ANALYSIS & SYNTHESIS OF SPEECH OF STUTTERERS

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DEDICATED TO THE AUTHOR AND FINISHER OF MY FAITH

THE BEGINNING AND THE END

OMNIPOTENT OMNIPRESENT

CERTIFICATE

This is to certify that the dissertation entitled "ANALYSIS & SYNTHESIS OF THE SPEECH OF STUTTERERS" has been prepared under my guidance and supervision.

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CERTIFICATE

This is to certify that the dissertation entitled "ANALYSIS & SYNTHESIS OF SPEECH OF STUTTERERS" is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Register number M 9621.

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DECLARATI0N

This dissertation entitled **"ANALYSIS & *SYNTHESIS* OF *SPEECH* OF *STUTTERERS"*** *is the result of my own study under, the guidance of Dr.* ***N. P. NATARAJA,*** *Reader and HOD, Department of speech and Hearing. All India Institute of speech and Hearing, Mysore and has not been submittezd earlier at any other univercity for, any other. Diploma OR DEGREE.*

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Kuttan,little bro,I am always aware that as my world changes, so does yours and yet you are still the same special bro who means so much to me and i am so grateful you are.

Megha, loneliness is the sorrow nobody can share but you proved me otherwise, I miss you a lot.

Suja, Kavitha words are few to describe thanks for being there with your genuine smile and time whenever i needed it.

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THE DOOTS- time tampers with memories much as the sun changes shadows as it shifts its position in the sky. I loved loving you all.

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Future- I await you with as much apprehension as anticipation but I promise to wait, share, care. I wonder what you have for me!

Last but not the least B.K. Venkatesh Kowshik, Sir if not for your fast typing and effort, I would never have completed this study.

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INTRODUCTION

"Stuttering is a baffling disorder for both client and clinician. It is amazing that such an ancient universal and obvious human problem should defy precise description, despite countless scientific investigation, the basic nature and use of stuttering remain a mystery (Emerick and Hatten, 1974) "people have attempted to explain stuttering in various days during the past 5000 years. Itard a French physician in a book published in 1817 speculated that stuttering was caused by a general debality of the nerves which stimulated the movements of the tongue and larynx (Huntl967) Rutter stated that "stuttering was caused by a disproportion between the rate at which the brain can produce thoughts and that at which it can transfer them to the different stages of innervation (Appelt 1911). Dunlip(1932) believed that the habit of stuttering could be weakened by practicing voluntary stuttering.

Futhill (1940, 1946) showed that they higher expert observer may have difficulty in agreeing on whether an instance of stuttering has occurred on a given occasion. It should be noted that the instruments and methods of the acoustic phonetics laboratory have hardly been used as yet in the attempt to define stuttering. In early studies Bobbins (1955), Cords (1936) and Shaffer (1940) described some of the temporal characteristics of stuttered speech.

More recently, Stromster (1965) and Agnello (cited by Von Riper, 1971) have made start in the spectrographic analysis of stuttering.

Boome and Richardson (1931) and Gyford (1940) conferred that stuttering was due to faulty learning. Freud developed and conception of stuttering as an expectancy necrosis. Johnson (1958) viewed it as the avoidance of speaking. While Bluemel (1951) said that a chid is made prone to disorganized speech by the nature of his personality.

The hypothesis that stuttering is basically an organic disorder is atleast as old as Aristotle who speculated that there was something wrong with the swallower's tongue. Another view point in the context of dyphemia has been suggested by Eugenson (1958), while Orton and Travis gave stress to the dominant cerebral hemisphere larynx of the stutterer is more tensed as compared to that of non stutterer (Gantheron et al., 1973).

Later according to aerodynamic theory of voice production by Lefermenn (1961) and Fitze (1976) the higher censors of the vocal cords and the increased subglottic air pressure found in stutterers should result in raised mean F_0 and it leads to the question whether there is difference in mean F_0 between stutters and non-stutters.

Stalkweather et al. (1976) have observed that stutterer was slower in initiating vocalization.

Hillmen and Gilbert (1971) have reported that VOT values of stutterers for intervocalic voiceless stop consonant influent contextual speech were specificantly higher than that of normals.

Healey and Gudkin (1984) observed that VOT differences between the stutterer and non-stutterer and found that for the voiceless stops the stutterers did not have big long VOT than the non-stutterer although they showed a wide range of fundamental frequencies than on stutterers. But for the voiced stops the difference in VOT was more and not the of differences. The authors ruled out the influence of rate of speech on the values of VOT as the big difference appeared between the two groups.

The inappropriate vigorous contraction of post cricothyroid as suggested by Schwartz (1974) and the simultaneous contraction of intrinsic muscles of larynx as observed by Freemen and Ushizima (1975) during stuttering might result in a change in the temporal aspects of speech with respect to voicing. VOT, voice initiating time, voice termination on are some parameter and the temporal aspects of speech.

The present study has made use of spectrography for studying these parameters in stutterer and non-stutterer and

to see the correction effect of these parameter to match the normals and vice versa.

Need for the study

Considering the protable relationship of the acoustic parameters with the speech intelligibility, the need to study ensure the acoustic parameters was found and later to obtain the effect of correction of these acoustic parameters on the intelligibility of the speech of stutterers And vice versa

For this purpose, the study was attempted to compare the acoustic parameters of normals and stutterers and to later find the effect of correction of these parameters on speech of stutterers to sound like normal and addition of these parameters on normals to sound like stutterers.

Purpose of the study

The purpose of the study is to list the following hypotheses.

1. Voice onset time
2. Formant frequency
3. vowel duration
4. Transition duration
5. Word duration
6. fund frequency

Limitations of the study

- Done only Kannada
- Had done using only 5 stutterers
  5 non-stutterers
- Limited age group
- done only in males

Correction of only repetitions and prolongations done due to lack of time.

Implications of the study

This study helps in knowing the probable relationship of corrected acoustic parameter and speech intelligibility.

REVIEW OF LITERATURE

Stuttering genesis to metamorphosis - still a mystery

Among the many calameties incidental to human nature there are few so distressing as confirmed stuttering. It is indeed, a melencholy spectacle to see a youth born to a good position of refined intelligence, possessing extensive information seemingly destined to adorn society and yet though so highly gifted unable to give oral expression to his thought without inflecting pain on those who listen to him or subjecting himself to redicule for while deaf mute is pitied, stutterer is laughed at.

Aristotle who wrote practically everything, discussed stuttering unambiguously. He offered the suggestion that stuttering is due to weak tongue that acts too sluggishly to keep up with the conception of the mind. In the nineteenth century Andrew Combe stated that stuttering results from "the ineffectual struggle of a small organ of language to keep pace with the workings of layer organs of intelligence. In the second century AD, Galen renowned Greek physician of Peyamum thought that stutterer's tongue were either to short or too thick and swollen.

Mucukalis (1583) published a volume on the diseases of children in which he recommended applying either moisture

or warming and deying substance to the tongue, depending on circumstances. He believed that stuttering might be caused by excessive moisture or deafness of the tongue/brain or muscles or by a missing tooth and advocated a variety of therapeutic measure including diet and vocal exercises.Bacon (1927) attributed stuttering simply to coldness of the tongue and prescribed wine moderations "because it health".

With the coming of the scientific revolution in the 17th century, more was raised about the physiology of speech production, and the tongue was gradually joined by the larynx, the breathing mechanism, the nerves, and eventually the brain as suspects in the causation of stuttering.

There is disagreement about the definition of the term stuttering. Almost all definitions mentioned repetitions of sounds and syllables and prolongations of speech sounds and almost all mention difficulty in beginning to say words that is, the person knows what he or she wants to say, but has to 'strain' to say it.

Formerly researchers tried to differentiate between stuttering and stammering by saying that stuttering was a physical and stammering was a psychological defect; that stuttering was a rapid repetition of one sound (cec cat) and stammering was an inability to produce voice; that

stuttering was a halt on consonants and stammering was a halt on vowels or again that stuttering was a disorder met with only in young children which developed into stammering if incorrectly treated (Boome and Richardson).

Some of the definition are partially or wholly based on hypothesis about its etiology. Johnson (1956) defined stuttering as an "... anticipalory, apprehensive hypertonic avoidance reaction". Coriat (1933) defined it as "... a psychoneurosis caused by the persistance into later life of early pre-genital oral nuesity, oral sadistic and anal sadistic components.

Some definitions deal only with audible aspects of speaking behaviour. The following are representative of such definitions "stuttering is a deviation in the ongoing fluency of speech, an inability to maintain the connected rhythm of speech (Van Riper, 1982).

According to Andrews et al. (1983) there is a consensus that repetitions and prolongations are necessary and sufficient for the diagnosis of stuttering.

Considerable attempts have been made to putforth a common definition of stuttering. Winjate (1964) has said that, "the definitions of stuttering vary on several dimensions one kind attempts a fairly straight forward

statement of speech characteristics, another implies denial that such a condition exists; other presumptively define in terms of etiology, others offer a description of the full range of behavioural. Features observed in only some stutterers and there are short which are some combination of the foregoing. In many definitions the speech characteristics are either taken for granted, compromised or minimized".

After a detailed analysis of the elements of stuttering, Mingate (1964) has offered and definition of stuttering.

The term stuttering means:

1. Disruption in the fluency of verbal expression; which is characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech element, namely sounds, syllables words of one syllable. These disruptions usually occur frequently or are marked in character and are not readily controllable.

2. Sometimes the disruptions are accompanied by accessory activities involving the speech apparatus related or unrelated body structures, or stereo-typed speech disturbances. These activities give the appearance of speech related struggle.

3. Also, there are not infrequent indications or report of the presence of an emotional state, ranging from a general condition of 'excitement' or 'tension' to be more specific emotions of negative nature such as fear, embarassment, irritation or the like.

The immediate source of stuttering is some in coordination expressed in the peripheral speech mechanism, the ultimate cause is presently unknown and may be complex/ compound. The first part, are to Wingate, denotes the core feature which he use universal applicability and the second and third part identify other features which deserve mention.

Several attempts have been made and are going into locate the causative factors of stuttering but none of them have definitely indicated the factors which cause the stuttering behaviour. Dalton and Castle (1977) summarized the various theories of stuttering under the headings "organic" including some of the possible physical or constitutional factors, "psychogenic" where personality tracts and particularly neurotic features are given most importance, "learned behaviour" in which anticipation, conflicts and reinforcement are seen as the key factors and 'evaluational' where the diagnosis by the parents play a major role. Beery and Eisenson (1956) have grouped the

etiologies of stuttering under the heading of biochemical neurological, psychological and genetic factors.

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

Ainsworth (1971) has classified theories of stuttering into two types. Under the first type he grouped those theories looking for an "active agent" within the child which causes stuttering. It may be constitutional or psychodynamic in nature. Constitutionally the cause may lie in the generalised cortical activity affecting the speech areas (West, 1958; Eisenoon, 1958) may involve relatively complex auditory feedback disturbances (Stromsta, 1959). Psychodynamically the speech interruption may be triggered by a primary anxiety (Trans, 1972) on the contrary there are theories that seek an active agent outside the child in the listener, in the immediate environment or in the culture itself (Johnson, Brown, Curtes, Edney and Keaster, 1967).

This disorder has developed not from a single cause, but as the result of a complex interrelationship between

many factors (Andrew and Hartes, 1964). There is something about the sight of an adult in the theories of a seere movement of stutering which immediately suggests that there must be something organically wrong with him (Van Riper, 1971). Larynx has been thought to be the output even in early days (Avienna, 1037, Hann, 1736, Morgagni, 1931). As early as 1800, some of the authors have attributed stuttering to malfunctioning of larynx d'Alias (1829) and Amott (1829) regarded chronic spasm of the glottis as the source of stuttering. Avianna (1837) related stuttering to brain lesions which in him were the cause of glottic spasms, which produced the stuttering symptoms. Kussmaul (1877) defined stuttering as a syllabic dysacthera, produced by a lack of coordination of voice, respiration, and articulation due to neurological deficits.

Perkins, Rudas, Johnson and Bell (1976) Studied the effect of systematically simplifying the complexity of phonatory and respiratory adjustments 30 stutterers read under three conditions - voiced, whispered and articulation without phonation. They reported that stuttering was considerably reduced when whispering and voice was practically eliminated when articulating silently. They considered the simplification of phonatory and respiratory adjustments during these two conditions to facilitate

rhythmical flow of speech. Adams and Reis (1971) found that the stuttering reduced when a voiced passage was used when compared to a passage consisting of equal occurrences of voiced and voiceless sounds.

According to the myoelastic aerodynamic theory of voice production by Liebermann (1961) and Fitze (1976) the higher tension of the vocal cords and the increased subglottic air pressure found in stutterers, should result in raised mean F_0 and it leads to the question whether there is a difference in means F_0 between stutterers and non-stutterers during spontaneous speech. In recent years, laryngeal behaviour in stutterers have attracted the attention of many investigators and several attempts have been made and are being made to investigate various aspects of phonatory behaviour in stutterers.

Wyke (1970, 1974) believed that stuttering is a manifestation of phonatory alaxia, resulting from temporal dysfunction in the operations of the voluntary and reflex mechanisms that continuously regulate the tone of the phonatory musculature during speech. He distinguished two clinical types of stuttering. "Voluntary or cortical stammering" could arise from genetic, acquired or emotional inability to produce accurate voluntary presetting of the phonatory musculature for the utterance of particular

sounds. The second type is reflexogenic stammering. It is the defective reflex maintenance of the prephonatory posture. This could lead to repeated stress provoking voluntary efforts to override unconscious reflex dysfunction, by rapidly repeated voluntary resetting of the musculature and consequent reiteration of the initial sound in the word being uttered.

