CROSS LINGUISTIC STUDY OF SOME TEMPORAL **PARAMETERS**

Ravanan (M P)
REGISTER NO : M 9116

A Dissertation submitted as part fulfilment
final year M.Sc., [Speech and hearing]
to the University of Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE - 570006
MAY – 1993

TO

MY DAD AND MUM

C E R T I F I C A T E

This is to certify that this dissertation entitled "Cross Linguistic study of some temporal parameters" is the bonafied work as a part fulfilment for the Degree of Master of Science (Speech & Hearing) ,of the student with Register no. M 9116.

DIRECTOR

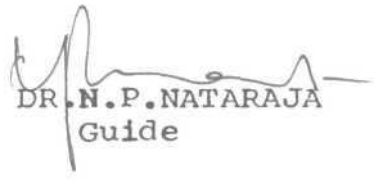
All India Institute Of Speech & Hearing

Mysore -570006

C E R T I F I C A T E

This is to certify that this Dissertation entitled "Cross Linguistic study of some temporal parameters" has been prepared under my supervision and guidance.

May 1993



DR.N.P.NATARAJA
Guide

DECLARATION

This dissertation is the result of my own study undertaken under the guidance of Dr N.P.Natara.ia, Prof & H.G.D. Speech Science, All India Institute Of Speech and Hearing, Mysore, and has not been submitted Carlier at any university far any other Diploma or Degree

MYSORE

MAY 1993 **REG.NO. M 9116**

A C K N O W L E D G E M E N T S

First and foremost, I extend my heartful gratitude to Dr. N.P. Natraja Professor & Head of the Department of Speech Science, A.I.I.S.H, Mysore, for willingly accepting to guide me sparing much of his precious time and calmly enduring to the problems faced at various stages.

I acknowledge Dr. Nikam, Director, All India Institute of Speech & Hearing, Mysore for having given me permission to *carry* out" this work. Mr. P.Kaliah, Reader, Psychology Department, Dr. M.V. Sushi la. Professor and H.O.D Dept. of E.N.T., Dr. G Purusothama, Professor Dept. of Speech Pathology, Dr Sundarraj Lecturer Dept. of E.N.T, Dr. Rajshekar H.O.D. of Speech *Z-.* Hearing K.M.C, Manipal, Dr. Dilip Kumar Patro Asst Prof. Pondichery. I am thankful to you all for the kindness you all showed to me , the scoldings and also the consoling words you had given me when I was broken down which really helped me a lot. I am grateful to Mr Venkatesh , Lecturer, Dept. of Speech Sciences, Mrs Sredevi, Miss Rohini, Miss Sujatha,Miss Lalitha,Mrs Uma . Mr K, Animesh,Mr Gopal and sowmya Anna for helping me in each and every part of this work with moral support when required. My thanks *are* also due to my subjects who participated in the experiments with Kind co-operation. My sincere thanks to the library staff.

I like to acknowledge the support encouragement,inspiration, scoldings which I got from you Swathi which will be due always. Santhala, Sangetha, Suhasini,

Maheshwari, Pani, Patra, Monoj, Pushpa you all went along the proverb "A friend in need is a friend indeed". I am very grateful to Bala, Ganesh, Rajkumar, Santosh Sanyogetha,Zaver,Prema,C.S.Bhuvana who were ready to help me whenever I was in need of them. I will not forget the support you all had given me at different stages of this work.

I wish to express my thanks to my classmates, Juniors and Seniors who helped me directly or indirectly in one way or other. I wish to express my acknowledgment to my friends Deva, Sudha, Sophitha, Jansi, Tenny, Marie,Samu,Beula,3huvana, Suriya &: Vimala aunty. I can just say thanks for your help Rakesh.

Gowri, Rubby, Goldy, Jemmi & Sachin here I am remembering you all for showing me so much of love and affection whenever I am at home. I like to acknowledge with affection the support and encouragement received from my brothers and sisters. No thanks for you Rakhee but I am lucky to have a naughty and bright sister like you.

Dad and Mum you are all for me. I have nothing more to say.

Thanks to Mr.Raghava ,Mr Sudarshan & Miss Rathna who spent long time typing the various drafts of the manuscript.

TABLE OF CONTENTS

	PAGE NO.
1. INTRODUCTION	1- 8
2. REVIEW OF LITERATURE	9- 34
3. METHODOLOGY	35- 41
4. RESULTS & DISCUSSION	42- 76
5. SUMNARY & CONCLUSION	77 - 31
GRAPHS	
BIBLIGORAGHY	
APPENDIX	

INTRODUCTION

Speech is superimposition of a number of actions in the upper respiratory tract upon the action of the larynx (in producing a "fundamental tone) and lungs to result in audible phontions of that sounds, in appropriate sequence. Mere changes in the shape of the resonating supraglottic airway results in transition from one vowel to another and for the consonants, the tongue, lip and palate perform a variety of maneuvers to interrupt or modify the air stream in the manner suitalbe to the language being spoken.

Speech may be viewed as the unique method of communication evolved by man to suit the uniqueness of his mind. By its great flexibility, it permits man to produce a variety of signals commensurate with the richness of his imagination. At the same times the ability to think in terms of causality and purposiveness [time blending] enables man to expand enormously his use of reciprocal communication for the co ordination of social activities'(Eisenson ,D.Amer, and Irwin., 1963)

Hirano(1931, has pointed out that the acoustic anaiyssis of the speech signal may be one of the most attractive methods for assesing, speech function because it is non-invasive and provides objective and quantitive data.

In recent years, there has been an increase in the application of acoustic analysis to the study of speech development in childern. The major areas being, the studies on (l)vocal fundamental frequency,(3) Static formant patterns of

vocalic sounds and (3)Temporal properties such as voice onset time, rates of formant movement and segment duration. These refers to respectively (l)the adjustment of the phonatory apparatus, (2)the shaping of the vocal tract and (3)the timing and co-ordination of articulation (Kent 1976).

Voice onset time (vot)is one of the parameters among the temporal aspects of speech, which has been widely studied in the areas of speech development and stuttering. Kent (1976)has suggested that "one of the objectives of systematic, quantitative research on speech development is voice onset time (VOT)for stop consonants in syllable in the initial position.Further people who belive larynx as the culprit for stuttering mainly argue by comparing the voice onset time values of stutterers with normals.

There have been reports in the litrature that stutterres vary from normals in terms of the VOT measurements. Agnello (1970) has found that the voice onset time and voice termination times in "fluent" speech of the stutterers were longer than that cf non-stutters.

Starkweather et.al.,(l976)found that stutterers were slower than normals in initiating vocalization. Hillman and Gilbert (1976)reported that the stutterers had longer VOY values than non-stutterers for intervocalic voiceless stop consonants in fluent contextual speech.

Voice onset time VOT has been defined as the duration between the release of a complete articulatory constriction or

burst transient and the onset of phonation (Lisker & Abramson 1964;1967).

Measurement of VOT in children's speech have been reported, and VOT has been found to vary from childhood upto a certain age (Preston, Yeni-Komshian and Stark 1967;Minter, Horn, MacKellage and Freston 1967;Eimas et.al 1971; Kewly-port and Preston 1974;Stark 1972;Trehub and Rubinovitch 1972; Zlatin and Koenigskneeht 1975; 1976).

Language has been fund to affect the VOT values (Lisker and Abramson 1964; Abrasmson and Lisker 1967; Yeni-Komshian, Preston and Benson 1968 ;Babul basu 1979).

VOT has been found to be different for different Stop consonants depending upon the place of articulation(Lisker & Abtramson 1964; 1967;Hillman and Gilbert 1977).

Summerfield (1974),Klatt(1975) have indicated that the VOT for a given stop depends upon several features of phonetic context. Summerfield (1975)have observed VOT values to be varying with speaking rate. Their results have indicated a decreased VOT values with increase in speaking rate. Thus a number of variables have been found to affect the VOT.

Another important temporal aspects of speech is the vowel duration. Bruce C.Smith et.al (1986) tried to determine whether any difference occurs as a result of using spectrograms versus digital oscillograms to make durational measurements.Oscilloqrams tended to reveal slightly longer vowel duration and more voicing during consonant closure while spectrograms evidenced slightly longer consonant closure

duration.

Bruce.L.Smith et.al.,(1987) studied the temporal characteristics of the speech of the normal elderly adults. Analysis indicated that the elderly adults had segment,syllable and sentence duration which were longer than those of the young adults.

Molly Mack (1982) studied the voicing dependent vowel duration in English and French monolingual and bilingual productions. Analysis revealed that there were largercontext dependent difference in preconsonantal vowel duration in English than in French, and the English and French vowel duration ratios of French-English bilinguals were essentially like those of French monolinguals. However the bilinguals English vowels were longer than their French vowels.

In English, vowels preceding voiced consonants are generally longer than vowels preceeding voiceless consonants (Heffner 1937; Jones 1940; Kenyon 19S4).

House and Fairbanks (1753), Lehiste (1960) found that a vowel in a voiceless context had a duration approximately S\3 that of a vowel in a voiced context.

Zimmerman and Sapon [1958] determined that the durational percentages for korean, Russian and French were 78.O% -87.O% considerably higher than for English 61.O%.

Rapheal et. al .,[19803 have found that perceptual judgments of word final voicing in C V C syllables can be made not only on the basis of vowel duration , but also on the

basis of the duration of the formants in the initial voiced consonants

Mack[1981] indicated that closure duration difference between voiced and voiceless stops were smaller in English than in French.

Flege [1980] found that some of the Arabic -English bilinguals in his study utilised different voicing-dependent vowel duration in Arabic and in English.

Usha Rani (1939) studied the effect of five temporal parameters in Indian languages.(closure duration, preceding vowel duration, transition duration of the preceeding and following vowels and the VOT). She found that there was no significant difference in the percepts by the listeners of Kannada and Hindi languages.

Extensive research on production indicates language differences, especially for VOT. (S) is and Damste, 1967; Lindquist 197S. Frokjair-Jensen et.al.,1973;Benguerelet.al., 1978;Keating 1984;Brownman and Goldstein 1936).

The relation between perception and production is a topic of concern in the cross-language studies. This is one way of investigating the effect of exposure to a given phonological system on the perception & production of phonemes from another phonological system (Aslin & F'isoni 1980).

Thus the present review of literature shows that the temporal parameters in normals are different from individual

to individual. The vowel duration and VOT vary from individual to individual and difference is seen in between languages. However no information is available regarding within the subject variation.

Hence it was intended to study the VOT & VD for different subjects speaking different languages & to determine the inter & intra subject variability.

STATEMENT OF THE PROBLEM :-

The problem is to study the VOT & VD values for voiceless stop sounds and following vowels in different languages(Tamil, English,Kannada, Hindi) in reading by subjects who had on of these languages as mothertongue & others as either second or third language and to determine, inter & intrasubject variability.

PURPOSE OF THE STUDY:-

The purpose of the study is to test the following hypothesis

l.a) There will be no difference in the VOT for voiceless stop sounds with reference to languages as in Hindi, Kannada, Tamil,& English in both native & non-native speakers.

l.b) There will be no difference in the VOT values for voiceless stop sounds with reference to individuals & repetitions.

l.c) There will be no difference between the VOT values of voiceless stop, consonants with respect to the point of articulatory constriction .

l.d) There will be no significant difference between the languages in terms of VOT of different sounds as spoken by subjects using there mothertongue.

l.e) There will be no difference in the Voice Onset Time across the vowel environment.

2.a) There will be no difference in the vowel duration for vowels with reference to languages Hindi, Kannada,Tamil & English both by the native & non-native speakers.

2.b) There will be no difference in the vowel duration values for vowels with reference to individual and repetition.

2.c) There will be no difference between the languages in terms of vowel duration of different vowels as spoken by subjects using their mothertongue.

2.d) There will be significant difference in vowel duration in the utterance of subjects speaking a third language who had different mothertongues.

To test this hypothesis, nine subjects were taken in the age range of 18 to 25 years who were randomly selected from among the student population of A.I.I.S.H. Four subjects (female) had kannada as mother tongue and could speak English and Hindi as additional languages. Two subjects (males) had Hindi as mothertcngue and English as additional language. Three subjects(two males, one female) had Tamil as mothertongus and had English as additional language. They were asked to read the sentences which had the words starting with the target consonant \p\,\t\,\t\,\k\ wit the vowels \a\,\i\,\u\,\o\,\e\ in a CV paradigm. The speech samples were recorded simultaneously using a tape recorder & the computer. The

target words were then selected for spectographic analysis & analysed using the program given spectrogram.

VOT & VD were measured in all the speak samples i.e., the mothertongue & other languages spoken by all ths subjects. Descriptive & inferential statistics have been carried out for all.

IMPLICATION OF THE STUDY:-

l.The study would provide information regarding VOT in adult speaking different languages.

S. It would provide information regarding VOT & VD of stops & vowels depending upon the place of articulation.

3. The VOT data on normals may be used to compare stutterers with normals.

4. The VOT & VD on normals may be used to compare with subjects of other languages also.

LIMITATIONS OF THE STUDY:-

1. Only nine subjects were taken for the study i.e., four females(Kannada), two males(Hindi),three subjects two males & two females (Tamil) were included for the study.

REVIEW OF LITERATURE

"Speech is the way of life of man - No normal person is without this faculty and no other species is known to poses it". (Punt, 1952)

Once acquired, speech becones a constant companion to man. It becomes a property of the individual,, at the same time it is the bond which establishes the society.

Speech is produced without any observable effort by the human being. The range of speech variation is immense, and yet considered normal.

Only a small part of the information conveyed by speech., less than 1%, is used for linguistic purposes, as such the rest gives other kinds of information, about the specific character of the vocal tract of the speaker which enables us to recognise his voice, his phvsical well being, his emotional state and his attitudes towards the entire contest in which the speech event occurs. It can also carry other information about the speaker, with reference to the conventions of social class, occassion and style.

The spoken utterance is an impact on the atmosphere, very short in duration and on a very small scale, in which the component sounds die away at different distances depending on their inherent energy. But these vibrations are of utmost complexity. Acoustic analysis resolves this tortuous oscillation in a three - dimensional frame work of frequency, intensity and time, in which each sound is characterised by a

typical display of energy in various frequency regions along the unlimited line axis. [Cotz 1961].

The crucial event essential for voice production is vibration of the vocal folds. It changes DC air stream to AC air stream, converting aerodynamic energy to acoustical energy.

Analysis of such acoustic parameters have been considered to be useful in knowing more about the developmental disorders of speech.

The major areas of research being the studies on

(1) vocal fundamental frequency.

(2) Static formant patterns of vocalic sound's

(3) Temporal properties such as voice onset time,

rates of formant movement and segment duration

These refers to respectively

1. the adjustment of phonatory apparatus

2. the shaping of the vocal tract and

3. the timing and co ordination of articulation [kent 1976]

VARIABILITY PRODUCED BY THE TALKERS THEMSELVES:

Assuming a population of homogeneous talkers, that is talkers of same dialect of a given language of same age, and the same background group, intertalker variability has basically two sources

a) The anatomical and physiological difference existing among different persons

&

b) The learned speaking difference among different persons.

In the section on "Acoustic speech production" Oscar Tosi[19797]. It is explained that speech is produced by the resonance in the talkers vocal tract. The notion that no two similar things are equal is almost a natural law. The conclusion that logically follows is that different vocal tracts necessarily have to produce different resonances or speech spectra, differences significant for voice identification purposes.

In addition to these anatomical differences, every person "experimentally" develop an individual and unique process of learning tc speak, although these process are generally similar. The uniqueness of the processes contributes to the building of unique speech spectra for each individual when uttering a given word. This learned difference is dramatically illustrated by persons speaking a non-native language.

There is no controversy concerning intertalkar variability other than possible confusion arising when two people speech is very similar. A more important problem is produced by the

intertalker variability i.e..the variability of speech spectra between two utterances of the same words produced by the same talker . Are these intra talker variabilities lesser than or different than intertalker variabilities. The whole problem of talker identification and elimination could be basically centered in the reliable answer to this question. Two alternative types of research might find such an answer, at least tentatively.

a) inference through a substantial number of laboratory tests using any method but testing speech samples from "unknown" talker who are known to the experiments because errors committed by examiners in these tests might bring controlled data on which to base the inference;

b) definition of optimal parameters from spectral ,' temporal speech samples that can be proved to be invariant for the same talkers speech but highly variable for different talkers speech.

Both ways have been tried by researcher Tosi et.al.,(l972) tried inference through controlled testing and Wolf(l972) tried to define optimal parameters. Still more experimentation with controlled data is necessary to eliminate controversy in this area.

On the other hand, there is no problem in the identification of source of intratalkers variability. The commonly accepted sources are

1) time elapsed between pairs of utterances from from

the same talker ;

2) anatomically physiological & psychological circumstantial condition of the talker;

3) manner of utterances

4) disguising or mimicking attempts by the talkers.

The analysis of speech has gained importance, not only because of its contribution in understanding speech disorders but also because of its use in speech technology. The computer scientist have been looking for information on acoustic variation in speech at different levels., like segmental, suprasegmental, contextual inter subject, intra subject and across the languages spoken by native and non native speakers for applications in speech technology, There is a lack of this information particularly with reference to Indian languages. Therefore the present study is an attempt at finding the inter & intra speaker variabillity across different languages in terms of voice onset time and vowel duration. The investigation has been limited to the study of voice onset time and vowel duration as these have been considered to be important parameters among others in understanding the complexity of speech. This study is a part of a project aims at acoustic, Spectral & temporal analysis of speech.

VOICE ONSET TIME

Voice onset time(VOT) is one of the parameters among the temporal features of speech. VOT may be defined as "the duration between the release of a complete articulatory constriction or burst transient and the onset of phonation (Lisker and Obramson 1964,1964;1967).

According to kent (1976) "one of the most frequent objects of systematic, quantitative research on speech development is Voice Onset Time (VOT), for stop cognates in syllable - initial position.

Voice Onset Time(VOT) has been found to be affected by several variables such as age, articulatory position and language. VOT has been found to be more during early childhood upto certain age (Breston, Yeni- Komshian & stark 1967; Winter, Mac Keilage and Prestol 1967: Eimas et.al 1971; Stark 1972; Trehub & Rubinovitch 1972; Kewley-Port & Preston 1974; Zlatin & Koenigsknecht 1975,1976). It has been stated that "changes in the VOT distributions that occur during the first six years of life appears to be fairly systematic " (Kent,1976) .

The nature of the sound i.e., whether it is voiced or voiceless is determined by the voice onset time. when the voice onset occurs after the release of articulatory constriction in the vocal tract, the sound will be unvoiced while the voice onset occurs before or simultaneously with the release of the articulatory constriction, the sound will be considered as voiced. The term voice onset: refers be

initiation of vocal card vibrations.

