
Dedicated to
All My
Teachers

Certificate

This is to certify that the dissertation entitled *"Voice Initiation Time and Voice Termination Time in Children with Stuttering and Normal Children"* is the bonafide work done in part fulfillment of the degree of Master of Science (Speech and Hearing) of the student (Register No. M9914).

Mysore

May 2001

Director

All India Institute of
Speech & Hearing
Mysore - 570006.

Certificate

This is to certify that the dissertation entitled *"Voice Initiation Time and Voice Termination Time in Children with Stuttering and Normal Children"* has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

Guide

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Declaration

I hereby declare that this dissertation entitled *"Voice Initiation Time and Voice Termination Time in Children with Stuttering and Normal Children"* is the result of my own study under the guidance of Mrs. M. Pushpavathi, Lecturer, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier in any other University for the award of any Diploma or Degree.

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INTRODUCTION

DEFINITION OF "STUTTERING"

The term *'stuttering'* means

(1) (a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary audible (or) silent, repetition (or) prolongations in the utterance of short speech elements, namely : sound syllables and words of one syllable. These disruptions (c) usually occur frequently (or) are marked in character and (d) are not readily controllable.

(2) Sometimes the disruptions are (e) accompanied by accessory activities involving the speech apparatus, related (or) unrelated body structures, (or) stereotyped speech utterances. These activities give the appearances of being speech-related struggle.

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

Wingate-(1964)

Stuttering is a disorder known for its variability both for inter and intra individual variation as well as within and across situational variations. The variability can be in the frequency, type, severity and duration of stuttering as well as in related speech and non speech behavior (or) attribute.

The last 30 years have been eventual for speech pathologists, interested in stuttering, as stuttering research has grown in multi directions. Various studies on laryngeal, respiratory, articulations, auditory and central nervous system relations to stuttering are being explored. The notable findings of this research have indeed helped us to better understand the dynamics of stuttering but we are still far away from the causes of stuttering.

The etiology of stuttering has been viewed from various view points. One of the earliest theories proposed by Travis (1934) postulated that an inadequate cerebral dominance produces a breakdown in the motor control of speech. In the years that followed, interest in neuro-anatomical and neuro-physiological substrates of stuttering dwindled, the reason as McFarlane and Prins (1978) point out was "partly because of the influence of Johnson's (1938, 1942, 1959) view that stuttering was a continuation of normal disfluencies and, later as a result of the rapid growth in popularity of behaviourism.

In 1960's and 1970's theory and research in stuttering was being focused on learning theories (Shames and Sherrick, 1963; Brutten and Shoemaker, 1967), emotional issues (Sheehan, 1975) and parental reactions (Johnson, 1942). Currently stuttering is being explained from a motoric perspective

(Adams, 1974, Kent, 1984). However the portrayal of stuttering in the motoric facet has waxed and wanned over the past few decades.

Speech language pathology with special reference to the exploration of the disorder of stuttering, has had a surge of voice onset studies followed by a surge of vocal reaction time studies in 1970's. But towards the end of 1980's the literature of stuttering being focussed on laryngeal dynamics gave birth to broader interest in the role of speech motor behavior in fluency (Zimmerman, 1980; Cross and Luper, 1984; Starkweather, 1982).

However, the speech motor control perspective of stuttering is more than just one single theory (or) model. It encompasses at least four comprehensive motor control hypothesis proposed to fill the lacuna in the etiological domain of stuttering. Peters, Hulstijn &Starkweather (1989) have suggested a deficit in speech programming ability; Harbison, Porter & Tobey (1989) and Borden(1983), have suggested the disorder in speech execution. Results by Caruso, Gracco & Abbs' (1987) indicated the deficiency in feedforward adaptation skills; while Zimmerman (1984) proposed that hyper reflexia and disinhibition of brainstem reflexes disrupt speech motor control during stuttering." Peters, Hulstijn and Van Leishout (2000) hypothesized that stuttering may be the result of deficiency in speech motor skill. Thus as evidences, over the last decade, there has been a "snow ball" effect with respect to the upsurge of interest in stuttering as a disorder of motor control, in particular as a dysfunction at a level of processing preceding the overt execution of speech movements i.e speech motor planning (Wijnen & Boers, 1994).