Healey and Ramig (1986) compared stutterers and non-stutterers' fluency during multiple productions of two dissimilar speed contents spectrographic analysis were performed on subjects give consequently fluent productions of a simple isolated phrase and a phrase extracted from an oral reacting passage. Measures of fluent voice onset time (VOT) and vowel, consonant and total phrase durations were calculated from five repetitions of each phrase. From the isolated phrase, there were a total of five fluent durational measure (i.e. one VOT, two vowel, one consonant and one phrase duration). For the phrase taken from the oral reading passage, six fluent measures were obtained (i.e. one VOT, three vowel, one consonant and one phrase duration).

Results demonstrated that only one of the five measurements taken during the isolated phrase condition was significantly different between the groups. Three of the six measures obtained from the phrase taken from the oral

reading condition revealed significant differences between groups. No group differences were associated with the repetitions of either phrase for any of the dependent measures for both groups. These findings suggest that the length and complexity of the speech tasks used to obtain measures of stutterers fluency play an important role in discovery of differences between the fluency of the two groups.

Stuttering episodes were found to become more frequent when changed in voicing were increasingly required (Adams and Reis, 1974). Even when judged to be fluent, stutterers have been found to be slower than normals in initiating voicing during reaction time experiments (Adams and Hayden, 1976; Cross and Luper, 1979; Stackweather, Hirscheman and Tannebaum, 1976). VOT in CV combinations has also been found to be longer in the perpetually fluent allowances of stutterers then in tokens uttered by normal control subjects (Hillman and Gilbert, 1975) although there have been findings that contradict or qualify the longer VOT results (Heltz, Conture and Caenso, 1979; Watson and Alfonso, 1983).

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should be expected in stutterers as compared to non-stutterers. It was shown that a change in scores of the mean fundamental frequency from reading to free conversation that stutterers tend to have a higher fundamental frequency during spontaneous speech.

A number of studies have directly or indirectly indicated phonatory involvement. Wingate (1969) considers stuttering to be a transition defect and suggests that it is the difficulty in shifting from one sound to another sound which makes the stutterers to stutter. Adams and Reis (1971, 1974) reported that stutterers stutter significantly less and get adopted faster while reading a passage contained all voiced sounds when compared to a passage containing both voiced and unvoiced sounds. They maintained that fluency is dependent on the consent timing and prompt smooth initiation and maintenance of airflow and glottal vibrations. Manning and Confab (1976) found that both stutterers and non-stutterers exhibit lower percentage of dysfluencies during voiced to voiced transitions, then during voiceless to voiced, voiced to voiceless and voiceless to voiceless phonatory transitions. Moss (1976) prepared four separate lists of sentence of equal length. His subjects read the lists under four different conditions silent rehersal, and aloud rehersal. Aloud rehersal resulted in significantly

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less stuttering than the other three types of rehersals. He suggested that the crucial factors which distinguished the four types of rehersals has localization.

There are many studies which have shown that stutterers are injuries to than non-stuttering peers in their ability to start and stop phonation (Hillmer Bilbert, 1974; Agnello, Wingate and Wendal, 1974; Adams and Hayden, 1976). Evidence to phonatory involvement in stuttering has also comes from physiological studies certain abnormal laryngeal activities like erythmic vocal fold vibration (Muller, 1963) wide separation of the posterior vocal folds (Conture, McCall and Breves, 1974) asymmetric tight closure of the larynx (Gupta, 1966) and disruption of normal reciprocity between abductor and adductor muscle groups (Freeman and Ushipma, 1974) have been observed to occur in the laryngeal mechanisms of stutterers at the time of the stuttering block. All these indicate that there is some disruption in the flow of air from the subglottal to the supraglottal region, either because of the failure of the coordinated activity of the laryngeal muscles or because of increased muscular tension. Johnson and Rosen (1937) found that stutterers speak more fluently when they whisper. Bloodstein (1950) reported that stutterers seldom have difficulty when they whisper. Meckenize (1955) has found

complete elimination of stuttering in the stutterers who had used electrolarynx. Oswald (1948) and Irwing and Webb (1965) reported that laryngeolomized stutterers did not stutter after having learned oesophageal speech.

Ratna and Nataraja (1972) reported a stutterer who stuttered severely with secondaries even while whispering and during silent reading.Ramesh(1983) reported that there was reduction in vot values of stutterers for /p/ /t/ /k/ under DAF while non stutterer showed increased vot values for /k/, /t/, /p/. This indicates that non stutterers behave like stutterers under DAF in terms of vot. Nataraja etal(1982) reported that normals showed speech disruption in terms of repetition prolongation and pauses under DAF apart from these there was an increase in loudness pitch with abnormal prosody and articulation. Nandur(1982) found decrease in no of stutterer blocks under binaural masking noise. Increase in fO vocal intensity vowel duration seen in stutterers and non stutterers.

Abraham and lisker(1974) studied vot for a no of languages including Tamil,Hindi,Marathi,English for the stop sounds in word initial position. The vot values obtained in their expression were found to vary from language to language. Also reported vot values in running speech are less than that in nonsense syllables. Kotby etal(1989)

studied the coorticulation in the Arabic language where in sound spectrograghic analysis of Arabic words in terms of formant transition was found. Results obtained of 8 words provided evidence that formant transition exist in spoken Arabic indicating presence of coorticulation in Arabic.

Gayathree (1980) investigated some aspects phonatory behaviour in stutterers. She investigated the

i. effects of varying degrees of voicing while reading a passage.

ii. The relationship between the frequency of stuttering and onset of phonation in varied contexts, syllables word lists and passage.

iii. The relationship between the frequency of stuttering and the stressed syllable.

She has concluded that phonatory behaviour is not normal in stutterers.

Ramig and Adems (1980) studied the effect of changing the pitches on the reading rate, number of disfluencies and the vowel and pause duration of groups of children and adult stutterers and normal speaker. The subjects were asked to read a passage in three conditions, habitual conditions, higher pitch and lower pitch. Results

showed that all four subjects reduced their frequency of disfluencies from the habitual to both experimental conditions. The reduction in disfluencies were accompanied by significant reductions influent reading rate and increase in both vowel and pause duration.

Lyke (1974) has suggested some categories of stutterers may involve temporal in coordination of activity in one or more of these neurological systems. He has further added "stuttering of laryngeal origin may be a form of phonatory aloxia arising either because of disordered voluntary pre-phonatory tuning of the vocal fold musculature from incoordinated reflex modulation of the activity of this musculature during actual utterance.

Recent trend is to simultaneously measure the related physiological events which gets at the question of coordination, specifically as suggested by Peekens et al. (1979) that stuttering is a discoordination of different systems of speech. Border, Bar and Kenneg (1985) listed this by measuring oral movement with optical tracking systems, laryngeal movement with laryngograph simultaneously and found that the vocal belt functioned as a coordinated whole, even during stuttering and rejected the hypothesis that stuttering resulted from a discoordination of different systems.

Continued interest in the acoustic features related to laryngeal function is reflected in recent studies that have investigated more discrete measurements of fundamental frequency in various speaking context. Flaek et al. (1985) found that adults who stuttered exhibited measurable cycle to cycle temporal changes prior to moments of stuttering, such changes were absent in the identical but fluent utterances of same speaker.

Healey (1984) and Healey and Gutain (1984) reported that fundamental frequency discrimination patterns in adult stutterer producing vowels following stop consonants were not significantly different from the patterns of non-stutterers. Sacco and Kretz (1989) however argued that the data in the last and studies indicated that people who stutter demonstrate greater fundamental frequency instability than non-stutterers. Ademid Reis (1971, 1974) reported that stutterers stutter significantly less and get adopted faster while reading a passage containing all voiced sounds when compared to a passage containing both voiced and unvoiced sounds. They maintained that fluency is dependent on the correct timing and prompt smooth initiation and maintenance of airflow and glottal vibrations.

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during voiceless to voiced, voiced to voiceless and voiceless to voiceless phonatory transitions.

Corresponding to the higher tension of muscles involved in speech production, a higher mean fundamental frequency should be expected in stutterers as compared to non-stutterers. They found a change in scores of mean fundamental frequency from reading to free conversation and concluded that stutterers tend to have a higher fundamental frequency during spontaneous speech (Schafeeskupper and Simon, 1983).

Fallk, Lawler and Yonowitz (1985) investigated quantitative fundamental frequency measures prior to moments of stuttering and related these measures to the severity and type of stuttering. A repeated readings adaptation procedure was employed to acquire samples of the stuttered and identical fluent speech of stutters. Four temporal periods preceeding the stuttering block were compared with the same periods in a fluently produced sample of similar speech. The analysis revealed differences relative to mean fundamental frequency. Variation around the mean fundamental frequency and the number of voiced data points contained within each temporal segment. The results of this study confirm the existence of acoustic changes in the vocal production of stutterers prior to overt blocks. These changes relate to the type of block that follows.

There are many studies which have shown that stutterer the injector to their non-stuttering peaces in their ability to start and stop phonation (Gilbert, 1974; Agnello, Lingate and Wendell, 1974) Adams and Hayden (1976), Stalkweather, Hirschmenn and Tannebaum, 1976). Voice onset time is one of the parameters among the temporal aspects of speech. VOT has been defined as "the duration between the release of a complete articulatory constriction or burst transient and the onset of phonation" (Lisker and Abramsom, 1964, 1967). Stalkweather et al. (1976) has observed that stutterers were slower in initiating vocalization. Hillmen and Gilbert (1977) have reported that VOT values of stutterer for intervocatic voiceless stop consonants in fluent contextual speech were significantly, higher than that of normals. VOT and VIT studies have shown that the laryngeal behaviour in stutterers are different when compared to normals. Many studies have found longer VOTs and VIT studies have shown that the laryngeal behaviour in stutterers are different when compared to normals. Many studies have found longer VOTs in stutterer, even during their fluent speech (Agnello and Wingate, 1972; Basu, 1974).

Adams and Hayden (1976) hypothesized that the stutterers had difficulty in initiating and terminating phonation independent of the acts of running speech. Ten

young adult stutterers served as experimental group. They were matched for age and sex which 10 normal speakers subjects from both the groups were tested individually. The experimental task required that the subjects start and stop phonation as possible, upon hearing each number of 1000 Hz puretone series appear and disappear. Subjects vocalization were permanently recorded using an optical oscillograph. Stutterers performed significantly poorer than normals both in terms of prompt starting and stopping of voicing.

Stalkweather (1976) have measured the latency of vocalization onset for stutterers and non-stutterers. The subjects were asked to produce different syllables following a visual stimulus. Responses were filtered to remove supraglottaly produced sounds and the time between visual stimulus and the onset of vocalization was measured by a voice operated relay and a computers internal clock. The results have showed that stutterers are slower in initiating vocalization across a wide variety of syllables. They have further, concluded that "... either vocal dysfunction or the lack of cerebral dominance may be responsible for these differences". Agnello, Wingate and Wendell (1974) have reported that the VOT for stutterers are longer than that of non-stutterers in fluent speech.

Jauke (1994) measured the duration of phonation voice onset time and coefficients of variation for

stutterers and non-stutterers who were matched according to age and social status while speaking the test words /kakakas//tatatas/ and /papapas/ stress on middle syllable at two different speech rates. It was found that stutterers produced,even during non-stuttering periods under repletive articulation, an enhanced variation of voices onset time and an increased vocability for the duration of phonation associated with the production of the first syllable. There was no different in VOT and vowel duration between stutterers and non-stutterers.

Denil and Brutten (1991) investigated the influence of time pressure on the VOTs of 10 young stutterers and a like number of age and sex matched non-stutterers. The children were instructed to read a series of single syllable target words first at a self-selected pace and next as quickly as possible (external time pressure). In addition articulation complexity of the target words were varied systematically (linguistic time pressure). No statistically significant differences were found between the mean VOTs of the stuttering and non-stuttering children VOTs of the stuttering children were significantly more variable than those of the non-stutterers.

Murphy and Boumgarther measured (1991) voice initiation time (VIT) in stuttering and non-stuttering

children ranging in age from 4 years 6 months to 6 years 10 months. The experimental task was the production of /a/ in response to a 1000 Hz pure tone. No statistically significant differences were found between the two groups with respect to either VOT or VIT. No apparent relationships were present among VIT, VIT or stuttering severity.

Conture, Zehroski and Cudahy (1985) compared the temporal parameters of speech production of young stutterers and normally fluent peers as represented within the acoustic waveform (eg. frication and aspiration duration) for word initial /p/ and /b/. Measured acoustic variables consisted of vowel consonant transition duration and rate, stop-gap, frication and aspiration durations, VOT and consonant-vowel transition duration and rate and vowel duration. Results indicated no significant difference between young stutterers and their normally fluent peers for any of the temporal measures for either /b/ or /p/. Findings suggest that young stutterers exhibit some difficulties effecting the relatively smooth coordinated "compensating" relations between laryngeal and supralaryngeal behaviour which would allow the system to remain within the "time-limits" necessary for optimally smooth, in fluent speech production.

Healey and Gulkin (1984) examined stutterers and non-stutterers fluent VOT and F_0 contour measures from

largest syllables located at the beginning of a carrier phrase. Oscillographic and spectrographic analysis of subjects VOT and F_0 at vowels onset, average vowel F_0 and speed and range of F_0 changes were obtained from fluent production of 18 stop consonant vowel syllables. Results showed that VOTs for voiced stop and the range of F_0 change. For voiceless stops were associated with significant between group differences.