VOT has been found to vary with the position of articulation i.e., it has been found to increase consistently as the constriction of articulation moves backwards from the lip to velum. Hillman & Gilbert (l977) Port,(1979) Lisker & Abramson (1965) have shown that the mean VOT values as for \p\ 58 msecs, \t\ 70 msecs & \k\ 85 msecs respectively Prestim, Yeni-Komshian & Stark (1967) reported that the distribution of the values of voice onset time for children approximated the adult models. Zalten(l974) Studied voicing constrast perceptual and productive Voice Onset Time characteristics of adults and reported that, the analysis of perceptual data revealed significant difference among labial. apical stops in Voice Onset Time. In the production of voiced & voiceless stops reliable difference for mean VOT were shown for all cognates & among places of articulatory constriction within voicing category as age increased.

Basu (1979) reported that there was a consistent increase in the VGT with respect to the position of the articulatory constriction (as it moved backwards in the oral cavity) in case of non stutterers. Fort (1979) in his study regarding relation between VOT & vowel duration in initial English stops reported that the results implied the temporal implementation rules simultaneously influence several acoustic intervals including both VOT & the inherent intervals corresponding to a segment either by independent control of the relevant articalatory variables or by some unknown common mechanism.

According to Summerfield & Haggard (1972) VOT decreases with increase in speaking rate. Another variable affecting the VOT on is the age of the speaker. Many studies have been reported with reference to speech development in children given due importance to VOT as an important temporal feature,

Preston et.al (1967) have studied VOT for Lebanese & American infants of 15 months old and showed that they produced apical stop consonants with essentially the same range of VOT values in the short lag region of the continium. Between 1 & 2 years of age group stop production spread from a relatively narrow unimodel distribution as the American and the Lebanese children begin to exhibit differential phonologically appropriate characteristics for their respective languages. It was also found that the magnitude of VOT difference required for distinguishing between free vocalic stop cognates decreases as a function of age.

Menyuk & Flatt (1975) from their study on VOT in consonant clusters production by children & adults report that overall timing characteristic were similar for children & adults. VoT generally increased from labial to dental to velar cluster, and was shorter in single tone. Children's VOT averages were generally but not significantly longer than adults in all context and co-articulation constraints affected the accuracy with which children produced the stops and liquid portion of a particular cluster. Kent (1976) noted feusly systematic changes in the VOT distribution during the first six years of life. The majority of stops in the early words of the child are characterized by the occurrence of a short delay between

articulatory release & the onset of vocal fold vibration. Shortly thereafter, the VOT distribution of children begins to assume a form which is similar to that of adult speakers. By the age of six, the range of VOT values for voiced & voiceless stops overlapped to a greater degree than for adults. Voicing lead (negative values of VOT. for which voicing proceeds articulatory release) becomes more common with maturation, especially for bilabials. In addition., the variability of VOT decreases so that adult like stability of production is noted at about eight years of life.

Lisker & Abramson (1964) have studied the VOT in various languages including Hindi,English, Tamil, Marathi for the stop sound in word initial position. The Voice Onset Time(VOT) values were not same for any two languages. Hence language has been found to be a variable affecting VOT. They have also reported that VOT is less in running speed than in nonsense syllables. Presence of voiceless stop in a stressed syllables. Presence of voiceless stop in a stressed syllables makes for a greater lag in the onset of voicing hence, type of speech sample in another variable for VOT measurement.

Basu (1979) from his study of VOT in stutterers and non stutterers using Kannada voiced and voiceless step sounds in isolations and in spontaneous reading, has reported that his "indings did not agree with the findings of Lisker & Abramson (1964) i.e., VOT in Hindi,English,Tamil & Marathi.

Ravishankar (1981) who studied on VOT in different age ranges using Kannada as the language to elicit voiced &

voiceless stops & has reported results similar to the results of Basu's (1979) investigation. Further he also states that the VOT varied with age.

Zlatin & Koeneqsknecht(1976) studied the development of the contrast : A comparison of VOT in stop perception & production in 10, two year old children, ten six year old children and 20 adults has been made. They reported that the mean VOT differed significantly as a function of age. In the case of adult speakers, it was reported that the mean VOT for voiced stops was in the short lead range while the average for their voiceless stop production was in the moderately long lag portions of the VOT continium. The children of two & six year old used primarily the short lag range for voiced stops . And in general their average VOT for voiceless cognates was smaller than those of adults. In frequent occurrence of lead during the production of voiced stop sounds was common in two & six year old children. They have also observed significant differences between voicing categories for all cognate pairs within each age group & a progression of later mean lag times following from the most anterior point of constriction in the vocal tract to the velar position in case of adults and six year old children, which agree with the studies of Lisker & Abramson (1964). There was no significant difference in results with respect to sex in all the group studied.

The unstable & infrequent occurrence of lead in the production of voiced stops & long laq in the production of voiceless stops during the early period of life is attributed

to lack of consistent control over the timmq of larynqeal & supraglottal articulatory events.

Greham & House (1971) & Edwards (1974) have opined that the distinctive acoustic cue VOT is helpful to assess the general process of motor spill acquisition, since VOT production distribution appropriate to the child's language acquire during the period of speech sound learning. Morley's etal (1980) report that as the child acquires productive control over voicing VOT values change concomitantly.

There are many studies which have considered the involvement of Larynx in stuttering (Travis 1931; kJmqate 197C; Adams ^ Reis 1971; Van riper 1971; Wyke 1974; Freeman & Ushijima 1975; Hanna, welfling & M C Neil 1975). Schwartz (1974). " The cause of the stuttering block ". According to this model "the disorder is essentially inappropriate vigorous contraction of the posterior crico—arytenoid in response to the sub glottal air pressures required for speech". Thus this leads to increased VOT in stutterers. Neurophysiologically VOT can be defined as the activity of posterior crico-arytenoid during phonation .

Vot has been found to vary between stutterers and non -stutterers i.e., stutterers have been found to and have longer VOT than normals [Basu 1979; Agnello & winqate 1972; Adam's & Haydem 1974; Starkweather etal 1976; Hullman and Gilbert 1977; & Miller 1977)

Adam's and Hayden (1974) have compared the VOT and voice termination times of stutterers with those of non stutters as they produced an initial vowel in rapid response to a pure

tone stimulus. Their study has tested the hypothesis that stutterers have difficulty in initiating and terminating phonation independent of the acts of running speech and stuttering. Ten adult stutterers served as experimental group. They were matched as a group for age and sex with ten normal speakers. Subjects from both the groups were tested individually. They were required to start and stop phonation as quickly as possible upon hearing each number of a series of 100 Hz pure tones appear and disappear. Subjects vocalization were permanently recorded on an optical oscillograph. The results showed that both the group's improved (shortened) their voice initation and termination times from the beginning to the end of the experiment. Typically however, the stutters were significantly slower than the control subjects on most of the temporal measures.

Starkweather et.al (1976) have measured the latency of vocalization onset for stutters and non stutters. The subjects were asked to produce different syllable following a Responses were filtered to remove supraglottly 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 shown that stutters are slower in initiating vocalization across a wide variety of syllable. They have further concluded that "... either vocal dysfunctions or the lack of cerebral dominance may be responsible for these difference".

Hillman & Gilbert (1977) have studied VOT values of the

fluent contextual speech of stutters. Ten stutterers and ten nan—stutterers were asked to read " The rainbow passage ". Intervocallic vowels stop consonant segments were selected and displayed wide band spectra games. Results indicated that

a) the stutters displayed longer VOT values than the nonstutterers,

&

b) VOT values increased in duration as the place of articulation moved back in the oral cavity.

Neurophysiologically VOT can be defined as the amount of time required to inhibit the activity of posterior circo-arytenoid during phonation. when a subject is asked to say reflesive posterior circo—arytenoid 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 - plossive - vowel, (sv) paradigms .... VOT appeals to involve not the adducting muscle of the larynx, but also the control of the neural inhibition of the abductor muscle as well (Schwartz 19?74). So,when the speaker has the difficulty to inhibit the posterior circo-arytenoid reflex activity his VOT will be more.

Ravishankar (1981) from his study on VOT in different age ranges have found that there is no significant difference in VOT values for voiceless stop sounds with increasing age in both males and females, but not so in case of voiced stop sounds and no statistical difference in VOT mean values was

noted between the age range of 4 to 7 years but significant difference was noted in mean value for subjects above 7-8 years group. This was found in both males and females & no sex difference was reported. There were significant difference in VOT between each voiceless stop and its voiced. Counterpart for both males and females at all age groups. A consistent increase in mean VOT values with respect to the point of articulatory constriction was seen for all subjects above 7 years of age.

Basically two techniques have been used to measure. Voice onset time thev are

I) Wide band spectrogram method.

II) Optical oscilloscope method.

In a series of investigations of VOT Lisker and Abramson (1964), Abramson and Lisker (1974) have used spectrography to find v'OT in different languages including Hindi, Tamil and Marathi. Malecct (1966) Lubker ana Parris (1969), Han and weitzman (1970), Stevens and Klate (1971), Handcastha (1973) and others have also used wide band spectrogram's for the measurement of VOT. Wintiz et. al (1975) have used optical oscilloscopic method for measurements of VOT.

F'ocn et. al (19S5) studied VOT in Nepali stop consonants. Speech samples (720 CVC words) from 10 adult male Nepali speakers were analyzed with the aid of a video spectroqraph. The distribution of VOT based on group data for each of four stop categories showed that only these of the categories could

be differentiated by VOT alone; voice load, short-log and long-lag stops.

Analysis of individual data revealed masked inter subject variability in the VOT distribution of the voiced aspirate category supporting the necessity of multiple subject samples in a caustically based cross linquistic studies.

Benjamin (1982) found significantly longer vowel and consonant duration in the speech of 68 to 8S year old versus 21 to 32 year old adults, but she showed shorter voice onset time valves for the older adults.

weismer and Fronn (1933) reported similar results for VOT., but observed that there were differences between younger and older subjects for duration of voiceless intervals. Duration produced by elderly male subjects were generally snorter than those of the young adults. But the elderly female subjects commonly showed longer duration than the young adults.

Sweeting and Baken (1982) studied three groups of subjects (25 to 39, 67 to 74 and 75+ years of age) and found no significant difference in VOT Aeron the three age groups. They observed that the v'OT measures were significantly varied for the older subjects.

Flege and Eefting (1787) in their study examined production of \b,d,g\ and \p,t,k\ in the initial position of English and Spanish words by two groups of native Spanish adults and native Spanish 9-10 years olds who began learning English as a

second language by the age of 5-6 years. The subjects in all the three group produced \p,t,k\ with significantly longer VOT values in English than Spanish words, but with significantly shorter VOT values in English words than age-matched English monolinguals.

Earlier studies showed that adults who learnt English as a second language realize English \p,t,k\ with significantly shorter VOT values than native English speakers if \p,t,k\ are implemented as short-lag stops in their first language. (Caramazza, Yeni - Komshian, Zurif and Carbone 1973, Flege and Part 1981, Fort and Mithebh 1983).

Flege and Eefting (1986) consistently identified the end point stimuli in the VOT continuum which varied according to both age and native language. This was also seen in Spanish language.

Flege (1981,1986 a) showed that highly experienced native English speakers of French produced English \t\ with significantly shorter (French like) VOT values than English monolinguals and and conversely that highly experienced native French speakers of English produced \t\ in French words with significantly longer VOT than French monolinguals.

Flege (1986 b) had differentiated I language stops from corresponding second language stops as a result of "Polarization".

Keating (1984) proposed that the Universal phonetic

principle of polarization leads to a small VOT difference between the short-log stops of Spanish and English.

According to Lado (1957), Chinese learners of English are often unable to produce a perceptually effective contrast between phonologically voiced and voiceless stops in the final position of English words.

Lee Williams (1977) had conducted investigation of VOT in word-initial voiced and voiceless stop consonants obtained from venenzualan. perwian and Guatamalan Spanish dialect groups showed no significant cross-dialect differences in the distribution of voice-onset-time (VOT) values.

According to Goldstein (1979) Wesmen's etal (1979), a child-adult difference in VOT (if observed) might derive from changes in vocal tract anatomy or age-related changes in speaking rate rather than from changes in the realization rules used to produce stop consonants.

Caramazza etal (1973) nave concluded that VOT is an insufficient cue to the contrast between \ba\, \pa\, \da\ \ta\ and \qa\ \ka\ for native French Canadian subjects because their identification function had shallow shapes and were non monotonic,

Repp (1979) found that increasing burst and aspiration intensity shifted the boundaries of native English subjects to lower VOT values.

Thus, VOT are of the important temper parameter, has shown both inter and intra subject and across the languages differences. Hence it was considered that the study to note inter and intra of cross-languages variable in VOT.

Vowel Duration :

Acoustic studies along this line in children, were recently reported by Disimoni (1974) who made oscillaqraphic measurements of vowel and consonant duration in CVC and VCV utterances of children aged 3—, 6- and 9— years. It was concluded from these studies that the variability of the durations tended to decrease with age and this paralles the age related variance. Check this English and Hurish (1969). In addition the vowel duration in the voilen consonant environments remained relatively consonant for all ages tested, while the duration of vowels in voiced consonant environments were found to increase with age.

Mean duration for vowels \i\ and \a\ pooled in voiced (::) and voiceless (o) consonant environment (Data in adult column takes from Peterson and Lehiste1 1960 (Dismoni 1974),

Mean duration and standard deviation for Vowels in plosive (o) and sibililent (x) environment (Data in adult column taken from Peterson and Lehiste, 1960 Disimoni 1974).

Vowel durational values compared for both voiceless and voiced consonant envert were found to be significantly different in six and nine year old subjects but not in three

year old subjects. Durational differences begin to appear by age of three although the difference do not reach statistical significance until age six. Disimoni interpreted his data as evidence of a developmental pattern in which the control of duration charges rapidly in the period between 3 and 6 years.

Raphael, Darman and Geffner (1780) studied the vowel duration in minimal pairs differing only in the voicing characteristic of the final consonant, in 3- and +- year old children. Spectrographic analysis revealed that children produced vowel duration differences of the same nature and magnitude as those found in adult speakers utterances. However they reported that the duration of a preceding vowel, as well as the duration of voicing during the final consonant closure, are reliable production of the voicing characteristic of the final consonant.

Smith (1778) reported that ourations of nonsense utterances were 15% larger for four year old than for adults and 31% longer for two year olds than for adults. Reduction of segment duration with age may be a consequence of neuromuscular maturation, therefore durational measurements may be one way of characterizing a child developmental progress in attaining adult-like speech motor control, another reason may be that the developmental patterns in the control of duration are a necessary substrate for research on the acquisition of phonological process (Kent 198O).

Another developmental pattern emerging from studies of children's speech is an age dependent decline in variability of performance (Eguchi and Hersh 1969 : Disimoni 1974; lingley and Allen, 1975; Kent 1980). If variability is taken as an index of maturation of motor control, then it appears that a child's speech production continues to improve in precession until at least, 11 to 12 years of age. This gradual decline in performance variability as a function of age, accords with part of Bruner's (1973) definition of development of skilled acts.

Comprehensive data on the development of tuning control in children's speech also are needed for the quantitative study of speech disorders. Many disorders particularly those of neurologic origin involve disturbance of timing control. For both diagnostic and rehabilative purpose, it is useful to know similarities and differences between these abnormalities of timing normal development and the children's timing control of that of normal adults (Kent 1980,'.

Speculations on the sole of the cerebellum in motor control after emphasizes the need for the cerebellum to gain experience in motor accomplishment and to "learn" from that experience to predict and modify as required the motor consequences of afferent outflow. By this reasoning the cerebellum must be an active participant in the motor learning of speech production. There is at least a superficial resemblance in so far as both young children and individuals with dysarthric of carabellar origin tend to have speech

segments that are longer and more variable in duration than those of normal adults (Kent, Netsell and Abbs 1979). However, Kent (1980) has pointed out that although four year olds and cerebellar dysarthrias share a tendency to prolong speech segments, the timing control for sulbnere were determined duration does not seem to be fundamentally similar for these two groups. In this way, systematic studies of temporal regulation in developing and disordered speech should be helpful in testing hypothesis about the structure of motor programs in speech productions and the ways in which these programmes are acquired and maintained.

There are guidances to show that slow speakers are more variable in timing control than fast speakers.

Vowel duration has been measured in various languages English (Klait, 1980; Raphael, etal., 1975; walsh and F'arker 1981); Kannada (Rajapurohit. 1985); Malayalam (Velaudan); Tamil (Ealasubramanyan 1982); Japanese (Homma, 1981); French (O'Shaughnessy, 1981), Nack, 1982); Swedish (Lyberg, 1981); Hungarian (Fonagy, Fonagy and Dupuy, 1980) and in Dutch Nooteboon, 1972).

The average durations of the English vowels have been named by Petersonand Lehiste (i960).

Average duration of syllable nuclei measured from minimal pans differing in the voicing of the final consonant. The solid curve is for a large set of CMC words spoken by one speaker while the dotted curve represents the values for 30 minimal pairs offered by 5 speakers (Peterson and Lehiste, 1960).

Durations of individual segment differ widely from these averages due to systematic influences of phonetic and syntactic environments. There are a host of variations which affect the duration.

Factors that influence the durational structure of sentence are as follows (Klatt, 1976):

Extra linguistic :

Psychological and physical state (Williams and stevens. 1972)

Speaking Rate (Huggeins, 1964: Goldman - Eisler, 1968)

Discourse level :

Position within a paragraph (lehiste, 1975)

Semantic:

Emphases and semantic noveltv (Cokes etal 1973).

Syntactic :

Phrase structure lengthening

(Martin, 1970; Keatt, 1975)

word Level :

word final lengthening (Lehiste 1972; Otter, 1973).

Phono Logical / phonetic :

Inherent phonological duration for a segment (Peterson and Lehiste 1960)

Effect of linguistic stress (Parameter and Trevino 1936)

Effect of post vocalic consonant (House and Fairbanks 1953)

Segmental Interaction for example consonant clusters (Klatt, 1973;Haggard, 1973).

Physiological :

Incompressibility (Klatt, 1973)=

In addition to these factors, Lyberg (1981) reported a strong relationship between duration and the fundamental frequency change. However, he further goes on to say that the fundamental freguency contours can never be a secondary effect of the segment durations and that it seems guite impossible to generate the fundamental freguency contain only from duration values.

Lee (1978) has reported that the difference in duration between tone classes is primarily determined by the shape of the fundamental freguency contour, The intrinsic duration of a vowel in a tone language is conditioned by the tone that the vowel carries.

Gn the other hand Notebborn (1972), Cooper (1976), Lindbion etal. (1976) and Lehiste (1976) have observed duration to be

independent of the fundamental frequency contour.

Measurement of vowel duration have been made using oscilloqrams, spectograms, electro kymographic casings and computers.