There has been many empirical studies as well as theoretical descriptions of the role of larynx during stuttering(Adams, 1974,1984; Adams, Freeman & conture, 1984). Of the two general aspects of laryngeal activity for speech (a) Phonatory vibrations (Hirano, Kakita, Kawasaki, Gould & Lambiase, 1981) and (b) Abductory adjustments ("Laryngeal articulation") of glottal aperture for voicing distinctions (Sawashima & Hirose, (1981) are more likely to be related to physiological disruptions associated with stuttering. This relationship seems probable because instances of stuttering typically occurs at onset and transitions between sounds / syllables, that is, instances when the vocal folds must be quickly, precisely and appropriately adjusted towards (or) away from the midline to begin (or) terminate phonatory vibrations. Such difficulties may be one component of the peripheral physiological disruptions associated with stuttering.

Laryngeal, articulatory adjustments have been studied objectively by Conture et. al.,(1977). They observed the slow movement of laryngeal muscles.. Further studies of these laryngeal articulatory adjustments during connected stuttered speech, also had provided meaningful insight into the role of the larynx during stuttering.

Within recent years stuttering has increasingly been described from a motoric perspective (VanRiper, 1982; Zimmerman, 1980). These approaches have in common at least the idea that stutterers have greater difficulty than non-stutterers in initiating and controlling speech movement. VanRiper (1971) suggested that the controlling speech movement core behavior feature of stuttering is the disruption of proper programming of the physiological movements necessary for fluent speech. Due to this ample evidence of involvement of motoric aspects in stuttering, various models were proposed by Mackay and Soderberg (1970); Steinberg et al., (1980); Evarts, Shinoda & Wise (1984); Marsden (1984); Levelt, (1989) to explain the act of speech planning and execution.

The most common experimental approach to study the speech movements has been the 'Reaction time paradigm'. This paradigm helps us to understand the co-ordination between respiratory, phonatory and articulatory systems. This can be studied by measuring the stutterers ability to initiate & terminate speech movements rapidly in response to external stimuli.

The simple reaction time paradigm has been used extensively to compare phonatory response times of adult stutterers, child stutterers and non stutterers (Adams & Hayden, 1976; Cross & Luper, 1979). These studies have revealed longer reaction time in stuttering group.

The measures used in the above studies are (i) "Voice initiation time" (VIT) i e time elapsing between the onset of the first stimulus and the onset of the phonatory response, (ii) "Voice termination time" (VTT) i. e time elapsing between the onset of the second stimulus and the termination of voicing.

In recent years, the laryngeal co-ordinative abilities of stutterers and non-stutterers have been frequently compared in reaction time experiments. The results by Adams & Hayden, 1976; Starkweather, Hirschmann & Tannenbaum, 1976; Cross & Luper, 1983; Watson & Alfonso, 1983; Peters, Hulstijn & Starkweather, (1989) have shown that the laryngeal response of stutterers were slower than that of non-stutterers. Generally, this has been interpreted as an indication that the laryngeal co-ordination of those who stutter is less efficient than that of non-stutterers. However, the laryngeal lag which has been observed to be present among stutterers in most of the Laryngeal Reaction Time (LRT) experiments was located only during the initial stages of laryngeal co-ordination. That is, the reported findings were specific only to the period during which the subjects phonatory response was programmed and the laryngeal as well as respiratory adjustments for phonation were being made. However, the data did not provide comparitive evidence relative to phonation itself. As a result, it is not known whether (or) not stutterers and non-stutterers also differ with respect to the co-ordination of the laryngeal behaviors that are being executed during phonation.

The hypothesis that laryngeal dysfunction plays a primary role in stuttering block has lead unusual interest to the observation that stutterers tend to have longer voice reaction times than non-stutterers. This observations has now been repeatedly confirmed and even appears to extend to non-speech activities such as throat clearing and humming.

The delay that stutterers often manifest in their vocal reaction times is very small, but the regularity with which researchers have obtained this finding is nevertheless impressive. Some adopt the view that it reflects some type of overall neuromotor dificit in the stutterers make up. Stutterers also have exhibited delay in manual reaction time. If any lag in the manual reaction time exists, it is not comparable to the delay in vocal reaction time.

Another hypothesis that researchers find congenial at the present time is that the stutterers slower voice initiation is due to a specific impairment of the motor speech control mechanism in the brain. Bakker & Brutten (1989) suggested that the delay may reflect a "learned strategy" to slow down to reduce the risk of fluency failure.