It has been shown (Klich and May, 19S2) that temporal measures made from sound spectrograms of the acoustic speech signal can provide accurate objective evidence relative to supraglotted and laryngeal behaviour. For eg. certain acoustic measurements provide very close estimates of the time taken by the supraglottal articulators to move from one speech sound to another (transition duration) or the time period from oral release of a consonant to the beginning of the vocal fold vibration for the subsequent vowel (VOT). These as well as similar measures can assist in discerning similarities and differences between the temporal parameter of the fluent speech of young stutterers and those of non-stutterers. Harrington (1985), Howell and Vauser (1985), Howell, Williams and Vause (1985), Kentogamey and Cooke (1976) have reported missing or atypical formant transitions in the fluent and disfluent speech of adults who stutterer.

Howell and Rause (1986) reported that 85% of spectrograms of the fluent speech of adults who stutterers were judged as lacking transition between the initial consonant and the medial vowel and 84.4% of the dysfluent productions. Howell et al. (1987) reported that the speech of adults who stutter lacked normal formant transition between the consonant and the following vowel.

Harrington (1987) provided some possible explanation for patterns of apparent abnormality observed in the transition of adults who stutterer. According to Harrington the formants might -

1. bend in the direction of but not reach the frequency values of the acoustic vowel target.

2. remain level in contrast to the clear transition shown in the production of the target syllable.

3. point in the wrong direction compared with the formant transition in the target syllable.

Disimoni (1974) studied the vowel duration of adult stutterers. On the average it was 13lMsec longer in stutterers than non-stutterers. Stackwedher and Meyer (1979) studied speech of adults.

Speech of transition was slower in the transitional subsegments within an intervocatic interval but had normal

speech in the steady state subsegment. They interpreted that stutterers were not able to move their laryngeal and supralaryngeal structures as quickly as non-stutterer.

Zimmermann (1986) used high speech cineradiography to describe the temporal organization of perceptually fluent speech in stutterers and non-stutterers. Movements of lower lip and jaw were analyzed in these CVC syllables. It was reported that the stutterers consistently showed:

1. longer transition times for downward movements of the articulators.
2. longer times between movement onset and peak velocity in the CV gesture.
3. longer steady state position of the lip and jaw during the vowel portion of the syllable.

These indicate that stutterers were slower than normals in coarticulatory movements.

Results of Healey's (1981) study indicated that the adult stutterers were slower in completing the transition from frication onset to peak amplitude during the production of the first phoneme. Suchita (1985) conducted a study to find the acostic parameters vot,sit,stt,fOand rate of speech in stutterers in pre and post therapy condition and found that

1. non stutterers values are smaller compared toper and post therapy vot values of stutterers.

2.speech initiation time less than that of stutterer in pre and post therapy condition

3.stutterer post therapy vot value smaller than pre therapy value

4.reduced post therapy sit value of stutterer compared to pre therapy.

5.Both show no difference in fO

stutterers post therapy fO does not vary as compared to pre therapy.

Zebrowski et al. (1985) studied children in the age range of 3.1-6.8 years. They did not find any difference in the stop gap duration/frication duration vowel direction and the rating CV and VC transitions. However they speculated that unlike normals, stutterers do not show any systematic relationship between the peak glottal opening and articulatory release. This was based on the stop gap duration date. They interpreted that stutterers show less control and stabilization of laryngeal and supralaryngeal temporal coordination.

Healey and Romig (1986) noticed that greater differences existed between stutterers and non-stutterers fluent durational measures extracted from already sample then from a short, isolated nonsense phrase and durational measure for the stutterers remained relatively stable during

multiple repetitions of both the short phrase and the reading phrase.

Pindzoia (1985) mentioned that the stutterers spend longer time in static articulatory positions. Vowel duration was reported to be same in both normals and stutterers. Stutterers had faster VC transition but equivalent CV_2 transition. Total word duration also remained same in both the groups.

Invariance of total duration of word and difficulty with initiating movements as seen in lengthened steady states must be recovered. It was speculated that if temporal compensation was the effect which operates to modify the duration of internal segments of the articulatory units, so that the overall duration of the unit remains relatively constant, then the brains, articulatory programmes in stutterers was forced by these temporal constraints to move faster throughout the transitional subsequent. However they opine that it should be confirmed whether stutterers limited their movement to conform with temporal constraints or whether they 'speed up' their movements to accomplish the same extent.

Slow vocal reactions are reported in adult stutterers in several studies (Adams and Haydeh, 1976), Stack Weather

et al. (1976), Yarurs and Conture (1993) examined the second Forment (F_2) transitions during the sound/syllable repetition of young children like stutter. Acoustic analysis showed differences in F_2 transition between the repeated (stuttered) and fluent portions of the words.

Stromsta (1986) reported that children who stutter produce F_2 transitions during stuttering that are non-meassurable or missing or that differ in direction of movement from fluent transitions.

Robb and Michael Blomgren (1997) did analysis of F_2 transitions in the speech of stutterers and non-stutterers. Lingual coarticulation was acoustically examined in the fluent speech of stutterers and non-stutterers. Coarticulation was evaluated by determining the slope of second formant transitions following consonant release. In general, stutterers were found to display larger slope coefficients in comparison to non-stutterers. The large coefficient was interpreted to reflect greater or quicker dimensional changes in vocal tract behaviour compared to those of non-stutterers.

Jaricke (1997) studied variability and duration of voice onset time and phonation in stutterers and non-stuttering adults. Eighteen male stutterers and 16 male non-

stutterers who were matched according to age and social status were required to speak test words /kakakas/,/tatatas/ and /papapas/ with stress on the middle syllable at two different speech rates. Duration of phonation, voice onset time and coefficient of variation were computed and analyzed. It was shown that stutterers produced, even during non-stuttering periods under repetitive articulation an enhanced variation of voice onset time and an increased variability for the duration of phonation associated with the production of first syllable. Furthermore, this experiment did not confirm the often reported differences in VOT and vowel duration between stutterers and non-stutterers and compared.

Sebastien (1997) studied the acoustic parameter in stutterers and non-stutterers and came to the following conclusion.

1. The VOT values were less for the non-stutterers compared to stutterers.
2. No significant difference between the stutterers and non-stutterers in terms of ferment frequencies was found.
3. Significant differences were found between stutterers and non-stutterers in word duration and vowel duration.

Then she came to the conclusion that the laryngeal anisms during speech in different for stutterers to that on-stutterers.

Thus the review of literature indicate that tering may be due to faulty functioning of laryngeal anism which might reflect by acoustic analysis of speech tutterers. Hence it is proposed to find the acoustic leter for the non-stuttering group and fluent as well sfluent utterances of stuttering group to note the rences between them and later to find the probable ionship of those acoustic parameter and speech ligibility.

METHODOLOGY

The study was carried out with the aim of comparing the speech of the stutterers with that of the normals and to note the effect of the correction of stutterering that is eliminating repetition and prolongation by computer manipulation of changing some parameters on the perception of speech of the stutterers and vice versa, i.e. introducing the repetitions and prolongations in the normal speech. Vowels have been found to play an important role in the intelligibility speech hence, this study has Considered repetitions and prolongations of vowels only. Further due to time constraints the study was limited to these aspects in speech of the stutterers.

I. Parameters studied

The following parameters have been studied -

Acoustic parameters

1. Fundamental frequency of speech
2. Formant frequencies (F_1, F_2 and F_3) of the vowels /a/, /i/, /u/, /o/, /e/
3. Duration of the vowels /a/, /i/, /u/, /o/, /e/
4. Word duration
5. Transition duration
6. Voice onset time

Psychoacoustic parameters

1. Speech clarity rating
2. identification of fluency

The following parameters were corrected in the speech of the stutterers and introduced into the speech of normals.

1. Vowel duration taking repetition and prolongation into consideration.

2. Word duration again taking repetition and prolongation into consideration.

II. Subjects

Two groups of five subjects each were selected for the study. Group I consisted of stutterers and group II consisted of normals,all aged between 17-25 years of age (mean age of group I = 20 years)

Group I consisted of stutterers, five Kannada speaking males selected from those who had been diagnosed by certified speech and language pathologists at the All India Institute of Speech and Hearing. The severity of stutterering varied from mild to severe. They all satisfied the following conditions.

1. Had mild to severe stuttering as diagnosed by speech and language pathologists at AIISH.

2. Had no other problems except for stuttering.

3. Had Kannada as their mother tongue.

Group II consisted of normals aging 17-25 years from the All India Institute of Speech and Hearing matching with the adults in group I in terms of age.

Materials

Two Kannada passages voiced (passage A) and combined (passage B) were used. Both were meaningful and non-emotional,the combined passage had voiceless and voiced consonants and vowels.and voiced passage had only voiced consonants and vowels. The number of syllables in each of the passages of A and B were 124 and 139 respectively. These passages are used regularly in clinics for the recording of speech of stutterers.

Procedure-PART-1 Analysis of speech

The subjects were seated comfortably in the recording room which is sound treated at the Department of Speech Sciences, AIISH, Mysore and made to read both the passages A and B. These were recorded on cassette tape using the tape recorder (Sony deck TC FX 170) in the sound treated room.

ACOUSTIC ANALYSIS

Instruments

1. Analyzing filter (low pass filter having cut off frequency set at 7.5hz)with speech interfacing unit.
2. A-D/D-A converter (12bit)
3. Personal computer with intel (Pentium 200 MHz processor)
4. Software for analysis and of speech (developed by voice speech system,Bangalore)
5. Amplifier and speaker(2011.8015 ampli speaker)

Analysis of data

Selected speech samples were used for the purpose of analysis h. The recorded passages were digitized at a sampling rate frequency of 16000hz and the block duration and resolution were 500msec and 10msec respectively using A/D converter and a Pentium processor.

The parameters Measured were vowel duration,word duration, voice onset time,transition duration,formant frequency.

These parameters were measured from the stutterer words of the sample of stutterers and the same words also in normal samples.

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These parameters were measured from the stutterer words of the sample of stutterers and the same words also in normal samples.

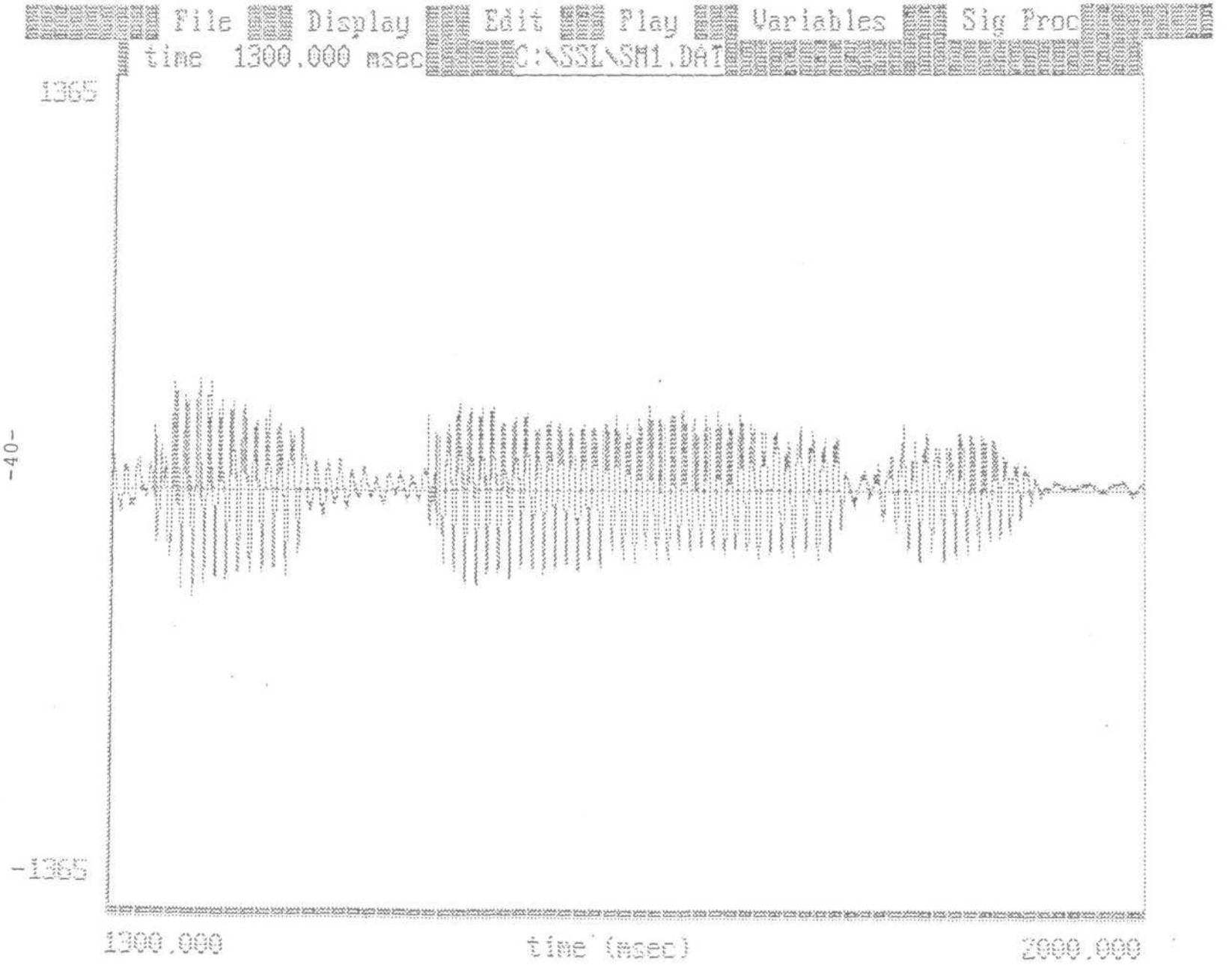
Word duration

The time between initiation and termination of a word was measured directly from the speech waveform. The waveform was displayed on the computer monitor using the DISPLAY programme of SSL. The words were identified based upon the continuity of the waveform.