The duration of the preceding vowel is often cited as an important cue to the voicing feature of final stop consonants in English; preceding vowel duration has been called under certain conditions a primary (Klatt. 1976) and even necessary (Raphel, 1972) cue to the voicing distinction.

wardrip - Frum (198S) suggested that neutral speech, vowel duration differences are probably neither necessarv nor adequate cue to this distinction and that voicing during closure may be required to disambiguate voiced stops.

For American English, the finding of shorter vowel duration before vowels as opposed to voiced stops is consistant over a large number of adult speakers. studies and phonetic environments (House, 1961; House and Fairbanks, 1953; Klatt 1973). For pre-pasual syllables. the vowel before the voiceless coqnats averages about 60% (range 52% to 69%) of the vowel before the voiced cognate. The data on children's productions show the same tendency, although the difference is not clearly significant for the Youngest (2 to 3 year old) Speakers (Disimoni 1774; Gseenles, 1978; Naeser, 1970).

Krause (1982) reporting the data on boundary in children aged three and six year's, suggested that as the age of the

listener increased, progressively shorter vowel duration were required. to shift a listener's judgments of a past vocalic stop from voiceless to voiced.

krause (1983) reporting the data on boundary in children aged three and six year's, suggested that as the age of the listener increased, progressively shorter vowel duration were required to shift a listener's judgments of a past vocalic stop from voiceless to voiced.

Refinement of vowel duration with an increase in age is demonstrated for both speech perception and production (Krause 1982).

Vowel duration has been studied in some speech improved adults. Disimom (1974) is a preliminary study of certain turning relationship in the speech of stutterers indicated that differences exist in the duration and in certain aspects of timing of fluent sequences of phonemes in stutterers. Stutters also showed greater variability than non-stutters in duration control.

Christnerser and wenberg (1976) observed that the overall vowel durations of esophogeal speakers were consistently lonqer than those of normal speakers, indicating that esophogeal speakers do not compensate for their striking domination in an supply for speech by decreasing the vowel duration.

Collins, Rosenbek and wertz (1983) pointed cut that most

normal speakers of English reduce the duration of the vowel, as the words increase in length. Howevsr, in a spectrographic analysis of vowel duration in apraxia of speech,, they found the vowel duration to be significantly longer than those for normal speakers. The results suggest that vowel reduction is a robust phenomenon which resists impairment in apraxia of speech, despite often significant disturbances in motor programming.

Natra.ia and Jagadeesh (1984) have shown a relationship between F.F. of voice and vowel duration.

Rashmi (l985) has reported that both the males and females show a decrease in the vowel duration with increase in age. After 12 years the decrease in vowel duration is not significant. Disimoni. (1973) reports similar finding.

Detailed analysis of the Chinese speakers of English of the production of \p\ and \b\ in word - final position have shown that Chinese subjects had produced a much smaller duration and difference between vowels preceeding \p\ vs \b\ (Flege etal 1987, Fleqe 1988).

METHODOLOGY

This study was aimed at investigating the inter and intra subject variability in some temporal aspects of speech i.e..

1.Vowel duration,

2.Voice onset time.

and also across the mother tongue and other languages that subject could speak Kannada,Tamil.Hindi and English).

SUBJECTS:- Nine subjects were taken for the study,[four males and five females] age ranging from 18-55 years. The subjects were randomly selected from among the students of A.I.I.S.H.

I. The criteria for the selection of the subiects was that

1) the subjects had no speech and/or hearing problems.

2) The subjects selected were hearing either Hindi,Kannada or Tamil as their first language,

3) English as their second lanquage and any language in either of these three was taken as additional lanquage or third language.

The subjects were divided in to three groups based on mother tongue.

The first group consisted of three subjects[females] who had Kannada as their mother tongue. They had learnt English and Hindi in their school and were using them m their day to day activities. All the three subjects wera fluent in their mother tongue (Kannada) and other two languages. They were proficient in a11 the three modes speaking,reading & writing) in all the three languages.

The second group consisted of three[males] subjects who had Hindi as their mother tongue. They had learnt English in school and were using both the languages regularly. They could read.write and speak using these two languages.

The third group consisted of three subiects who had Tamil as their mother tongue. They had learnt English in school and were using both the languages regularly. They could read, write and speak using these two languages.

TEST MATERIAL:- Twenty meaningful words consisting of CVC or CvCv syllables with voiceless consonants [p,t,t,k] in the initial position of the word were used to form 20 meaningful sentences.in each language,,(Kannada,Hindi,English & Tamil). The test word occurred as either second or third word of the sentence.

Thus SO sentences in each language were developed for the purpose of studv.

The recording of analysis principally involved the following equipment as shown in the block diagram fig no

Instruments used :

1, Tape deck [Philips ampi Deck f6121] to record the speech sample.

2, Antialiasing filter Clow pass filter having cut off freguercy at 3.7/7=5k]

3. A-D/D-A converter [sampling frequency at 8/16 KHZ.12 bit]

4. Personal computer - A T intel - 30386. microprocessor with 30S37 Numerical data processor.

5. software [developed by voice speech systems Bangalore] for acquisition of data,storing data & analysis of data

6. Amplifier and speaker.

COLLECTION OF DATA:

The speech sample for each subject was recorded in a sound treated chamber. Recording were made an the cassette tape and on the disc of the computer [Using analog to digital converter] simultaneously. The microphone-to—mouth distance was approximately 15 cms for all the subjects.

The subjects were instructed as follows for recording speech. "Now whenever I give the signal [demonstration of presenting the signal] you have to read one sentence as normally as possible, using the cards provided to you., in the same order as they have been arranged.

The test material consisting of 50 sentences in each language [Kannada,Hindi,english and Tamil] were written down on flash cards. 20 cards of a language chosen were randomly arranged. Five trials of each sentence was recorded, each sentence was read by the subjects five times. Thus for each subjects 100 sentences were recorded. The cards of each languages ware presented randomly.

Recordings of the five trials was done separately on 5 different days. The mother tongue was recorded first and in second session second language was recorded and 3rd session the 3rd language was recorded. [Recordings of the five trials on five different days was done to find if there is any intra subject variability]

The speech samples of each subjects were digitized at the rate of 16000Hz sampling frequency using a 12 bit (ADC) Analog to digital converter and havina antialiasing filter at 3.5 KHz APC - AT 386 computer lintel 80386 and intel 80387 with 16 MHz clock speed was used for the diaitization .

The digitized speech sample were segmented and onlv the test words were stored on hard disk / floppies / cassettes for further analvsis.

From the analysis of digitized speech sample using DSW & spectrogram programmes, a) Voice onset time (VOT), (B) Vowel duration (vD) were obtained.

All the five utterances of each sentence were analvzed using the computer programmers and the values of each parameter for each subject were noted.

Programme:

D.S.W :- The execution of programme with particular data (signal), the wave form would be displayed on the monitor of the computer (fig- 2) .It has a vertical cursor, which can be moved horizontally. This can be used to mark specific part on the waveform and listen to the signal present in that marked part of the waveform and also to note the time at any given point/ points on the waveform, Using this it would possible to seqment,, edit Dr measure duration of anv desired portion of the wave form,

D S P S :

a) This programme produces the spectrograms wide band / narrow band) and display the same on the monitor of the

computer (VGA colour)

b) It has both horizontal & vertical cursors which helps

1) to mark any two points and listen to the signal present between the markings and listen to that particular part or the whole signal

2) To find out the duration between the marked points

3) To obtain sectioning.

4) To measure intensity, frequency and duration at any given point.

vowel Duration :-

The Vowel duration (in msecs) for each vowel were measured from the spectrogram. The measurement criteria for vowel duration were as suggested by Peterson & Lehista 1960 i.e.. the vowels were identified on the spectrograms & the duration from the onset of phonation indicated by the initial periodic striations of the first formant at the last vertical striation associated with the second formant was considered as duration for each vowel.

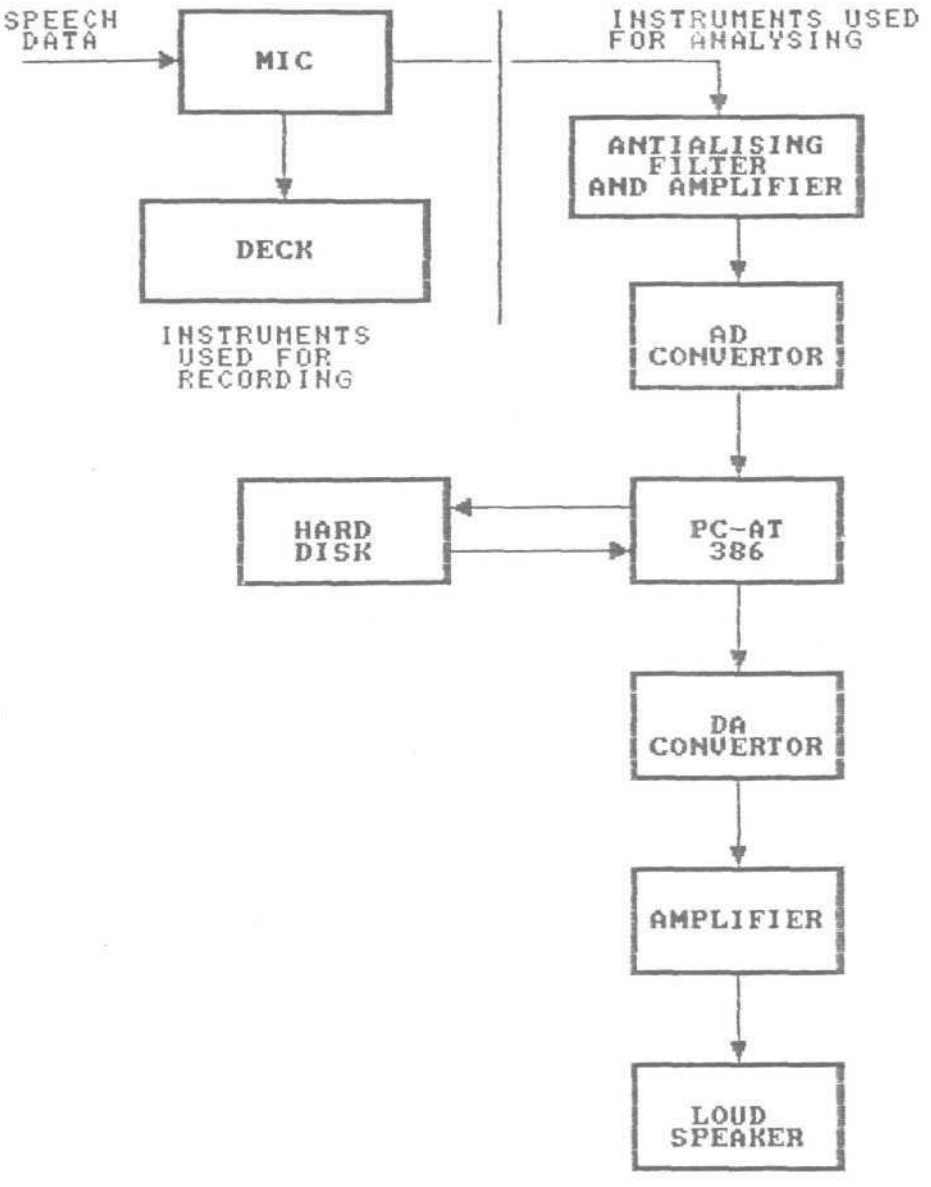
VOICE ONSET TIME (VOT):-

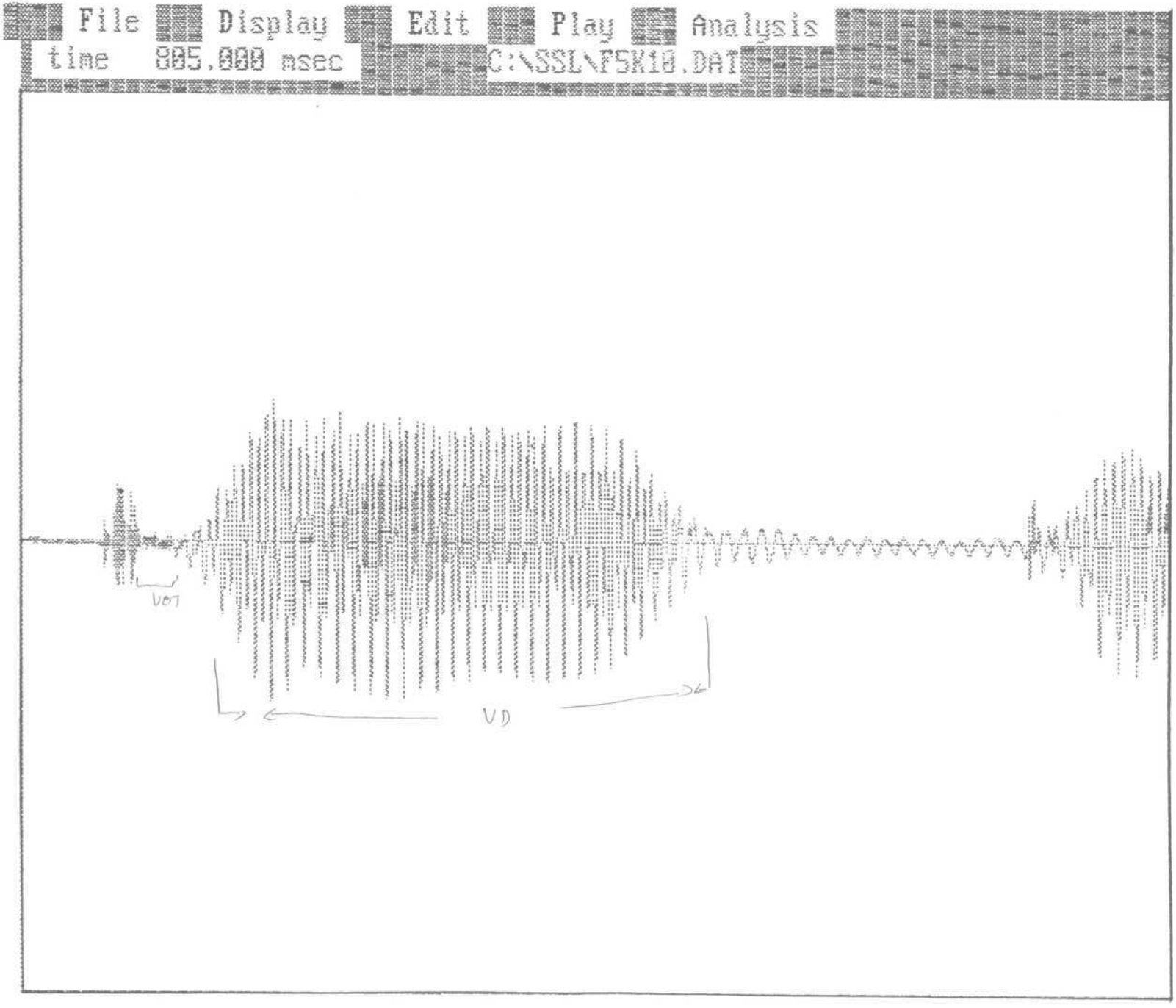
The same procedure was followed for measuring VOT also. The VOT was measured in msecs using the definition given by Lisker & Abramson (1967) i.e.. the time interval between the burst [i.e., briaf intervals of high intensity noise] that marks the release of the stop closure and the onset of guasi-periodic pulsing that reflected larygeal vibration was the voice onset time.

STATISTICAL ANALYSIS:-

Both descriptive & inferential statistical analysis were carried out. Mean, range, standard deviation were found out & MAN-WHITNEY 'u' tests were performed on the data and appropriate inferences drawn.

BLOCK DIAGRAM SHOWING SETUP OF INSTRUMENTS FOR THE EXPERIMENT:




File
Display
Edit
Play
Analysis
time 805.000 msec
C:\SSL\F5K10.DAT
VOT
VD

RESULTS AND DISCUSSION

The main purpose of the study was to determine the VOT and vowel duration for subjects speaking mothertongue and other additional languaaea. VOT for (F'), (L). (k). (t) and the duration of (a).(i),(u).(o),(e) following the voiceless stop consonants were obtained from the ulterances of different subjects using wide band spectrograms. The means, standard deviation and range of Voice Onset Time VOT's and Vowel Duration VD for the subjects of each language group were computed.

VOICE ONSET TImE(VOT)

Table l(a) and Sraphl gives the of VOT's values for voiceless stop sound's in reading for each subject speaking kannada as mothertongue. It can be noted from the table that each subject showed a longer VOT for \k\ (10.48 - 11.84) mscs than for other sounds i.e. \p\,\L\,\t\. The difference in VOT across repeatations was always seen for each voiceless stop sound within each subject. The mean VOT varied from 7.3E to 10.36 mscs. 4.84 to 6-96 mscs. 6.48 to 13.96 mscs. 10.48 to 11.86 mscs for \t\i\t\i\p\ and \k\ sounds respectively in reading

Further it can be noted from table l(a) and graph 1 that the VOT for \p\ has varied from 1 msec to 25 msec across the subjects. Subject 3 (K3) sharing maximim range 3 to 25 msec and subject K4 showing minimum range i.e.. 1 to 13.6 msec. The mean range being 17.65 msec. In other words the variability expressed in terms of standard deviation subjects K1 to K3 showing around 5 msec and K4 had 3.73, the least among the subjects.

Table l(a) showing Mean,SD,Range of VOT for the subjects speaking Kannada.

		P	t^h	t	k
KF1	MEAN	9.46	8.65	5.76	10.67
	S D	5.2	2.49	3.14	4.76
	RANGE	2-19	3-15	2-14.05	5-20
	MEAN	13.96	8.19	6.24	10.48
KF2	S D	5.87	3.21	2.63	3.76
	RANGE	6- 25	4-18	2-13	2-20
KF3	MEAN	10.56	10.36	6.96	11.84
	S D	5.89	4.65	5.08	6.401
	RANGE	3-25	4-22	1-25	3-24
KF4	MEAN	6.48	7.32	4.84	10.61
	S D	3-73	5.31	2.48	6.20
	RANGE	1-13.6	1-20	2-11.7	1.6(29.5)

Similinly for repeated production \t^h\, the variability within the subject i.e., across the repeatation by the same subject, the 3D had been maximim of 5.31 for subject K4 and least for Kl i.e., 2.49 and other subjects falling in between. The SD for \t\ on reoetation for each subject had varied from 5.08 to 2.48, as shown by K3 and K4 respectively. The other subjects had SD falling within this range.

The vOT for \k\ had been longer among all the stops studied as shown bv all subjects except subject KB. The range of SD for this sound had been 6.4 to 3.76.again as shown by K3 and K2. The other subjects had SD within this range. The

administration of 'T' test had shown siqinificant difference across the stops studied. Thus it can be concluded that

1) There is variabilit across the repeated production of stop consonant in Kannada

2) Longest VOT is shown by \k\ and the least by \t\ and \p\ and \t\ following in between.