Armson & Kalinowski, (1994), in a critique of the use of findings on the perceptually fluent speech of stutterers to support organic theories of stuttering, have expressed the belief that even the 'fluent' phonations of isolated vowels which have generally been used in vocal reaction time studies may be contaminated by stuttering (or) stuttering related events which are not evident perceptually.

NEED FOR THE STUDY :

The literature has indicated that the slower phonatory reaction time (voice initiation time and voice termination time) in stutterers may be some how related to the etiology of stuttering. This indirectly refers to the behavior of larynx during the stuttering. Poor abilities in initiating & terminating voice (or) delay in initiating and terminating voice prompts the speaker to repeat and prolong the oral articulatory gestures. Few studies (Cross and Luper, 1979 ; Cullinan and Springer, 1980 ; Murphy and Baumgartner, 1981 ; Till et al., 1983; Cross and Luper, 1983 ; Bishop Williams and Cooper, 1991a,b) have been done to compare VIT and VTT between children with stuttering and normal children. The results obtained were equivocal. Therefore the present study was undertaken to compare VIT and VTT between children with stuttering and normal children. This will further help in determining the notion that, whether slowness in initiating and terminating phonation exist in children with stuttering or not.

Children who stutter may differ in subtle ways in terms of speech production. These differences (or) abilities are influenced by developmental events and environmental forces. Since speech motor control is developmental in nature, as the age increases the child may learn to co-ordinate the various systems precisely. Considering this view point, the present study was designed to investigate the developmental trend in VIT and VTT with increase in age, which will throw light on speech motor development in children with stuttering.

Adaptation or practice effect is one of the charecterstic feature seen in developmental stuttering. There are only few studies (Adams and Hayden, 1976 ; Cross and Shadden, 1977 ; Cullinan and Springer, 1980) which have focussed on adaptation effect or practice effect in VIT, VTT tasks and revealed contradictory results. Hence the present study was attempted to explore whether the adaptation effect or practice effect is observed in voice initiation time or voice termination time task in children with stuttering. Literature on linguistic aspects of stuttering reveals that stuttering is more common in initial position of syllables words and sentences than medial and final position. There is a dearth of literature on comparison between VIT and VTT in children with stuttering and normal children. Therefore the present study was also aimed to compare between VIT and VTT in normal children and children with stuttering to determine whether, stutterers exhibit more of phonatory initiation deficit or termination deficit.

AIM OF THE STUDY

The present study was aimed ,

1. To compare Voice Initiation Time (VIT) & Voice Termination Time (VTT) of normal children with those of children with stuttering in the age range of six to nine years.
2. To compare VIT and VTT between different age groups (6-7 Vs 7-8 years, 7-8 Vs 8-9 years, 6-7 Vs 8-9 years) in both normal children and in children with stuttering.
3. To compare between Voice initiation time (VIT) and Voice termination time (VTT) in normal children and in children with stuttering.
4. To study the possibility of adaptation effect or practice effect in children with stuttering and normal children in VIT & VTT tasks across ten trials.

CHAPTER 2
REVIEW OF LITERATURE

Stuttering is a disorder of childhood and rarely begins in later life when it does start in adulthood, it often has a sudden onset and may be a different type of fluency disorder. Stuttering has many origin, many sources and that the original causes are not nearly so important as the maintaining causes once stuttering has started. Cause of stuttering is so subtle that despite several research, it is still in the realm of theory for proper understanding of stuttering. Several theories have been formulated by various authors. We can find stutterers who partly fit to any one of these various statements of theory and some stutterers who fit to several. The river of stuttering does not flow out of only one lake.

THEORIES OF STUTTERING

Stuttering was viewed as a psychological difficulty and should be diagnosed and described as well as treated as a morbidity of social consciousness (Fletcher, 1928). According to Johnson, (1942) stuttering is an evaluational disorder which results when normal non-fluency evaluated as something to be feared and avoided; it is outwardly what the stutterers does in an attempt to avoid non-fluency.

Brutten & Shoemaker, (1967) says that stuttering is a form of fluency failure that result from conditional negative emotions. Sheehan, (1958) proposed approach avoidance theory which indicated that, stuttering may be represented as the resultant of a conflict between opposing wishes to speak and to keep silent. Van Riper, (1937d & 1954) stated that stutterers tend to place themselves in a characteristic muscular and psychological set when attempting a word which is percieved as difficult (or) feared . He emphasized on lack of synchronization of motor nerve impulses to the speech structures. For synchronization of these, one cerebral hemisphere is dominant over the other. If there is no sufficient dominance, both tend to function independently. Hence poor synchronized function and a predisposition to speech breakdown would exist.