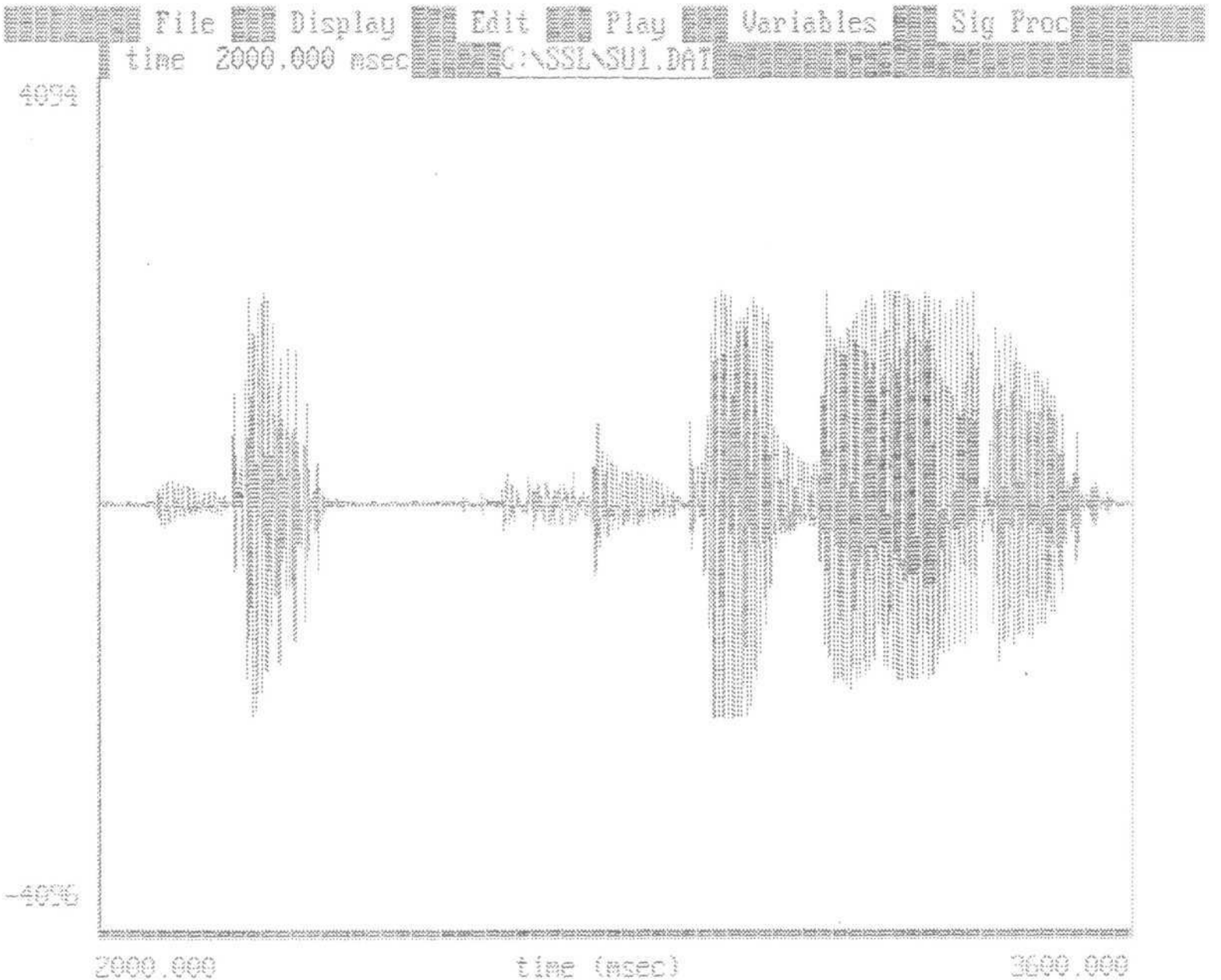
The word duration was considered to extend from the beginning of the periodic signal to the end of the periodic signal. This duration was highlighted through the use of cursors. The highlighted portion was played back through headphones or speakers to confirm that it contained the word under study . once this was confirmed, the duration of the highlighted portion was read from the display and considered as the duration of that particular word.

Vowel duration

The vowel duration was measured directly from the speech waveform and spectrogram.The waveform and spectrogram were displayed on the computer monitor using the SPGM programme of SSL. The vowels were identified based on the regularity of the waveform and vertical striations and formants. The vowel duration was considered to extend from, the end of one periodic portion to the beginning of the next periodic portion. This duration was highlighted using the cursors. The highlighted portion was played back through



Readings at Cursor: Mark 1: Mark 2: Diff: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C:\SSL\SU1.DAT
4094
-4096
2000.000
time (msec)
3600.000
Readings at Cursor: Mark 1:
Mark 2:
Diff:

headphones to confirm that it contained the vowel under study. Once this was confirmed the duration of the highlighted portion was read from the display.

Extraction of formant frequencies

To extract the vowel formant frequencies(Fl F2 F3) the spectrogram of each utterance using the SPGM programme of the software speech science lab was obtained. After identifying the target vowel the cursor was placed in the middle portion of the vowel so as to avoid the formant transitions and the formant frequencies were determined by using the sectioning method through the use of linear predictive coding(lpc) this was done with 181pc coefficients. The frequencies at the peaks representing the formants were noted using the cursor which gave the values of Fl,F2,F3 respectively.

Transition duration

Time between the onset of transition of fl/f2 aid the termination of the transition of vowel / consonant.

This was also measured using the spgm programme with the display of the spectrogaph from which the values were noted down.

Voice onset time

VOT was defined as the time equivalent space from the onset of the stop release burst from the first vertical

headphones to confirm that it contained the vowel under study. Once this was confirmed the duration of the highlighted portion was read from the display.

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striation representing glottal pulsing(Libermann. etall952) VOT was measured for the 6 stop consonants in the target word from the spectrogram. The cursor was moved to the first indication of energy associated with the stop oral release and then cursor was moved to the beginning of the regularly appearing waveform of the vowel following the stop. The real time value between these two markings provided the VOT for particular consonant.

Determining the fO

For measurement of fO the INTON off-line programme in the voice diagnosis module of the software vaghmi was used. The utterance was first analyzed and then displayed to obtain the fO contour then the speech statistics were displayed to obtain the mean fO. Thus the word duration of stutterer words,(doda,bombai) vowel duration of vowels(/a/, /i/,/u/, /o/,/e/)and formant frequencies 1,2,3 the vowels(/a/,/i/, /o/,/e/,/u/)VOT of(/b/,/d/,/g/,/p/,/k/,/t/) consonants and fundamental frequencies were measured for each subject. Thus a total of 7 data prints for groupl (stutterers)and 7 data prints for group2 (normals)were obtained after analyzing the speech sample of subjects of both the groups.

Statistical analysis

Descriptive statistics consisting of mean, standard deviations, minimum and maximum values were obtained for all the parameters analyzed. To check whether there were any significant differences between the values of the normals and stutterers, the Wilcoxon signed Ranks test was applied, all these were carried using the statistical software package 'SPSS'.

PART - 2 Correction of errors

The following parameters were corrected:

1. Vowel duration (pertaining to repetitions and prolongations)
2. Word duration (pertaining to repetitions and prolongations)

Correction procedures

1. Correction of vowel duration: Vowel duration of the words in the utterances of stutterers were modified (by deleting repetitions, prolongation of the consonants and vowel respectively. To match those of the age and sex matched normals the corrections were done only in the stable portion of the waveform so as to preserve the transitions, intact These corrections were done by cutting the required duration from the vowel waveform using the edit of'DISPLAY' programme of the SSL. The duration required to be reduced

was highlighted and then deleted from the word.thus reducing the prolongation of vowels to normals.The repetitions were removed using the same procedure.Then the word duration were measured and corrected to match the word duration of subject of the normal group as shown in the figure of the waveform.

Similarly the normal speech was added/modified with some number of repetitions.The initial consonant portion was copied by highlighting that portion and then by pasting the copied consonant portion of the word repeated 3 or 4 times as required as that it would sound like repetition as in case of stutterers. Then by adding (pasting) the middle portion of the vowel which was copied earlier till the vowel duration was enough to sound like prolongation and similar to vowel duration as in case of stutterers. and prolongation (vowel duration) as seen in the stutterers to match with the speech of the stutterers.

2. Correction of word duration: Pertaining to prolongations and repetitions the speech of the stutterers Were modified in terms of the word duration matching with the normals and the normal speech was modified to equal the word duration as in case of the stutterers.thus a total of approx 7-8 words which were stutterer in each passage were corrected.

II. Re-recording the speech samples

The unaltered and altered speech samples were transferred from computer to a cassette tape in a random order there were 10 passages which contained unaltered utterances and altered utterances.

Measures of speech intelligibility

Five listeners, all post-graduate students in speech and hearing, native speakers of Kannada, and experienced in analyzing the speech of stutterers were asked to listen to the speech samples and to write down the clarity of the speech on 5-point scale and to identify if it is a normal or stutterered word These were carried out in a sound treated room, using a Sony tape recorder and each listener was delivered the speech samples through a headphone at comfortable loudness level.whenever necessary clarification were provided by the experimenter.

perceptual analysis

a. Clarity rating

b. Identification of normals vs. stutterers.

Instruction to judges

The judges were asked to rate the utterances on a 5-point rating scale (1 good to 5 poor). The ratings made by

majority of the judges that is three or more judges was considered to be the clarity rating of that particular word. Descriptive statistics was obtained for both altered and unaltered sentences. The Wilcoxon signed ranks test was performed to check whether there was any significant difference between unaltered and each type of altered sets. the judgements were found to be highly reliable.

b. Judges were asked to identify the speech as fluent or non fluent(normals or stutterers)after altering the normal speech to stuttering like and stuttering to normal speech.The results have been discussed.

RESULTS AND DISCUSSION

This study was planned to compare certain parameters of speech of the stutterers with that of the normal speakers, to determine the differences between the two and also to determine the effects of computer correction of some of these parameters to find out their effect on the intelligibility and clarity of the speech of stutterers and effect of modification of these parameters on normal speech.

Speech samples of both the normals and stutterers were analyzed to obtain various parameters. These were.vowel duration,word duration formant frequencies and fundamental frequencies.

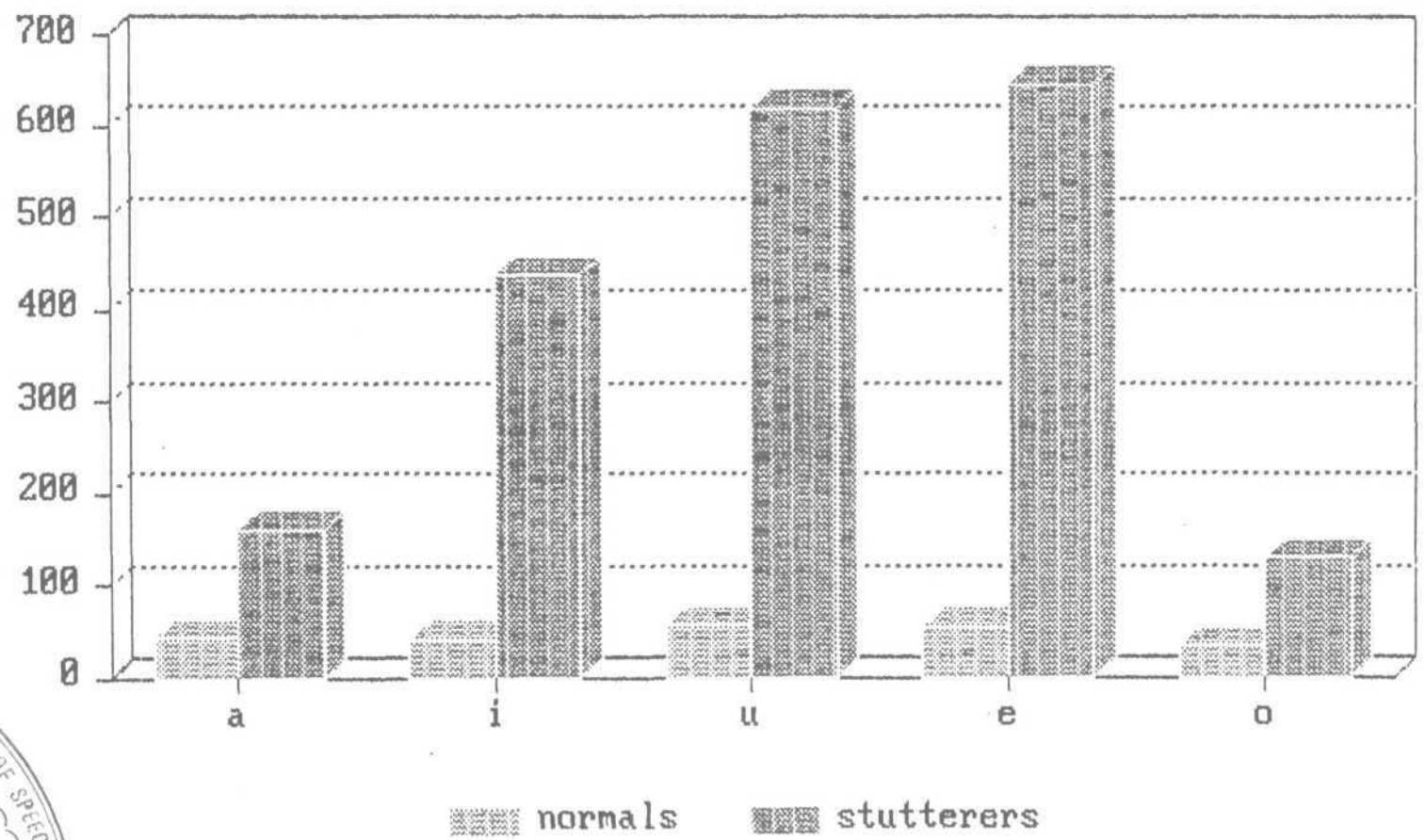
Vowel duration

The duration of all the vowels a,i,u,e,o were measured for both the groups. This was done by measuring the vowel in the word that was stuttered and the same vowel in the word was noted in case of normals. he results are tabulated in table 1, table 2 respectively. A study of these Graphs show that mean vowel duration of stutterers were much higher than in normals. While these ranged from 28.06-56.60 for normals,the range for stutterers was 58.20-2325.The mean and S. D deviation of /a/ was 44.37,10.41 for normals and

	Vowel duration-normals			Vowel duration-stutterers			
	Range	Mean	SD	Range	Mean	SD	
/a/	28.06-56.60	44.37	10.41	26.20-375	161.24	132.85	*
/i/	37.60-46.50	42.36	3.61	35.60-968	438.12	389.47	*
/u/	54.20-58.30	56.90	1.66	58.20-2325	620.24	961.89	*
/o/	29.50-42.40	35.64	5.71	24.80-203	128.76	73.40	*
/e/	50.20-58.32	55.54	3.58	53.20-1812	645.78	789.93	*

Table 1: Table showing vowel duration for normals and stutterers

Indicates statistically significant Difference in values between the two groups at $p < 0.05$ level.