Table l(b) showing Mean SD and Range of VOT for the Hindi samples.

		P	t^h	t	k
HM1	MEAN	3.172	12.42	7.79	10.64
	3 D	4.212	5.36	2.68	4.06
	RANGE	0-16	4-24	3.8-15	4-20
HM2	MEAN	7.64	15.12	8.99	13.5
	3 D	4.50	7.19	4.13	4.84
	RANGE	9.22	5.25	0.16	5-22
KF1H	MEAN	10.86	12.17	3.64	13.16
	S D	5.42	4.93	3.33	3.42
	RANGE	0-21	5-23	0-15.3	4—22
KF2H	MEAN	5.46	11.32	6.48	14.16
	S D	3 .26	5.94	3.22	6.73
	RANGE	0-13	4.8-27	0-12.9	3-26
KF3H	MEAN	8.22	6 . 5	3.06	14.60
	S D	4.59	4.17	5.50	6.54
	RANGE	2.4-20	0-14	2.5-26.6	6-29
KF4H	MEAN	8.56	10.30	7.74	11.60
	S D	5.132	5.91	5.30	5.26
	RANGE	13-22.4	1-22	3-20	3.5-22

Table l(b) and Graph2 shows the mean, standard deviation and range of VOT for Hindi speakinq (Hindi as mother tongue and as second language) subjects in reading. It can be seen from the table l(b) that the Hindi speaking subjects constantly showed a lonqer VOT for the voiceless stop consonants \k\ i.e.. the mean VOT for \k\ ranged from 10.64 to 14.60 mscs, Whereas \$t^h$\ showed the least mean V0T ranginq from 6.48 to 8.99 mscs. The remaining two sounds \p\ and \t\ showed VOT values of 6-48 to 8.99 mscs and 6.54 to 12.43 mscs. The change in VOT was seen for each voiceless stop from repetation to repetation within each subject. The ranges were 6.54 to 12.42 mscs. 6.48 to 8.99 mscs. 5.48 to 10.86 mscs. 11.60 to 16.60 mscs for \$t^h$\. \t\, \p\ and \k\ sounds respectively in reading.

Table l(c) and Graph3 shows the means standard deviations, range of VOT for subjects who had Tamil as mother tonque. it can be seen from the table that the subjects constantly showed a lonqer V0T for voiceless stop consonant \k\. mean ranqinq from 9.03 to 16.45 mscs whereas the stop consonent \i;\ showed the least with the mean ranqinq from 6.73 to 10.63 mscs. The difference in the VOT was seen for the each subject. The range of difference varied from 10.01 to 11.30 mscs, 7 to 10.63 mscs. 9.55 to 11.27 mscs. 9.03 to 13.86 mscs for \t^h\,\t\,\p\ and \k\ sounds respectively.

The studv table l(c) and graph 3 for \p\ sound. the variability across the repeatation has ranged from 1.89 to 1.72 by subjects H3 and H2 respectively. The other subjects sharing SD within this range. Similarily for \t\ had ranged from 4.81 to 3.77 as shown by subjects T3 and Tl respectively. It had ranged from 2.32 to 7.41 (T3 and T2 respectively) in

the repeatation of \k\.

Table l(c) Showing Mean S D Range of VOT for the subject speeking Tamil.

		p	t^h	t	k
TM1	MEAN	9.55	11.10	7	13.85
	S D	3.456	3-77	2.61	4.221
	RANGE	5-18	5-19	2-12	6.22
TM2	MEAN	10-75	11.30	6.73	16.45
	S D	7.42	4.34	3.08	7.416
	RANGE	6-38	5-19	2-14	6.38
TF1	MEAN	11.27	10.01	10.63	9.05
	S D	1.894	4.81	2.56	2.825
	RANGE	4-16	5-21	6-17	4.16

The mean VOT tor \k\ had bean longest (12.95 msec) except in case of one subject (13) who shot-.'n the lonaest moan 'VOT for \p\. Simnillraly the next longest mean "VOT (11.39 msec.- had been for \t^h\ except in case of subject T8. who had longer mean "VOT for \p\.

The mean VOT for \t\ had been the least among the stops produced bv Tamil speaking subjects i.e. 7.95 msec.

The mean VOT for \p\ comes in between \t^h\ and \t\ i.e.. 8.49 msec. The overall variability had been 0.8. 1.53. 1.80 and 2.85 for \t\, \k\, \p\ and \t\ respectively. Thus it can be concluded that there is a significant difference in 'VOT' across the sounds studied. Further it can be stated that the intra subject variability exists just like in Kannda speaking

subjects and VOT does not vary consistently with shifting of construction like in Kannda speakers.

Table l(d) showing Mean.SD and Range of VOT of the subject speaking English

MEAN VOT IN ENGLISH

		P	t^h	t	k
KF1E	MEAN	8.55	11.4	5.84	7.77
	S D	3.383	5.4	1.86	3.60
	RANGE	2-16	4-21	3-10	3-18
KF2E	MEAN	9.64	8.04	6.2	10.48
	S D	3.61	2.31	2.46	2.82
	RANGE	2.8-19	4-15	2-11	7-17
KF3E	MEAN	10.6	14.08	9.76	11.16
	S D	3.42	6.76	4.46	3.41
	RANGE	2-14	5-26	3-19	5-17
KF4E	MEAN	9.53	8.63	8.76	10.44
	S D	14.10	2.96	3.192	3.84
	RANGE	0-16	4.2-17	2.9-17	6-25
HM1E	MEAN	11.8	14.8	7.72	11.04
	S D	5.69	6.44	3.22	5.37
	RANGE	5-25	5-25	2-13	6-25
HM2E	MEAN	12.5	12.43	9.04	11.28
	S D	5.47	4.66	4.363	6.51
	RANGE	4-25	4-25	3-20	6-25
TM1E	MEAN	11.45	11.72	9.08	9.6
	S D	5.38	6.66	5.55	4.21
	RANGE	4-21	5-20	2-29	3-16
TM2E	MEAN	12.8	8.7	10.2	13.41
	S D	4.59	3.12	5.67	4.22
	RANGE	6-20	4-16	3-28	8-21
TF1E	MEAN	10.95	10.24	9	8.64
	S D	3.25	3.73	3.67	3.49
	RANGE	4-19	5-22	4-17	0-16

Table 1(d) and Graphs shows the mean, standard deviation and range of VOT for subjects speaking English as second lanquage or additional language. It can be seen from the table 1(d) that the subjects constantly showed a longer VOT for the voiceless stop consonant \k\,, The overall mean VOT for \k\ is 10.42 mscs and for \t\ it was ll.2 mscs. The stop consonat \t^{h}\ showed the lowest VOT. The total mean was 8.*21 m*scs and mean ranged from 5.84 to 9.76 mscs . The difference in VOT was always seen for each voiceless consonant within each subject's repeatations. This range of differences were 8.04 to 14.8 mscs, 5.3 to 10.2 mscs. 8. 5 to 12.8 mscs. 7.76 to 13.41 mscs for \t^{h}\, \t\,\p\,\k\ sounds respectivley . There was no significant difference in V0T of the voiceless consonants with reference to the sex.

Table l(e) and Graphs shows the total mean. standard deviation and range of subjects. The voiceless consonant \t\ had the least VOT values. The mean VOT values for \t\ were 8.31 mscs, 5.95 mscs, 8.12 mscs, 7.95 mscs for Eng1ish, Kannada, Tamil and Hindi respectively.

The stop consonant \k\ was noticed to have had a longer vOT. The overall mean VOT values for \k\ were 10.42 mscs, 10.90 mscs, 11.44 mscs, 12.15 mscs for English, Kannada, Tamil and Hindi respectively. The total mean VOT values for \t\ was noticed as 11 .12 mscs., 8.61 mscs. 10.78 mscs. ll.81 mscs for English, Kannada, Tamil and Hindi respectively. The total mean for \p\ was notieced as 10.90 mscs. 1O.ll mscs, 10.52 mscs, 5.49 mscs for English, kannada, Tamil and Hindi.

Table 1 (e) showing the Total Mean, Range and SD in reading for sentences for different languages for normal speaking(in msecs .

	NO.OF SUB		P	t^h	t	k
ENG	9	MEAN	10.90	11.12	8.31	10.42
		S D	1.47	2.42	1.70	1.64
		RANGE	0-25	4-26	2-29	0-25
KAN	4	MEAN	10.11	8.61	5.95	10.90
		S D	3.09	1.29	0.88	0.63
		RANGE	1-25	1-22	1-25	16-29.5
TAM	3	MEAN	10.52	10.78	8.12	11.44
		S D	0.88	0.68	2.17	2.41
		RANGE	1-22	5-21	2-17	4-38
HIN	6	MEAN	8.49	11.39	7.95	12.95
		S D	1.80	2.85	0.87	1.53
		RANGE	0-22.4	0-28	0-26.6	3-29

It can be noted from the table and graph that the mean VOT for each voiceless stop consonant varied for each subject. Thus the hypothesis stating that there is no difference in VOT between different subjects using the same language as mother tongue is rejected. The hypothesis stating that there 1= no difference in VOT values of same stop cosonant of different languages spoken by the same subjects *is* rejected.

Lisker and Abramson (1964) and Hillman and Gilbert (1977) found that there is a consistent increase in vOT for stop sounds as the place of articuiatory constriction move

backwards in the oral cavity. The result of the present study supports the above reports as \p\ has a VOT value of 12.5 msec, \t\ \th\ have 4.8 msec,9.8 msec as VOT and \k\ has 11.28 msec of VOT.

Babul Basu (1979) found that the VOT values are different for different stop sounds. He also showed that there was a consistent increase in VOT as place of articulation moved back in the oral cavity. Similar result's are being noted in the presentstudyalso.

Table l(f) shows Mean and Range of VOT in reading of sentences for different languages for normal speakers.(In msecs)

* Data as presented by Lisker & Abramson (1964).

	NO.OF SUB		P	t^h	t	k
KAN		MEAN	10.6	13.93	24.77	30.96
		RANGE	7.74 TO 11.61	11.61 TO 15.48	23.23 TO 27.09	27.09 TO 38.7
HIN		MEAN	12	11	11	16
		RANGE	5-20	5-20	5-25	10-25
TAM		MEAN	12	10	-	27
		RANGE	0-45	0-25	-	15-40
MAR		MEAN	0	11	11	21
		RANGE	0	10-15	10-15	20-25
ENG		MEAN	28	39	-	43
		RANGE	0-45	15-70	-	30-85

Table 1(T) shows the mean. ranqe of VOT value's for each voiceless stop sounds in different languages for the normal speakers.

The mean VOT for stop sounds in initial position of a word in a sentence in Hindi,, Tamil, English, Marathi as presented by Lisker and Abramson (1964) are also shown.

On comparison with the values obtained in the present study it can be noted that, the Mean VOT for \p\ in Kannada was found to be less than that of Hindi and Tamil, i. e , . Mean VOT for \p\ in Kannada was 10.06 mscs. In the present study \t\ was found to be less i.e., 8.31 mscs followed by \p\ 10.90 mscs, \k\ 10.42 MSCS \t\ 11.12 mscs. Whereas in Hindi and Tamil it was 12 mscs. In the case of English the mean VOT for \p\ was reported to be 28 mscs, Thus in English initial \p\ had a longer VOT than that of Kannada. In Marathi the mean VOT for \p\ sound was reported to be 0 mscs.

VOT for \t\, \t\ and \k\ sound in Kannada was found to be more than that of Hindi and Marathi. VOT for \t\ and \k\ in Kannada was found to be more than that of Tamil. In English the voiceless stop sounds in initial position of words (in reading) showed a longer VOT than that of Kannada.

Thus it can be concluded that the English \t\ had longer VOT i.e., 1.12 msec and \t\ had least V0T i.e, 8.31 msec, when all the subjects considered were studied.

In Kannada \k\ had a longer VOT of (10.90 mscs) and \t\ had

the least VOT i.e. . 5.95 mscs. as shown by speakers with Kannda as mother tongue.

In Tamil \k\ had longest VOT (11 .44) mscs and \th\ had least VOT(8.12 msecs) as shown by speakers with Tamil as mother tongue.

in

In Hindi also \k\ had longest VOT (12.95) mscs and \th\ had least VOT (7.95msecs), when speakers who had Hindi as mother tongue and an additional lanquage were considered.

It was noticed that \k\ was having longer VOT in all. languages followed by \th\ then \p\ and \t\. \t\ . Thus the "findings are not in agreeent the findings of Lisker and Abramson (1964) as \t\ had shown least VOT and not \p\.

\k\ produced by hindi speakers in hindi was noticed to be longer i.e.. 12. 95 msecs & \k\ produceed by English as spoken by all subjects was noticed to had lowest value i.e., 1O.42 msecs.

\t\ in English had longest duration (8.31msecs.) and \t\ produce by Kannada speaker had the lowest value 5.95 msecs. \t\ produced by Hindi speaker in Hindi it was noticed to have had was noticed to be 11.39 msecs as VOT .

\p\ produced by English speakers had longest duration i.e.. 10.90 msecs and \p\ produced by Hindi speakers had least value VOT of (8.49) msecs.

In the present studv also it was noticed that V*0T* values

increased as the position of the articulatory constriction moved backward in the oral cavity as noticed bv Lisker & Abramson(1964), Babul Basu(1979) (except fur the fact that \t\ had lower VOT than \p\.

In the present study it was noticed that the VOT in different languages were different. This indicates that VOT varies from language to lanquaqe as noticed by Lisker & Abramson . (1964)

In the present study it was also noticed that VOT varies with subjects. No two subjects had the similar VOT values, Which goes along with the saying that no two things wi11 be simi 1lar.

Thus the hypothesis 1(b) stating that there is no significant difference in the repetation of same sound by the same subject in terms of VOT is rejected in this study.

Table i(g) shows the mean, range and standard deviation of voice onset time VOT in subjects speaking Hindi as a first and second language. It can be seen from the Table that the subject showed a constant longest VOT for /k/ 1 1 .'75 msec. and 13.39 msec. But the subject having Hindi as mother tongue showed longest VCT in /th/ also. In both the subject groups /t/ was noted to have a lesser VOT of 8.39 m. sec. and 7.73 msec. The mean value for the group which had Hindi as first lanauage i.e. group II were 8. 88 msec.,, 13.56 msec., 8. 89 msec & 11.75 msec. for ′*p/*- /th/, */t* / &: /k/ respectively. The qroup I subjects who had Hindi as second language had VOT as 8.26 msec., 10.21 msec., 7.73 msec. &. 18. 19 msec, for ,/p/, */th/, /t/*

& /k/ respectively. So from the table we Can conclude that there is difference in subjects having Hindi as mother tongue and as second language.

TABLE l(a) COMPARISION Of VOT IN HINDI WITH SUBJECTS HAVING HINDI AND KANNADA AS MOTHER TONGUE

MOTHER TONGUE		NO. Of SUBJECTS	/p/	/ṭ/	/t/	/k/
HINDI	MEAN	2	8.88	13.56	8.39	11.75
	S D		1.09	2.20	0.841	2.474
	RANGE		0-22	4-25	0-22	4-22
KAN-NADA	MEAN	4	8.26	10.21	7.73	13.39
	S D		2.21	2.57	0.91	1.33
	RANGE		0-22.4	0-28	0-22.4	3-26

Thus the hypothesis *1(d)* stating that there will be *no* difference in VOT across languages of different sounds as spoken by subjects using their mother tongue and second language is rejected.

Table l(h) COMPARISION OF VOT IN ENGLISH WITH SUBJECTS' HAVING DIFFERENT LANGUAGES AS MOTHER TONGUE.

MOTHER TONGUE		NO. OF SUBJECTS	/p/	/t^h/	/t/	/k/
KAN-NADA	MEAN	4	10.70	11.67	7.2	10.5
	S D		1.95	2.71	1.47	1.62
	RANGE		0-25	4-26	2-20	5-25
HINDI	MEAN	2	10.06	11.35	9.26	10.8
	S D		0.756	3.85	0.707	0.509
	RANGE		2-25	4-25	3-13	3-25
TAMIL	MEAN	3	11.73	10.22	9.42	10.55
	S D		0.956	1.51	0.670	2.52
	RANGE		4-21	4-22	2-29	0-21

Table l(h) gives the Comparison *of* VOT in subjects having Enqlish as second lanquage. It can be noticed that in all the language groups \t\ was having the longest VUT 11.67 msec, 11.35 msec and 10.22 msec in group 1 Kannda speakers, group 1 Hindi speaker's, group 3 Tamil speakers respectively. \t\ had the lowest VOT value i.e.. .7.2 msec, 9.26 msec. 9.42 msec in group 1, group 2 and group 3 subjects respectively. In the group 3 i.e., Tamil group the stop consonant \p\ was found to have had longer VOT than other groups i.e., 11.73 msec in Tamil compared to 10.06 msec in Hindi, 10.70 msec in Kannda. There was variation in VOT in all the language groups, But in the three groups Tamil was noted to have had lonqer VOT in ail the stop consonants except in \ th \ i.e, 11.73 msec., 10.22 msec, 9.42 msec & 10.55 msec for \p\, \th\, \t\ & \k\

respectively.

SIGNIFICANCE OF DIFFERENCE OF VOT ACROSS LANGUAGE GROUPS IN T-TESTS

As mentioned in the methodology the three qroups i.e.. Group 1 subjects having Kannada as mothertongue knowing Hindi &. English. Group 2 having Hindi as mothertongue & knowing English., Group *3* having Tamil as mother tongue and knowing English were used for the study. The Voice Onset time were compared using T—test across mother tongue's and across additiona1 1anguaqes.

The comparison of Voice Onset Time- of Group 1 &: Group 2 as shown in the table II not show difference. When the */p/* with the environment of /i/ was compared for both subjects having Hindi & Kannada as mothertongue showed significant difference, similarly (t^ha) ,(t^ni) &. (t^hc) also had difference in terms of VOT (Ku).(Kc) & (Kc) also showed difference *in* total of sight out of t w e n t y *(8 /* 2 0) difference' were seen .

Camparision of significance of difference in Kannada samples (MT) Hindi samples(MT) .

Table 1(i):

		a	1	u	e	o
K	P	NS	S	NS	NS	NS
	t^h	S	NS	NS	S	S
	t	NS	S	NS	NS	NS
	k	NS	NS	S	S	S

Comparison VOT of Tamil(MT) samples and Hindi (NT) samples

Tab1e 1(j):

		a	i	u	e	o
T	P	NS	S	NS	NS	S
	t	S	S	S	S	S
	t	S	S	NS	S	NS
	k	NS	NS	NS	S	NS

Comparison of VOT Kannada (MT) Vs Tamil (MT).

