speaker is asked to inhibit the reflexive posterior cricoarytenoid to pressure

only for the final vowel /a/. The amount of time required to achieve this state is an important physical constraint underlying voice onset time in voiceless plosive vowel (CV) paradigm——voice onset time appears to involve not only a consideration of the neural control over the adductory muscles of larynx, but also the control of the neural inhibition of the abductor muscle as well. So, when a speaker has difficulty inhibiting the posterior cricoarytenoid reflex activity, his voice onset time will be more.

Menyuk and Klatt (1975) examined VOT in the production of words and sentences in three and four year old children and compared it with VOT in adults for voiced and unvoiced sounds. They reported that the overall duration of VOT was faster in the adults. Starkweather et al (1975) have observed stutterers to be slower in initiating vocalization. Hillman and Gilbert (1977) have obtained voice onset time, values for fluent contextual speech of stutterers and compared with those of nonstutterers. Results were - a) stutterers displayed longer voice onset time than that of nonstutterers even in their fluent speech. b) voice onset time values increased in duration as the place of articulation moved back in the oral cavity.

Babul Basu (1979) has reported that - a) stutterers showed longer voice onset time for voiceless and voiced stop

sounds both in reading and in isolation when compared to nonstutterers. b) There was a difference in voice onset time between each voiceless stop sound and its voiced counterpart ie., there was always a voicing lag for the voiceless stop sounds (indicated by a positive number) and a voicing lead for voiced stop sounds (indicated by a negative number). This was observed for both stutterers and nonstutterers. c) There was a consistent increase in voice onset time with respect to the position of articulatory constriction (as it moved backward in the oral cavity) in case of nonstutterers, but no consistent variation in voice onset times of stutterers with respect to the position of articulatory constriction was observed. However, there was a difference in voice onset time for various stop sounds, d) He concluded that voice onset time values do vary from language to language.

Ramesh (1983) reported that there was reduction in voice onset time values of stutterers for /k/, /t/, /t/ under delayed auditory feedback, while nonstutterers showed increased voice onset time values for /k/, /t/, /t/ under delayed auditory feedback when compared to normal auditory feedback, indicating that nonstutterers behave like stutterers under delayed auditory feedback in terms of voice onset time.

Adams (1984) summarized a number of studies which showed longer VOTs for fluent utterances of stutterers than for nonstutterers.

Voice onset time has been found to be different for different stop consonants depending on the place of articulation (Lisker and Abramson 1964, 1967; Hillman and Gilbert 1977). Speaker's age is another variable which influences voice onset time (Zlatin and Koenigsknecht 1976).

Thus the different studies indicate that stuttering may be due to faulty functioning of laryngeal mechanism which might be reflected by voice onset time measurement of stutterers. Research indicates that voice onset time for stutterers is different from nonstutterers (Agnello and Wingate 1972, Wendall 1973; Hillman and Gilbert 1977, Babul Basu 1979). Thus it would be interesting to know whether voice onset time characteristics alter in post therapy speech samples as compared to pretherapy speech samples.

One such study has been conducted by Webster, Morgan, Cannon (1987) who studied voice onset time abruptness in ten stutterers before and after therapy. The therapy plan recommended to subjects was "Precision Fluency Shaping Program" (Webster, 1974). The main aim was to achieve gentle voice onset time.

Results indicated that -

a) pretherapy mean reading disfluency rate was 23.06% with the range of 4% to 74%. Posttherapy disfluency rate was decreased to 0 to 1.6% with a mean of 0.4%.

b) gentleness was evident in the level of onset in posttherapy results ie., posttherapy mean voice onset gentleness was significantly increased when compared with the mean of the voice onset time values before therapy.

c) overt stuttering was not perceived to occur with extended syllable duration.

d) extended syllable duration might have decreased levels of muscle tension associated with speech initiation (Kent 1984).

No other reports were available to the present investigators regarding the pre and post therapy evaluation of stuttering. Hence it is proposed to study the voice onset time for stutterers in both pre and post therapy conditions and compare them with that of nonstutterers.

SPEECH INITIATION TIME AND SPEECH TERMINATION TIME

As it is known, phonation and speech involve the basic systems, namely the neurological and the laryngeal. However, speech involves complex motor programming to bring about rapid and precise articulatory movements and fine co-aritculatory adjustments, to result in the required acoustic

output (Gray and Wise 1946) as against phonation which is mainly representative of aerodynamic system. Thus, speech is more representative of higher level functioning and hence it is natural to use speech as a sample for studying the various parameters. And since the studies on phonation are inconclusive in stutterers, proposedly, speech initiation time and speech termination time were used and not voice initiation time and voice termination time.

SPEECH INITIATION TIME

Speech initiation time is defined as the time lapse between the appearance of some experimenter - controlled external stimulus (for example, a pure tone or a flash light) and subject's initiation of glottal vibration for the act of speaking. Measurement of speech initiation time was done by asking the subjects to utter a response of one word or longer beginning with a voice sound.

Other variable used for measuring the reaction time of stutterers is voice initiation time or vocal reaction time which represents the time lapse between some non speech event and the start of voicing.

Agnello (1970) reported that voice initiation time in 'fluent' speech of stutterers was also longer than the nonstutterers. Adams and Hayden (1976) reported that stutterers had longer voice initiation times than did the normals in response to a pure tone of lOOOHz. Thus

stutterers were poorer in terms of prompt starting of phonation of vowel /a/. Starkweather, Hirschman and Tannebaum (1976) reported that the stutterers were slower in initiating vocalization across a wide variety of syllables as compared to normals on presentation of a visual stimulus presented on a screen.

While Cullinan and Springer (1980) reported that not all children who stutter show slower voice initiation time than children who do not stutter. Murphy and Baumgartner (1981) also reported that there was no significant difference between young stutterers and non stutterers in items of voice initiation time.

Reich and Goldsmith (1981) reported that adult stutterers had significantly slower voice reaction time as compared to normals.

Hayden, Jordahl, Adams (1982) reported that

a) stutterer's voice initiation time in the pacing condition was improved as compared to the control condition.

b) stutterers had significantly faster voice initiation time in the pacing condition as compared to the masking condition.

c) stutterers had better voice initiation time in masking condition as compared to the control condition.

Watson and Alfonso (1982) reported that there was no significant difference between the laryngeal reaction times of stuttering and nonstuttering adults on presentation of both visual and auditory stimuli.

Horii (1984) reported that stutterers were slower in voice initiation time as compared to non stutterers.

Nataraja, Venkatesh and Jagadish (1984) reported that there was a significant difference in terms of reaction time between normals and stutterers, stutterers being significantly slower in initiating phonation. They also reported that both normals and stutterers have taken more time to react to visual stimulus than auditory stimulus.

Thus the review of literature suggests that there are a very few studies on voice initiation time and that stutterers show slower voice initiation time as compared to non stutterers, as cited by different researchers (Adams and Hayden 1976; Starkweath, Hirschman, Tannebaum 1976; Cross and Luper 1979; Hayden, Jordahl and Adams 1982; Horii 1984; Nataraja, Venkatesh and Jagadish 1984).

Different researchers have reported different external cuing signals for initiation of phonation as pure tones (Adams and Hayden 1976), or a visual stimulus as flash light. In the present study 'a tap on the table' was used as an external cueing signal for the subject to initiate speech.

SPEECH TERMINATION TIME

Speech termination time is defined as the time lapse between the appearance of some experimenter controlled external stimulus (for example, 'a tap on the table') and subject's termination of spontaneous speech.

Agnello and Wingate (1971) have shown that stutterers were slower than normals in terminating phonation at the end of several CV syllables. Agnello (1975) reported longer voice termination time values in fluent production of the stop consonants /p/ and /b/ as compared to nonstutterers. Cullinan and Springer (1980) reported that young stutterers (children) were found to have significantly slower voice termination time than the normal children.

While, Murphy and Baumgartner (1981) reported no significant difference between the stuttering and non-stuttering children with respect to voice termination time.

Horii (1984) reported that stutterers were as fast as nonstutterers in terminating phonation.

Thus the review of literature suggests that there are a very few studies on voice termination time, especially on speech termination time. The external cueing signal used for termination of speech stimulus was 'a tap on the table'.

As stated earlier speech involves complex motor programming to bring about rapid and precise articulatory

movements and fine coarticulatory adjustments as against phonation which is mainly the representative of aerodynamic system. So, it was considered that it would be interesting to study the change in speech initiation time and speech termination time values of stutterers after they have undergone therapy and to compare both pre and posttherapy conditions and then compare them with the nonstutterers. As there are no reports of such with Indian population, the present study was undertaken.

FUNDAMENTAL FREQUENCY

Fundamental frequency is the lowest frequency found in periodic speech signals. It is produced by the human larynx and determined by the anatomical and physiological properties. The actual level of the fundamental frequency depends on myoelastic and aerodynamic forces which are produced by the activity of the muscles in speech production (Liberman 1961). The fundamental frequency increases with the increasing tension of the larynx muscles and subglottic air pressure. Hence, compared to high tension of muscles involved in speech production, a high mean fundamental frequency should be expected in stutterers as compared to nonstutterers.

Since Schulthess (1830) defined stuttering as a problem of phonation, different aspects of voice production in stutterers have been investigated (Agnello 1975; Freeman and

Ushijima 1975, Conture et al 1977). The results of these studies indicate that the larynx of a stutterer is more tense as compared to that of a nonstutterers.

Investigations of the respiratory processes in stutterers have shown a synchronous activity of the intercostal muscles and the diaphragm, (Nadoleczny 1926, Heese 1967) resulting in a raised subglottic air pressure which was found by other investigators too (Brown 1971; Moser and Kittel 1976).

Schmitt and Cooper (1978) found in their study that during reading, stutterers and nonstuttering children did not differ in mean fundamental frequency, may be due to the specific speech situation which causes a higher articulatory effort in both groups.

Schaferskupper and Simon (1983) reported that (i) there was no significant difference between the mean fundamental frequency of stutterers and nonstutterers during reading (ii) significant decrease in mean fundamental frequency from reading to spontaneous speech was seen. They also suggested that speech therapy should intend to relax the muscles of the subject's larynx and pharynx by lowering fundamental frequency.

Thus it is proposed to study fundamental frequency in stutterers in pre and posttherapy conditions, and to study the changes with respect to nonstutterers.

RATE OF SPEECH

Rate of speech is measured by total number of syllables or words in a particular time period. There is a close relation between the rate of speech and stuttering (Amster, 1984). Struggle behaviours naturally slow the rate of speech, even abnormally repeated and prolonged sounds, and other stuttering behaviours affect the rate of speech. It is evident that stuttering severity, whether measured by judges or determined by the frequency of stuttering behavior, is related to the rate of speech production. Stuttering tends to retard the speaker's speed of verbal output. Darley (1940) stated that normal reading rate ranged from 129 to 222 words per minute, with a mean rate of 148 words per minute. Bloodstein (1944) stated that oral reading rate of adult stutters was 123 words per minute and range was 42 to 191 words per minute. But extensive normative data by Johnson (1961a) for both reading and speaking shows comparable differences and overlapping between stutterers and non-stutterers.

Correlation between judged severity of stuttering and speech rate have been significant .76 (Sherman, Young, Gough 1958), .69 (Minife and'Cooker 1964), .68 (Young 1961), .80 (Prosek 1979). Similarly the correlation between the frequency of stuttering behaviours and speech rate have also been significant as 0.88 (Bloodstein 1944, 1974).

Starkweather (1980) states that rate is a primary indicator of fluency. Several investigators provide evidence that link speech rate to motor coordination. Kent and Forner (1980) found that the duration of children's speech sounds diminishes and the variability of the durations also diminishes with increasing age, which may be a reflection of children's increasing ability to control the temporal aspects of speech even as the rate of their speech also increases. Tiffany (1980) reported that adults talk at a rate that is close to the limits of their motor ability, thus there may be connections between the rate of speech, stuttering and the motor control of speech production.

Pat (1986) stated that speech and language pathologists should attempt to establish speaking rate above 129 words per minute in successfully treated stutterers.

Thus the review of literature indicates that there are a very few studies regarding rate of speech in stutterers and no other reports were available to the present investigators regarding the pre and posttherapy rate of speech. Hence, it is proposed to study the rate of speech in pretherapy and posttherapy conditions and compare them with that of non-stutterers.

TOTAL NUMBER OF STUTTERING MOMENTS

Over the years, majority of studies have reported the amount of improvement in speech of stutterers in terms of

percentage in order to show the effectiveness of different therapeutic procedures.

Cherry, Sayers, Marland (1955) reported significant improvement in their subjects after therapy. They used 'Shadouing' as a therapeutic procedure. Kondas (1967) reported that 74% his stutterers improved when 'Shadouing' was used in therapy.

Adamczyk (1959) used 'Delayed Auditory Feedback' and reported that 87% of his stutterers showed improvement.

Andrews and Harris (1964) reported that there was significant improvement in their stutterers on usage of 'Syllable Timed Speech'.

Zaliouk and Zaliouk (1965) reported that 81% of his stutterers showed significant improvement when relaxation, breathing and speech exercises were used.

While Adams (1972) reported that 75% of his stutterers showed some improvement when 'Reciprocal Inhibition' was used as a therapeutic procedure.

Thus, Bloodstein (1975) inferred that substantial improvement, typically occurs as a result of almost any kind of therapy in about 60 to 80 percent of cases.

Thus the review of literature indicates that there are a very few studies regarding total number of stuttering moments

and no other reports were available to the present investigators regarding quantitative measurement of stuttering moments in pretherapy and posttherapy conditions. Hence it is proposed to study the total number of stuttering moments in pre and posttherapy conditions and compare them with that of nonstutterers.

METHODOLOGY

PART-1

SUBJECTS

Two groups of subjects were included for the study. The first group consisted of ten normals (nine males and one female) with the age range of 15 to 25 years and mean age of 20 years. Other group consisted of ten stutterers (nine males and one female) with the age range of 15 to 25 years and mean age of 20 years, as diagnosed clinically by the qualified speech and language pathologists at the All India Institute of Speech and Hearing, Mysore. Amongst the stutterers the severity varied from mild to severe as shown in the following table:

Severity Rating	Number of stutterers
Mild	6
Moderate	5
Moderately severe	2
Severe	2
Total	15

MATERIALS

The subjects were comfortably seated in the room and were instructed to read the first paragraph of 'Rainbow Passage' which had 122 syllables.

METHOD

The reading samples were audio-recorded onto a C-90 cassette by using a 'Philips' deck recorder (F-6121) and a microphone (AKG D 222). The recording was carried out in the recording room of Department of Speech Sciences, All India

Institute of Speech and Hearing, Mysore. The reading samples were recorded before the speech therapy commenced.

These reading samples were rated in two ways:
1) Rating by judges: Three post-graduate students of speech pathology served as the judges to rate the severity of stuttering on a five point scale as O-Normal, 1-Mild, 2-Moderate, 4-Severe. They were also to judge the rate of speech on a three point scale as O-Normal, 1-Slow, 2-Fast. The judges were explained regarding the experimenter's criteria of severity rating of stuttering, with reference to Wingate*s definition of stuttering. According to Wingate (1964) - Stuttering is a :

1) a) disruption in the fluency of verbal expression,
b) characterized by involuntary, audible or silent repetitions or prolongations in the utterance of short speech elements namely sounds, syllables and words of one syllable. These disruptions c) usually occur frequently or are marked in character d) are not readily controllable. 2) Sometimes the disruptions are e) accompanied by accessory activities involving the speech apparatus, related or unrelated body structures, or stereotyped speech utterances. These activities give the appearance of being speech-related struggle. 3) Also, there are not infrequently f) Indications or reports of the presence of an emotional state, ranging from a general condition of excitement' or ' tension' to more

specific emotions of a negative nature such as fear, embarrassment, irritation or the like. g) The immediate source of stuttering is some incoordination expressed in the peripheral speech mechanism; the ultimate cause is presently unknown and may be complex or compound.