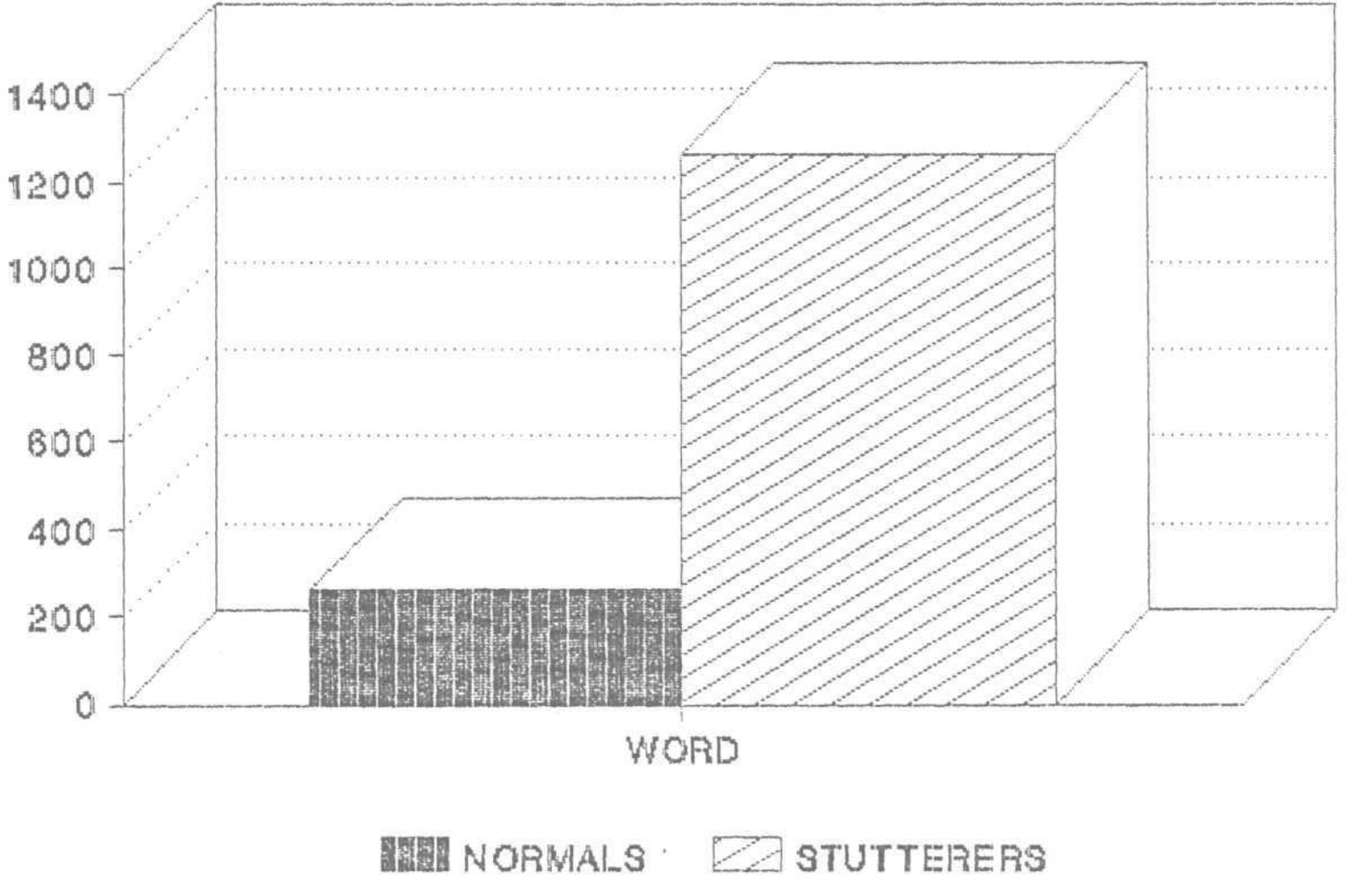


Word duration-normals			Word duration-stutterers			
Range	Mean	SD	Range	Mean	SD	sig
						*
208-304.60	256.88	34.502	375-3000	1262.50	1027.36	

Table 2; Table showing word duration for normals and stutterers

Indicates statistically significant difference in values between tne two groups at p <0.05 level

WORD DURATION OF NORMALS AND STUTTERE



161.24,132.85 for stg,/i/ was 42.36,3.61 for normals and 438.12,389.47 for stg /u/ was 56.90,1.66 for normals and 620.24,961.89 for stg,/o/ was 35.64,5.71 for normals and 128.76,73.40 for stg,/e/ was55.54,3.58 for normals and 645.8 789.93 for stg.

The Wilcoxon sighed rank test was done to determine if the differences between the 2 groups. The results of the test indicates a statistically significant difference for all samples with vowel duration of stutterers being 2-3 times greater than normals. Stutterers also showed inter-speaker variability due to severity of stuttering and stuttered word considered.

These results were similar to several reports which had tried to map the difference between the two groups. (Sebastian 1996; Alck, Lawler, Yonowitz, 1985)

Similarly word duration was also found by measuring the word that was stuttered in stutterers and the same in normals, which was found to be higher in stutterer than normals which can be attributed to blocks like repititions prolongation pauses etc. The mean , S.D., Range of the normals were found to be 256.88,34,50,208-304.60 and the same for stg were 1262.50,1027.36,375-3000.Sebastian(97) has reported similar results.

Fundamental frequency

The examination of table 2 showed that stutterers differed significantly from normal group in terms of fundamental frequency. Normal subjects showed a mean fundamental frequency of 116,for i 123,u 127,stutterers showed mean fundamental frequency for a 218,i 223,u 221. the mean S. D range of the normals has been found to be 124.60,3.84,120-1 40,for stg 223.8,19.75,215-292.According to Schaferskapper and Simon(1983) corresponding to the higher tension of muscles involved in speech production, a higher mean fundamental frequency should be expected in stutters as compared to normals,the findings of present study agree with this.

Formants frequencies

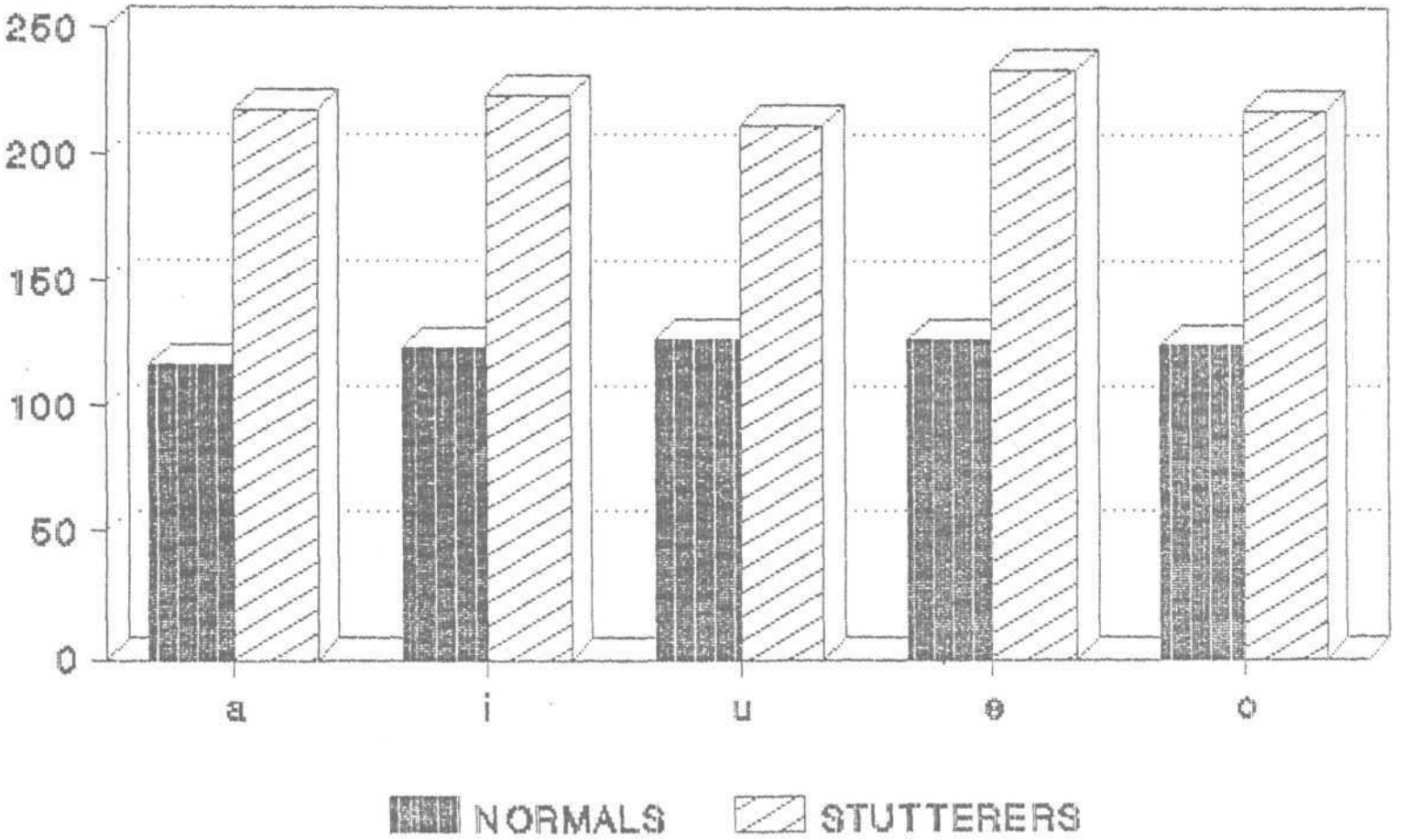
These are presented in tables and graph. The examination of the results show that the formant frequencies differ from stutterers and non stutteres. It has been found that stutterers had a slightly higher value for Fl,F2,F3 than the non stutteres in some instances,Though overlap is also seen. This supports the study by klich and may(1982) who has found differsnces in formant frequencies between stutterers and non stutterers who produced fluent vowels in an (hvd) content.The mean,S. D,and range for(Fl) the vowel /a/ in normals were 686.22,99.76,510-750.30 and for stg were

	Fundamental freguency-normals			Fundamental freguency-stutterers			
	Range	Mean	SD	Range	Mean	SD	sig
1	101-122	116.6	8.76	180-252	218.3	31.5	*
2	120-130	123.4	4.21	200-247	223.8	19.75	*
3	120-140	127	8.42	180-250	211.8	33.42	-
4	120-130	124.60	3.84	200-240	218.2	15.56	*
5	120-133	126.80	4.86	215-292	233.6	33.26	*

TABLE 4; Table showing Mean,Range,SD of fundamental freguency.

Indicates statistically significant difference in values between the two groups at $p<0.05$ level.