Table l(k):

		a	i	u	e	o
T	P	NS	S	NS	S	S
	t	NS	S	NS	NS	NS
	t	S	S	NS	NS	S
	k	NS	NS	S	NS	S

Comparison of languages (Hindi & kannada) spoken by the group i subjects i.e.., subejects with Kannada as mother tongue & Hindi as second language, showed difference in the production of /pi/ , / p u / / p e / . /t^h i/ , / t^h e / , / t^h o / ,: /ta / , /t1 / . /te / / to/. /ki/,/ku/,/ko/, both in Kannada and Hindi.. Thus a total of thirteen out of twenty (13/20) differences were seen in the comparison.

Comparison of Group 2 (Hindi speakers) & Group 3 (Tamil speakers) did not show much difference. That is difference were seen only on the comparison of /pi/, /po/ , / ta/ , / t^hu/ , / t^ho/ , / ta/ , / t i / , / te/ , / ti/ , / te/ , / ke/ . Thus a total of eleven out of twenty (11/20) differences were noticed.

Comparison of Group 1 (Kannada speakers) Group 3 (Tamil

speakers) showed difference in the following. They were /pi/,/pe/,/po/,/thi/,/tha/,/ti/,/to/,/ku/ & /ko/.Thus a total of nine out of twenty (9/2O) difference were noticed.:

On comparison of English of above three groups(Group 1, Group 2 &. Group 3) showed the following results. Comparison of VOT in the utterances of English words by Group 1 (Kannada speakers) &: Group £ (Hindi speakers) showed difference in the production of /po/,/pu/,/pe/,/ka/,/ku/,/ke/,/ko/ & no significant difference was noticed in the production of other sounds. In total differences were observed on seven out of twenty (7/2O) utterances. Comparison of English spoken bv Group 1 speaker's & Group 3 speakers did not show any difference. Comparison of English spoken by Group 2 (Hindi speakers) & Group 3 (Tamil speakers) did not show much difference, i.e.. difference were seen in the production of /pe/, /po/, /ta/, /ti/, /te/, /to/. In total difference were observed *in* six out of twenty (*5/20)* utterances,

So from the above results except in Group 1 & Group 3 comparison (Kannada speakers & Tamil speakers English) no evidence was there to show that the mother tongue influences the second or additional language spoken.

Thus the hypothesis I(d) stating that there is no significant dirference in VOICE- Unset Time in the production of additional language spoken by subjects having different mother tongues is accepted.

Determining the influence of the following Vowels on **the VOT** of preceding consonant

The' duration of the VOT in different Vowel environment was studied and the results were as follows.

From the table 2.. it was found that in the subject with Hindi as mother tongue \pa\ did not differ significantly across different Vowels except with \po\ showed significant difference only with \pi\. \p\ occurring with \e\ and in it was compared with \p\ occurring with \o\ it showed significant difference. When \pu\ was compared with \po\ it showed significant difference.

(Table 2.1)

	Pa	Pi	Pu	Pe	Po
Pa		NS	NS	NS	S
Pi			NS	NS	S
Pu				NS	S
Pe					S
Po					

4 Significant difference out of 10

(Table 2.2)

	$t^h a$	$t^h i$	$t^h u$	$t^h e$	$t^h o$
$t^h a$		NS	NS	NS	NS
$t^h i$			S	NS	NS
$t^h u$				S	S
$t^h e$					NS
$t^h o$					

3. significant difference out ot 10

(Table 2.3)

	ta	ti	tu	te	to
ta		NS	NS	NS	NS
ti			NS	NS	S
tu				NS	S
te					S
to					

3 significant difference of 10

(Table 2.4)

	Ka	Ki	Ku	Ke	Ko
Ka		NS	NS	NS	S
Ki			NS	NS	S
Ku				NS	NS
Ke					NS
Ko					

2 significant difference out of 10

In total 12 out of 40 Siginficant differance.

So thus from the table it can be noticed that; /po/, /pe/ \pu\ and \pe\ showed consistent difference when compared with \po\.

When \tha\, \thi\, \t^{h}u\ and \t^{h}e\ with the consonant \t^{K}\ occuriing at different vowe1 envirnmont onlY three out *of* ten showed significant difference. When \$t^{h}a$\ was compared with \ t^{h}u\, when \t^{h}u. \ was compared with \t^{h}o\. all the other

comparison showed no significant difference.

Comparison of \ta\ with \t\ occurring in other Vowel environments significant difference was seen only with \ti\ and \to\. Only three out of ten showed significant difference.

\k\ when compared with \ko\ significant difference were seen. \ki\ and \ko\ also showed significant difference. Thus only two out of ten comparisons shewed significant difference.

Table 3... shows the comparisons of tha samples of subjects having Tamil as mother tongue was also carried out. \pa\ and \pe\ when compared showed significant difference. \pe\ and \po\ also showed significant difference. when \pa\, \pi\, \pu\, \pe\ and \po\ were compared compared with other Vowel environments no significant difference were found.

\t^{h}a\ with \t^{h}u\ showed significant; difference. \t^{h}a\ with \t^{h}o\,\t^{h}i\ with \t^{h}o\,\t^{h}e\.with \t^{h}o\ also showed sianificant difference. When \t^{h}a\ was campared with other verbal environment it didnot show any significant difference.

Comparison of the samples of subject having Tamil as MT

(Table 3,1)

	Pa	Pi	Pu	Pe	Po
Pa		NS	NS	NS	NS
Pi			NS	NS	NS
Pu				S	NS
Pe					S
Po					

2 significant difference out of 10

(Table 3.2)

	t^ha	t^hi	t^hu	t^he	t^ho
t^ha		NS	S	NS	S
t^hi			NS	NS	S
t^hu				NS	NS
t^he					S
t^ho					

4 significant difference out of 10

(Table 3.3)

	ta	ti	tu	te	to
ta		NS	NS	NS	NS
ti			S	NS	NS
tu				S	S
te					NS
to					

3 significant difference of 10

(Table 3.4)

	Ka	Ki	Ku	Ke	Ko
Ka		S	NS	S	NS
Ki			NS	NS	NS
Ku				NS	NS
Ke					NS
Ko					

2. significant difference out of 10

In total 11 out of 40 significant difference seen.

\ta\ in Tamil speakers did not show significant difference with other Vowel environment. \ti\ when compared with \tu\ showed significant difference. \tu\ when compared with \te\ and \to\ shows significant difference.

\ka\ when compared with \ki\ and \ke\ also showed significant difference. Other comparisons did not show any difference.

Table 4..showing the comparison of group 1. When utterences of subjects having Kannda as mother tongue were studied the following showed significant difference. \pa\ with \pi\, \pa\ with \pu\, \pa\ with \po\, \pi\ with \pu\, \pi\ with \pe\, \pi\ with \po\, \pu\ with \pe\. \pu\ with \po\, \pe\ with \po\. Difference was not noticed onlv between \pa\ with \pe\. Thus nine out of ben comparisons showed difference.

Comparison of vowels in subjects having Kannada as MT.

(Table 4.1)

	Pa	Pi	Pu	Pe	Po
Pa		S	S	NS	S
Pi			S	S	S
Pu				S	S
Pe					S
Po					

9 Significant difference out of 10

(Table 4.2)

	ta	ti	tu	te	to
ta		S	S	NS	NS
ti			S	S	S
tu				NS	S
te					NS
to					

6 significant difference out of 10

(Table 4.3)

	ta	ti	tu	te	to
ta		NS	NS	NS	NS
ti			NS	NS	NS
tu				S	S
te					S
to					

3 significant difference of 10

(fable 4.4)

	Ka	Ki	Ku	Ke	Ko
Ka		S	NS	S	S
Ki			S	S	S
Ku				S	S
Ke					NS
Ko					

8 significant difference cut of 10

In total 26 out of 40 significant difference.

Significant differences were also seen with \t^{h}\ occurring at different Vowel environment in the following. \ta\ with \t^{h}i\, \t^{h}a\ with \t^{h}u\, \t^{h}i\ with \t^{h}u\, \t^{h}i\ with \t^{h}e\, \t^{h}i\ with \t^{h}o\, \t^{h}o\ with \t^{h}u\ showed difference. Difference were not noticed in \t^{h}a\ with \t^{h}e\, \t^{h}a\ with \t^{h}o\, \t^{h}u\ with \t^{h}e\, \t^{h}e\ with \t^{h}o\. Thus six out of ten comparisons showed significant difference.

\ta\ showed significant difference only in \tu\ with \te\, \tu\ with \to\, \te\ with \to\. \t\ with other Vowel environments did not show any significant difference. Thus only three out of ten comparisons showed significant difference.

\k\ showed significant difference almost in ail the vowel environments except \ka\ with \ku\ and \ke\ with \ko\ which did not show difference. There was eight out of ten difference noticed.

Thus out of Hundred and twenty (120) vowel environments showed significant difference. Hence it has been concluded that the vowel has no influence on VOT in any of the languages studied.

Thus the hypothesis 1() stating that there is no significant difference in VOT across the vowel environment has been accepted.

Similarly the hypothesis l(a) stating that there is no significant difference across and between the subjects in terms of VOT of the speak sounds having a language as mother

tongue is also rejected with reference to subjects having Kannda, Tamil and Hindi as mother tongue.

Hypothesis statinq that there is no significant difference between the languages in terms or VOT of different sounds as spoken by subjects using their mother tongue is also rejected as there was significant difference statistically.

The hypothesis 1() stating that there is difference in terms of VOT across the languages for difrerent speech sound is accepted.

VOWEL DURATION

Table 5 (a) & graph 8 gives the comparison of vowel duration following voiceless stop consonants. It can be noted from table 5 (a) which shows the vowel duration of the subjects speaking group 1 Kannada as the mother tongue. The vowel duration was found to be longest for \a\ 57 - 193 msec. 'i' was found to have least vowel duration 76 - 155 msec. The variation in vowel duration was always seen for all the vowels in all the subjects. The range or variations were 57-193 msec. 76-155 msec, 70-147 msec, 54 197 msec. 59 159 msec for \a\, \i\, \u\, \c\, \e\ vowels respectively.

Table 5 (a) shows the mean,standard deviation and range of vowel duration of vowels for different subjects in Kannada(in msecs)

		a	i	u	o	e
* KF1	MEAN	136.65	112.6	103.9	127.83	133.6
	S D	24.28	15.68	18.381	12.88	18.793
	RANGE	107-193	87-155	76-147	102-159	95-158
* KF2	MEAN	112.7	105.1	110.95	115.15	122.85
	S D	7.255	9.031	12.713	22.172	21.653
	RANGE	102-126	87-123	78-132	100-197	93-159
* KF3	MEAN	110.35	107.7	94.9	100.8	109.15
	S D	15.89	13.757	11.461	16.133	15.465
	RANGE	57-135	91-137	73-119	54-127	88-135
* KF4	MEAN	121.5	99.137	97.47	112	113.58
	S D	17.067	13.02	14.05	13.567	10.544
	RANGE	87-146	76-125	70-124	93-144	59-146

Table 5 (b) and Graph 9 shows the mean, Standard Deviation, range of vowel duration (VD) for Hindi subjects. It can be also seen from table 5 (b) that the Hindi speakers (group 2) constantly showed a longer vowel duration for the vowel \e\. Ranging from [58-185] msecs. The vowel 'i' showed the least vowel duration among the vowels studied, ranging from 57-188 msecs. Variation in Vowel Duration was always seen for each vowel within each subject. The ranges of variation were 53-186 msecs, 57-198 msecs, 63-191 msecs, 59-191 msecs, 58-185 msecs for \a\, \i\, \u\, \o\. \e\ respectively.

Table 5(b) shows the Mean, SD & Range of VD's for vowels for different subjects in Hindi (in msecs)

		a	i	u	o	e
* HM 1	MEAN	114.7	117.9	120.8	113.55	108.25
	S D	19.381	19.498	20.603	10.782	14.189
	RANGE	89-160	95-160	87-161	93-181	78-130
* HM 2	MEAN	102.75	105.27	103.744	115.6	105.6
	S D	10.661	13.283	13.460	20.633	11.736
	RANGE	87-124	79-129	89-150	88-168	88-140
* KF1H	MEAN	115.4	99.25	112.15	105.85	112.7
	S D	5.079	18.597	9.761	12.018	20.437
	RANGE	110-120	70-132	95-132	85-125	90-160
* KF2H	MEAN	91.6	91.12	105.35	98.95	110.8
	S D	7.956	15.385	30.628	13.200	18.636
	RANGE	78-97	70-137	54-152	97-126	88-147
* KF3H	MEAN	99.4	90.7	94.75	98.2	105.35
	S D	14.570	11.328	31.134	10.6925	12.355
	RANGE	87-124	60-110	61-191	83-120	70-126
* KF4H	MEAN	111.05	92.2	101.95	107.4	118.38
	S D	13.11	12.479	33.667	16.291	22.57
	RANGE	99-131.25	74-115	42-194	83-157	72-159

Table 5(c) Shows the Mean, SD & Range of VD's for Vowels for different subjects in Tamil (in msecs).

		a	i	u	o	e
* TM1	MEAN	133.55	125.6	142.1	145.65	139
	S D	19.063	14.925	23.56	17.08	31.18
	RANGE	84-1703	99-150	110-182	120-183	95-192
* TM2	MEAN	130.05	120.05	144.85	146.23	136.775
	S D	21.045	17.72	26.46	16.44	39.76
	RANGE	72-162	86-160	103-193	124-183	64-197
* TF1	MEAN	105.35	100.42	101.75	100.85	113.98
	S D	21.813	10.43	15.84	11.42	26.27
	RANGE	79-153	75-120	72-123	78-128	75-160

* REFER APPENDIX :

Table 5 (c) and Graph 10 shows the mean. Standard Deviation, range of Vowel Duration for the subjects having Tamil as mother tongue. It can be seen from the table 5(c) that the Tamil speakers (group 3) constantly had a longer duration for the vowel \o\ ranging from 78 to 183 mcs. \i\ the least vowel duration among the vowels studied, ranging from 75 to 160 mcs. The variation in Vowel Duration was alwavs seen for each vowel in each subject. The range of variations were 72 to 170 mcs, 75 to 160 mcs, 72 to 193 mcs, 78 to 183 mcs, 64 to 197 mces for \a\, \i\, \u\, \o\and \e\ respectively.

Table 5(d) and Graph 11 shows the mean ,Standard Deviation and the range of Vowel Duration for the subjects English samples as second language (group 1, group 2 and group 3). It can be seen from the table 5(d) that the English speech data constantly showed longer Vowel Duration for vowel \a\

ranging from 58 to 185 msecs and vowel \i\ was found to have the least Vd, ranging from 57 to 188 msecs among the vowels studied. The variation in Vowel Duration was always seen for each vowel within the subjects english speech utterances. A comparison of Vowel Duration in English utterances by speakers with different mother tongues showed significant differences. The range of difference were 53 to 186 msecs.57 to 198 msecs, 63 to 191 msecs, 59 to 191 msecs, 58 to 185 msecs for \a\, \i\,\u\,\o\ and \e\ respectively.

Table 2(d) Shows the Mean, SD & Range of VD's for Vowels fo, different subjects in English (in msecs;.

		a	i	u	o	e
* KF1E	MEAN	122.15	131.75	119.7	124.2	129.45
	S D	23.50	23.962	22.501	15.119	24.72
	RANGE	53-154	100-180	84-162	93-144	83-169
* KF2E	MEAN	100.9	103.85	105.5	113.1	103.85
	S D	14.559	18.08	36.21	25.07	11.736
	RANGE	78-125	75-150	70-191	81-168	58-139
* KF3E	MEAN	108.05	104.00	122.4	110.1	124.3
	S D	17.349	27.67	20.45	18.23	29.02
	RANGE	75-134	73-188	80-166	70-137	85-185
* KF4E	MEAN	107.6	111.85	111.05	111.55	102.95
	S D	24.69	16.406	17.71	15.38	8.720
	RANGE	72-186	75-140	76-134	82-138	79-120
* HM1E	MEAN	104.95	92.00	99.62	91.15	110.5
	S D	35.03	18.18	21.938	21.16	30.527
	RANGE	65-167	57-125	68-130	59-131	66-172
* HM2E	MEAN	111.25	120.35	119.2	121.25	118.35
	S D	14.78	21.962	12.75	28.38	20.176
	RANGE	72-128	84-169	86-135	78-191	84-156
* TM1E	MEAN	103.2	87.55	87.15	96.3	102.7
	S D	16.116	10.923	17.55	13.452	15.841
	RANGE	79-139	64-106	63-117	74-122	76-135
* TM2E	MEAN	116.1	107.35	116.75	97.1	105.95
	S D	30.624	24.092	23.02	17.81	21.05
	RANGE	85-151	74-166	69-160	74-135	71-147
* TM3E	MEAN	96.05	98.00	98.4	102.6	113.55
	S D	16.856	13.15	17.836	19.24	29.41
	RANGE	76-132	72-120	75-125	70-138	65-165

Table 2(d)

TABLE 5(e) SHOWS THE TOTAL MEAN, RANGE.STANDARD DEVIATION OF VOWEL DURATION IN READING OF SENTENCE FOR DIFFERENT LANGUAGES BY NORMAL SPEAKERS. (IN MSECS)

MOTHER TONGUE		NO. OF SUBJECTS	/a/	/i/	/u/	/o/	/e/
ENG-LISH	MEAN	9	107.81	106.3	108.86	107.48	112.4
	S D		7.92	13.75	12	11.44	7.82
	RANGE		53-186	57-188	63-191	59-191	58-185
KAN-NADA	MEAN	4	120.32	106.13	101.95	113.75	119.79
	S D		11.91	5.61	7.18	11.12	10.83
	RANGE		57-193	76-155	70-147	54-197	59-159
TAMIL	MEAN	3	122.98	115.39	129.57	130.97	127.92
	S D		15.37	13.24	24.13	20.09	13.85
	RANGE		72-170	75-160	72-143	78-183	64-193
HINDI	MEAN	5	105.73	99.40	106.46	106.59	110.18
	S D		9.40	10.70	8.99	7.20	4.94
	RANGE		78-160	60-180	40-196	83-168	70-160

Table 5(e) and Graph 12 shows the total mean. Standard Deviation, range of Vowel Duration Tor the subjects in different languages. The vowel \i\ has been, noticed to have least Vowel Duration in all the languages studied i.e.. 106.3msecs. 106.13msecs, 1l5.39msecs. 199.40 msecs in English, Kannada, Tamil and Hindi respectively. Vowel \e\ was noticed to have had a longer Vowel Duration i.e.. the total means were 1l2.4msecs. 119.79msecs, 129.92msecs, 110.l8msecs for English, Kannada, Tamil and Hindi respectively Among the subjects speaking Tamil as mother tongue vowel \o\ had the longest duration ie, 130.97msecs. Vowel \i\ of the subjects speaking Hindi was found to be have had least duration among the vowels

studied i.e.,99.40 msecs.The subjects speakinq Kannada showed a longer range of Vowel Duration for vowel \o\, i.e., ranging from 54 to 197.