2) Measurement using computer: Initially the reading samples were digitized using a computer at 12 bit ADC and 4000Hz sampling rate. The digitized samples were then visually displayed on the computer (PC-XT) screen as a wave form (time-intensity function) in the program 'VAGHMI' developed by VSS-Bangalore. Then the experimenters identified the instances of stuttering and duration of each of the instances of stuttering based on the audio-sample and the visual display simultaneously. On identifying the stuttering moments as repetitions, prolongations, hesitations and pauses, the duration of each stuttering moment was measured moving the cursor on the computer. The program facilitated measurement of duration of each of the stuttering moments, especially the pauses.

Initially a sample of particular duration was selected and displayed on the computer screen. The cursor was moved across the screen to mark the starting and the end point of the sample that is displayed on the screen. Then the visual display was correlated with the auditory from of sample. Thus the stuttering moment on the screen was identified and marked with the cursor and the type, number and duration of a

particular stuttering moment was registered and stored in the computer memory.

Fig (1) Shows a repetition of the word, "the" and a pause of duration 500msecs.

Similarly prolongations and hesitations can be measured.

Criteria for defining each of the stuttering moments:

Each word repetition was marked separately. A syllable repetition as pa-pa-pat was marked as a single repetition. Prolongation was considered when a sound/syllable was prolonged for a longer duration or when it was lengthened during production beyond its appropriate duration. A hesitation was considered when a person showed a doubt or indecision or delay in the act of speech production. A pause was considered as a silence that lasts longer than a given interval typically around 250 msces i.e., 0.25 seconds (Goldman-Eisler 1958).

Once the instances of stuttering moments were identified, the data was processed in terms of number of stuttering moments, average duration of stuttering moments and rate of speech (number of syllables/second).

The data was tabulated to analyze

a) Correlation between rating by judges and measurement using computer by using Spearman's (rho) Coefficient's Correlation.

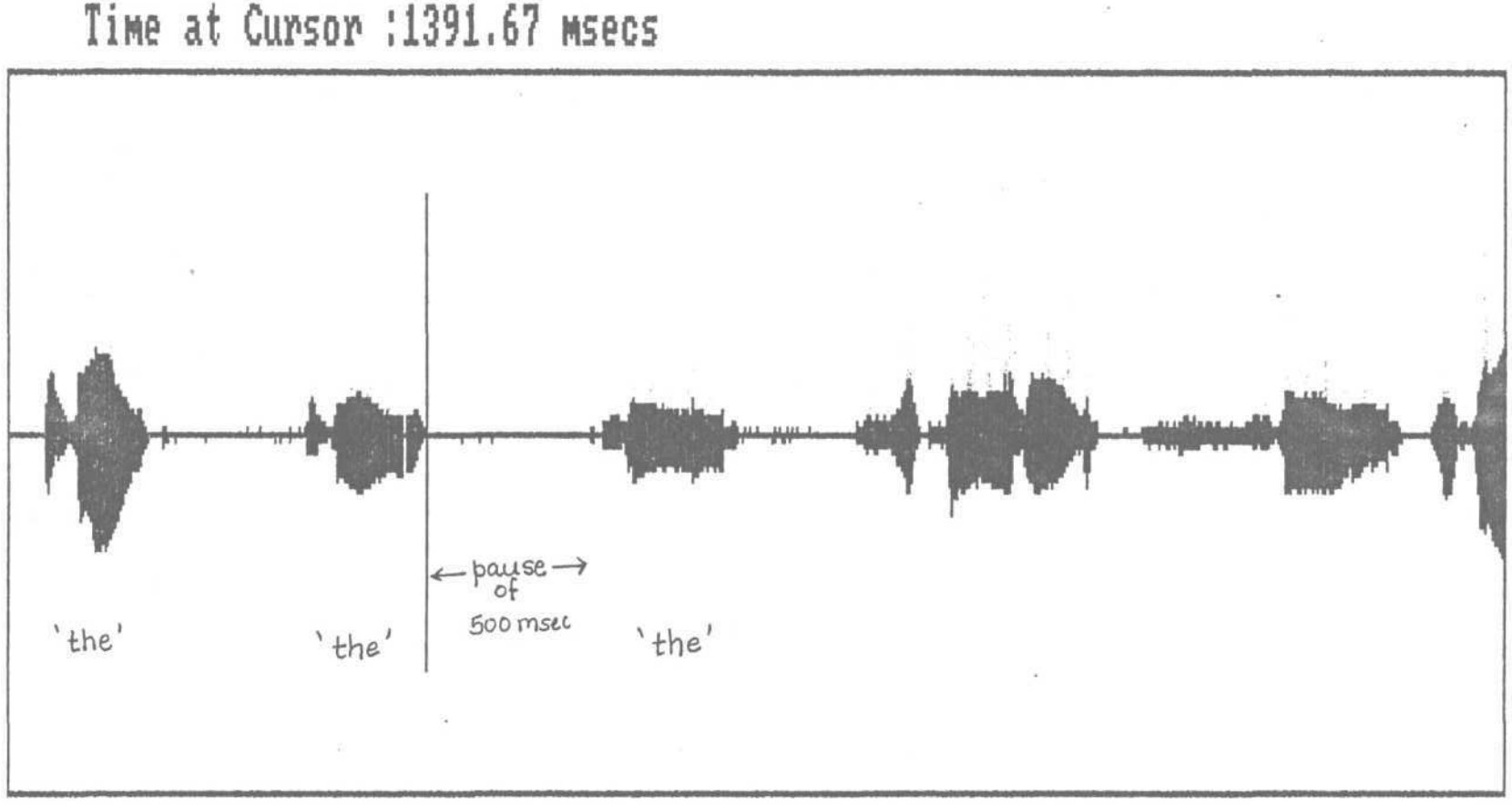


FIG.I Shows repetition of a word and a pause

PART-II

The study was aimed at investigating various acoustic parameters of speech of stutterers in pre and posttherapy conditions and to compare them with nonstutterers. The therapy program for each of the subject is given in Appendix-A.

I) VOICE ONSET TIME:

The study was carried out in following steps:

Selection of subjects: Two groups of subjects were selected for the study. One group consisted of five stutterers, four males and one female. The age range of the subjects was from 15 to 28 years, with the mean age of 22.8 years.

Three of the stutterers were Kannada speakers, while two of them were English speakers.

The stutterers were selected randomly from the clinic of All India Institute of Speech and Hearing, Mysore on the following criteria:

1) To be able to read and speak Kannada or English.
2) Registered at All India Institute of Speech and Hearing, Mysore, for their speech problem and were diagnosed and confirmed by competent speech pathologist, as stutterers.
3) The stuttering was marked as mild to severe in nature, by the speech pathologists.

4) Willing to attend the therapy at the clinic of All India Institute of Speech and Hearing, Mysore.
5) With no other speech and hearing problems, except stuttering.

The number of stutterers in each severity group is shown below:

Severity Rating	Number of stuttering
Mild	1
Moderate	2
Moderate to Severe	1
Severe	1

Brief history and speech evaluation reports of the stutterers are given in Appendix-A. Same groups of subjects were used to test all acoustic parameters.

The other group consisted of five nonstutterers four males and one female. The age range of the subjects being 15 to 28 years with the mean age of 22.8 years. These subjects were matched with the subjects of group one in terms of age, sex, language background.

Selection of the material: The materials were both in Kannada and English.

Kannada speakers were asked to read four syllables with voiceless stop sound in the initial position, /pa/, /ta/, /ta/, /ka/. The subjects were instructed to read each syllable three times, and the average of the three readings

was taken into consideration for the measurement. They were also asked to read three words, with the voiceless stop sounds in the initial position; the words were - pakkada, taar, ṭam, kamala. These materials were selected from an earlier study referring to Babul Basu (1979).

English speakers were asked to read the syllables with voiceless stop sounds in the initial position, /pa/, /ta/, /ka/. The subjects were instructed to read each syllable three times and the average of three readings was taken for the measurement. They were also asked to read three words, with the voiceless stop sounds in the initial position; the words were pen, ṭeeth, kite. Only 2 subjects read English words.

Recording of reading samples: The syllables and words were given to the subjects for reading.

The following instructions were given prior to reading:

"You will be given a few syllables and words, please read them. Start reading when I tell you to read".

The instructions were given in Kannada for Kannada speakers and in English for English speakers. The instructions are given in Appendix-B.

All the reading samples were recorded in the recording room of the Department of Speech Sciences of All India

Institute of Speech and Hearing. They were audio-recorded onto a Meltrack DR-X90 cassette by using a 'Philips' deck recorder (F-6121) and a microphone (AKG D 222). For stutterers, the recording was done in both pre and posttherapy conditions.

Measurement of voice onset time: Voice onset time is the duration between the burst and the subsequent onset of voicing of the following vowel.

The low pass filtered speech at 3500Hz SI unit was digitized an a computer PC-AT/386/ (based upon intels 80386 microprocessor and 80387 NDP) using 12 bit analog to digital converter at the sampling rate of 8000Hz. The digitized samples were segmented using the soft-ware program VSS-DSEGF developed by VSS-Bangalore. The digitized samples were stored in a floppy disk to carry out further analysis.

The digitized samples from the floppy disk were fed into computer memory of PC-SX-386 for the spectral analysis. The spectral analysis was carried out using a soft ware program 'SSL - Spectrogram' developed by VSS-Bangalore. Areil DSP-16 addon cord based on TMS 320025 DSP chip was used for the FFT analysis. The instrument set up has been shown in Photograph-I.

The reading samples were displayed on a wide band spectrogram as shown in Photograph-II. The distance between

PHOTO I

Shows instrument set up for measurement of voice onset time

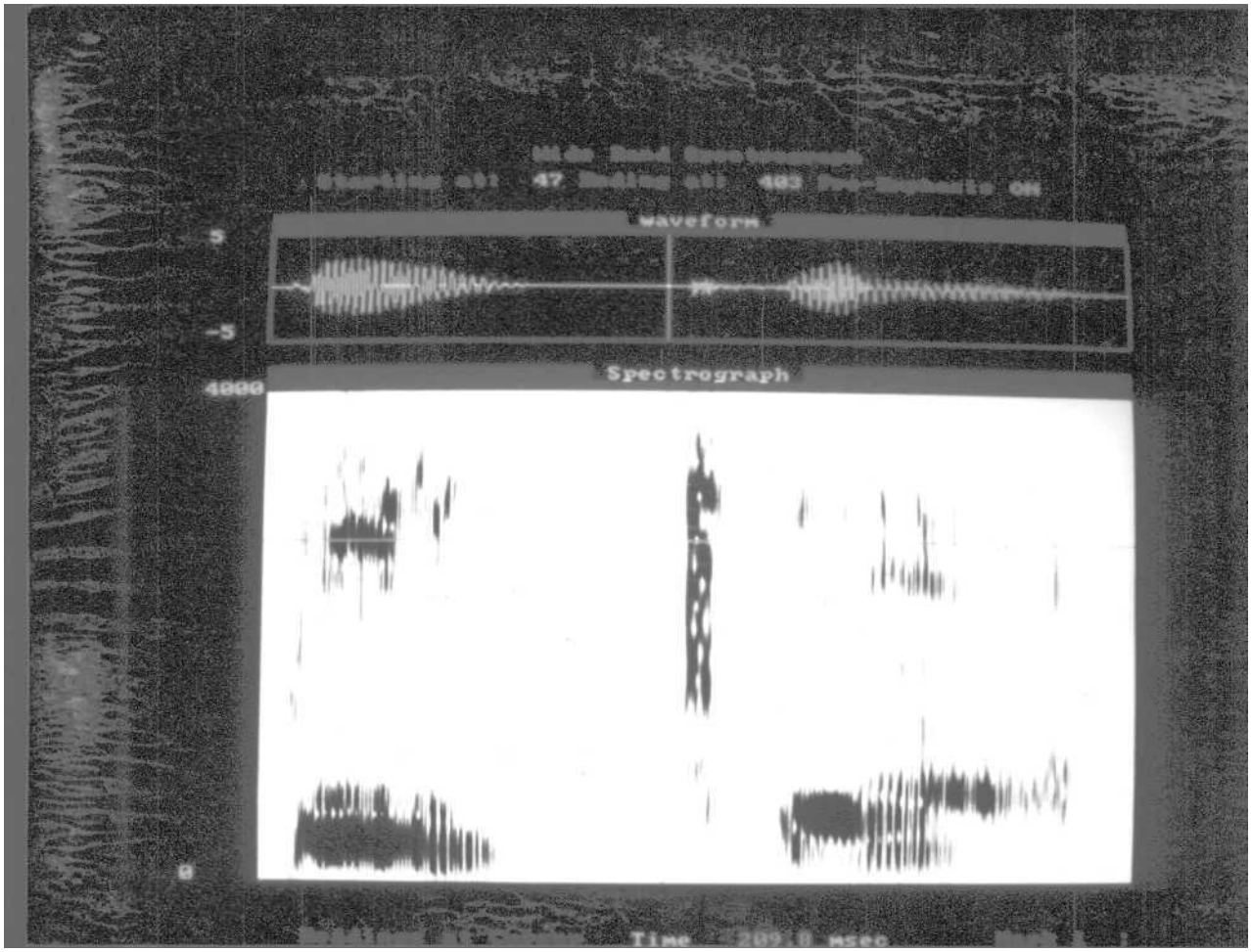


PHOTO II

Shows wide band spectrogram displayed on the computer screen for the measurement of VOT.

the vertical striation (burst) observed for articulatory release in stop consonant and the initiation of phonation indicated by vertical striations for the vowel component was measured in millisecond scale by moving the cursor across X-axis of the spectrograph which gives time duration. A positive value was given if the voicing occurred after the release of the articulator (Fig-II) and a zero value was given if the release as well as the voicing occurred simultaneously (Fig-III).

II. MEASUREMENT OF SPEECH INITIATION TIME AND SPEECH TERMINATION TIME:

Subjects: The group of subjects used for voice onset time, served as subjects for measurement of speech initiation time and speech termination time.

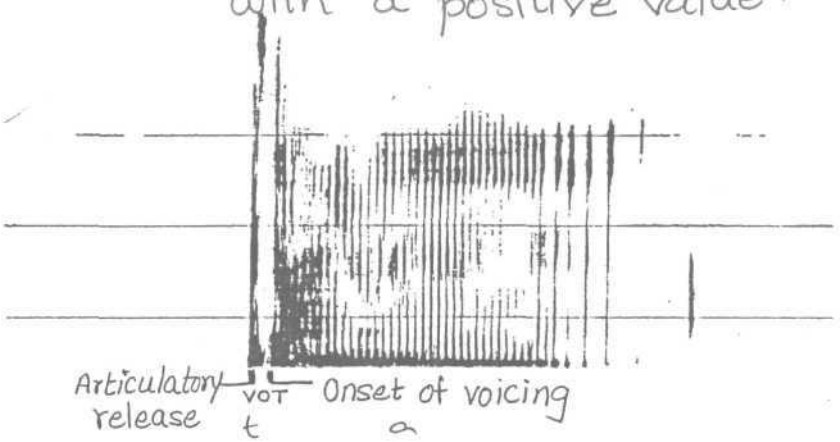
Materials and Recording: Recording procedure carried out was same as described previously.

A 'tap on the table' was used as an external stimulus for initiation and termination of the speech.

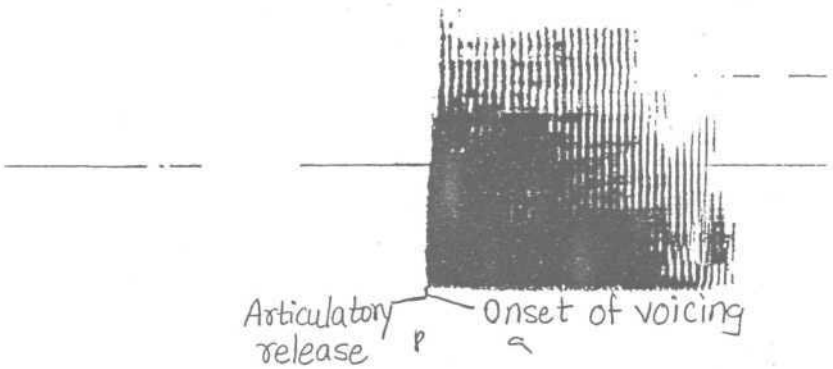
Following instructions were given prior to recording either in Kannada and English.