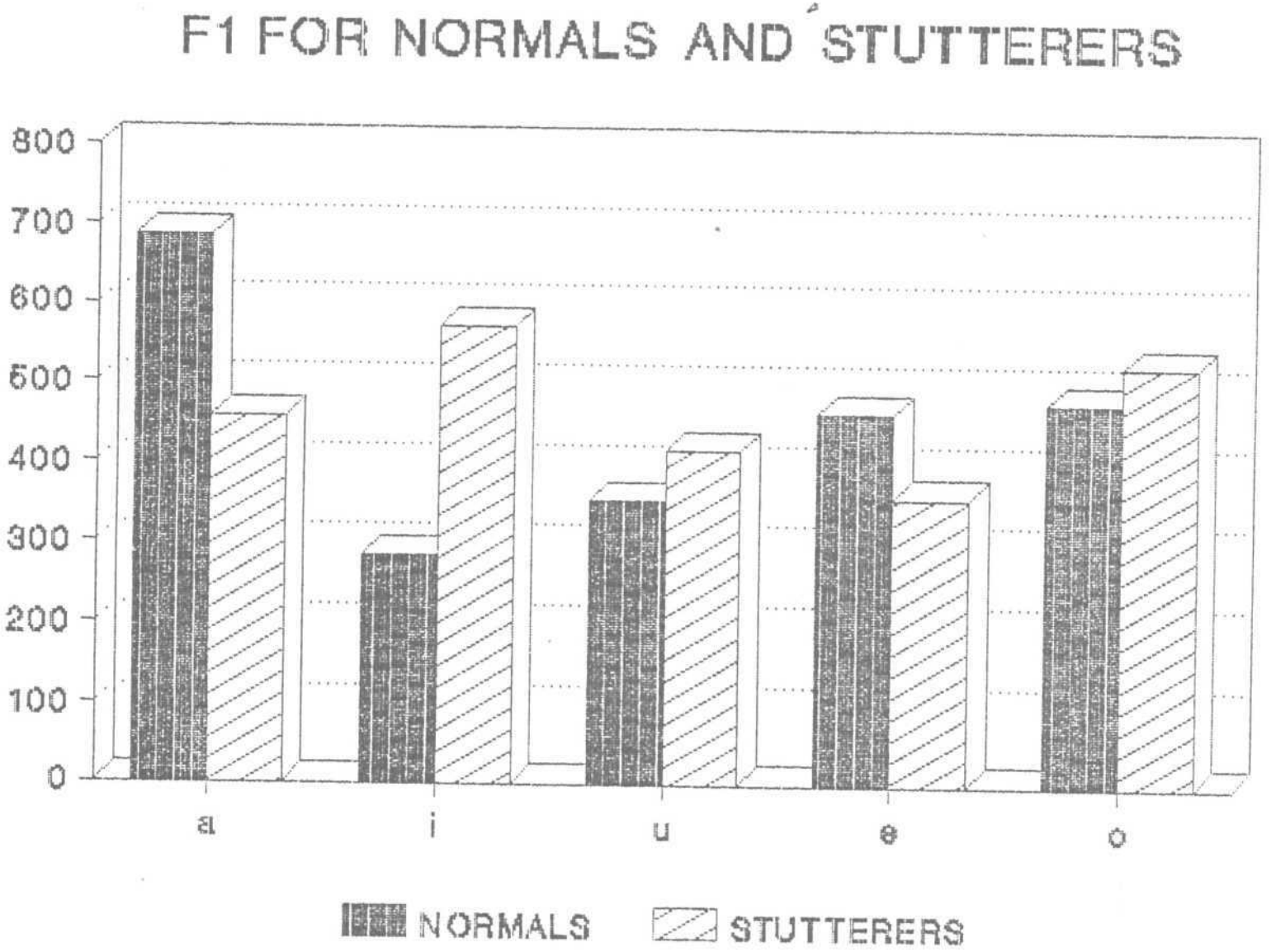
FUNDAMENTAL FREQUENCY FOR NORMALS AN STUTTERERS



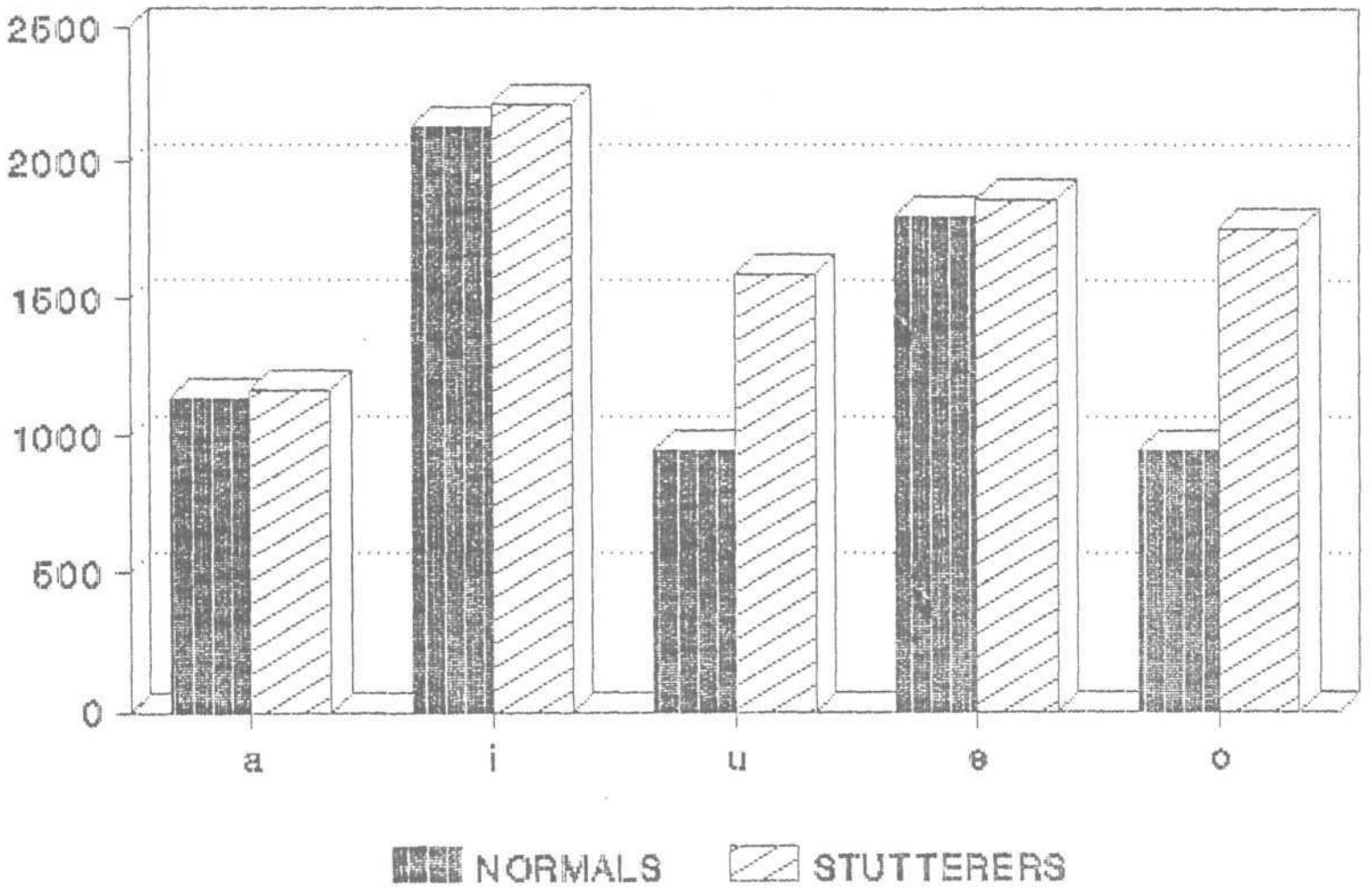
	Formant frequencies-normals			Formant frequencies-stutterers			
	Range	Mean	SD	Range	Mean	5D	sig
F1 for/a/	510-750.30	686.22	99.76	232-674.5	456.30	190.73	*
F2 for/a/	1033.3-1499	1139.70	55.94	1176.5-2282	1170.70	258.58	*
F3 for/a/	2432.3-2542	2461.57	45.51	2180.5-2877	2539.10	307.93	*
F1 for/i/	259.5-371	283.59	48.93	223-963	572.72	320.16	*
F2 for/i/	2083.8-2223.5	2128.29	55.94	1857-2549	2218.12	258.58	*
F3 for/i/	2710.4-2852	2783.43	52.39	2830-3786	3239.72	424.24	*
F1 for/u/	345-360.2	353.45	6.048	294-583	415.52	121.97	*
F2 for/u/	932.70-967.40	948.52	13.178	821-2900	1597.40	856.195	*
F3 for/u/	1942.6-2154.8	2031.23	110.77	2345.23-4243	3093.84	800.233	
F1 for/o/	459.15-483.5	476.128	10.063	298-743	525.20	189.90	*
F2 for/o/	937.5-958.5	951.12	8.2337	862.70-2686	1761.74	681.65	*
F3 for/o/	1650.3-1823.5	1722.16	75.79	1427.5-3686	2933.10	900.44	*
F1 for/e/	437-534.2	465.74	38.87	208-492	358.58	113.20	*
F2 for/e/	1596.3-2021.3	1806.7	166.99	1138-2402	1873.68	478.97	*
F3 for/e/	2456.6-2723.2	2568.44	96.74	2244-3795	2951.4	710.36	*

TABLE 3; Table showing Mean,Range,SD of formant frequencies.

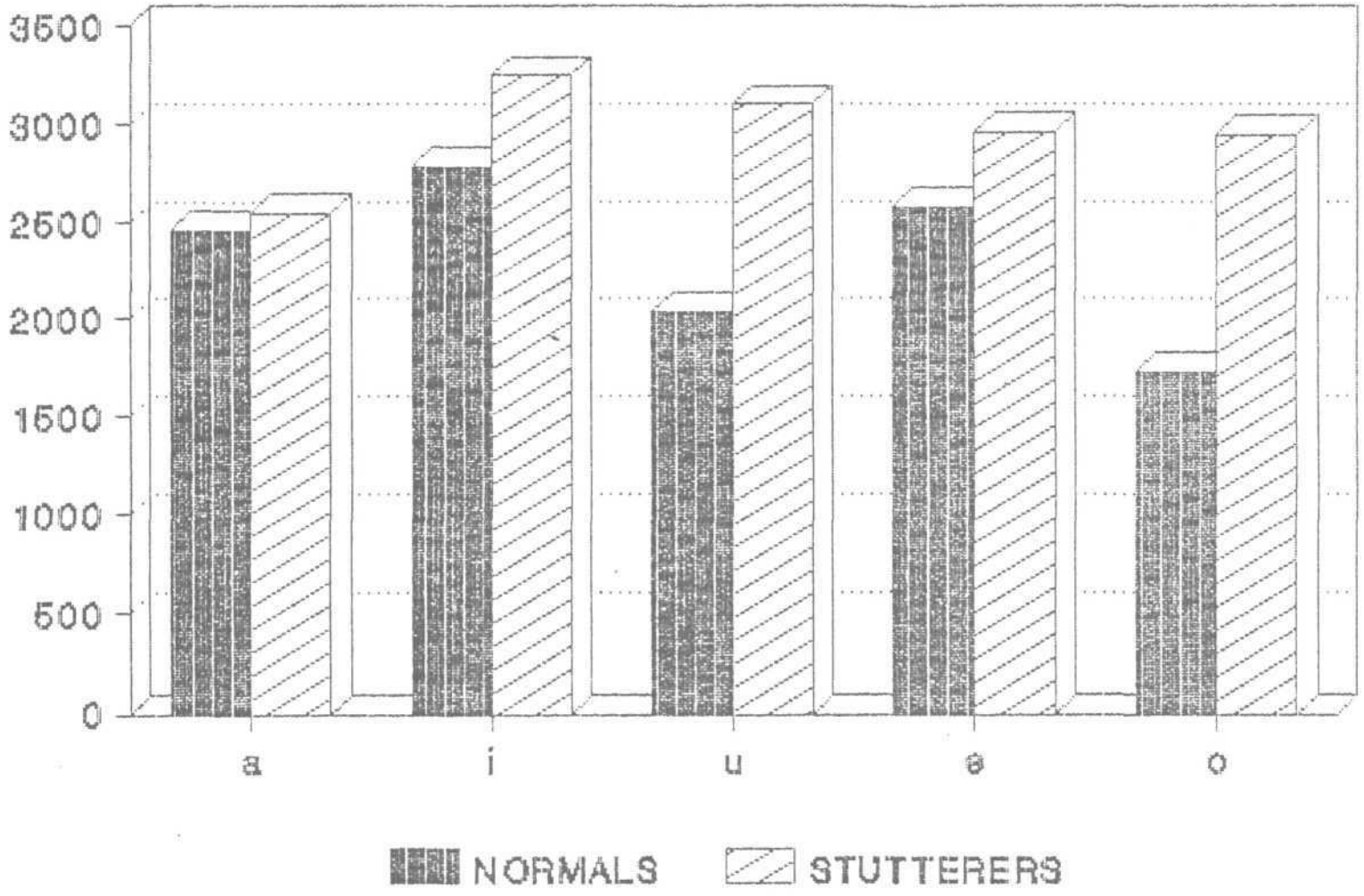
Indicates statistically significant difference values between the two groups at p <0.05 level


F1 FOR NORMALS AND STUTTERERS
800
700
600
500
400
300
200
100
0
a
i
u
e
o
NORMALS
STUTTERERS

F2 FOR NORMALS AND STUTTERERS



F3 FOR NORMALS AND STUTTERERS



456.30,190.73,232-674.5, The (F2) were 1139.70,55.94 for normals and 1170.70,258.58. for the stg group.The(Fl)for /o/ were 476.12,10.06for the normal and 525.20,189,90for the stg (F2)were 951.12,8.22 for normals andl761.74,681.65 for stg. lly for (F2, F3)results for other instances were found to be the same.

Transition duration

The study shows that the transition duration varies in stutterers and non stutterers as it is higher in the stutterers.The mean S. D for the normals were 34.21,5.95 and 94.84,4.08 for the stg for /a/(Fl).and41.95,10.07(F2) for normals and 121.64,5.59 for stg. For /e/in normals it was 37.2,5.05(Fl)and 160.06,30.90 for stg group.lly for F2 in all other vowels similar patterns were seen. This has been found support from many studies Starkweather and Myers(1979) have found stutterers to have longer transition times of inter vocalic intervals, systematic differences in transition times and articulatory displacement.