Eisenson, (1958) reported stuttering as constitutional predisposition to motor and sensory perseveration. Harmonal theory stated that, male sex harmone 'testosterone' tends to retard neuronal development in the fetal brain. As testosterone is more in male fetus left hemisphere development is reported to be delayed. As a result, males will be more prone to developmental disturbances of left hemisphere including those of speech and language.

Starkweather, (1987) proposed Demand-capacity model in which stuttering results when demands for fluency from the child's social environment exceed the child's cognitive, linguistic (or) motor and emotional capacities for fluent speech.

Stuttering: Disco-ordination of phonation with articulation and respiration

Many of abnormal disfluencies judged as stuttering involve problems of smooth co-ordination of phonation with articulation and respiration (Travis, 1931). After reviewing the vast literature of stuttering, Van Riper (1971) concluded that the core of the disorder is a disruption of timing of the motor sequences of sound, syllable and word production. He suggested that the marked reduction of stuttering during whispering and its elimination during pantomimed speech could be attributed to the high degree of conscious articulation at slower speech rates that permit synchronization. He also proposed the alternative that this puzzling reduction of stuttering could be accounted for ' the basis of a simplified synergy (the absence of voice and / or airflow).

Adams, (1974) opined that fluency is dependent on smooth co-ordination of activities of the respiratory, phonatory and articulatory systems. He suggested that the muscles and forces that promote control and co-ordinate subglottic pressure, glottal resistance and supraglottal pressure are the major determinants of both fluency and stuttering.

Disco-ordination of these elements would be manifested as difficulty in achieving transglottic pressures that would promote the precisely timed glottal airflow and vocalization required to facilitate smoothly articulated speech. Respiratory mistimings could disrupt phonatory and articulatory processes and conversely oral articulatory (or) phonatory mistimings could impair the smooth management of subglottic, transglottic and supraglottic pressures required for fluent speech (Adams, 1974).

MOTOR ASPECTS IN STUTTERING

Mackay's (1970a) model of "Stuttering as a defect in phonetic and syllabic contextual programming" highlights the importance of linguistic programming in stuttering. It suggests that certain phonetic sequences are inherently more difficult to say than others and proposes that phonetic (or) syllabic contexts are important determinants of such difficulty.

The model also suggests that speech production units involves in stuttering vary in size, from distinctive features to phrase. It also proposes that different stuttering symptoms (repetitions, prolongations & blocks) are determined by selective programming differences. This is also supported by Bloodstein's, (1975b) model of stuttering as tension and fragmentation.

Wingate's, (1969b) view of "Stuttering as a defect in prosodic transition to stressed syllables" highlights the importance of moment to moment changes in voicing necessary to generate appropriate stress and intonation patterns in fluent speech. It emphasized that stutterers has difficulty not in producing single sounds but in moving from one sound to the next.

Van Riper's, (1971) notion of "Stuttering as a defect in co-articulatory timing", like Mackay's model, stresses the importance of contextual programming in stuttering. Van Riper's model emphasizes the contributions of motor pattern stability and motor learning in stuttering. It also indicates the importance of strategies used in monitoring longer speech units, such as phrases.

Adam's (1974) model of "Stuttering as a defect in outflow and vocalization" clearly points out the inter dependent relationship between those two processes phonatory irregularities are understood interms of respiratory problems and viceversa. Adam's results leads the researchers to suspect that breathing and voicing problems in stutterers are somehow more basic than articulatory problems.

Schwartz's (1974) model of "Stuttering as a learned extricatory response to a laryngeal abductor reflex" has focused important attention on laryngeal behavior prior to speaking. Moreover, it leads us to suspect that voicing is the speech activity most likely to go away in stuttering.

In summary, stuttering is primarily a defect of syllable production due to

1. Excessive tension and lack of co-ordination in the processes of respiration , phonation and articulation
2. Breakdown in normal phonological programming. Stuttering is nearly always associated with the initial position of syllable, words and sentences. This is true of children and adults in all kinds of speech tasks. The recent research suggests that stutterers have problem in co-ordinating the precise muscular adjustments necessary in initiating and maintaining normal phonation. Stutterers have difficulty in co-ordinating the precise movements of breathing and voicing with those of articulating moreover, it appears that there are peripheral neural connections between larynx and tongue as well as between the larynx and middle ear muscles (Mc Call, (1975). Therefore it is possible that many of the respiratory, phonatory and articulatory irregularities observed in stuttering are due to "peripheral mechanics" rather than cortical programming errors.