"You will have to utter few sentences as soon as you hear 'a tap on the table' without any delay in responding. Following the second tap, immediately stop the utterances, without any delay".

FIG. II Spectrograph showing voice onset time with a positive value.



Positive VOT



Zero VOT

FIG. III Spectrograph showing voice onset time with a zero value

The instructions are given in Appendix-B.

These speech samples were used in measurement of speech initiation and speech termination time.

Measurement technique for SIT and STT: Measurement of speech initiation and speech termination time was carried out by using 'PM-100 pitch analyzer', which facilitates visual display of the given speech signal as shown in Photograph-III. The settings were adjusted at 70 to 500Hz frequency display magnification with 9 seconds sweep time. Both upper and lower screens were made use of in the analysis.

Speech initiation time was measured as the time lapse between the appearance of some experimenter controlled stimulus (eg: a tap on the table, which was seen as a burst in intensity wave on the PM-100 screen) and subjects initiation of spontaneous speech (which was considered as the first point on PM-100 screen which indicated initiation of spontaneous speech) as shown in Photograph-IV.

Speech termination time was measured as the time lapse between the appearance of some experimenter controlled stimulus (eg: a tap on the table, which was seen as a burst in intensity wave on PM-100 screen) and subjects termination of spontaneous speech (which was considered as the last point on PM-100 screen which indicated termination of spontaneous speech) as shown in Photograph-IV.

PHOTO III

Shows Pitch Analyzer (PM-100)

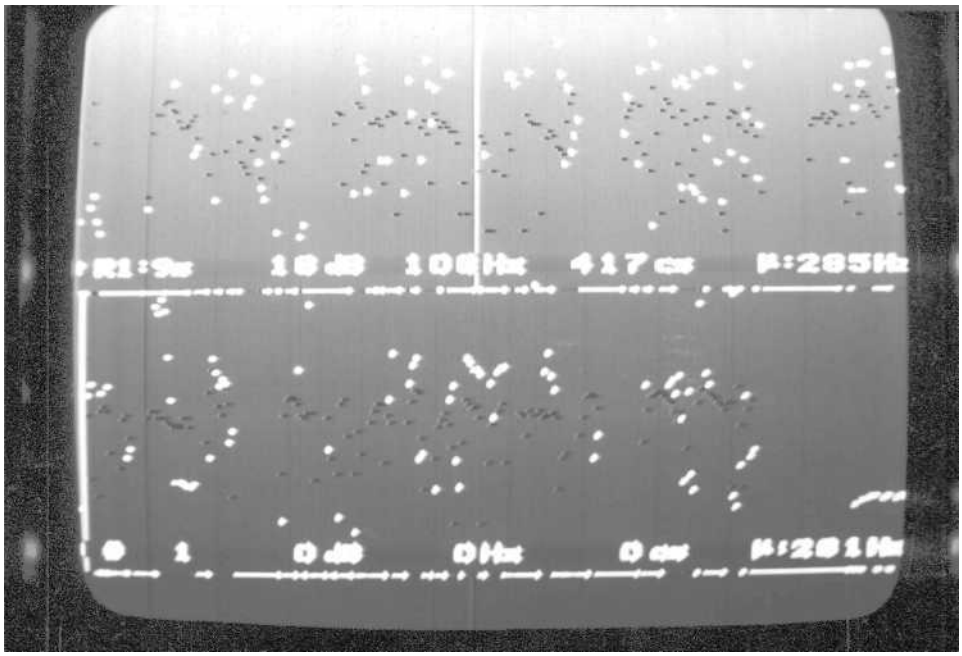


PHOTO IV
Shows display of PM-100 screen while measuring SIT and STT

Measurement of:

Fundamental frequency

Rate of Speech, and

Total Number of stuttering moments

Subjects: The group of subjects used for voice onset time served as subjects for measurement of fundamental frequency (Fo), rate of speech and total number of stuttering moments.

Materials: One standard passage was selected for Kannada speakers. While Rainbow passage was used as the reading material for English speakers.

Recording: Recording procedure was carried out as described previously.

Measurement technique: a) Measurement of fundamental frequency was carried out using PM-100 pitch analyzer.

PM-100 facilitates visual display of the given speech signal. The settings were adjusted at 70 to 500Hz frequency display magnification with 9 seconds sweep time. Both upper and lower screens were made use of in the analysis.

Fundamental frequency for each of the subjects was measured by taking an average of three readings from the passage read.

b) Rate of speech was defined as total number of syllables produced by the individual per second.

Total time taken to read the passage was calculated by playing the sample read and recorded on a "Philips' deck recorder (F-6121) and measuring the total duration of passage separately for each subject using a stop-watch. The number of syllables in the passage was also determined.

c) Total number of stuttering moments - four types of stuttering moments were identified as repetitions (sound/syllable, part word, word), prolongations, hesitations, pauses. These stuttering moments were measured using the procedure described in part-I to determine the severity of stuttering.

RESULTS AND DISCUSSION
PART-I

A high interjudge and intrajudge reliability was found out by using Spearman's coefficient of correlation.

Table-I

	Judge I	Judge II	Judge II
Intrajudge reliability	0.97	0.70	0.89

Table-I shows the intrajudge reliability of judgement of severity of stuttering.

Table-1][

	Judge I & II	Judge II & III	Judge II & III
Intrajudge reliability	0.89	0.88	0.99

Table-II, shows the interjudge reliability of judgement of severity of stuttering.

Table-III

Subject No.	No.of Repe-titions	No.of Pro-long-gations	No.of Hesi-tations	No.of Pauses	Total No. of stg. moments	Severity rating by the judge
1	0	0	0	11	11	0
2	0	1	1	3	5	0
3	0	0	0	8	8	0
4	4	0	0	4	8	0
5	0	0	2	0	2	0
6	1	0	1	9	11	1
7	2	0	0	23	25	1
8	2	1	1	19	23	1
9	1	0	0	3	4	1
10	2	0	0	16	18	1
11	2	1	2	13	18	2
12	8	0	1	27	36	2
13	6	0	2	37	45	3
14	8	1	1	11	21	3
15	22	2	3	31	58	4

Table-Ill shows number of repetitions, prolongations, hesitations, pauses and total number of blocks as measured using the computer and the ratings of severity of stuttering as judged by the judges on a 5-point scale.

Table-IV

Subject No.	Avg.dur. of repe-titions	Avg.dur. of pro-long-gations	Avg.dur. of hesi-tations	Avg.dur of pauses	Avg.dur. of total no. of stg.momt	Severity rating by the judges
1	0	0	0	562.2	562.2	0
2	0	300	200	478.3	387	0
3	0	0	0	504.4	404.4	0
4	257.3	0	0	435.5	346.4	0
5	0	0	300	0	300	0
6	500	0	1000	603.9	630.5	1
7	237.5	0	0	534.4	510.7	1
8	295	315	450	779.45	638.85	1
9	470	0	0	278.3	326.3	1
10	295	0	0	485.9	464.7	1
11	302.5	250	625	578.4	534.7	2
12	318.8	0	550	837.15	801.2	2
13	365	0	450	779.45	638.85	3
14	364.4	810	250	997.3	711.7	3
15	1029.35	955.8	396.7	681.9	756.65	4

Table-IV shows the average duration of repetition, prolongation, hesitation, pauses and total average duration of blocks in msec as measured by the computer and the rating of stuttering by the judges on a 5-point scale.

Table-V

Subject No.	Rate of Speech in syllables/sec by the computer	Rate of speech judged by the judges	Severity rating of stuttering by the judges.
1	2.90	0	0
2	3.98	2	0
3	3.77	0	0
4	4.7	2	0
5	4.3	0	0
6	2.48	0	1
7	2.65	1	1
8	2.61	2	1
9	4.29	2	1
10	3.57	2	1
11	3.12	2	2
12	2.03	1	2
13	1.91	1	3
14	2.54	0	3
15	1.26	1	4

Table-V shows rate of speech in number of syllables per second as measured by the computer, rate of speech judged by the judges on a 3 point scale and severity

rating of stuttering by the judges on a 5 point scale.

Spearman's coefficient of correlation was applied to find out the correlation between ratings by judges and measurement using computer.

Table-VI

Number	Correlation between stuttering moment and rating by judges	Correlation Value (r)
1	No. of repetitions Vs Rating by judges	0.8230
2	No. of pauses Vs Rating by judges	0.7393
3	Total number of stuttering moments Vs Rating by judges	0.7995
4	No. of prolongations Vs Rating by judges	0.4232
5	No. of hesitations Vs Rating by judges	0.5097
6	Average duration of repetitions Vs Rating by judges	0.8175
7	Average duration of pauses Vs Rating by judges	0.7386
8	Total average duration of stuttering moments Vs Rating by judges	0.7386
9	Average duration of prolongations Vs Rating by judges	0.4421
10	Average duration of hesitations Vs Rating by judges	0.5345
11	Rate of speech (syll/sec) as measured using computer Vs Rating by judges	-0.7890

Table-VI: Shows correlation between ratings by judges and measurement using computer.

From Table III, it was noted that there was

1) a high positive correlation between number of repetitions and severity rating of stuttering by judges (r = 0.8230).

2) a positive correlation between number of prolongations and severity rating of stuttering by judges (r = 0.4232).

3) a positive correlation between number of hesitations and severity rating of stuttering by judges (r = 0.5097).

4) a high positive correlation between number of pauses and severity rating of stuttering by judges (r - 0.7393).

5) a high positive correlation between total number of stuttering moments severity rating of stuttering by judges (r = 0.7995).

From Table-IV, it was noted that there was

1) a high positive correlation between average duration of repetitions and severity rating of stuttering by the judges (r - 0.8175).

2) a positive correlation between average duration of prolongations and severity rating of stuttering by the judges (r = 0.4421).

3) a positive correlation between average duration of hesitations and severity rating of stuttering by judges (r - 0.5345).

4) a high positive correlation between average duration of pauses and severity rating of stuttering by judges (r = 0.7385).

5) a high positive correlation between total average duration of stuttering moments and severity rating of stuttering by judges (r - 0.7368).

From Table-V, it was noted that there was

1) a high negative correlation between rate of speech in syllables/second as measured using computer and severity of rating of stuttering by the judges on a 5 point scale (r = 0.7890).

Thus the results shows that:

I) The rating by judges is predominantly based on -
   a) Number of repetitions
   b) Number of pauses
   c) Total number of stuttering moments
   d) Average duration of repetitions
   e) Average duration of pauses
   f) Total average duration of stuttering moments
   g) Rate of speech.

II) There is negative correlation between rate of speech in syllables/second as measured using the computer and severity rating of stuttering by the judges indicating that as the number of syllables/second decreases, the degree of severity judged by judges increases.

III) The computer also gives the average duration of each of the stuttering behavior which is not possible in

rating done by the judges, which is the advantage of computer over the rating by judges. As the results indicate duration of pauses, repetitions, total number of blocks is important in rating the severity of stuttering, hence accurate measurement of duration is an important parameter, which has been made easy because of the computer.

Viajalaxmi (1983) reported that measurement of duration of stuttering blocks is important, which is in agreement with findings of the present study. Bloodstein (1975) reports same factors as given in the present study, influencing the rating of stuttering.

Differentiating between a pause of 0.25msecs as reported by Goldman Eisler (1958) and an abnormal stuttering pause is made easier with the help of computer.

Identification of stuttering moments has become easy due to simultaneous audio-visual display provided by the computer.

The measurement of severity using computer provides same results as rating by judges. But still more accurate measurement can be provided using computer to avoid individual variations in judgement in severity rating of stuttering.

PART-II

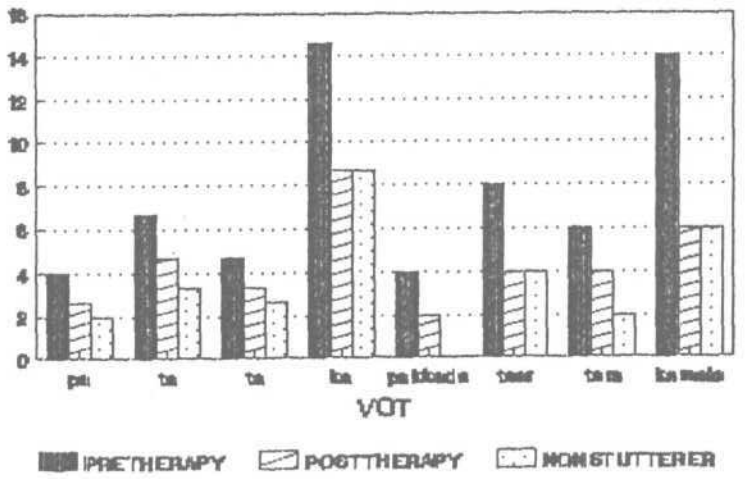
The experiment was conducted to verify the null hypotheses. The findings have been discussed both for individual and group data for stutterers and non-stutterers for different variables. First the results for individuals cases have been given:

TABLE-1

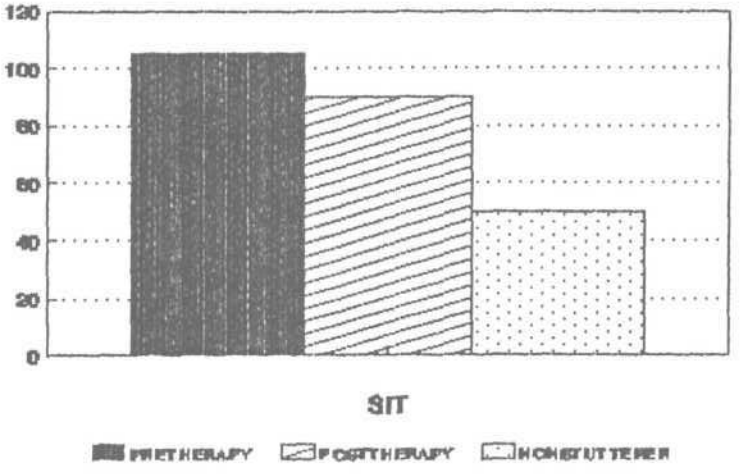
	Stutterer		Nonstutterer
	Pretheray	Posttherapy	
a) VOT (in msecs):			
pa	4.00	2.66 (2-4)	2.00 (0-4)
ta	6.66 (6-8)	4.66 (4-6)	3.33 (2-4)
ta	4.66 (4-6)	3.33 (2-4)	2.66 (2-4)
ka	14.66 (14-16)	8.66 (10-14)	8.66(10-14)
pakkada	4.88	2.00	0.00
taar	8 88	4..00	4.00
tam	6 88	4.00	2.00
kamala	14 88	6.00	6.00
b) SIT (in centiseconds)	105	30	50
c) STT (in centiseconds)	55	50	31
d) Rate of speech (in syllables/ seconds)	5.47	5.02	5.93
e) Fo	264 Hz	291 Hz	172 Hz
f) Total number of stuttering moments	6	1	0

Table-1 and Graph-1 give results for subject number 1 (male) in both pre and post therapy conditions as against the matched nonstutterer (both being Kannada speakers). Their results are given below:

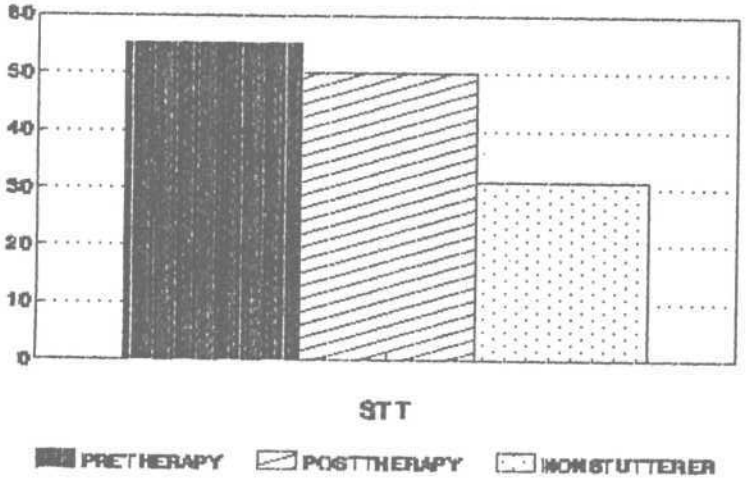
GRAPH-I DISPLAYS THE RESULTS FOR
STUTTERER-1 & MATCHED NONSTUTTERER



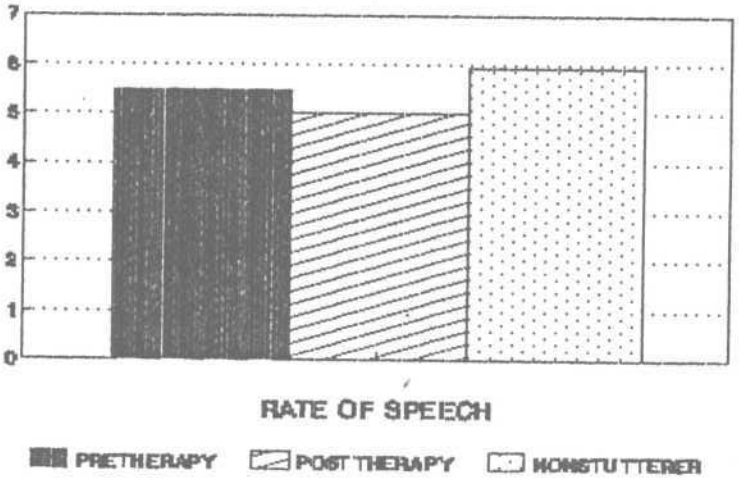
GRAPH-I DISPLAYS RESULTS FOR
STUTTERER-I & MATCHED NONSTUTTERER



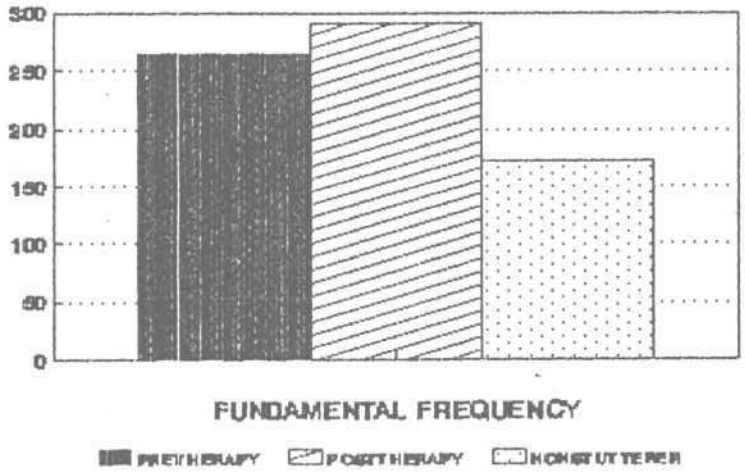
GRAPH-I DISPLAYS RESULTS FOR
STUTTERER-I & MATCHED NONSTUTTERER



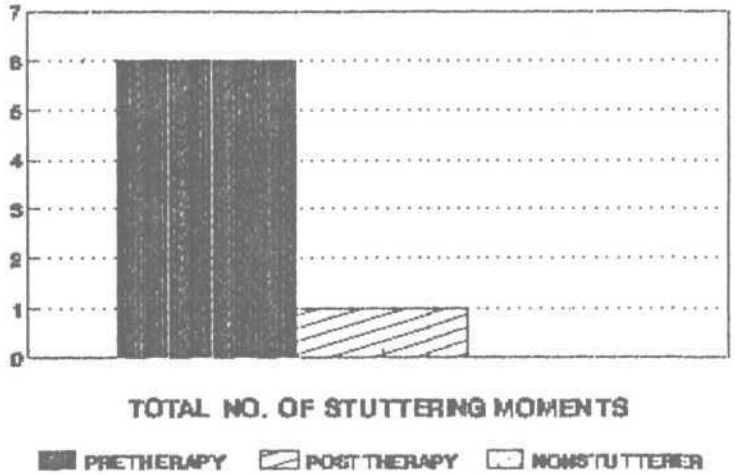
GRAPH-I DISPLAYS RESULTS FOR
STUTTERER-I & MATCHED NONSTUTTERER



GRAPH-I DISPLAYS RESULTS FOR
STUTTERER-I & MATCHED NONSTUTTERER



GRAPH-I DISPLAYS RESULTS FOR
STUTTERER-I AND MATCHED NONSTUTTERER



The examination of Table-I and Graph-I shows that the null hypothesis stating that -

I) "there will be no difference between the stutterer in pretherapy condition and matched nonstutterer".

The comparisons were made on the following parameters:

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala) is not acceptable. Stutterers VOT values for the syllables ranged from 4msecs to 16msecs, while for the words it was from 4msces to 14msces. For the nonstutterers the range was from Omsces to 14 msces for the syllables and Omsces to 6msces for the words. The voice onset time values for both, syllables and words were less for the nonstutterers as compared to stutterer's pretherapy voice onset time values.

ii) The SIT for the nonstutterers (50CS) was less as compared to stutterer's pretherapy SIT values (105CS). Therefore the hypothesis with reference to Speech Initiation Time was rejected.

iii) Similarly, STT for the nonstutterers (31CS) was less as compared to stutterer's pretherapy STT value (55CS). Therefore the hypothesis regarding Speech Termination Time was rejected.

iv) The hypothesis with respect to rate of speech in syllables per second was also rejected as the rate of speech was higher for the nonstutterer (5.93syll/sec) than the stutterer's pretherapy condition (5.47syll/sec).

v) The fundamental frequency in nonstutterer (172Hz) was lower than in the case of stutterer (264Hz).

vi) The nonstutterer showed no stuttering moments as compared to the stutterer's in pretherapy condition (6). Thus the hypothesis regarding the number of stuttering movements was also rejected.

In order to verify the hypothesis that

II) "there will be no difference between the stutterer in posttherapy condition and the matched nonstutterer" on the following parameters. The results presented in Table and Graph were examined. It was found that

i) Voice onset time of voiceless stop sounds -

a) in syllables (pa, ta, ṭa, ka) b) in words in (pakkada, taar, ṭam, kamala) is not acceptable. Stutterer's VOT values for the syllables ranged from 3msces to 14 msces, while for the word it was 2msces to 6msces. For the nonstutterers it was Omsces to 14msces for the syllables and 0 msces to 6msces for the words. The voice onset time values for nonstutterer were less than the stutterer, except for one Syllable (ka = 8.68msce) and two words (taar = 4msces, kamala

= 6msce) for which the VOT values were equal for both subjects. Since in majority of conditions the VOT was more in case of stutterer in posttherapy condition than for nonstutterer the hypothesis was rejected.

ii) As SIT for the nonstutterer was less (50CS) than the stutterer (90CS), the hypothesis was rejected.

iii) STT for the nonstutterer was also less (31CS) than the stutterer (50CS), the hypothesis was rejected.

iv) Rate of speech (syllables per second) was more (5.93syll/sec) for the nonstutterer than the stutterer (5.02syll/sec), hence the hypothesis was rejected.

v) Fundamental frequency was less for the nonstutterer (172Hz) than the stutterer (291Hz), hence the hypothesis was rejected.

vi) The nonstutterer showed no stuttering moments and the stutterer also showed only one stuttering moment. Hence, it was decided to accept the hypothesis with respect to total number of stuttering moments.

The examination of Table and Graph reveal that the null hypothesis

III) "there will be no difference between the stutterer's pretherapy and posttherapy conditions" with respect to -

i) Voice onset time of voiceless stop sounds both a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala). Stutterer's pretherapy VOT values for syllables ranged from 4msecs to 16mecs, while for words from 4msecs to 14msecs. Posttherapy VOT values for syllables ranged from 2msecs to 14msecs for syllables and for words it was from 2 msecs to 6 msecs. The posttherapy voice onset time values for the stutterer were less than the pretherapy VOT values, hence, the hypothesis was rejected.

ii) Speech initiation time was not acceptable as the posttherapy SIT value was considerably less (90CS) than the pretherapy value (105SC).

iii) Speech termination, time was rejected, as the posttherapy STT value was less (50SC) than the pretherapy value (55CS).

iv) Rate of speech (syllables per second) was lower in posttherapy condition (5.02syll/sec) than the pretherapy condition (5.47syll/sec), hence the hypothesis with respect to rate of speech was rejected.

v) Fundamental frequency was rejected, as the posttherapy fundamental frequency was higher (291Hz) than the pretherapy condition (264Hz).

vi) The number of stuttering moments in posttherapy condition was less (1) than the pretherapy condition (6), hence the hypothesis is rejected.

TABLE-II

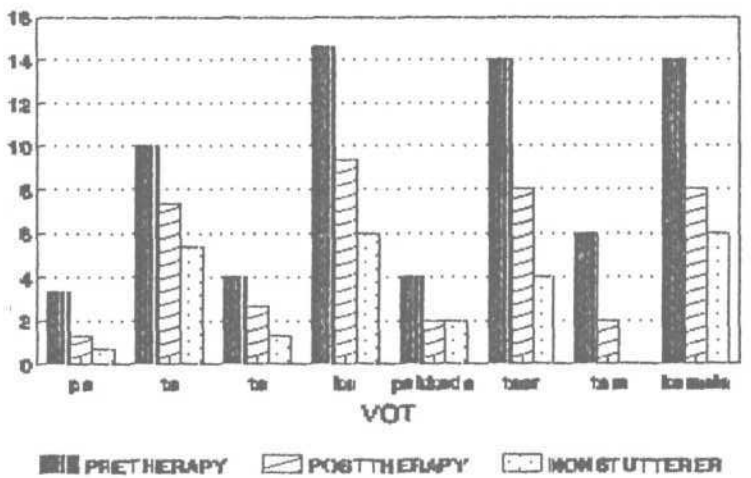
	Stutterer		Nonstutterer
	Pretheray	Posttherapy	
a) VOT (in msecs):			
pa	3.33(2-4)	1.33(0-2)	0.66(0-2)
ta	10.00(8-12)	7.33(6-8)	5.33(4-8)
ṭa	4.00	2.66(2-4)	1.33(0-2)
ka	14.66(12-18)	9.33(8-10)	6.00
pakkada	4.00	2.00	2.00
taar	14.00	8.00	4.00
tam	6.00	2.00	0.00
kamala	14.00	8.00	6.00
b) SIT (in centiseconds)	85	72	65
c) STT (in centiseconds)	42	36	31
d) Rate of speech (in syllables/ seconds)	4.59	4.35	5.77
e) Fo	158 Hz	127 Hz	130 Hz
f) Total number of stuttering moments	10	2	0

Table-II and Graph-II give results for subject number II (male) in both pre and posttherapy conditions as against for the matched nonstutterer, both being Kannada speakers. Their results are given below:

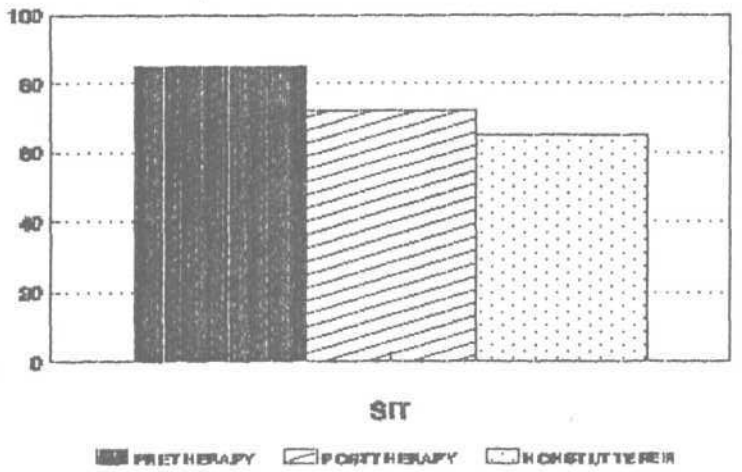
Table-II and Graph-II were examined. The results showed that the null hypothesis -

I) "there will be no difference between the stutterer in pretherapy condition and matched nonstutterer" for -

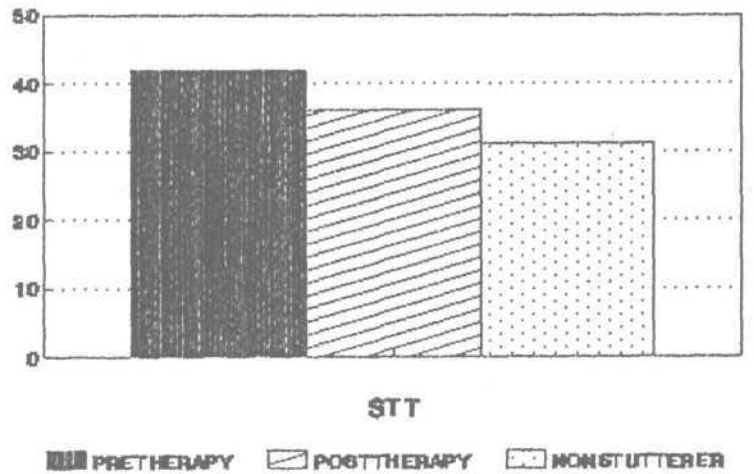
GRAPH-II DISPLAYS THE RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



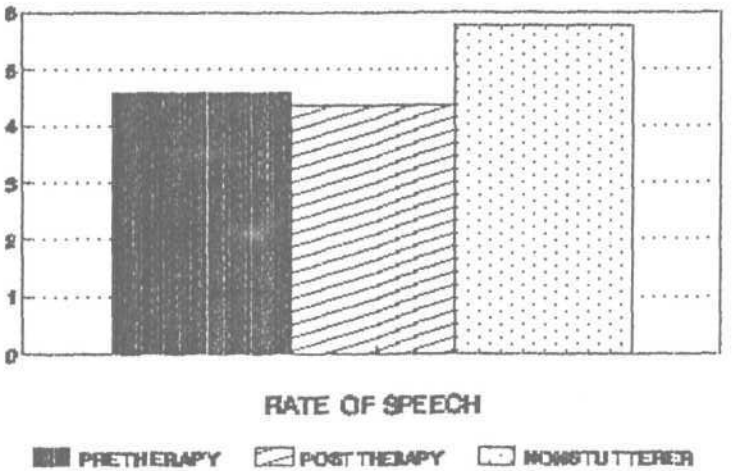
GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



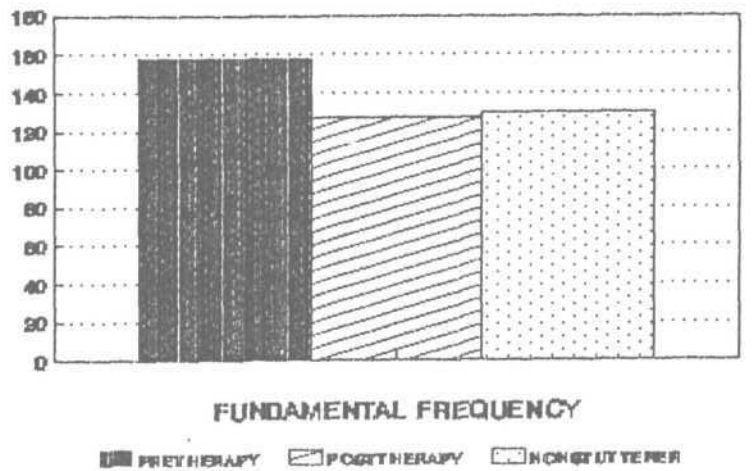
GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



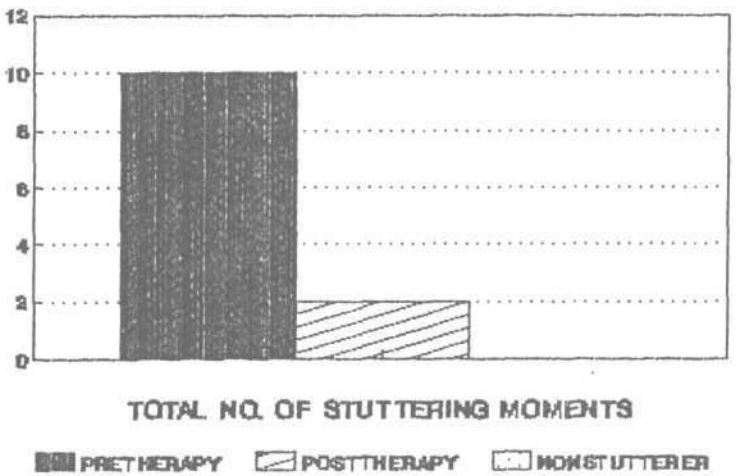
GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



i) Voice onset time values of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala) is not acceptable. Stutterer's VOT values for syllables ranged from 2msec to 18msecs, while for words the range was 4msecs to 14msecs. For the nonstutterer, the VOT for syllables ranged from Omsecs to 8msecs, while for words the range was from 2msecs to 6msecs. The voice onset time values for both syllables and words were considerably less for nonstutterer as compared to stutterer's pretherapy voice onset time values.

ii) Speech initiation time was rejected, as SIT for the nonstutterer (65CS) was less as compared to stutterer's pretherapy SIT values (85CS).

iii) Speech termination time was rejected, as STT for the nonstutterer (31CS) was less compared to stutterer's pretherapy STT values (42CS).

iv) As rate of speech for the nonstutterer (5.77syll/sec) was higher than the stutterer (4.59syll/sec), the hypothesis was rejected.

v) Fundamental frequency is not acceptable, as the nonstutterer's Fo (130Hz) was lower than the stutterer's in pretherapy Fo (152Hz).

vi) Number of stuttering moments was rejected, as the nonstuttarer showed no stuttering moments as compared to the stutterers in prathsrapy condition (10).