Voice onset time

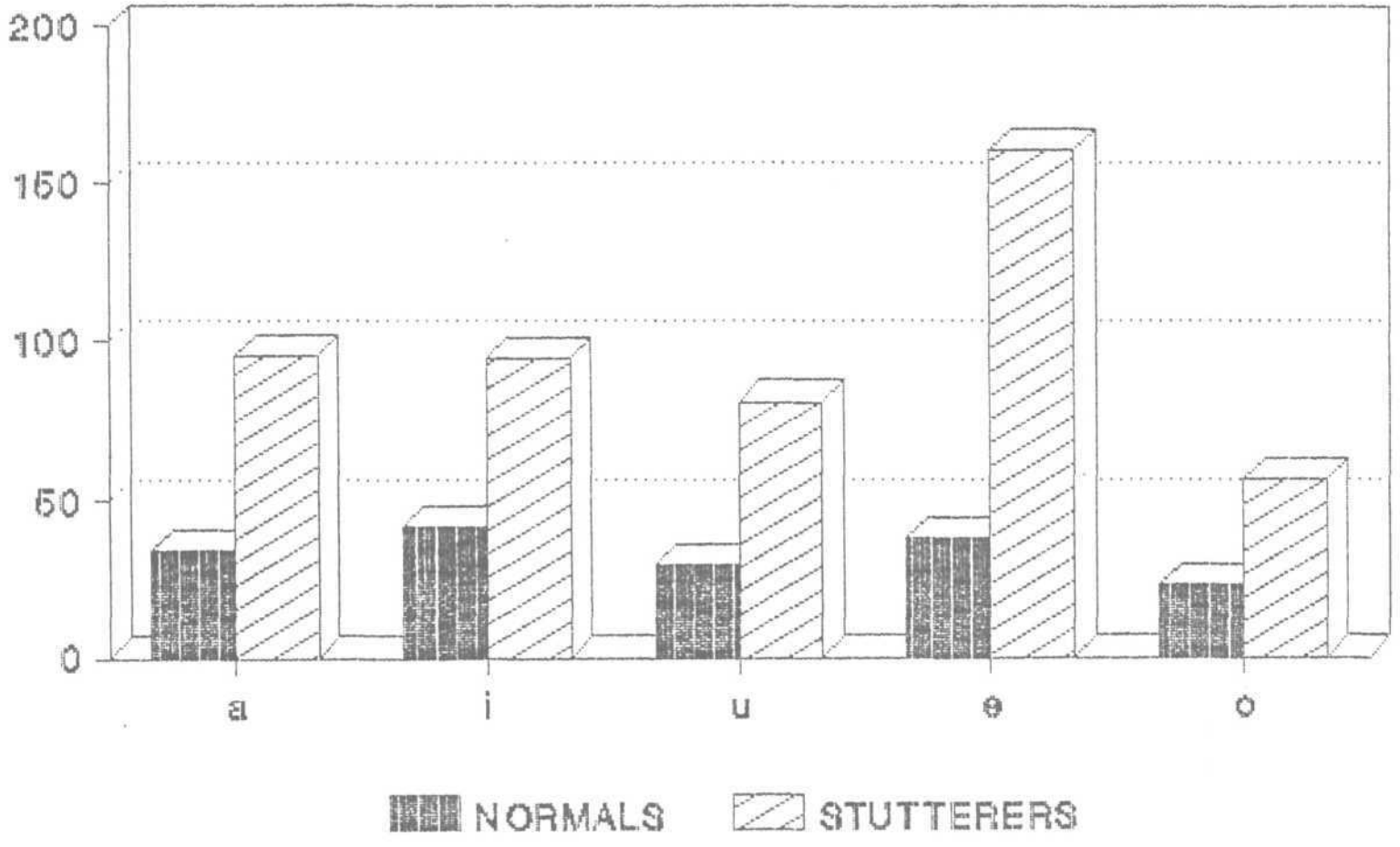
This has also been found to be longer in stutterers than the non stutterers. The mean, SD for the normals has been found to be -103.98,2.42(/b)and 83.3,4.14 in stg,/p/ was 96.2,2.23 in normals and 11.89,3.70 in the stg. lly the same was found for all other consonants Evidence accumulated

	Transition duration-normals			Transition duration-stut terers			
	Range	Mean	SD	Range	Mean	SD	sig
Fl for/a/	21.2-41.2	34.21	5.95	90.2-101.2	94.84	4.08	*
F2 for/a/	30.6-50.8	41.95	10.07	112.2-127.8	121.64	5.59	*
F1 for/i/	44.6-54.3	47.5	4.009	90.3-97.2	94.02	2.56	*
F2 for/i/	50.2-58.4	54.57	4.05	117.4-122.2	120.16	1. 73	*
F1 for/u/	21.2-43.2	29.03	8.55	20.8-133.4	80.84	41.98	*
F2 for/u/	23-32	27.23	3. 74	24.6-103.5	78.8	31.1	*
F1 for/o/	20.2-25.8	23.07	2.62	52.2-61.4	56.5	3.67	*
F2 for/o/	25.3-43	35.7	6.99	56-69	63.3	4.75	*
F1 for/e/	28.2-40.2	37.2	5.05	110-190.4	160.06	30.90	*
F2 for/e/	25.4-34.4	30.85	3.46	113.4-170	126.4	24.37	*

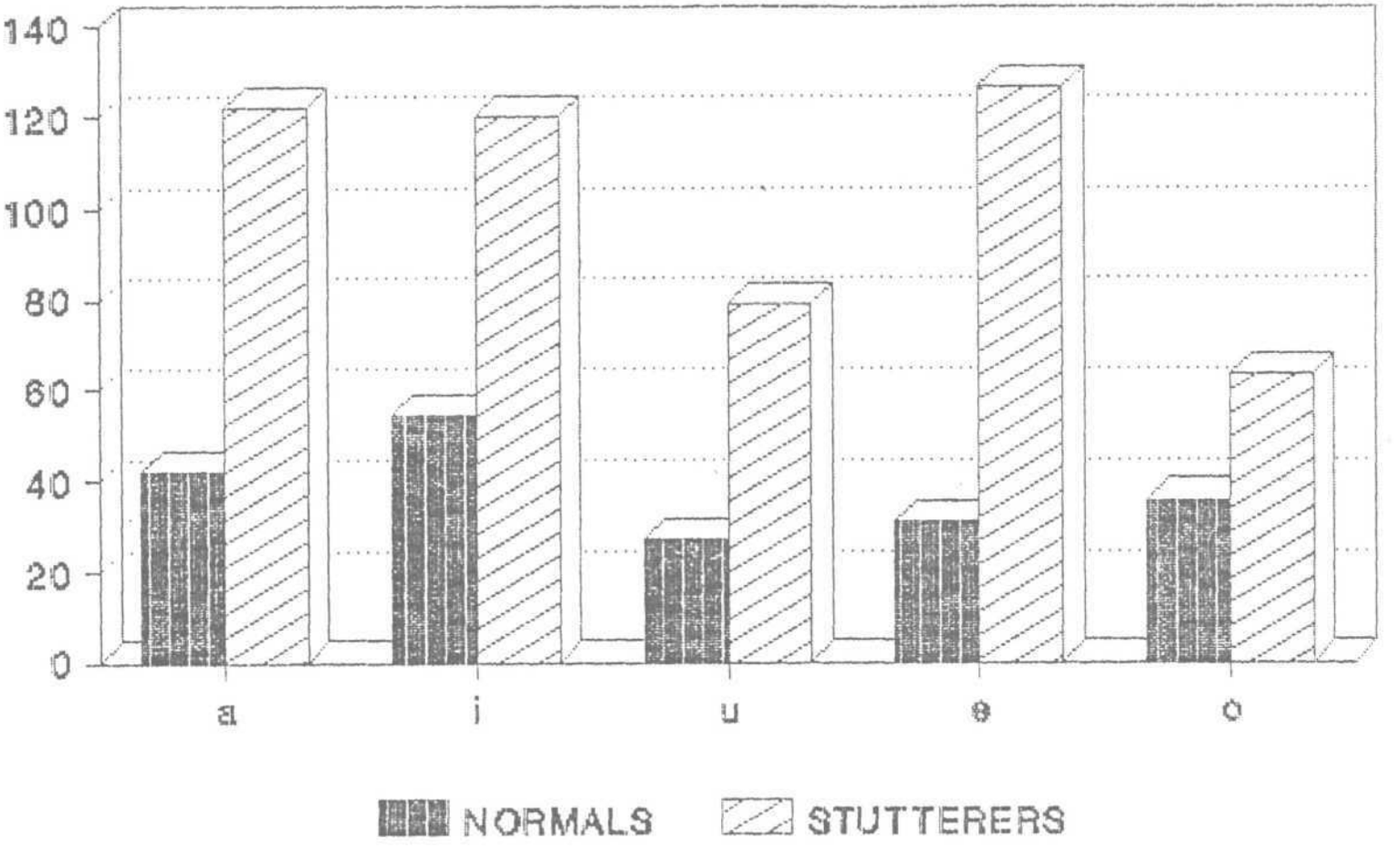
TABLE 5; Tabie s/icwing transition duration (mean, range^SD)

Indicates statistically significant difference in values between the ttvo groups at p<0.05 level.

TRANSITION DURATION OF F1 IN NORMALS AND STUTTERERS



TRANSITION DURATION OF F2 IN NORMALS AND STUTTERERS

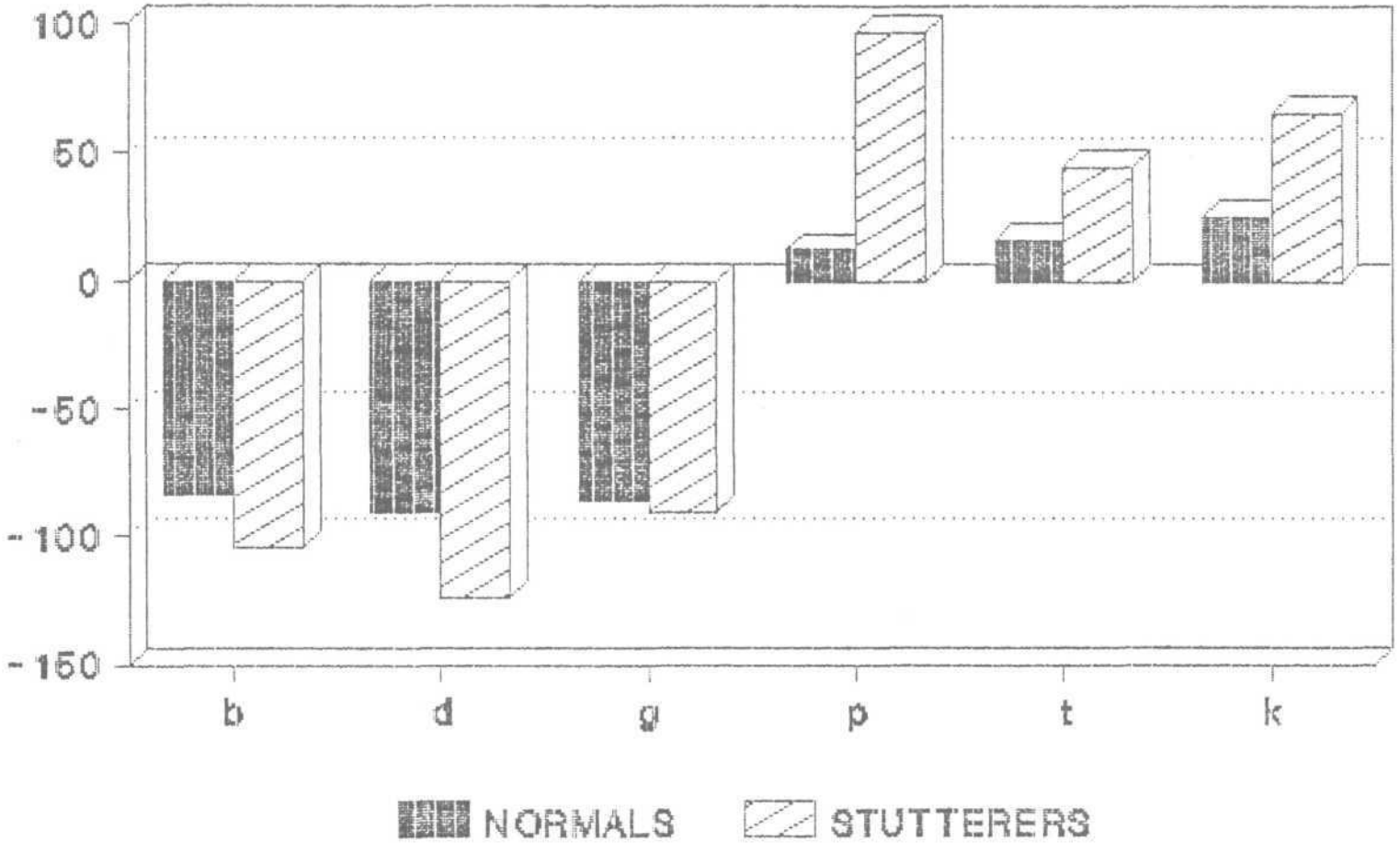


	VOT-normals			VOT-stutterers			
	Range	Mean	SD	Range	Mean	SD	sig
Vot /b/	-107.2-101.2	-103.98	2.42	-90.23-80.4	-83.3	4.14	*
Vot/d/	-25.2-123.2	-123.9	1.79	-94.3-88.4	-91.05	2.30	*
Vot /g/	-93.2-87.4	-90.1	2.86	-87.2-3.7	-85.7	1.48	*
Vot/p/	93.3-99.3	96.2	2.23	7.74-16.14	11.89	3.70	*
Vot/t/	20.3-81.2	44.6	2.36	15.04-18.05	15.75	1.29	*
Vot/k/	64.2-67.2	65.2	1.32	23.24-26.76	25.33	1.29	*

TABLE 6; Table showing Mean,Range,SD of VOT

Indicates statistically significant differences between values at $p<0.05$ level.

VOICE ONSET TIME FOR NORMALS AND STUTTERERS



in recent years has indicated that stutterers had been found to have longer voice onset time values (Hillman and gilbert 1977) (Henley and Gutkin 1984) (Halm 1942, Conture 1983) than normals.

The results showed greater variation in stutterers in terms of all acoustic parameter when compared to the non-stutteres. All the values of the acoustic parameters have been found to be higher in the stutterers. This can be attributed to increased tension, arrest of articulatory postures, repetition and articulatory movement in stutterers further leading to the large variation.