From the above results it can be concluded the the vowel duration varies across language of the speaker ranging from 99.40msecs to 106.30 msecs and the subjects speakinq Hindi had the lowest mean of 99.40msecs. It was also noticed that the duration of \e\ was longer comparing the other mean of the other languages, ranging from (110.18 to 129.92) msecs and the lowest was 110.18msecs seen in the subjects mean of Hindi language.

When the Vowel Duration values of different languages were compared as in the table 5(e) difference were observed between languages. Thus the hypothesis which states that there is no difference in the Vowel Duration in between languages is rejected.

When the mean vowel duration values were compared as shown in the table 5(a),5(b),5(c)and 5(d) a clear difference was observed across the subjects. Thus the hypothesis 1( ) stating that there is no difference in vowel duration in between subjects is rejected. Thus the study indicates that there is difference in the vowel duration across language and subjects.

Thus the results of the present study indicate that there is variability in the vowel duration across languages and individuals.

TABLE 5(F) COMFARISION 0F VD IN HINDI WITH SUBJECTS HAVE HINDI & KANNADA AS MOTHER TONGUE

MOTHER TONGUE		NO. OF SUBJECTS	/a/	/i/	/u/	/o/	/e
HINDI	MEAN	2	108.48	111.58	112.27	114.57	106.9
	S D		8.09	8.93	12.06	1.44	1.87
	RANGE		87-160	79-160	87-161	88-168	78-14
KAN-NADA	MEAN	4	104.36	93.91	103.55	102.55	111.8
	S D		10.86	4	7.23	4.75	5.37
	RANGE		78-131.3	60-137	40-194	83-157	70-15

Table 5 (f) and Graph 13 gives the comparison of vowel duration in Hindi samples within subjects having Hindi as mother tongue (group 2/ and as second language (group 1). Group 2 Hindi speaking subjects showed longest Vowel Duration on \c\ and subjects having Hindi as second language group 1 showed a longest vowel duration on \e\. The means were 114,57 msecs and 111.88 msecs respectively. The subjects having Hindi as mother tongue showed a least duration on \e\ i.e., 106.93 msecs. The group (1) who had Hindi as second language, had a least duration on \i\ i.e., 93.31 msecs. The mean of vowel duration in group 2 Hindi speakers was 108.46 msecs, 111.58 msecs. 112.27 msecs, 114.57 msecs, 106.93 msecs for \a\, \i\, \u\, \o\, \e\ respectively. In the case of group 1 having Hindi as second language the mean vowel duration were 104.36 msecs, 93.31 msecs, 103.55 msecs, 102.55 msecs. 111.88 msecs for \a\, \i\, \u\, \o\, \e\ respectively. It can be noticed from the table that the group which had Hindi as mother tongue had always a longest Vowel Duration than the group 1, except in \e\ where the group 2 showed a longest Vowel Duration i.e., 106.93 msecs for group 1 (Hindi speakers) and 111.88 msecs for group 2 subjects. The difference in Vowel Duration was alwavs noticed across vowels and languages groups.

Thus the hypothesis stating that there is no significant difference in vowel duration in speech of the subjects speaking a language as mother tongue and the other way the same language as second language is rejected.

Table 5(g) comparision of vowel duration in English with subjects having different language as mother tongue

MOTHER TONGUE		NO. OF SUBJECTS	/a/	/i/	/u/	/o/	/e/
KAN-NADA	MEAN	4	111.52	117.8	112.6	114.02	116.65
	S D		15.02	19.73	10.04	14.38	18.10
	RANGE		65--167	57--169	68-135	59-191	66-172
HINDI	MEAN	2	107.96	107.05	113.06	108.51	114.02
	S D		2.58	12.05	10.16	12.58	9.29
	RANGE		53--186	73-188	70-191	70-168	58-185
TAMIL	MEAN	3	105.13	97.63	100.76	98.66	107.4
	S D		10.16	9.90	14.94	3.42	5.56
	RANGE		76-151	64-164	63--160	70-138	65-165

Table 5(g) and Graph 14 shows that the comparison of shows the comparison of Vowel Duration in English samples the group 1 lad a longer vowel duration of \i\ i.e., 117.80 msecs and a lowest vowel duration on \a\ i.e., 111.52 msecs. The group 3 (Hindi subjects) showed a longest Vowel Duration on \i\ i.e.. 107.05 msecs. The group 3 (Tamil speakers showed a longest Vowel Duration on \e\ 107.4 msecs and a shortest Vowel Duration on \i\ 97.63 msecs. The group 2 and group 3 subjects were nearly having a similar duration for vowels. But the group 1 Kannada speakers had a longer Vowel duration compared to the other two groups. The vowel duration in group 1

(Kannada subjects) having English as second language showed 111.52 msecs, 117.8 msecs, 112.6 msecs, 114.02 msecs and 116.65 msecs for \a\, \i\, \u\, \o\ and \e\ respectively. The group 2 subjects (Hindi speakers) showed 107.96 msecs,, 107.05 msecs, 113.06 msecs, 108.51 msecs and 114.02 msecs for \a\, \i\, \u\, \o\ and \e. respectively, The group 3 (Tamil subjects) showed a duration of 105.12 msecs. 97.63 msecs. 100.76 msecs, 98.66 msecs and 107.4 msecs for \a\, \i\,\u\,o\ and \e\ sounds respectively.

Thus the hypothesis 2(d) stating that there is no significant difference in vowel duration in utterance of subjects speaking as second and a third language who had different mother tongues is rejected.

SUMMARY AND CONCLUSIONS

Speech is a neuromuscular activity. The output of this activity is the acoustic signal, which is used for communication as speech.

Today it is possible to measure the acoustic aspects of speech with sophisticated equipment, the use of computor for this analysis is an outcome of the recent development in speech research.

The acoustic analysis of some aspects of speech also has shown that there is variability across the languages and across the individuals.

Voice onset time(VOT)and vowel durations(VD)are two of the parameters among the temporal aspects of speech which are considered to be important in understanding speech. Studies have shown that Voice onset time (VOT) and vowel duration(VD) varies independently of language, individuals and sex .

This study was conducted to find out the changes in voice onset time (VOT)and vowel duration(VD)in different languages and within subjects.repetitions and across the individuals.

The following hypotheses were verified:-

l(a)There will be no difference in the voice onset time(VOT)for voiceless stop sounds with reference to languages as in Hindi,Kannada. Tamil and English both by the native and normative speakers.

l(b)There will be no difference in the voice onset time (V07) values for voiceless stops sounds with reference to individuals repetitions.

l(c)There will be no difference between the voice onset time (VOT)of voiceless stop consonants with respect to the point or articulator constriction.

1(d)There will be no difference in the voice onset time (VOT) with respect to the following vowel i.e., vowel does not contribute for the variation in the voice onset time.

2(a)There will be no difference in the Vowel duration ( ) for vowels with reference to the languages Hindi,Kannada,Tamil and English both by the native and normative speakers..

2(b)There will be no difference in the vowel duration (VD)values for vowels with reference to individuals and repetitions.

2(c) There will be no difference between the languages in terms of vowel duration of different vowels as spoken by the subjects using their mother tongue.

2(d) There will be no significant difference in vowel duration in the utterance of the subjects speaking a third languages who had different mother tongues.

To test these hypothesis nine subjects were taken. the nine subjects were divided into there groups based on there mother tongue. The subjects of different croups were matches with reference to age. The subjects with kannada were able tc speak

Hindi and English. The subjects with Tamil as mother tonque were able to speak English, similarly Hindi speakers could read and speak English. Thus all the subjects could speak English. Group l(Kannada speakers)could use Hindi also. These subjects were used to make a cross linquistic study. For the purpose of this study meaningful sentences were constructed consisting of words which contained /p/,/t/,/t/and /k/stops occurring in the initial position and the vowels a,i,u,o,e following this stops. These were constructed in each lanauage i.e., in Hindi, Kannada ,Tamil & English.

The subjects were instructed to read the sentences. The speech samples were simultaneously recorded using a Philips tape deck and a computer. Each subject was asked to repeat each sentence five times. Thus twenty sentence for each subject and a total of hundred sentence were recorded.

The initial segments of the words having the afore said stops and vowels were separated and displayed using wide band spectrogram program in the screen of the computer.Voice onset bime (VOT)and vowel duration (VD)were measured.

Thus from the study it is concluded that

l(b)There is significant difference across and between the subjects in terms of voice onset time (VOT) of the speech sounds having a language as mother tongue.

l(b)There significant difference between the languages in terms of Voice onset time (VOT)of different sounds as spoken by subjects using their mother tongue.

l(c)There is significant difference in the repetitions of the same sound by the same subject in terms of Voice onset time (VOT).

l(d) There is no significant difference in the Voice onset time (VOT)in the production of additional language as spoken by subjects having different mother tongues.

l(e)There is no significant difference in voice onset time (VOT)across the vowel environment,

l(f)There is a consistent increase in voice onset time (VOT)with respect to the position of articulator constriction (as it moves backwards in the oral cavity)

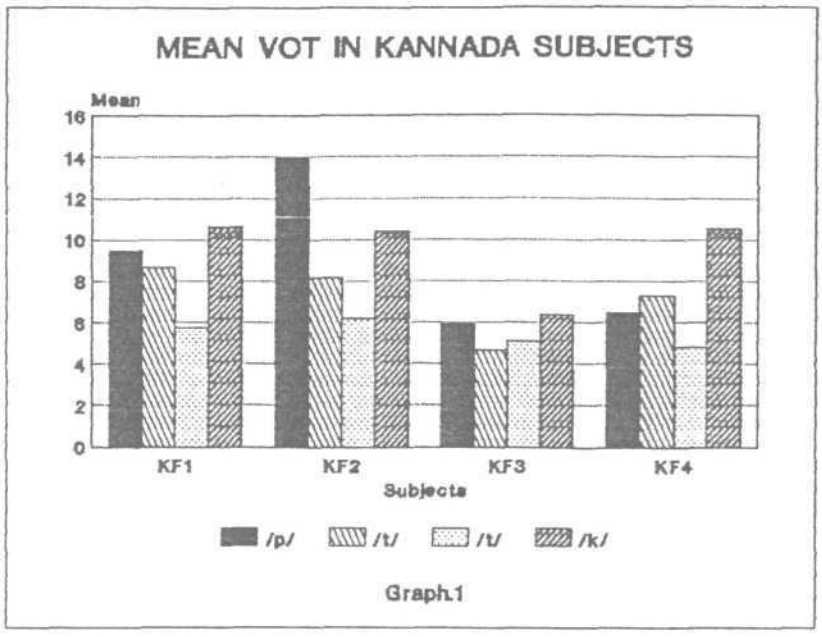
2(a)There is significant difference in the vowel duration in the speech of subjects having a language as mother tongue

2(b)There is significant difference in vowel duration (VD)in The utterances of the subjects speaking a second language and third language who liad different mother tongues,

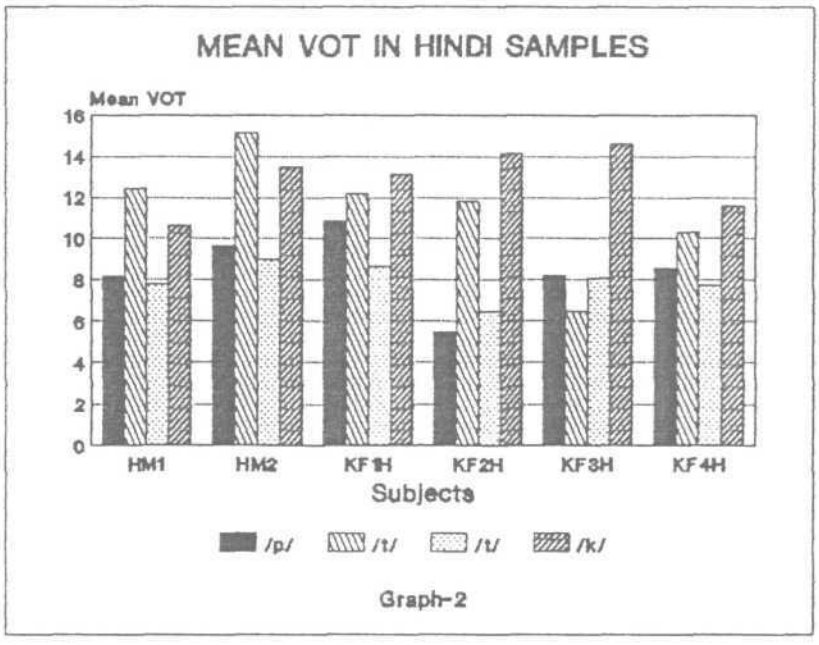
Recommendations for further study:-

1. The study may be carried out with a larger sample in each age and language.
2. The analysis could be extended to the varied consonants.
3.Voice onset time (VOT)and vowel duration (VD)in running speech, isolated sounds may be studied for normal adults.
4.Voice onset time for stops in medial and final positions of words may be studied.
5.Voice onset time and vowel duration for stop sounds in

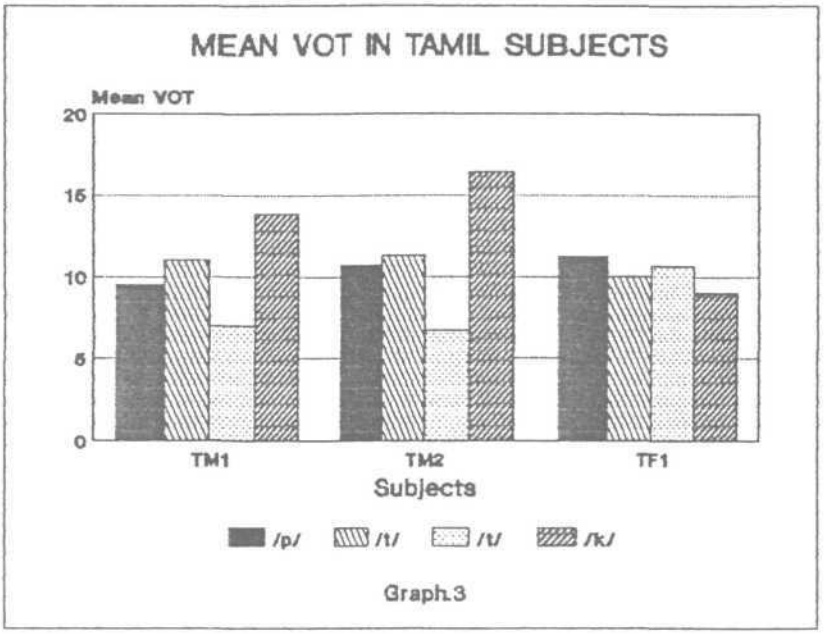
isolation may be studied for various languageo speakers to see whether voice onset time and vowel duration for isolated sounds are lanquage dependent.