In order to verify the null hypothesis -

II) "there will be no difference between the stutterer in posttherapy condition and the matched nonstutterer" for

i) Voice onset time of voiceless stop sounds -

a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala). It was found that stutterer's VOT values ranged from Omsecs to l0msecs for syllables and from 2msecs to 8msecs for words. For the nonstutterer, the VOT for syllables ranged from Omsecs to 8msecs, while for words the range was from 2msecs to 6msecs. The voice onset time values for nonstutterer were less than the stutterer except for one word (pakkada - 2msec) for which the VOT values were equal for both the subjects, hence the hypothesis was rejected.

ii) As SIT value for the nonstutterer was less (65CS) than the stutterer (72CS), the hypothesis regarding speech initiation time was rejected.

iii) STT for the nonstutterer was also less (31CS) than the stutterer (36CS), hence the hypothesis was rejected.

iv) Rate of speech (syllables/second) was rejected, as the rate of speech was higher for the nonstutterer (5.77syll/sec) than the stutterer (4.35syll/sec).

v) Fundamental frequency for the nonstutterer was (130Hz) and for the stutterer was (127Hz), hence it was decided to accept the hypothesis with respect to Fo.

vi) Number of stuttering moments for the stutterer was (2), while nonstutterer showed no stuttering moments. But there was no considerable difference between them, hence the hypothesis was accepted.

Considering null hypothesis -

III) "there will be no difference between the stutterer's pretherapy and posttherapy condition" with respect to -

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala) was rejected. As stutterer's pretherapy VOT ranged from 2msecs to 18msecs for syllables and from 4msecs to 14msecs for words. Posttherapy VOT range being Omsecs to lOmsecs for syllable and from 2msecs to 8msecs. Thus, the posttherapy VOTs for the stutterer were less than the pretherapy VOT values.

ii) Speech initiation time was not acceptable as the posttherapy SIT value was less (72CS) than the pretherapy value (85CS).

iii) Speech termination time was also not acceptable, as the posttherapy STT value was less (36CS) than the pretherapy value (42CS).

iv) Rate of speech (syllables per second) was less (4.35syll/sec) in posttherapy condition as compared to the pretherapy condition (4.59syll/sec), hence the hypothesis was rejected.

v) Fundamental frequency was rejected, as the posttherapy fundamental frequency was less (127Hz) than the pretherapy condition (158Hz).

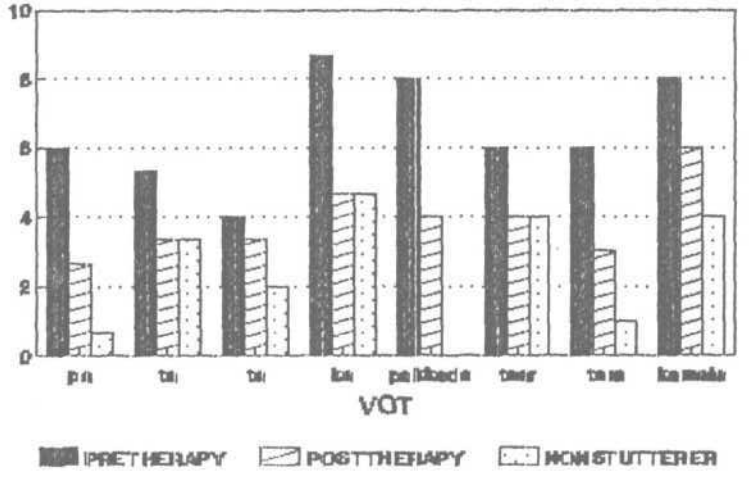
vi) The number of stuttering moments in posttherapy conditions was less (2) than the pretherapy condition (10). Hence, it was decided to reject the null hypothesis regarding number of stuttering moments.

TABLE-III

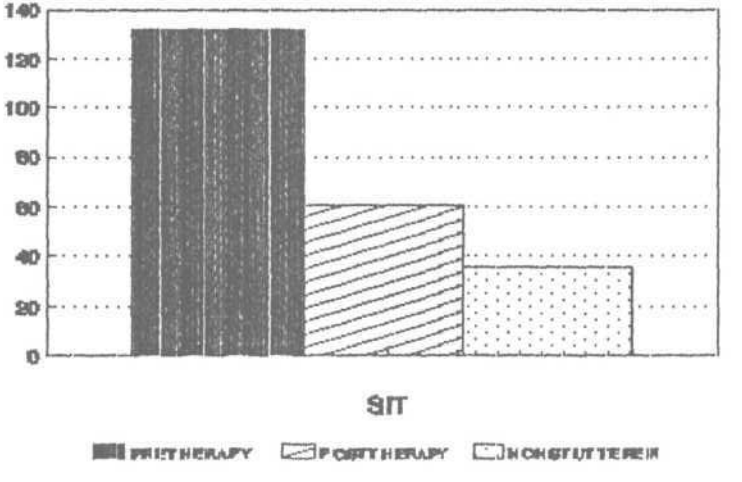
	Stutterer		Nonstutterer
	Pretheray	Posttherapy	
a) VOT (in msecs):			
pa	6.00	2 .66(2-4)	0.66(0-2)
ta	5.33(4-8)	3 .33(2-4)	3.33(2-4)
$a	4.00	3 .33(2-4)	2.00
ka	8.66(8-10)	4 .66(4-6)	4.66(4-6)
pakkada	8.00	4 .00	0.00
taar	6.00	4 .00	4.00
tam	6.00	3 .00	1.00
kamala	8.00	6 .00	4.00
b) SIT (in centiseconds)	132	61	36
c) STT (in centiseconds)	36	25	12
d) Rate of speech (in syllables/ seconds)	6.10	5 .69	6.67
e) Fo	196 Hz	123 Hz	119 Hz
f) Total no. of stuttering moments	4	1	0

Table-Ill and Graph-III give results for subject number III (male) in both pre and posttherapy conditions as against for, the matched nonstutterer, both being Kannada speakers. Their results are given below:

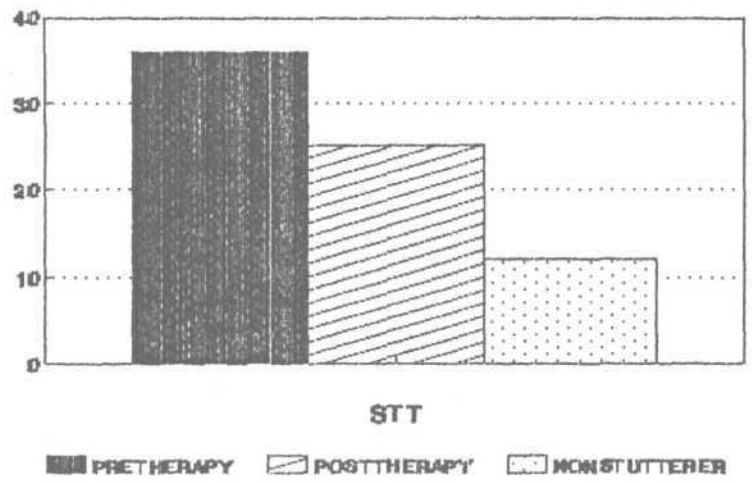
GRAPH-III DISPLAYS THE RESULTS FOR
STUTTERER-III & MATCHED NONSTUTTERER



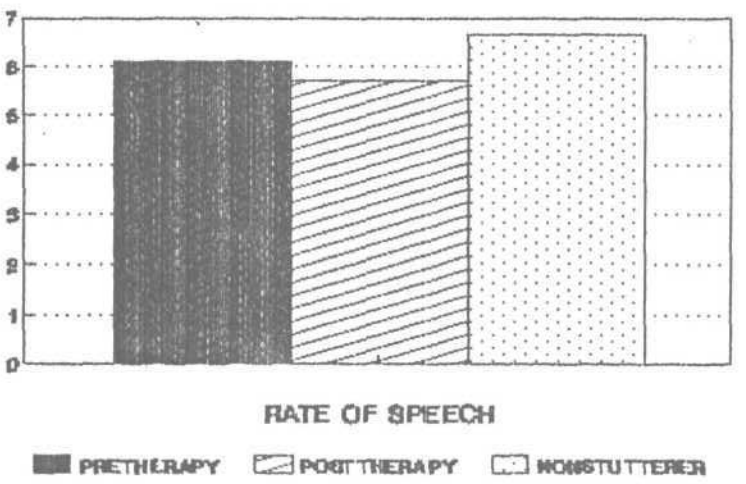
GRAPH-III DISPLAYS RESULTS FOR
STUTTERER-III & MATCHED NONSTUTTERER



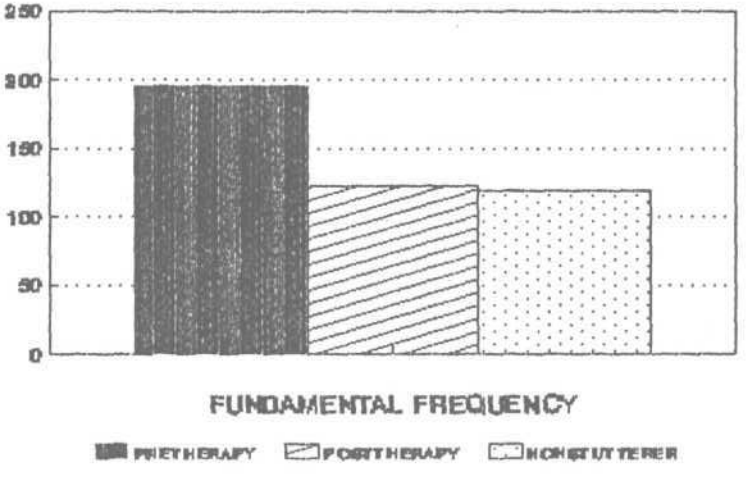
GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



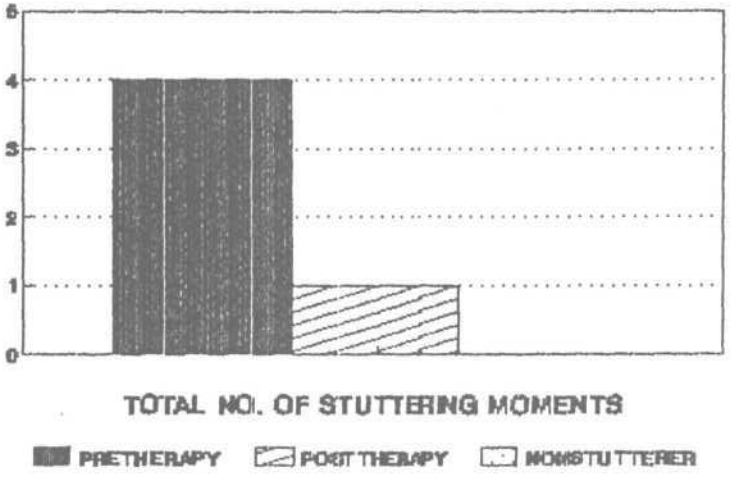
GRAPH-III DISPLAYS RESULTS FOR
STUTTERER-III & MATCHED NONSTUTTERER



GRAPH-II DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



GRAPH-III DISPLAYS RESULTS FOR
STUTTERER-II & MATCHED NONSTUTTERER



Examination of the Table-III and Graph-III show that the null hypothesis stating that

I) "there will be no difference between the stutterer in pretherapy condition and the matched nonstutterer". The comparisons were made on the following parameters -

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ṭa, ka) b) in words in isolation (pakkada, taar, ṭam, kamala). Stutterer's VOT range was from 4msecs to l0msecs for syllables, for words it was from 6msecs to 8msecs. For the nonstutterer, the VOT range was from Omsecs to 6msecs for syllables and for words, it was Omsecs of 4msecs. The voice onset time values for both, syllables and words were considerably less for the nonstutterer as compared to stutterer's pretherapy voice onset time values. Hence, the hypothesis was rejected.

ii) The hypothesis regarding speech initiation time was rejected, as SIT for the nonstutterer (36CS) was less than the stutterer's SIT value (132CS).

iii) Similarly, the hypothesis regarding speech termination time was rejected, as STT for the nonstutterer (12CS) was less than the stutterer's SIT value (36CS).

iv) Rate of speech (syllables per second) was higher for the nonstutterer (6.67syll/sec) than the stutterer (6.1syll/sec), hence the hypothesis was not acceptable.

v) Fundamental frequency was rejected, as the nonstutterer's Fo (119Hz) was considerably lower than the stutterer's pretherapy Fo (196Hz).

vi) Number of stuttering moments was not acceptable, as the nonstutterer showed no stuttering moments as compared to the stutterer's pretherapy condition (4).

Considering the null hypothesis stating that

II) "there will be no difference between the stutterer in posttherapy condition and the matched nonstutterer" for the following parameters -

i) Voice onset time of voiceless stop sounds -

a) in syllables (pa, ta, ta, ka) b) in words in isolation (pakkada, taar, tam, kamala) was rejected. Range of VOT value was -

	Syllables (msecs)	Words (msecs)
Post therapy	2-6	3-6
Nonstutterer	0-6	0-4

The voice onset time values for nonstutterer were less than the stutterer, except for two syllables (ta - 3.33msec, ka=4.66msec), and a word (taar = 4msec) for which the VOT values were equal for both the subject.

ii) SIT for the nonstutterer (36CS) was less than the stutterer (61CS), so, the hypothesis regarding speech initiation time was not accepted.

iii) Speech termination time was also not acceptable, as STT for the nonstutterer was less (12CS) than the stutterer (25CS).

iv) The hypothesis regarding rate of speech (syllables per second) was rejected, as rate of speech was higher (6.67syll/sec) for the nonstutterer than the stutterer (5.61syll/sec).

v) Fundamental frequency was rejected, as it was seen that Fo was less (119Hz) for the nonstutterer than the stutterer (123Hz).

vi) The nonstutterer showed no stuttering moments and the stutterer showed only one stuttering moment. Hence the hypothesis regarding number of stuttering moments was accepted.