In order to verify the hypothesis that there will be no difference between the stutterers and normals on the following parameters. The results presented in tables were examined. It was found that,the null hypothesis stating that

1. There will be no difference between the stutterers and normals in terms of vowel duration has been rejected.

2.There will be no difference between the stutterers and nonstutterers in terms of word duration has been rejected.

3. There will be no difference between the stutterers and non-stutterers in terms of transition duration has been rejected

4. There will be no difference between the stutterers and nonstutterers ion terms of formant frequencies has been rejected.

5.There will be no difference between the stutterers and nonstutterers in terms of fundamental frequency has been rejected.

6.There will be no difference between stutterers and nonstutterers in terms of voice onset time has been rejected.

Part-2 Correction of the parameters

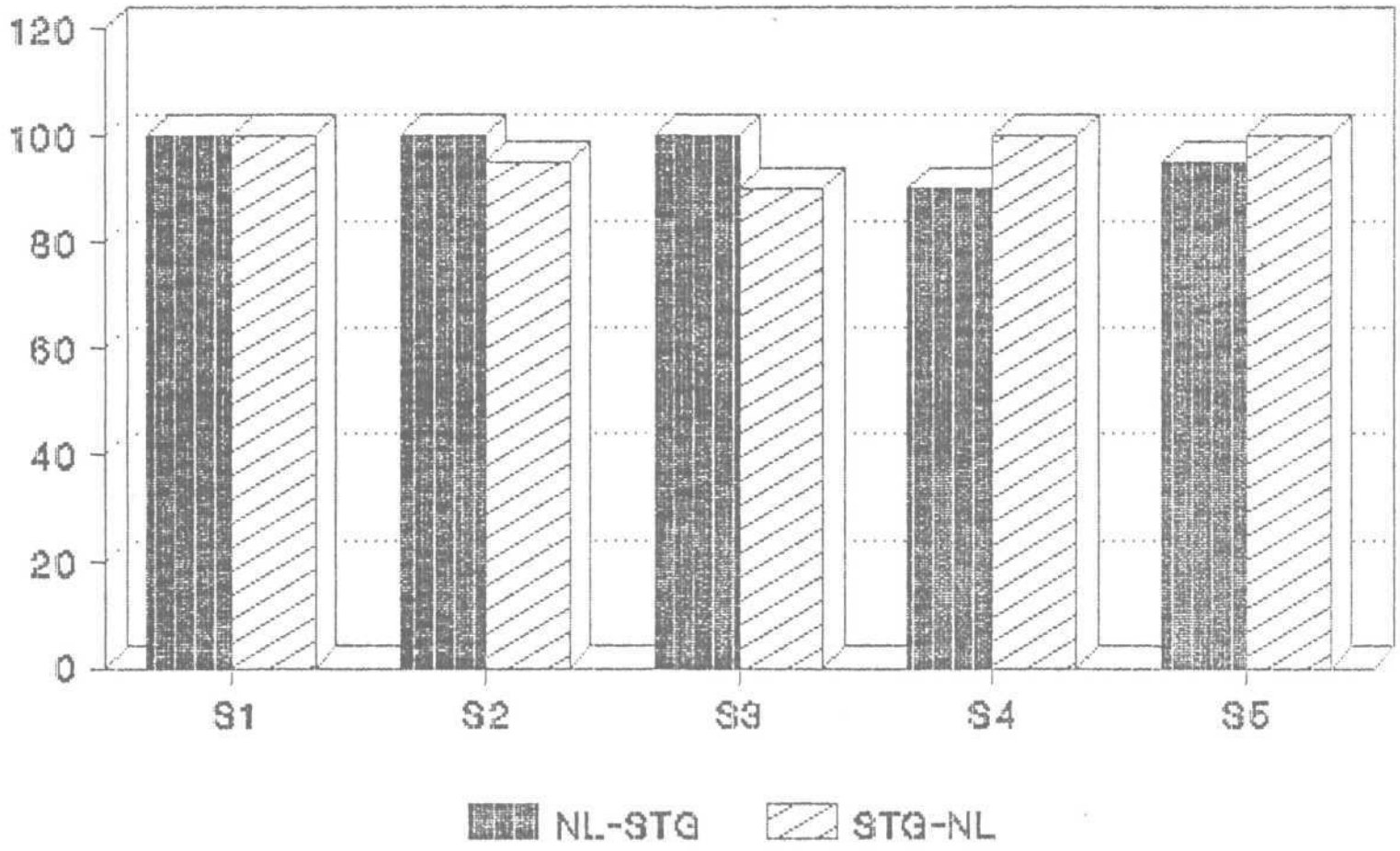
The acoustic parameters like vowel duration and word duration were corrected after deleting from the speech of stutterers and by adding to the speech of normals(the repetitions and prolongations present in the stutterers speech)and the clarity was rated by the judges. It was found that the judges rated it as intelligible. Later the parameters that were seen like repetitions and prolongation in stutterers were added to the non stutterers speech and this was presented to the judges to identify correctly/diagnose/ give their impression of the speech.

The corrected stutterers speech and corrected normal speech were presented to the judges individually one after the other and to give their impression. It was found that they identified the corrected stutterers speech as normal and the corrected normal speech as stutterers with all the samples presented to them,Thus the results lead to inference that there is a relationship between the acoustic parameters and intelligibility.

	Normals-stutterers		Stutterers-Normals	
1	Identified as- stutterers	100%	Identified as- normals	100%
2	Identified as-stutterers	100%	Identified as- normals	95%
3	Identified as-s,utterers	100%	Identified as-normals	90%%
4	Identified as-stutterers	90%	Identified as- normals	100%
5	Identified as-stutterers	95%	Identified as-mormals	100%

TABLE 7; Table showing the identification scores of synthesized speech

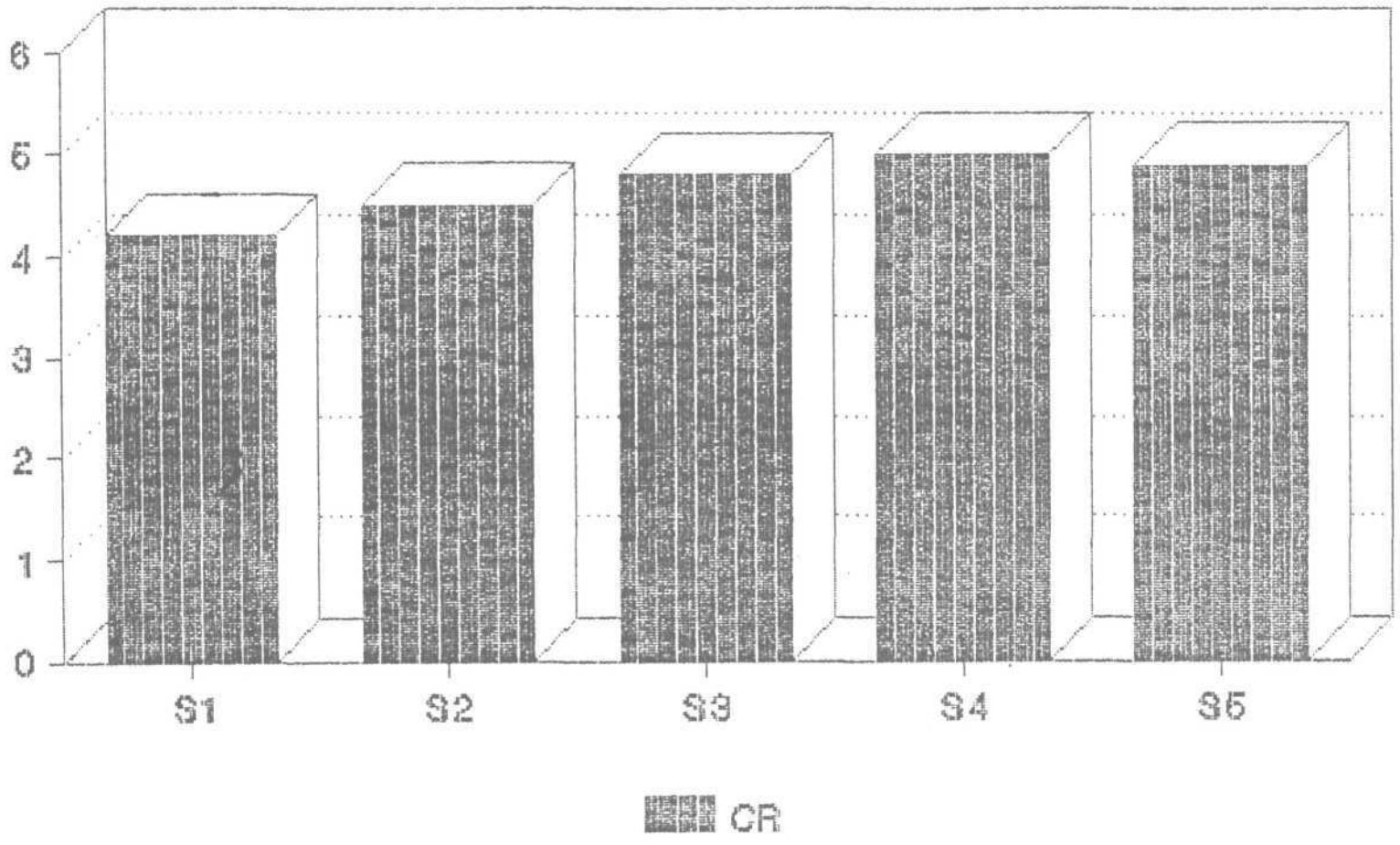
IDENTIFICATION SCORES OF SYNTHESIZED SPEECH (IN %AGE)



Subject	Clarity rating
1	4.2
2	4.5
3	4.8
4	5.0
5	4.9

Table 8; Table showing clarity rating of the synthesized speech On a 5 pt scale.

CLARITY RATING OF SYNTHESIZED SPEECH ON 5PT SCALE



SUMMARY AND CONCLUSION

The present investigation was carried out to study and compare the acoustic parameters of speech in stutterers with that of normal speakers.The second part of the study was to correct parameters of speech of stutterers to approximated normal speech and to add those parameters (repetitions and prolongation) in the normal speech to approximate stuttering.

Healey and Gutkin(1984) observed that VOT differences between the stutterers and non stutterers and found that for voiceless stops the stutterers did not significantly longer than non stuttering group. Corresponding to the higher tension of muscles involved in speech production, a higher fundamental frequency was found during spontaneous speech. (Schaferskupper and Simon(1983).

The study consisted of 5 stutterers and 5 normals matched for age,sex,and language background. Each subject read the voiced passage and unvoiced passage and this was recorded on a double channel,Sony deck tc fx 170.the samples were analyzed using spectrograph to find out vowel duration, word duration, F0,F1,F2,F3,transition duration and Voice Onset Time using computer programmes.

Wilcoxon matched pairs signed rank test was Used to findout the significant difference between stutterers and

non stutterers. Later the parameters were corrected using the SSL program.

Conclusions

Stutterers differed significantly from the non stutterers on the following Acoustic parameters.

1. Vowel duration

2. word duration

3.Transition duration

4.Voice onset time

5.Fundamental frequency

6.Formant frequency

The above findings indicates that the laryngeal mechanism during speech is different for stutterers to that of the non stutterers.

The correction of the parameters of normals to stutterers and stutterers to normals was indicative of only a minor deviation of the stutterers speech from normals as the intelligibility of the stutterers speech after correction was like normals and normals were sounding like stutterers when parameters were added in the normal speech.

Which point to implications in therapeutic intervention.That is,the therapeutic intervention provided effectively can help them to reach normalcy. The deviation of speech of the stutterers thus being an accessible entity to the speech pathologist.

RECOMMENDATION FOR FUTURE STUDY
RECOMMENDATION FOR FUTURE STUDY

l.The experiment can be done using large samples.

2.It can be carried out in different languages.

3.Various age groups can be included in the study.

4.It can be carried out to find how the acoustic parameters changes with the degree of stuttering.

5.It can be studied across the various sexes.

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APPENDIX -A

Subject -1 Satish no:80767 Age - 25yrs Sex - male

Mother tongue - Kannada other 1gs -

Onset of stutterering - gradual since childhood

P. D - Moderate stutterering

Subject - 2 Mahadevaswamy no:123197 Age - 21yrs

Sex - male

Mother tongue - Kannada other lgs -

Onset of stutterering - gradual since childhood

P. D - Severe stutterering

Subject - 3 Jayan Mohan no:123211 Age - 23yrs

Mother tongue - Kannada other lgs -

Onset of stutterering - gradual since childhood

P. D - Moderate stutterering

Subject - 4 Khatibur no:123210 Age 18yrs Sex- male

Mother tongue - Kannada other lgs -

Onset of stutterering - gradual since childhood

P. D Moderately severe stutterering

Subject -5 Mallegowda no:107441 Age 24yrs sex-male

Mother tongue - Kannada other lgs- English

Onset of stutterering - gradual childhood

P. D Mild stutterering

APPENDIX -B

Subject -1 Rajesh Age 24yrs sex male
Mother tongue Kannada other 1gs English
Family history -ve
studying in aiish

Subject - 2 Naveen Age 21yrs sex male
Mother tongue Kannada other 1gs English
Family history -ve
Studying in aiish

Subject - 3 Ajith Age 22yrs sex male
Mother tongue Kannada other 1gs English
Family history -ve
Studying in aiish

Subject - 4 Vinay Age 21yrs sex male
Mother tongue Kannada other 1gs English
Family history -ve
Studying in aiish

Subject - 5 satish Age 20yrs sex male
Mother tongue Kannada other 1gs English
Family history -ve
Studying in AIISH