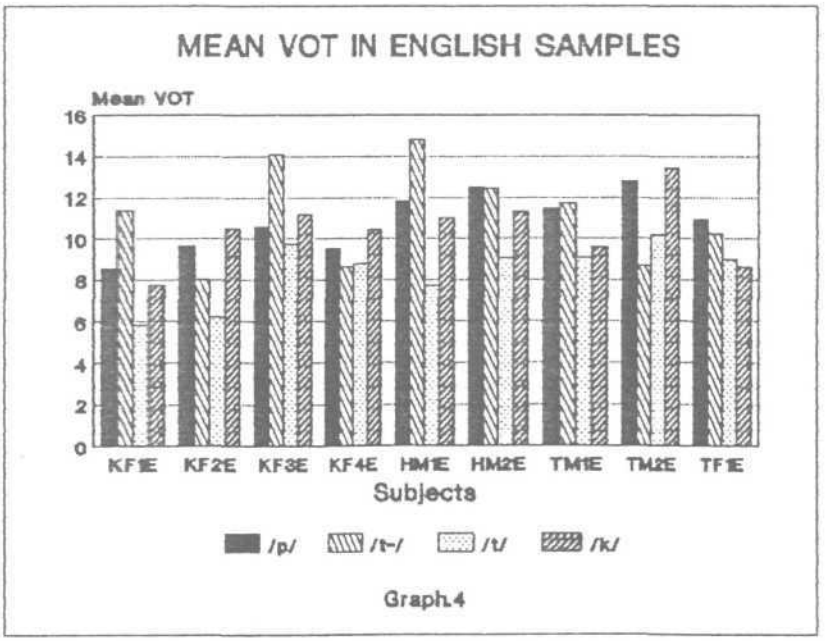
Graph.1



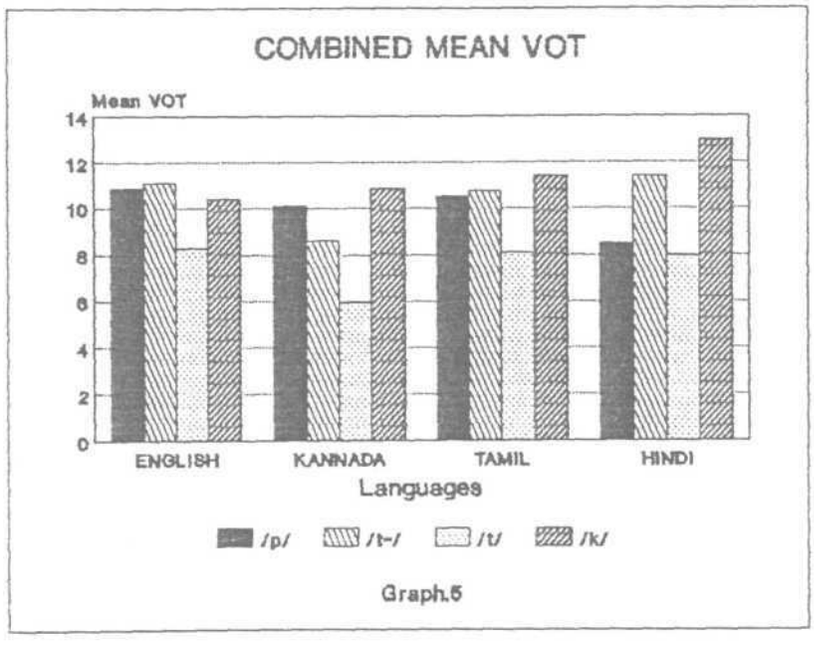
Graph-2



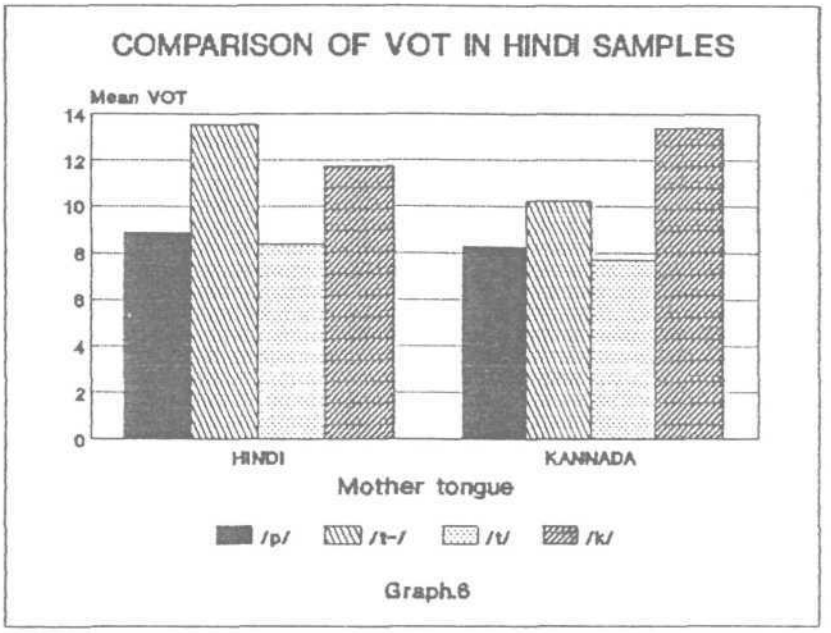
Graph.3



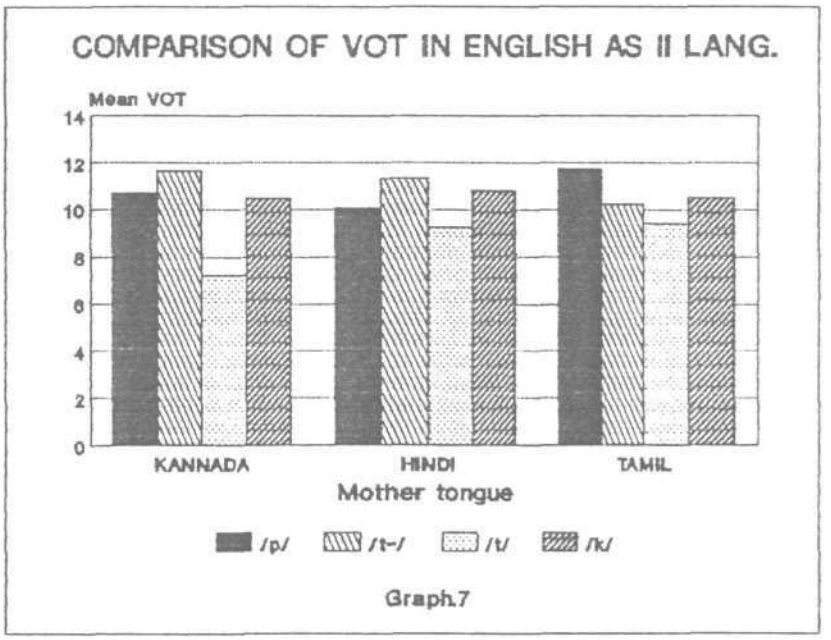
Graph.4


COMBINED MEAN VOT
Mean VOT
14
12
10
8
6
4
2
0
ENGLISH
KANNADA
TAMIL
HINDI
Languages
/p/
/t-/
/t/
/k/

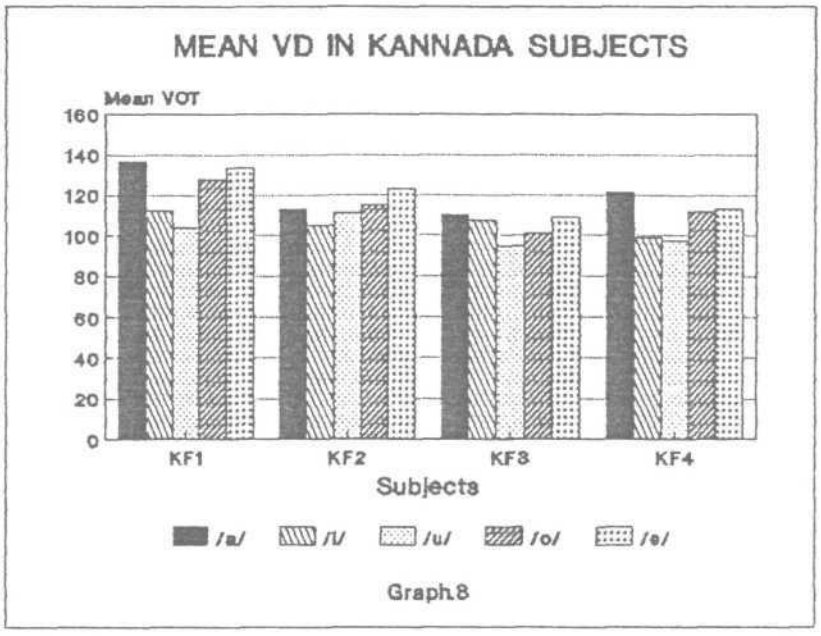
Graph.5



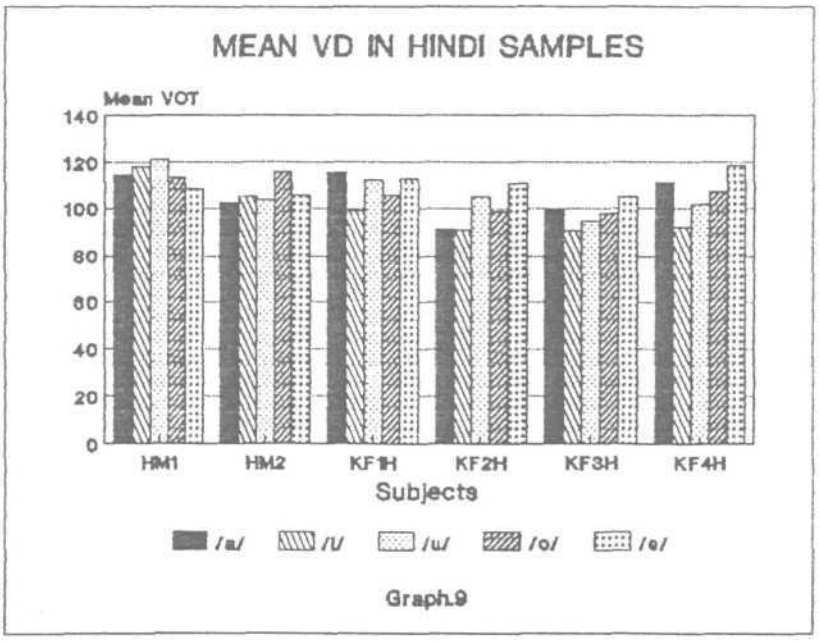
Graph.6



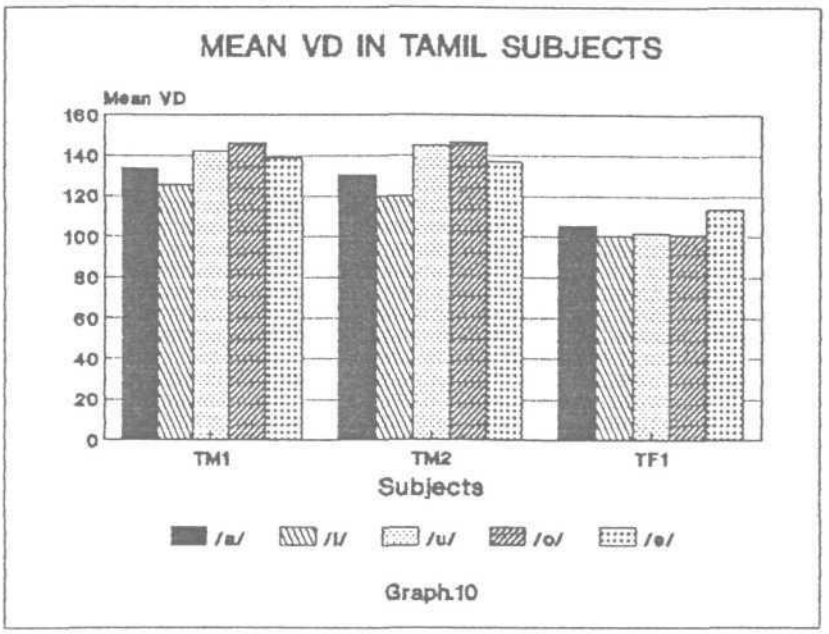
Graph.7



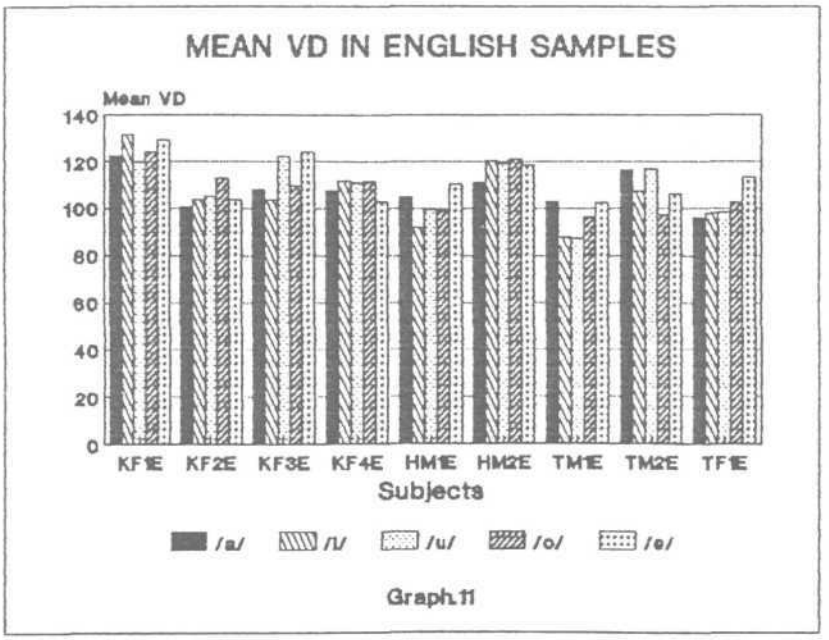
Graph.8



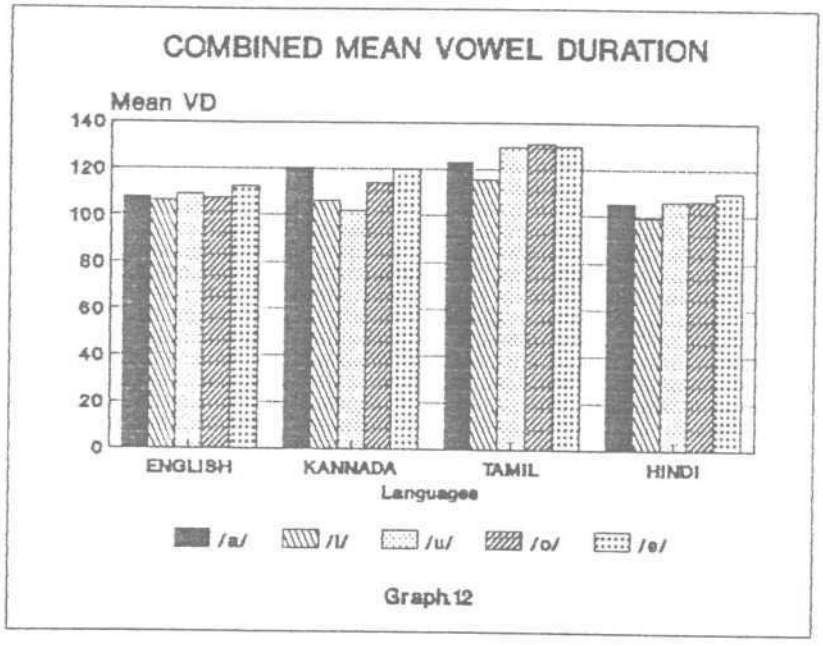
Graph.9



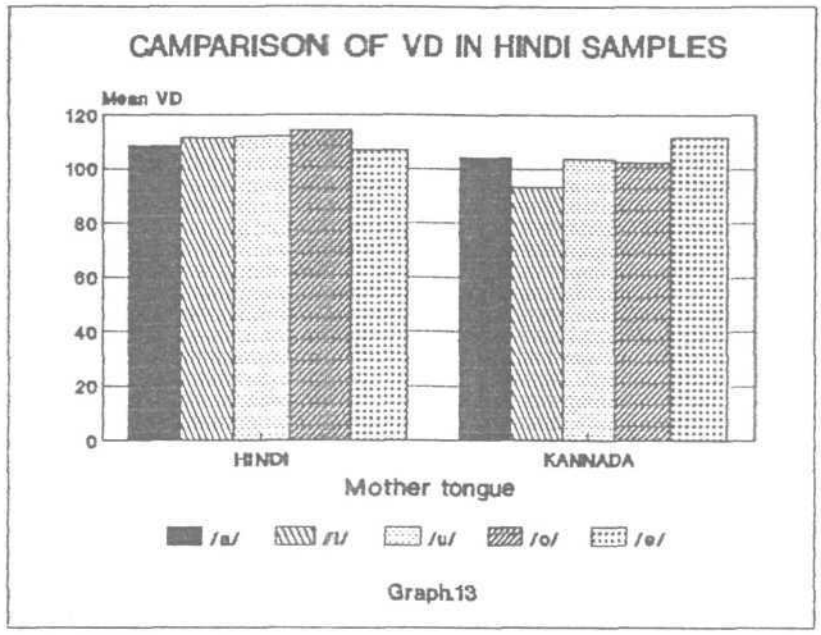
Graph.10



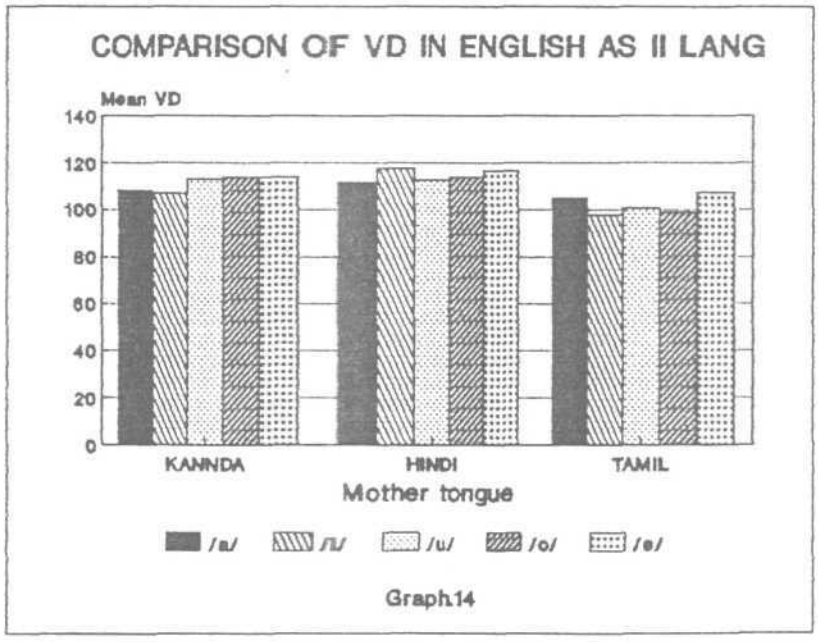
Graph.11


COMBINED MEAN VOWEL DURATION
Mean VD
140
120
100
80
60
40
20
0
ENGLISH
KANNADA
TAMIL
HINDI
Languages
/a/
/i/
/u/
/o/
/e/

Graph 12



Graph.13



Graph.14

BIBLIOGRAPHY

Abramson A.S & Lisker L. (1973) Voice timing perception in Spanish Word - initial stops Journal of phonetics - vol 1 (P-8).

Babul Basu, (1979) "Voice onset time for stutters and non-stutters", Mysore university, Dissertation.

Balasubramanian .T (1981) "Duration of vowels in Tamil" . Jo. of phonetics" 9,151-161.

Benguerel A.P Hisore H. Sawashima .M. & Ushijima .T (1986) cited in "Representation of voicing contrats using articulatory gestures " by Goldstin .L.& Brownman .C.D.J of phonetic 14(2) 339-42.

Chen M (1970) " Vowel length variation as a function of the voicing of consonent environment" Phonetic 22, 129-159.

L.F.Denil & G.J.Brutten, 1991. "Voice Onset Time of stuttering and Non stuttering childern" Journal of fluency disorders. Vol - 16 page 143.

Disimoni F.G., 1974 , "Influence of Vowel environment on the duration of consonants in the speech of three - six, and nine - year - old childern", J. Acoustic Soc. Amer 55,360-361.

Disimoni. F.J 1974 "Influence of consonant environment an duration of vowels in the speech 3- 6- 9 years old children J . Acoustic soceity America 55,362-63.

Emeric L.L. & Hatten .J.T.1974 "Diagnosis &: evaluation in speech pathalogy". Englewood cliffs. N.J, Prentice Hall(pl75).

Faaborg - Anderson. K (1951), "Eletromyographicc investigation of intrinsic investigation of intrinsic laryngeal muscle in humans " Acta phyiol seand — vol 41, Supp1 pl40.

Flege J.E. 1987 ""The production of new and similar phones in a foreign language evidence for the effect of equivalence classification " Journal of phonetics vol -15,page 47—66.

Flege. J.E. &. Wang c. 1939 "Native language phonotactic constraints affect how well Chinese subjects perceive the word - final English (t) -/d/ contrast ". Journal of phonetics, vol- 17, page 299-315.

Flege .J.E. & Efting W.1987 "Production and perception of english stop's by native Spanish speaker" Journal of phonetics. vol-15.page 67-84.

Frucin C.W. & Brichoff D.M(1976) "Vowel duration as a cue for consonant voicing " J. acoustic of south America, Vol 90, suppl no 1 591.

Gilbert . J.H.V 1977 "A VOT analysis of apical stop production in 3 years olds". Journalof child lang , 4,103-110.

Gupta .S.K. & others 1973."Perceptual study of segment of intervocalic stops & affricates" J.audio. Engineer SOL vol 21.

Harris .K.J. 1978 " Vowel duration change & its undelivering physiological mechanism " Lang & speech 21 (4) 354- 361.

Hirose .H (1971). " An electromyographic study of lanyngeal adjustments during speech articulation . A miliminary report". In status report on speech research SR - 25/26, Haskins lab, New haven comm.

House (1961) cited in Wardsip - Fruin , c. " On the status of temporaral eves to phonetic categories; Preceding vowel duration as a cue to voicing in final stop consonants" J.of Acous. socie of American,71 (1), 187-195.

House A.S (1961) " On vowel duration in English " J. Acoustic society America, vol 33 1764-1771.

Jamieson D.G & Cheesman 1987: " The adaptation of produced voice onset time". Journal of phonetics Vol -15 ,15-29.