Examination of the null hypothesis stating that

III) "there will be no difference between the stutterer's pretherapy and posttherapy" reveal that

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ta, ka) b) in words in isolation (pakkada, taar, tam, kamala) ranged from -

	Syllables (msecs)	Words (msecs)
Pretherapy	4-10	6-8
Posttherapy	2-6	3-6

As the posttherapy VOT values for the stutterer were less than the pretherapy VOT values, the hypothesis was rejected.

ii) Posttherapy SIT value was (61CS) and the pretherapy value was (132CS), as there was a considerable difference in two conditions, the null hypothesis was rejected.

iii) Speech termination time was rejected, as the posttherapy STT value was less (25CS) than the pretherapy value (36CS).

iv) The hypothesis regarding rate of speech (syllables per second) was rejected, as the rate of speech was less (5.69syll/sec) in posttherapy condition than the pretherapy condition (6.1syll/sec).

v) Fundamental frequency in posttherapy condition was lower (123Hz) than the pretherapy condition (196Hz). So, the null hypothesis was rejected.

vi) Number of stuttering moments was rejected. The number of stuttering moments in posttherapy condition was less (1) than the pretherapy condition (4).

TABLE-IV

	Stutterer		Nonstutterer
	Pretheray	Posttherapy	
a) VOT (in msecs):			
pa	2.66(0-4)	2.00	0.00
ta	6.00	4.00	0.66(0-2)
ka	24.66(24-26)	18.66(16-20)	6.66(6-8)
pen	4.00	2.00	2.00
teeth	4.00	2.00	1.00
kite	6.00	6.00	4.00
b) SIT (in centiseconds)	74	65	55
c) STT (in centiseconds)	50	39	35
d) Rate of speech (in syllables/ seconds)	2.28	2.55	3.77
e) Fo	133 Hz	152 Hz	140 Hz
f) Total number of stuttering moments	11	3	0

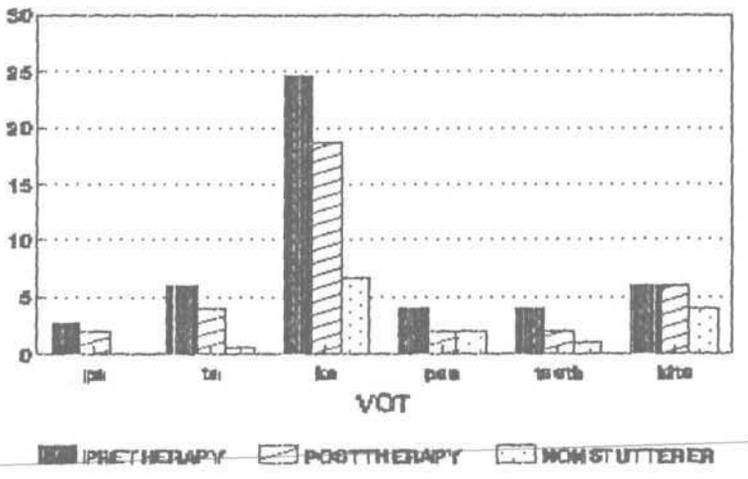
Table-IV and Graph-IV results for subject number IV (male) in both pre and posttherapy conditions as against for the matched nonstutterer, both being English speakers. Their results are given below:

Examination of the Table-IV and Graph-IV reveal that the null hypothesis stating that -

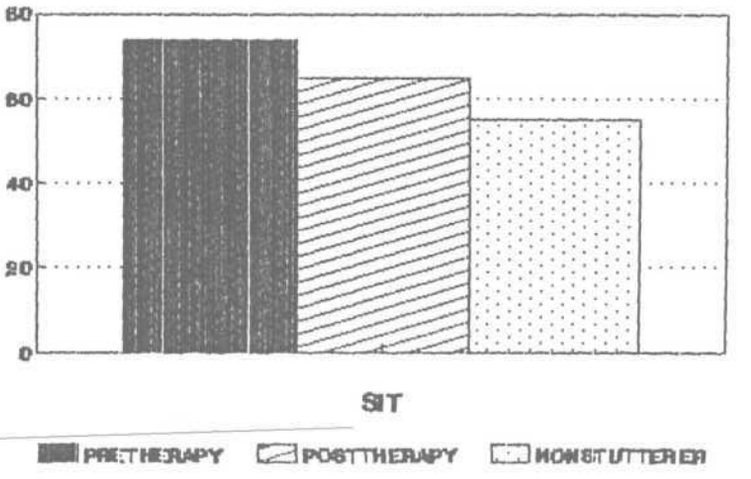
I) "there will be no difference between the stutterer in pretherapy condition and matched nonstutterer" for -

i) Voice onset time of voiceless stop sounds

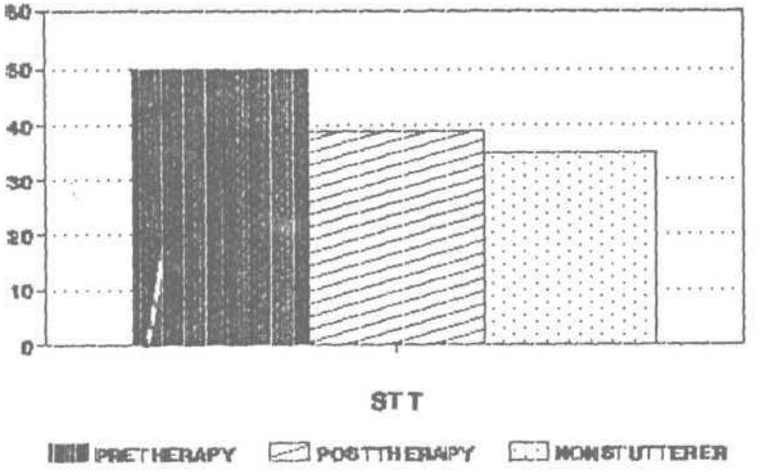
GRAPH-IV DISPLAYS THE RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



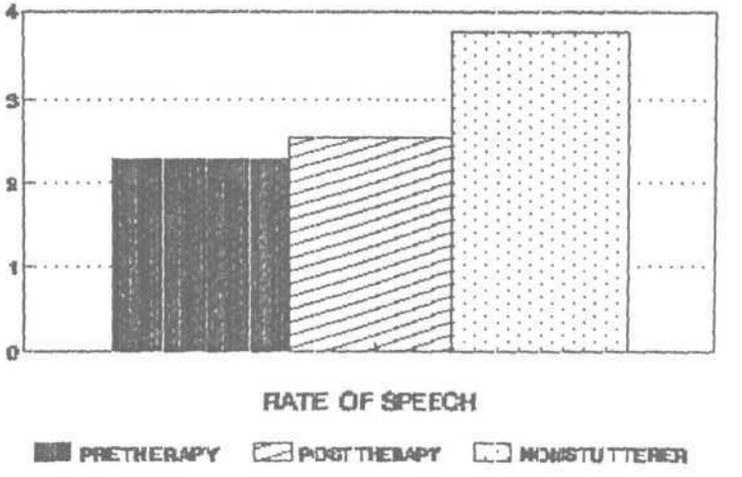
GRAPH-IV DISPLAYS RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



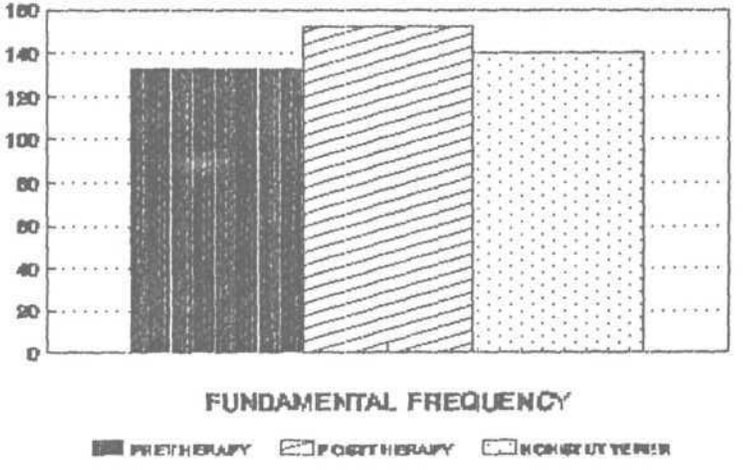
GRAPH-IV DISPLAYS RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



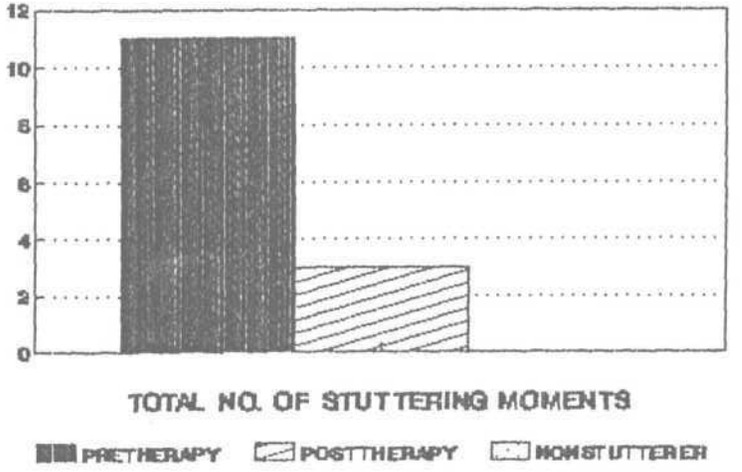
GRAPH-IV DISPLAYS RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



GRAPH-IV DISPLAYS RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



GRAPH-IV DISPLAYS RESULTS FOR
STUTTERER-IV & MATCHED NONSTUTTERER



a) in syllables (pa, ta, ka) b) in words in isolation (pen, teeth, kite) was rejected. Stutterer's VOT for syllables ranged from 0msec to 26msecs, while for words the range was from 4msecs to 6msecs. For the nonstutterer the VOT range for syllables was from Omsecs to 8msces and for words it was from 1msec to 4msec. The voice onset time values for both, syllables and words were less for the nonstutterer as compared to stutterer's pretherapy VOT values.

ii) The hypothesis regarding speech initiation time was rejected, as SIT for the nonstutterer (55CS) was less as compared to stutterer's pretherapy SIT values (74CS).

iii) Similarly, the hypothesis regarding 3peech termination time was rejected, as STT for the nonstutterer (35CS) was less as compared to Stutterer's pretherapy STT values (50CS).

iv) Rate of speech (syllables per second) was higher (3.77syll/sec) for the nonstutterer than the stutterer (2.28syll/sec), hence the hypothesis was not acceptable.

v) The hypothesis about fundamental frequency was rejected, as the nonstutterer's Fo (104Hz) was considerable different than the stutterer's pretherapy Fo (133Hz).

vi) Number of stuttering moments was rejected as the nonstutterer showed no stuttering moments while the stutterer showed (11) stuttering moments in pretherapy condition.

Studying the null hypothesis -

II) "there will no difference between the stutterer in posttherapy condition and the matched nonstutterer". It was found that

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ṭa, ka) b) in words in isolation (pen, ṭeeth, kite) ranged from -

	Syllables (msecs)	Words (msecs)
Post therapy	2-20	2-6
nonstutterer	0-8	1-4

The voice onset time values for nonstutterer were less than the stutterer, except for one word (pen=2msec) for which the VOT values were equal for both the subject. Hence it was decided to reject the hypothesis.

ii) Speech initiation time for the nonstutterer was less (55CS) than the stutterer (65CS). Hence the hypothesis was rejected.

iii) Speech termination time was (35CS) for the nonstutterer and (39CS) for the stutterer. Hence the null hypothesis was rejected.

iv) The hypothesis regarding rate of speech (syllables per second) was rejected as the rate of speech for the nonstutterer was (3.77syll/sec) and (2.55syll/sec) for the stutterer.

v) Fundamental frequency was lower (140Hz) for the nonstutterer than the stutterer (152Hz). Hence the hypothesis was rejected.

vi) The nonstutterer showed no stuttering moments while stutterer showed three stuttering moments. As the difference is not much the hypothesis was accepted.

On examination of the null hypothesis -

III "there will be no difference between the stutterer's pretherapy and posttherapy conditions'. It was found that -

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ka,) b) in words (pen, teeth kite) ranged from -

	Syllables (msec)	Words (msec)
Pretherapy	0-26	4-6
Posttherapy	0-8	1-4

The posttherapy VOT values for the stutterer were less than the pretherapy values, except for one word (kite=6msec) for which the VOT values were equal in both the conditions. Hence the hypothesis was rejected.

ii) Speech initiation time was rejected, as posttherapy SIT was less (65CS) than the pretherapy SIT value (74CS).

iii) Speech termination time was rejected, as posttherapy STT value was less (39CS) than pretherapy STT value (50CS).

iv) Rate of speech (syll/sec) was higher (2.55syll/sec) in the posttherapy condition than the pretherapy condition (2.28syll/sec). Hence the hypothesis was rejected.

v) Fundamental frequency in posttherapy condition was (152Hz) and in the pretherapy it was (133Hz). Hence the null hypothesis was rejected.

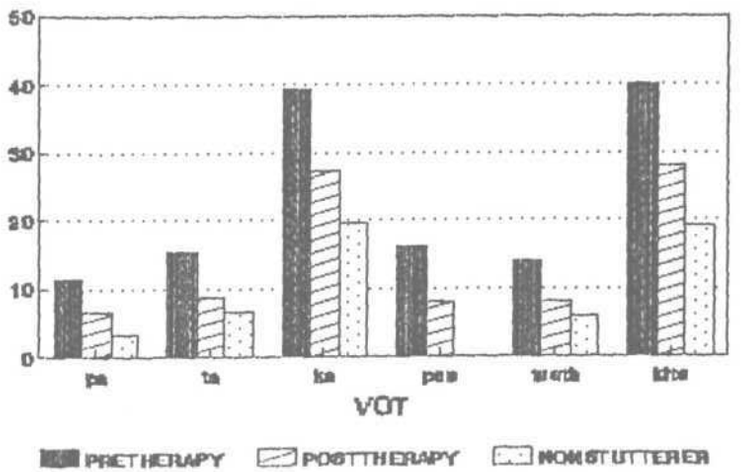
vi) The hypothesis for total number of stuttering moments was rejected, as the no. of stuttering moments in posttherapy condition was less (3) than the pretherapy condition (11).