STUTTERING AS A LEARNED EXTRICATORY RESPONSE TO A LARYNGEAL ABDUCTOR REFLEX (SCHWARTZ MODEL)

... Schwartz (1974, 1975) described a theoritical model of the core of the stuttering block. Specifically, he stated that the core of the stuttering block is the "tendency, under conditions of psychological stress, for the loss of supra medullar. inhibition controls upon the PCA (Posterior Cricorytenoid Muscle) in the presence of subglottal air pressure associated with speech"

Central to the model is an "airway dilatation reflex"(ADR) which flares the nostrils, moves the body of the tongue forward, dilates the pharynx and abducts the glottis (the only response). The ADR is normally active when theirr is a blockage of the airway (or) a need for greater than normal (supratidal) air volumes, as for yawning, sighing, (or) coughing. According to Schwartz, the ADR is mediated in the medulla and can be elicited by increased subglottic pressure receptors in the trachea. During normal speech subglottic pressure is elevated, but the ADR is not elicited because higher CNS (Supramedullary) speech centres inhibit the medullary centre which inhibits the reflex. This supra medullary inhibition breaks down, under periods of psychological stress.

As a result, the ADR is elicited and causes the PCA to contract and the glottis to abduct. Phonation is thus rendered impossible. The response to this reflexive glottal abduction is what comprises stuttering. The speaker who finds himself unable to phonate typically overcomes the abduction by a vigorous adductory effort, or a "laryngospasm". He may also attempt to "do battle supraglottaly" by tensing the lips, tongue (or) jaw overt stuttering, then.

consists of learned extricatory behaviour to escape from the Iaryngospasm (or) to avoid its occurance altogether.

.Schwartz (1976) lists several kinds of stress such as Psychological Stress Physical Stress (eg. Fatigue), External Stress (eg. Bad news), Speed Stress (eg. Need to talk in a hurry) which contribute to stuttering. This model doesn't account for the linguistic findings of stuttering and doesn't predict any general motor co-ordination deficits in stutterers.

SPEECH MOTOR CONTROL

Definition:

Speech motor control refers to the systems and strategies that regulate the production of speech including the planning and preparation of movements (sometimes called motor programming) and the execution of movement plans to result in muscle contractions and structural displacements.

NEEDS AND WA YS OF EVALUA TING SPEECH MOTOR CONTROL

In recent years stuttering has been described from motoric perspective (Adams(1974, 1984); Freeman(1984); Kent(1984); Zimmerman(1980); Van Riper(1982)). These approaches have in common atleast the idea that stutterers have great difficulty than non stutterers in initiating & controlling speech movement. There are different ways of evaluating speech motor control. They are as follows.

a) Simple reaction time

In simple reaction time (considered equivalent to a " delayed " task condition) task , subjects already know what response to perform and have only to wait for the "go" signal to execute .

It is a most common experimental approach to study speech movements. It helps in investigating the nature of motor organisation and execution. It makes it possible to control respirator}', laryngeal and articulatory behaviour by specifying phonetic characteristics of the response.

b) Choice reaction time

In choice reaction time task subjects must wait for information both on the response to perform and when to begin performance, equiring them to program and execute a response.(Klapp,Wyatt and Lingo, 1974).It helps in evaluating the programming & execution abilities of stutterers.

c) EGG (**Electro Glottography**)

It is suitable for studying young stutterers laryngeal behaviour. It is a non invasive procedure. It can be used to measure onset & offset of vocal fold vibraton, fundamental frequencies of vocal fold vibrations (Plus Perturbation in this frequency) and certain aspects of laryngeal waveform (waveform associated with vocal ford contact area). Temporal aspects of laryngeal behaviour consists of such measurable events as the onset and offset of vocal fold contact and vibrations, the duration of each cycle of vocal fold contact and glottal airflow, the duration of closed and open aspects of glottal cycle, transitions between voiced and unvoiced speech sounds and vice-versa. Temporal relations between onset and offset of laryngeal activity and supraglottal articulatory and respiratory behaviour can also be assessed.

d) EMG (**Electromyography**)

It is useful in obtaining information on movement and co-ordination of muscles of speech system during motor activity and helps in revealing abnormal laryngeal activity.

e) Manual Reaction Time

Indicative of time interval through the neural and mechanical components of a movement at a fundamental level of response organisation.

f) **Acoustic Studies** (or) Analysis

Shows about the acoustic and temporal parameters of stutterers speech.