Kewly - Port. & preston M S (1974) ." Early apical stop production 2 VOT analysis" Journal of Phonetics 2, 195-210.

Klott D.H (1975) VOT, Frication earpination in word initial consonant Cluster- J.S.H.R 18 686-706.

Komiyama (1972) cited cited in Hirano.M " Clinical examination of voice. Springer - verlag Wien N V 1981.

Krause S.E (1982) "Vowel duration as a perceptual cue to post vocralic consonant voicing in young childem & adults " J.of Acoustic society of America. 71(4), 990- 995.

Kushal Raj P (1983). Acoustic analysis of speech of the chiIdem "unpublished Master's dissseration, Mysore University.

Libermam : A.M & oters (1958) " Some cues for the distinction between voiced & voiceless stops in initial position " Lang speech Voll, parts.

Liberman .A M & others (1961) "Discrimination of relative onset time of the components of certain speech and nonspeech pattern" J.exp psychol vol 61.

Lisker .1 (1975) " Is it VOT or a first formant transition detector ",J Acoustic society of America. 57(6) , 1547-51.

Lisker & Abramson (1964) " A crosss language study of voicing in initial stops - Acoustic measurement", Word 20, 384-422.

Lisker L & Abramson .A.S 1971. "Distinction features & language control" language 47, p767-785.

Lisker L & Abramson A S 1971. "Some effect on context on voice onset time in English stops" language & speech , vol 10 part I pi -28.

Lyberg .B (1981) " Some observation on Vowel duration & the fundamental frequency contour in Swedish utterances J of phonetics 9 261-272.

Mack M (1982) " Voicing dependent vowel duration in English & French Monolinguial & Bilingual production" J. Acoust soc Ame 71 (1) , 173-178.

Morlin B.J & John K.S 1976 " Korean apical stop production , A vot analysis " J.Acoustic Soc America 60 suppl no 1 s-45.

Naeser (1970) cited in wardsip - french c "on the status of temporaral eves to phonetic

categories , proceeding vowel duration as a cues to voicing in final stop consonants " J acoust society America. 71 (1) 187-195.

Particia M Sweeting & R . J Baken (1982) " Voice onset time in a normal aged population" J.S.H.R.,25,129.

Poon .P G & Mateer .G.A (1985) " A study of VOT in nepali stop consonants " phonetics Vol 42 , page 39.

Port .R.F (1979) "Relation between VOT & Vowel duration " J of acoust society of America. 66(3) 654 - 662.

Saswashima (1966) cited in Hiranoo " Clinical examination of Voice " ,Springer - Venlog wien N.Y , 1881.

Sheila E. Blumstein ,etal (1980) "Perceptual invariance & onset spectra for stop consonants in different vowel environent . J.A.S.A vol 67 page 648.

Smith etal ,(1987) " temporaral characteristic of the speech of normal elderly adults " J.S.H.R 30,522.

Smith etal . (1986) " A comparison of temporal Measures of speech using spectrograms & digital oscillogram J.S.H.R , 29, 270 .

T-avis .L.E (ed) (1971) " Hand book of sp path & Audiology " . Appleton century - crafts N. Y.

Wajskop M & suberts .J (1973) " Voicing eves in oral stop consonants" Journal of phonetic Vol 1, (p!21 - 130)

Winitz H Lariviere & Herriman E (1975) " Variation in VOT for English initial stops. J.Phonetics, Vol 3, P 41-52.

Wood K.S (1971) " Terminology & nomenclature in Hand book of sp pathology & audiology" Ed Trauis, L.E, Appleton-century- crafts,NewYork

Zlatin M.A & Koeningsknecht R.A (1976) "Development of the voicing contrast, A comparison of VOT in stop perception & production . Journal of speech & hearing research 19, 93-111 (1976).

Zlatin .M.A voicing contrast , (1974) Perceptual & productive VOT characterstic of adults, J,acoustic society of America . 56,981-994.

A P P E N D I X

APPENDIX NO. II PERSONAL DETAILS OF SUBJECT'S

APPENDIX NO. II TEST MATERIAL'S USED FOR DATA COLLECTION

APPENDIX NO. III NAME'S GIVEN FOR THE SUBJECTS IN THE TABLE

APPENDIX No - I(a)

SUBJECT - I **KF_1**

AGE : **22 Yrs**

SEX **I F**

OTHER LANGUAGES KNOWN : **English, Hindi.**

SINCE HOW LONG : **Kannada - Sinc birth**
(EACH LANGUAGE) Hindi -since 10yrs of age

English - Since 12 Yrs of age

LANG | LANGUAGES USED AT HOME : **Kannada**

SCHOOL : **English**

EDUCATION : **M.Sc (Sp ft Hg.)**

MEDIUM OF EDUCATION : **Engish ft Kannada**

GE AT WHICH SCHOOLING STARTED : **5 Yrs.**

AGE OF WHICH DIFFERENT LANGUAGES LEARNED : **English : 12 Yrs.**
Hindi : 10 Yrs.

»

		FAMILIANTY	READING	WRITING	SPEAKING
KANNADA	I	/	✓	✓	✓
ENGLISH	II	/	✓	✓	✓
HINDI	III	/	✓	✓	✓
TAMIL	IV	/	✗	✗	✓

APPENDIX ; I(b)

SUBJECT - II KF_2

AGE	:	25 Yra.
SEX	:	Female
MOTHER TONGUE	:	Kannada
OTHER LANGUAGES KNOWN	:	English, Hindi, Tulu
SINCE HOW LONG (EACH LANGUAGE)	:	Kannada - Since Childhood English - 6 Yra of age Hindi - 12 Yra of age.
LONG } LANGUAGES USED AT HOME	:	Kannada
SCHOOL	:	English
EDUCATION	:	M.Sc (Sp. & Hg.)
MEDIUM OF EDUCATION	:	Enyliah
AGE AT WHICH SCHOOLING STARTED	:	6 Yrs.
AGE AT WHICH DIFFERENT LANGUAGES LEARNED	:	English : 5 Yrs. Hindi : 12 Yrs.

		FAMILIANTY	READING	WRITING	SPEAKING
KANNADA	I	/	✓	✓	✓
ENGLISH	II	/	✓	✓	✓
HINDI	III	/	✓	✓	✓
TULU	IV	-	-	-	-

APPENDIX - I(C)

SUBJECT - VI KF_4

AGE : 25 Yrs

SEX : female

MOTHER TONGUE : Kannada

OTHER LANGUAGES KNOWN : Hindi, English

SINCE HOW LONG

(EACH LANGUAGE) : Kannada - Childhood

Hindi - 12 Yrs of ape

English - 12 Yts of ape

LANG { LANGUAGES USED AT HOME : Kannada

SCHOOL : English

EDUCATION : : M.Sc (Sp . * Hg.)

MEDIUM OF EDUCATION : English

AGE OF WHICH SHCOOLING STARTED : 5 Yrs.

AGE AT WHICH DIFFERENT LANGUAGES LEARNED : Kannada Childhood

English 12 Yrs.

Hindi 12 Yrs.

		FAMILIANTY	READING	WRITING	SPEAKING
KANNADA	I	/	✓	✓	✓
ENGLISH	II	/	✓	✓	✓
HINDU	III	/	✓	✓	✓

APPENDIX - I(d)

SUBJECT - V HM_1

AGE	:	22 Yrs.
SEX	:	Male
MOTHER TONGUE	:	Hindi
OTHER LANGUAGES KNOWN	:	English, Kannada
SINCE HOW LONG (EACH LANGUAGE)	:	Hindi - Childhood English - 10 Yrs of age Kannada - 18 Yrs of age.
EDUCATION	:	B.Sc (Sp. & Hg.)
MEDIUM OF EDUCATION	:	English
AGE AT WHICH SCHOOLING STARTED	:	5 Yra.
AGE AT WHICH DIFFERENT LANGUAGES LEARNED	:	Hindi - Childhood English - 10 Yrs. Kannada - 18 Yrs.

		FAMILIARITY	READING	WRITING	SPEAKING
HINDI	I	/	✓	✓	✓
ENGLISH	II	/	✓	✓	✓
KANNADA	III	/	✓	✓	✓

APPENDIX - I(e)

SUBJECT - VI HM_2

AGE	:	19 Yrs.
SEX	:	Male
MOTHER TONGUE	:	Hindi
LANGUAGES KNOWN	:	English, Kannada
SINCE HOW LONG (EACH LANGUAGE)	:	English - 11 Yrs of age Hindi - Childhood Knnada - 17 Yrs of age.
LANG (LNAGUAGES USED AT HOME	:	Hindi
SCHOOL	:	Hindi & English
EDUCATION :	:	B.Sc (Sp. & Hg)
MEDIUM OF EDUCATION	:	Hindi, English
AGE OF WHICH SCHOOLING STARTED :	:	6 Yrs
AGE AT WHICH DIFFERENT LANGUAGES LEARNED	:	Hindi - Childhood Englsih - 11 Yrs. Kannada - 17 Yrs.

	FAMILIANTY	READING	WRITING	SPEAKING
HINDI	I	✓	✓	✓
ENGLISH	II	✓	✓	✓
KANNADA	III	-	-	✓

APPENDIX - I (f)

SUBJECT - VII TM_1

AGE	:	23 Yra
SEX	:	Male
MOTHER TONGUE	:	Tamil
OTHER LANGUAGES KNOWN	:	English, Hindi, Kannada, Malayalam
SINCE HOW LONG (EACH LANGUAGE)	:	Tamil - Chilhood English - 5 Yrs of age Hindi - 18 Yra of age Kannada - 18 Yra of age Malayalam - 15 Yrs of age
LONG LANGUAGE USED AT HOME	:	Tamil
SCHOOL	:	English, Kannada
EDUCATION	:	M.Sc (Sp. & Hg.)
MEDIUM OF EDUCATION	:	English
AGE AT WHICH SCHOOLING STARTED	:	31/2 yrs.
AGE AT WHICH DIFFERENT LANGUAGES LEARNED	:	Tamil - Childhood English - 5 Yrs. Hindi - 18 Yrs. Kannada - 18 Yrs, Malayalam 18 Yrs.

	FAMILIARITY	READING	WRITING	SPEAKING
TAMIL	I	✓	✓	✓
ENGLISH	II	✓	✓	✓
HINDI	III	-	-	✓
KANNADA	IV	✓	✓	✓
MALAYALAM	V	-	✓	✓

APPENDIX -g

SUBJECT - VII TM_2

AGE	:	19 Yrs
SEX	:	Male
MOTHER TONGUE	:	Tamil
OTHER LANGUAGES KNOWN	:	Engliah, Kannada.
SINCE HOW TO (EACH LANGUAGE)	:	Tamil - Childhood
		Engliah - 12 Yra of age
		Kannada - 18 Yrs of age
LANG } LANGUAGES USED AT HOME	:	Tamil
SCHOOL	:	English, Tamil
EDUCATION	:	B.Sc (Sp. & Hg.)
MEDIUM OF EDUCATION	:	English, Tamil
AGE OF WHICH SCHOOLING STARTED	:	5 Yrs.
AGE AT WHICH DIFFERENT LANGUAGES LEARNED	:	Tamil - Childhood
		English - 12 Yra.
		Kannada - 18 Yrs.

	FAMILIRITY	READING	WRITING	SPEAKING
TAMIL	I	✓ ✓	✓	✓
ENGLISH	II	✓	✓	✓
KANNADA	III	-	-	✓

APPENDIX - I (..)

SUBJECT - IX TF_1

AGE	:	20 Yrs
SEX	:	Female
MOTHER TONGUE	:	Tamil
OTHER LANGUAGES KNOWN	:	English, Kannada
SINCE HOW LONG (EACH LANGUAGE)	:	Tamil - Childhood Englsih - 12 **Yrs** of age Kannada - 18 yrs of age.
LANG | LANGUAGES USED AT HOME	:	Tamil
SCHOOL	:	Tamil
EDUCATION	:	B.Sc (Sp. a Hg.)
MEDIUM OP EDUCATION	:	Tamil
AGE AT WHICH SCHOOLING STARTED I	:	5 Yrs.
AGE AT WHICH DIFFERENT LANGUAGE LEARNED	:	Tamil - Childhood English - 12 Yrs. Kannada - 18 Yrs.

	FAMINLIANTY	READING	WRITING	SPEAKING
TAMIL	I	✓	✓	✓
ENGLISH	II	✓	✓	✓
KANNADA	III	≠	≠	✓

APPENDIX NO. II(a)

KANNADA

01) ಅದು ಪಾಪು ಅಂಗಿ

02) ನೀನು ಪೀಠ ಏರು

03) ಈಗ ಪೂಜೆ ಮಾಡು

04) ಬೇಗ ಪೇಟ ಕಟ್ಟು

05) ಅಲ್ಲಿ ಪೊಲೀಕರಿ ಬಂದ

06) ಹಳೆ ಟಾಕೀಸು ಬೇಡ

07) ಈಗ ಟೀಕೆ ಬೇಡ

08) ನೀನು ಟೂರಿಗೆ ಬಾ

09) ನೀನು ಟೀಪು ಕೊಡು

10) ಅಲ್ಲಿ ಟೊಪ್ಪಿ ಇಡು

11) ಅಲ್ಲಿ ತಾತ ಬಿದ್ದ

12) ನದೀ ತೀರಕ್ಕೆ ಬಾ

13) ಅಲ್ಲಿ ತೂಕ ಮಾಡು

14) ಅದು ತೇಗದ ಮರ

15) ನಿಮ್ಮ ತೊಪ್ಪಲು ಬೇಡ

16) ನೊಳ್ಳೆ ಕಾಟ ಇದೆ

17) ಬಳೆ ಕೀಟ ತೋರಿಸು

18) ನಿಮ್ಮ ಕೂಟ ಬೇಡ

19) ನಿಂಗೆ ಕೇಡು ಬೇಡ

20) ಅಲ್ಲಿ ಕೊಳ್ಳಿ ಬಂತು

APPENDIX NO - II (b)

TAMIL

1. அவன் பாக்கு தின்றான்.
2. எண்ணை பீப்பாய் எங்கே?
3. அவன் பூஜை செய்தான்.
4. நல்ல பேச்சு பேசு.
5. அவன் போட்டி போட்டான்.
6. எங்கே டாகீஸ் இருக்கு?
7. அவன் டீ-கப் எடுத்தான்.
8. ராமா டேர் போறியா?
9. அவன் டேப்டி கேட்டான்.
10. ஒரு டோகன் கொடு.
11. எங்கள் தாத்தா வந்தார்.
12. வர்ணம் தீட்டு என்றேன்.
13. மூட்டை தூக்கி பார்.
14. மாட்டை தேடி ஓடு.
15. அங்கே தோப்பு இருக்கா?
16. அவன் காப்பி குடித்தான்.
17. பாலு கீப்பிங் பண்ணு.
18. அவன் கூட்டு தின்றான்.
19. மது கேடு விளைக்கும்.
20. அது கோச்சு வண்டி.

APPENDIX NO- II 'c'

HINDI

1. दूसरा पापी गया ।
2. उसे पीटा गया ।
3. रखा कर पूजा करो ।
4. छोटी पेटी लाओ ।
5. मेरा पोता गया ।
6. नाव से टापू देखो ।
7. उसको टीका देदो ।
8. मेरा टूर अच्छा था ।
9. अपनी टेक पर रहो ।
10. नया टोपी लाओ ।
11. मुझे ताकत देना ।
12. सब्जी तीता करो ।
13. रात में तूफान आया ।
14. वहाँ तेजाब रखो ।
15. मैंने तोता देखा ।
16. मेरे काका आऊ ।
17. वहाँ कीचड़ कम है ।
18. सैनिक कूच कर गए ।
19. मीठा केला लाओ ।
20. बड़ी कोठी बेच दो ।

APPENDIX NO. II(d)

ENGLISH

01. PURPLE POPPY'S ARE NICE
02. UK MET PETER TODAY
03. ITS THE POODLE HE LOST
04. THE NEW PAPER IS GOOD
05. THE NEW POPE CAME BY BUS
06. THE NEW TALKIES IS THERE
07. THE TEA CUP IS NICE
08. THE SLOW TOURING ENDED
09. HE HAS TAKNE THE BOOK
10. HE'S A TOTAL FAILURE
11. ITS MY THOUGHT YOU HAVE GUESSED
12. SEE THE THIEF RUNNING THERE
13. HE MET TEJA YESTERDAY
14. RAJ AND TEJA ARE FRIENDS
15. ITS MY THORAX THAT HURTS
16. ITS MY COPY YOU HAVE
17. I SAW KEATING RUN FAST
18. ITS A COUPEN YOU HAVE
19. THE NEW CADRE IS BAD
20. THE NEW COATING IS GONE

* * *

APPENDIX HO. III

* EXPLANATION OP NAMES GIVEN FOR THE SUBJECT IN TABLE

KF_1 - Mean, Range, SD of Kannada Sample of I Subject Female

KF_2 - Mean, Range, SD of Kannada Sample of II Subject Female

KF_3 - Mean Range, SD of Kannada Sample of III Subject Female

KF_4 - Mean, Range, SD of Kannada sample of IV Subject Female

HM_1 - Mean, Range, SD of Hindi sample of I subject having mother tongue as Hindi Male

HM_2 - Mean, Range, SD of Hindi sample of II Subject having mother tongue as Hindi Male

HF_1H - Mean Range, SD of Hindi sample of III subject having mother tongue as Kanneda Female

KF_2H - Mean, Range, SD of hindi sample of IV subject having mother tongue as kannada Female

KF_3H - Mean, Range, SD of Hindi sample of V subject having mother tongue as Kannada Female

KF_4H - Mean, Range, SD of Hindi sample of VI subject having mother tongue as Kannada Female

TM_1 - Mean, Range, SD of Tamil sample of I subject Male

TM_2 - Mean, Range, SD of Tamil sample of II subject Male

TFg, - Mean, Range, SD of Tamil sample of III subject Female

KF_lE - Mean, Range, SD of English samples of I subject having mother tongue Kannada Female

KF_2E - Mean, Range, SD of English samples of II subject having mother tongue kannada Female

KF_3E - Mean, Range, SD of English samples III subject having mother tongue Kannada Female

KF_4E - Mean, Range, SD of English samples of IV subject having mother tongue Kannada Female

HM_1E - Mean, Range, SD of English samples of V subject having mother tongue Hindi Male

HM_2E - Mean, Range, SD of Engiiah samples of VI subject having mother tongue Hindi Mala

TM_1E - Mean, Range, SD of English samples of VII subject having mother tongue Tamil Male

HM_2E - Mean, Range, SD of English samples of VIII Subject having mother tongue Tamil Male

HM_1E - Mean, Range, SD of English samples of IX subject having mother tongue Tamil Female

* * *