TABLE-V

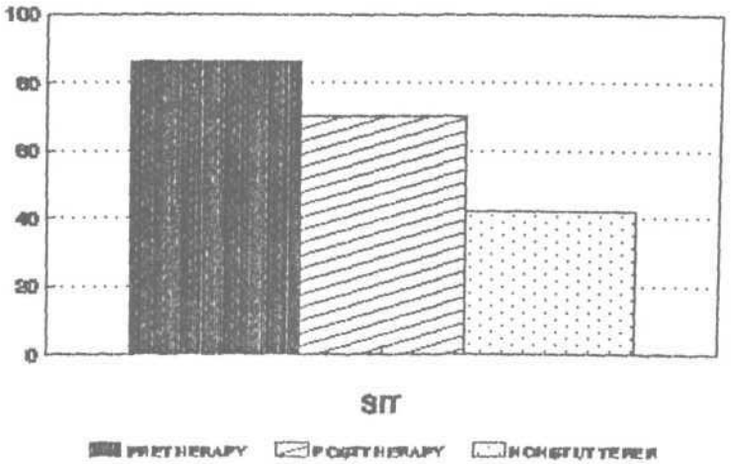
	Stutterer		Nonstutterer
	Pretheray	Posttherapy	
a) VOT (in msecs):			
pa	11.33(10-14)	6.66(6-8)	3.33(2-4)
ta	15.33(12-18)	8.66(8-10)	6.66(6-8)
ka	39.33(34-42)	27.33(22-34)	19.66(16-24)
pen	16.00	8.00	0.00
teeth	14.00	8.00	6.00
k'ite	40.00	28.00	19.00
b) SIT (in centiseconds)	86	70	42
c) STT (in centiseconds)	33	25	22
d) Rate of speech (in syllables/ seconds)	1.22	1.69	3.31
e) Fo	253 Hz	310 Hz	289 Hz
f) Total no. of stuttering moments	84	29	4

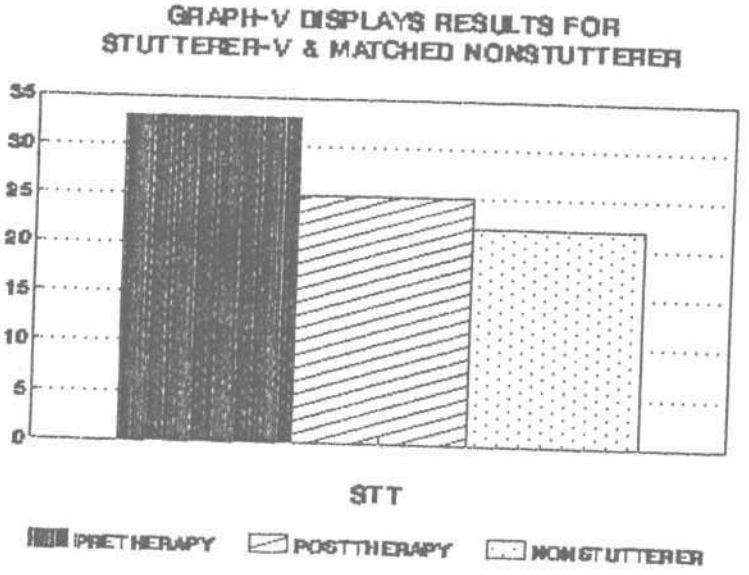
Table-V and Graph-V results for subject number V (female) in both pre and posttherapy condition as against for the matched nonstutterer, both being English speakers. Their results are given below:

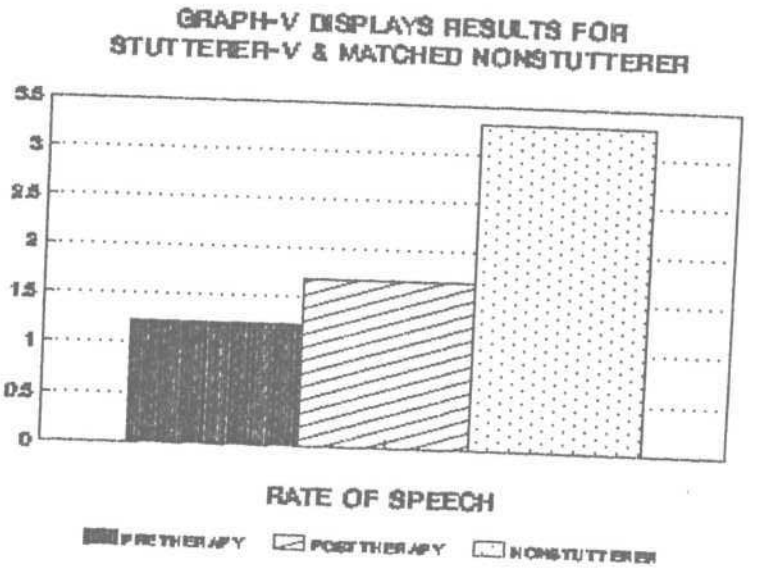
GRAPH-V DISPLAYS THE RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER



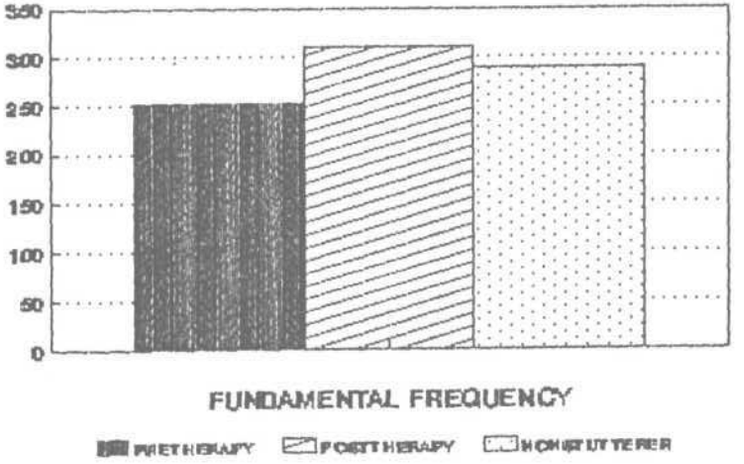
GRAPH-V DISPLAYS RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER



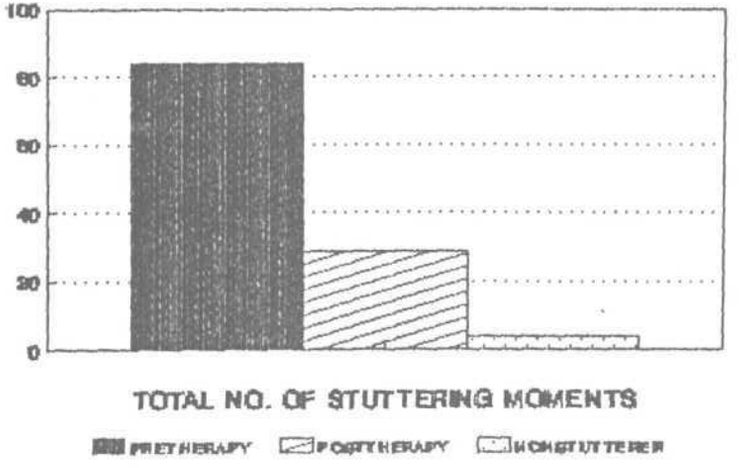

GRAPH-V DISPLAYS RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER
35
30
25
20
15
10
5
0
STT
PRETHERAPY
POSTTHERAPY
NONSTUTTERER


GRAPH-V DISPLAYS RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER
3.5
3
2.5
2
1.5
1
0.5
0
RATE OF SPEECH
PRETHERAPY
POSTTHERAPY
NONSTUTTERER

GRAPH-V DISPLAYS RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER



GRAPH-V DISPLAYS RESULTS FOR
STUTTERER-V & MATCHED NONSTUTTERER



On examination of the null hypothesis stating that -

I) "there will be no difference between the stutterer in pretherapy condition and matched nonstutterer." It was found that -

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ka) b) in words in isolation (pen, teeth, kite) for the stutterer for the syllables ranged from lOmsecs to 42msecs and for words it was 14msecs to 40msecs. For the nonstutterer, the VOT range for syllables was from 2msecs to 24 msecs and for words it was from Omsecs to 19msecs. The voice onset time values for both, syllables and words were less for the nonstutterer as compared to the stutterer's pretherapy VOT values. So, the hypothesis was not accepted.

ii) Speech initiation time was rejected, as SIT for the nonstutterer (42CS) was less as compared to stutterer's pretherapy SIT values (86CS).

iii) Speech termination time was rejected, as STT for the nonstutterer (22CS) was less as compared to stutterer's pretherapy STT value (33CS).

iv) The hypothesis regarding rate of speech (syllables per second) was rejected, as rate of speech was higher for the nonstutterer (3.31syll/sec) than the stutterer (1.22syll/sec).

v) Fundamental frequency was rejected, as the Fo for nonstutterer was higher (289Hz) than the stutterer's Fo (253Hz).

vi) The nonstutterer showed four word repetitions and the stutterer showed (84) stuttering moments. Hence it was decided to reject the hypothesis.

Examining the null hypothesis

II) "there will be no difference between the stutterer in posttherapy condition and the matched nonstutterer" for

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ka) b) in words in isolation (pen, teeth, kite) was rejected. Range of VOT for,

	Syllables (msec)	Words (msec)
Posttherapy	6-34	8-28
nonstutterer	2-24	0-19

The voice onset time values for the nonstutterer were less than the stutterer.

ii) As SIT for the nonstutterer was less (42CS) than the stutterer (70CS), the hypothesis was rejected.

iii) STT for the nonstutterer was also less (22CS) than the stutterer (25CS). So, the hypothesis was rejected.

iv) Rate of speech in syllables per second was rejected, as the rate of speech was higher in the nonstutterer (3.31syll/sec) than the stutterer (1.69syll/sec).

v) The hypothesis regarding fundamental frequency was rejected, as the nonstutterer's Fo was less (289Hz) than the stutterer (310Hz).

vi) The nonstutterer showed 4 word repetitions and stutterer showed (29) stuttering moments. Hence the hypothesis was rejected.

Considering the null hypothesis -

III) "there will be no difference between the stutterer's pretherapy and posttherapy conditions' for -

i) Voice onset time of voiceless stop sounds

a) in syllables (pa, ta, ka) b) in words in isolation (pen, teeth, kite) was rejected. Range of VOT for

	Syllables (msec)	Words (msec)
Pretherapy	10-42	14-40
Posttherapy	6-34	8-28

The posttherapy VOT values were less than the pretherapy VOT values.

ii) The posttherapy SIT value was (70CS) and the pretherapy SIT (86CS). So, the hypothesis was rejected.

iii) Posttherapy STT was less (25CS) than the pretherapy STT (33CS), hence the hypothesis regarding speech termination time was rejected.

vi) The hypothesis regarding rate of speech (syllables per second) was rejected, as rate of speech was higher in posttherapy condition (1.69syll/sec) than the pretherapy condition (1.22syll/sec).

v) Fundamental frequency in posttherapy condition was higher (310Hz) than the pretherapy condition (253Hz), hence the hypothesis was rejected.

vi) The hypothesis regarding total number of stuttering moments was rejected. The number of stuttering moments in post therapy had considerably reduced (29) as compared to the pretherapy condition (84).

Apart from study the behaviour of stutterers on five parameters mentioned with respect to each subject and matched nonstutterer it was considered that it would be interesting to study the behaviour of stutterers as a group in pre and posttherapy conditions as against the matched nonstutterers. Mean, Median, Standard Deviation and Range for different variables in pretherapy, posttherapy condition for stutterers and nonstutterers have been found out as shown in Table-VI. The comparisons have also been made by using "T"-test and Paired "T"-test to find out the significance of difference statistically. The results regarding a) VOT b)SIT c) STT d) Rate of Speech e) Fo f) Total number of stuttering moments for stutterers and nonstutterers are presented in Table-VI, VII, VIII and IX.

Table-VI shows mean, median, standard deviation and range for different variables in pretherapy, posttherapy condition for stutterers as against nonstutterers.

	VOT	SIT	STT	RATE OF SPEECH	FUNDA-MENTAL FREQU-ENCY	TOTAL NUMBER OF STUTT-ERING MOMENTS
MEAN:						
A) Pre	10.20	96.4	43.2	3.93	200.8	23.00
B) Post	6.34	71.6	35.0	3.86	200.6	7.2
C) Non.Str.	3.90	49.6	26.2	5.09	170.0	0.8
MEDIAN:						
A) Pre	6.33	86.0	42.0	4.59	196.0	10.0
B) Post	4.00	70.0	36.0	4.35	152.0	2.0
C) Non.Str.	3.33	50.0	31.0	5.77	140.0	0.0
S.l						
A) Pre	8.76	22.81	9.26	2.09	57.38	34.22
B) Post	6.20	11.14	10.51	1.68	92.11	12.21
C) Non.Str.	4.43	11.28	9.26	1.46	69.40	1.78
RANGE:						
A) Pre: Min	2.66	74	33	1.22	133	4
Mix	40	132	55	6.1	264	84
B) Post :Min	1.33	61	25	1.69	123	1
Mix	28	90	50	5.69	310	29
ONonSt :Min	0	36	12	3.31	119	0
Mix	19.66	65	35	6.67	289	4

TABLE-VII

	VOT	SIT	STT	RATE OF SPEECH	FUNDA-MENTAL FREQU-ENCY	TOTAL NUMBER OF STUTT-ERING MOMENTS
Pretherapy Vs Nonstutterers	P	P	P	A	A	P

Note: p = Difference is significant

A = Difference is not significant

Table-VII shows significance of difference between the stutterer's pretherapy condition and nonstutterers.

TABLE-VIII

	VOT	SIT	STT	RATE OF SPEECH	FUNDA-MENTAL FREQU-ENCY	TOTAL NUMBER OF STUTT-ERING MOMENTS
Posttherapy Vs Nonstutterers	P	P	A	A	A	A

Note: P = Difference is significant

A = Difference is not significant

Table-VIII shows significance of difference between the stutterer's posttherapy condition and nonstutterers.

TABLE-IX

	VOT	SIT	STT	RATE OF SPEECH	FUNDA-MENTAL FREQU-ENCY	TOTAL NUMBER OF STUTT-ERING MOMENTS
Pretherapy Vs Posttherapy	P	P	P	A	A	P

Note: p = Difference is significant

A = Difference is not significant

Table-IX Shows significance of difference between stutterer's pretherapy and posttherapy conditions.

Table VII, VIII and IX show significance difference for stutterers in pretherapy and posttherapy conditions as against the matched nonstutterer as a group. Thus indicating the significance of different parameters across the whole group.

The results presented in Table-VII were used to verify the hypothesis that -

I) "there will be no difference between stutterers in pretherapy condition as a group and matched nonstutterers as a group" for:

i) Voice onset time of voiceless stop sound

a) in syllables b) in words in isolation was rejected, as there is a significant difference found in both the conditions (P-0.0010).

ii) The hypothesis regarding speech initiation time was rejected as the significant difference was found between the two groups (P=0.0090).

iii) Speech termination time was rejected, as significant difference was seen (P=0.0463).

iv) The hypothesis regarding the rate of speech was accepted, as there was no significant difference between the two groups (P=0.3472).

v) Fundamental frequency was accepted as there was no significant difference between the two groups (P=0.3472).

vi) As there was significant difference between the two groups (P=0.0122), the hypothesis was rejected.

The results presented in Talbe-VIII were used to verify the hypothesis stating that -

II) "there will be no difference between the stutterers as a group in posttherapy condition and matched nonstutterers as a group" for -

i) Voice onset time for voiceless stop sounds

a) in syllables b) in words in isolation. As there was significant difference between the two groups (P-0.0132), the hypothesis was rejected.

ii) Speech initiation time was rejected as the significant difference between the two groups was seen (P=0.0126).

iii) Speech termination time was accepted, as there was no significant difference found between the two groups (P=0.1745).

iv) The hypothesis regarding the rate of speech was accepted, as there was no significant difference found out (P=0.1745).

v) The hypothesis regarding the fundamental frequency was accepted, as there was no significant difference between the two groups (P=0.6015).

vi) As there was no significant difference between the two groups (P=0.0758), when total number of stuttering moments was considered, the hypothesis was accepted.

The results presented in Table-IX were used to verify the hypothesis that -

III) "there will no difference between the stutterers as a group both in pretherapy and posttherapy conditions" for

i) Voice onset time. There was significant difference found for VOT values in both pre and posttherapy conditions for syllables and words in isolation (P=0.0002), hence the hypothesis was rejected.

ii) As there was significant difference between two conditions (P=0.431), the hypothesis was rejected.

iii) As there was significant difference between two condition (P=0.0431), the hypothesis was rejected.

iv) The hypothesis regarding the rate of speech was accepted, as there was no significant difference between two conditions (P=0.8927).

v) The hypothesis regarding fundamental frequency was accepted, as there was no significant difference between two conditions.

vi) There was significant difference between the pre and posttherapy conditions when total number of stuttering moments was considered (P=0.0431), hence the hypothesis was rejected.

Results of the present study indicate that as an individual and in group all stutterers in posttherapy condition have shown considerable improvement as compared to their pretherapy VOT values, which is in agreement with the results of a study by Webster, Morgan and Cannon (1987). As per their reports the reason could be that with the prolongation therapy may be that muscle forces in articulation, voicing and respiration were reduced when exaggerated syllable durations were used. Reduced velocities of movement could have lowered physical force requirements for speech initiation. That is to say that voice onset gentleness could have been increased simply as a function of generalized, reduced tension of the intrinsic laryngeal

muscles. They also suggest that careful and direct training in the gentle voice onset is strongly associated with the effective transfer of fluent speech into everyday settings and long-term self maintenance of fluent speech.

It is also evident from the results that the pretherapy VOT values are longer for the stutterers than the nonstutterer's VOT values in both individual and group data. Thus it is supporting the findings of Agnello and Wingate 1972, Kendall 1973, Hillman and Gilbert 1977, Babul Basu 1979). Thus it could be said that stuttering may be due to faulty functioning of laryngeal mechanism which might have reflected in increased voice onset time of stutterers in pretherapy condition.

It is interesting to note that even though there is significant difference in VOT values is pretherapy and posttherapy conditions, posttherapy VOT values in individual cases and in group are different, that is longer than VOT values of nonstutterers. Thus, even though stutterers have shown significant change from pretherapy to posttherapy condition, they are not attaining normal level. May be that some more training and stabilization would have helped the stutterers. But present study indicate that it could be that even after therapy laryngeal tension in the stutterers persists to some extent. It would be interesting to do the follow-up study of cases to note the level of laryngeal tension.

SIT values have significantly reduced in posttherapy as compared to pretherapy condition in both individual and group conditions. That means to say that vocal reaction times of stutterers have improved after the therapy. Which could be due to decreased laryngeal tension in the muscles of larynx, that stutterers are able to respond quickly without any struggle behaviours, which has increased the promptness in starting of speech on presentation of stimulus. Individual and group SIT values in pretherapy condition are different from nonstutterer's SIT values, which is in agreement with the studies done on stutterers to measure voice initiation time. Studies by Adams and Hayden (1976), Tannenbaum (1976), Reich and Goldsmith (1981), Horii (1984), state that vocal reaction times of stutterers are different from the nonstutterers.

It has also been evident from the results that there is a significant difference in individual and group SIT values of stutterers in post therapy condition and nonstutterers SIT values, which is again indicating that even though stutterers have shown improvement in SIT values in posttherapy condition compared to pretherapy condition, reaction times of stutterers are still not upto the normal level, that is, may be the state of larynx even after therapy has not attained the normal level; may be a few more therapy sessions would indicate some change in SIT values.

Individual and group STT values in posttherapy condition have shown a significant difference from pretherapy condition, which may be expected as a result of improvement in reaction times of stutterers secondary to reduced laryngeal tensions.

There is significant difference in pretherapy STT and nonstutterer's STT in both individual and group condition, which is in agreement with the findings of Agnello and Wingate (1971), Agnello (1975), Cullinan and Springer (1980), Horri (1984), may be because stutterers are not very efficient in quick termination of phonation due to laryngeal muscle tension.

In individual conditions, STT in posttherapy and nonstutterer's STT is different, but as a group they are not showing difference may be that overall all the cases have achieved remarkable decrease in laryngeal tension, but individually the difference is not very significant.

On Rate of speech subjects have shown mixed results. Individually, all three Kannada speakers showed decrease in rate of speech (syllables per second) from pretherapy to posttherapy condition. But two English speakers have shown increase in rate of speech (syllables per second) from pretherapy to posttherapy, which is supporting, Johnson (1961a) who states that stutterer's and nonstutterer's rate of speech are different. In posttherapy conditions, if the

stuttering symptoms have decreased, there should be increase in rate of speech, as seen in case of two English speakers in the study.

But the other three Kannada speakers have shown decrease in rate of speech in posttherapy condition. But as Johnson (1961a) states its possible to have comparable difference and overlapping between stutterers and nonstutterers, so its possible to have reduction in rate of speech. One other reason may be that the prolongation effect has been carried over in the reading situation, causing reduction of speech rate. Same explanation is possible to explain that there is no significant difference in rate of speech of stutterers in pretherapy and posttherapy condition in group situation.

When pretherapy rate of speech and nonstutterer's rate of speech is compared in individual case, there is a difference in two as seen in bar diagrams. But as a group they have not shown the significant differences, may be because on individual basis the difference is not significant for all the cases.

Posttherapy rate of speech and nonstutterers's rate of speech show difference when individual results are inspected, nonstutterer's rate of speech being higher, which may be possible because stutterers have shown a slight slowed rate due to use of prolongations in reading situation. As a group, stutterers have not shown any difference in rate of

speech when compared to nonstutterers which indicates that they have attained fluency to certain extent, that rate of speech has equaled to nonstutterer's rate of speech as expected, as Starkweather (1980) has stated that rate is primary indicator of fluency.

Considering fundamental frequency, subjects I, IV and V have shown increase in fundamental frequency, from pretherapy to posttherapy condition, which is against the studies which say that basically stutterer's larynx is tensed (Agnello 1975, Freeman and Ushijina 1975, Conture 1977). So after therapy, change in Fo ie, reduction in Fo is expected, as the tension in the larynx is reduced. While subjects II, III have shown decrease in Fo, which is in support of the notion that decrease in tension in larynx will reduce Fo. But as a group stutterers have not shown significant difference in pretherapy and posttherapy Fo, may be because the results are variable that is, a few subjects have shown increase and a few subjects have shown decrease in their Fo.

Considering pretherapy Fo and nonstutterer's Fo individually, two of the stutterers showed lower Fo as compared to nonstutterers, while three of the stutterers showed greater Fo as compared to nonstutterers.

As a group stutterer's pretherapy Fo and nonstutterer's Fo showed no difference, which in agreement with Schmitt and Cooper (1978), Schaterskupper and Simon (1983) who state that

mean Fo in stutterers and nonstutterers do not differ, but against the assumption that stutterers have high Fo due to tension in larynx.

Subject I, III, IV, V showed greater Fo in posttherapy condition, as compared to nonstutterer's Fo, indicating that stutterer's larynx may be tensed in post therapy condition, while only one subject II showed lowered Fo as compared to nonstutterers.

As a group stutterers showed no significant difference in posttherapy Fo and nonstutterer's Fo, which means that stutterer's larynx behaves like nonstutterer's due to reduction in tension in the muscles of larynx.

Considering total number of stuttering moments, there is reduction in number of stuttering moments, in both individual cases and in group in pretherapy condition as compared to posttherapy condition, which is in agreement with the previous studies (Cherry, Sayers, Marland 1955; Andrew and Harris 1964; Adamzyk 1959, Adams 1972), which proves effectiveness of therapy.

While there is significant difference in pretherapy condition and nonstutterers for total number of stuttering moments in both individual and group situation, which is as expected.

There is difference in individual cases for number of stuttering moments for posttherapy condition and nonstutterers, as expected because stutterers attain normal level with reduction in stuttering behaviours, but as a group the difference is not very significant.

SUMMARY AND CONCLUSION

PART-I

Attempts have been made to objectively rate severity of stuttering using different procedures.

The present study was conducted to provide an objective measurement of severity of stuttering using a computer.

This study consisted of fifteen stutterers and fifteen nonstutterers matched for age, sex and language background. Each subject read first paragraph of "Rainbo passage". The reading samples were recorded on a 'Philips' deck recorder. The reading samples were used for analysis. The analysis was carried out using a computer to find out the number of stuttering moments, duration of stuttering moments and rate of speech.

The three judges were asked to rate the severity of stuttering and rate of speech for the same samples. Intra and interjudge reliability for these ratings was found out.

Then the correlation between ratings by judges and measurement using computer was found out.

The definition of Wingate (1964) was considered as the criteria to define stuttering.

CONCLUSIONS

1) In the severity rating of stuttering the following parameters have been found to be important:

   a) Number of repetitions
   b) Number of pauses
   c) Total number of stuttering moments
   d) Average duration of repetitions
   e) Average duration of pauses
   f) Total average duration of stuttering moments.

2) Rate of Speech is an important parameter in rating severity of stuttering, which can be easily calculated with the help of computer.

3) Computer gives simultaneous audio-visual display of the speech, increasing the accuracy of rating stuttering severity, especially for the measurements of duration of stuttering blocks.

RECOMMENDATION FOR THE FUTURE STUDY

The study may be carried out on a large number of stutterers of different age.

PART-II

Many studies have reported that the acoustic parameters of speech of stutterers are different from the nonstutterers. Investigators have also reported that parameters like fundamental frequency, rate of speech are also different for stutterers when compared to nonstutterers.

This part of the study was conducted to find out the acoustic parameters voice onset time, speech initiation time, speech termination time, Fo and rate of speech in stuttering in pre and posttherapy conditions and to compare with the nonstutterers.

The study consisted of five stutterers and five nonstutterers matched for age, sex and language background; three of them being Kannada speakers and two English speakers. Each subject read a standard passage, syllables, words and spoke sentences. The reading and speech samples were recorded on a 'Philips' deck recorder. The reading samples were analyzed using the: computer spectrograph to find out the voice onset time; fundamental frequency; rate of speech and total number of stuttering moments. The speech samples were used to find out the speech initiation time and speech termination time. The definition of Wingate (1964) was used to measured the type of stuttering blocks.

CONCLUSIONS

l)(a) Nonstutterer's VOT values are smaller as compared to stutterer's pretherapy and posttherapy VOT values,

(b) Stutterer's posttherapy VOT values are smaller as compared to pretherapy VOT values.

2) (a) Speech initiation times of nonstutterers are less than that of stutterers in pretherapy and posttherapy conditions.

(b) There is a reduction in posttherapy speech initiation time of stutterers as compared to the pretherapy condition.

3) (a) Pretherapy speech termination time values of stutterers are different from nonstutterers, but there is no difference between stutterer's in posttherapy condition and nonstutterers when speech termination time is considered.

(b) Stutterer's posttherapy STT values are different ie., longer as compared to pretherapy STT values.

4) (a) Nonstutterers do not differ from stutterers in pretherapy and posttherapy conditions when rate of speech is considered.

(b) There was no difference in rate of speech of stutterer's in posttherapy condition and pretherapy condition.

5) (a) Nonstutterers and stutterers (pretherapy and posttherapy condition) show no difference in fundamental frequency.

(b) Stutterer's posttherapy Fo does not vary as compared to pretherapy Fo.

6) (a) Total number of stuttering moments are not seen in nonstutterers as compared to stutterer's pretherapy

condition. But stutterers behave as normals in posttherapy condition, as they show negligible number of stuttering moments.

(b) There is a great reduction in total number of stuttering moments in posttherapy condition than that of the pretherapy condition.

RECOMMENDATIONS FOR FUTURE STUDY

1) The experiment may be tried using large samples.
2) It can be carried out in different languages.
3) Various age groups can be included in the study.
4) Same experiment can be carried out to study the change in VOT with different places of articulation.

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APPENDIX-A

STUTTERERS

Subject-I Murthy M No.9671 Age - 25 years Sex=Male

Mother Tongue = Kannada Other Languages = -

Onset of stuttering = gradual, since childhood

Speech evaluation = Moderate stuttering characterized by hesitations, phoneme and syllable repetitions. Secondary symptoms were protrusion of lips, puffing of cheeks, hand movements, eye blinking. Stuttered more for the sounds /a/, /i/, /s/, /s/.

Advice = Prolongation

The case underwent therapy at AIISH clinic for a month and showed improvement. He was subjected to study before and after therapy.

Subject-11 Anilkumar No.73710 Age - 26 years Sex=Male

Mother Tongue = Kannada Other Languages = English, Hindi

Onset of stuttering = gradual, since childhood

Speech evaluation = Moderate to severe stuttering characterized by hesitations, repetitions and prolongations. Secondary symptoms were sweating on head and hand. Stuttered more for the sounds /a/, /p/, /m/, /r/.

Advice = Prolongation

The case underwent therapy at AIISH clinic for 10 days in Dec.1990 and showed improvement. He was subjected to study before and after therapy.

Subject-Ill M Madappa No.73776 Age - 20 years Sex-Male

Mother Tongue - Kannada Other Languages = - English,

Onset of stuttering = gradual, from the age of 18 years

Speech evaluation = Mild stuttering characterized by hesitations, repetitions and prolongation. Secondary symptoms include flaring of nostrils. Stuttered more on /p/, /m/, /v/, /s/.

Advice = Prolongation

The case attended therapy at AIISH clinic for 15 days in Dec.1990 and showed improvement. He was subjected to study before and after therapy.

Subject-IV Athu No.74338 Age - 28 years Sex=Male

Mother Tongue = Hindi Other Languages = English

Onset of stuttering = gradual, since childhood

Speech evaluation = Moderate stuttering characterized by hesitations, repetitions, blocks, prolongation. Secondary symptoms include eye blinking. Stuttered more for the sounds /p/, /b/, /m/, /I/.

Advice = Prolongation

The case attended therapy at AIISH clinic in the month of Feb.1991 and showed improvement. He was subjected to study before and after therapy.

Subject-V Veena B No.72856 Age - 15 years Sex=Female

Mother Tongue = Hindi Other Languages = English, Kannada

Onset of stuttering = gradual, since childhood

Speech evaluation = Severe stuttering characterized by prolongation, syllable, word and phrase repetitions, hesitations. Secondary symptoms were voice tremors and quivering of lips.

Advice = Prolongation

The case underwent therapy at AIISH clinic for 20 sessions and showed improvement. She was subjected to study before and after therapy.

NONSTCTTERERS

Subject-1 Premkumar Age - 25 years Sex=Male

Mother Tongue = Kannada Other Languages =

No family history of any speech and hearing problem. Working in AIISH.

Subject-11 Rameshbabu Age - 26 years Sex=Male

Mother Tongue = Kannada Other Languages - English, Hindi

No family history of any speech and hearing problem.
Working in AIISH.

Subject-Ill Venu Age - 20 years Sex=Male

Mother Tongue = Kannada Other Languages = English

No family history of any speech and hearing problem.
Studying in III B.Sc.

Subject-IV Manish Age - 28 years Sex=Male

Mother Tongue - Hindi Other Languages = English

No family history of any speech and hearing problem.
Working as a shopkeeper.

Subject-V Bindu Age - 15 years Sex-Female

Mother Tongue - Hindi Other Languages = English, Kannada

No family history of any speech and hearing problem.
Studying in 9th standard.

APPENDIX-B

The following instructions were given prior to reading for measurement of voice onset time for English Speakers;

"You will be given a few syllables and words, please read them. Start reading when I tell you to read".

The following instructions were given prior to reading for measurement of voice onset time for Kannada Speakers;

ಕೆಲವು ಕನ್ನಡ ಅಕ್ಷರಗಳನ್ನು ಮತ್ತು ಕೆಲವು ಶಬ್ದಗಳನ್ನು ನಿಮಗೆ ಕೊಡಲಾಗುತ್ತದೆ. ದಯವಿಟ್ಟು ಅವುಗಳನ್ನು ಓದಿ, ನಾನು ಶುರು ಎಂದು ಹೇಳಿದಾಗ ನೀವು ಶುರು ಮಾಡಿ.

The following instructions were given for measurement of speech initiation and speech termination time for English Speakers:

"You will have to utter few sentences as soon as you hear 'a tap on the table' without any delay in responding. Following the second tap, immediately stop the utterances, without any delay".

The following instructions were given for measurement of speech initiation and speech termination time for Kannada Speakers;

ಟೇಬಲನ್ನು ತಟ್ಟಿದ ಶಬ್ಧ ಕೇಳಿದ ತಕ್ಷಣ ನೀವು ಕೆಲವು ವಾಕ್ಯಗಳನ್ನು ಹೇಳಬೇಕು. ಮತ್ತೊಮ್ಮೆ ಟೇಬಲನ್ನು ತಟ್ಟಿದ ತಕ್ಷಣ ಹೇಳುವುದನ್ನು ನಿಲ್ಲಿಸಿ.