YOUNG STUTTERERS SPEECH PRODUCTION

Stuttering in children clearly involves disruption in speech production, this does not necessarily mean that childhood stuttering is solely a problem of moving the speech production apparatus through time and space.

The study of young stutterers stuttering can help us clarify and describe the acoustic, perceptual and productive nature of childhood stuttering, but the study of young stutterer's stuttering symptamatology cannot readily tell us what initiates (or) causes stuttering in children.

The study of speech of young stutteres provides a multi-paned window into those childrens neuromotor abilities and behaviors for speech production. Furthermore, findings aberrations in speech production during young stutterers speech might help us better understand whether disturbances in speech production associated with stuttering represent localized elaborations of pervasive, subtle disruption which characterize the whole of their speech (both fluent & stuttered).

Indeed, aberrations in speech production during the perceptible fluency of young stutterers may indicate that these children have subtle difficulties controlling and stabilizing the speech physiology. (Zebrowski, Conture & Cudahy, 1985)

However, even if young stutterers perceptibly fluent speech may be linked to a multi-paned window, researchers still don't know which pane of glass to look through for example, with acoustic studies alone. Researchers have investigated the following parameters: Speech initiation time, voice initiation and termination time, voice reaction time, voice onset time, consonant, vowel, aspiration ,frication and stop gap durations, rates and durations of consonant vowel (or) vowel consonant transitions. Some of the above studies seems to have clear motivation in assessment of young stutterer's ability to control vocal fold behavior.

Voice abnormalities are a well documented feature of stuttering behavior and are clearly apparent to an alert observer. Larynx has been suspected of being the primary source of the problem. Followed by Schwartz theory of a stuttering which focussed on the behavior of larynx, studies by Freeman and Ushijima (1975, 1978), which vividly depicted the abnormal state of the intrinsic muscles of larynx during stuttering. Based on this result, researchers were interested in an extensive series of investigation of the phonatory reaction times of stutterers, where stutterers have been instructed to produce voice in various forms as quickly as possible in response to a signal. With few exceptions the result have shown stuttering to be slower on the average than non-stutterers in initiating phonation.

Voice Reaction time "Studies in children

Most studies of young stutterers speech production involved the measurement of their reaction time to acoustic and visual signal. Findings in these areas have been equivocal. Some studies indicated differences in variables such as VIT and VTT (Agnello, Wingate and Wendall, 1974; Cross and Luper, 1979; Till, Reich, Dickey & Seiber, 1983) where as other studies indicate no significant differences (CuUinan & Springer. 1980; Murphy & Baumgartner, 1981; Winkler & Ramig, 1986).Similarly,some find significant differences for non speech reaction times (Cross & Luper, 1979; 1983) while others report no significant differences in non-speech reaction times between young stutterers and their normally fluent peers (Till et al., 1983).

In laryngeal reaction time studies in stuttering, significant slowness in initiating and terminating phonatory and articulatory movements is noted unequivocally (Adams, 1984). A lengthened latency time (ie interval between the response signal and first manifestation of physiologic activity) might reveal programming difficulties and lengthened initiation time (Interval between start of first physiologic activity and the onset of speech (or) initiation) give insight in to initiation problems of either a special response system (i.e in co-ordination among intrinsic laryngeal muscle (or) disco-ordination of in oral movements) or problems in the co-ordination of the different sub system involved (i.e co-ordination of laryngeal movements with articulation and respiration).

Motor programming according to Steinberg and Keele (1978) must be (or) will be completed before the movement is initiated. Therefore, if the total acoustic reaction time is divided between a latency period in which no behavioral (or) physiologic manifestation is observed and a second initiation period must expect the length of programming variables to have the most influence on the latency time.

However, in stutterers as well as in non-stutterers the effects of utterance length and task condition were equally evident in the initiation time. This suggests that motor programming may continue even after the first movement is made. This implies that programming and movement execution may occur more (or) less in parallel.

If parallel processing is adopted, stuttering is associated by ineffective motor programming. Stutterers are slower in all reaction time data and show larger effects of all independent variables on the latency and initiation times.

Studies on stutterers ability to terminate phonation have produced similar results. Stutterers have been found to differ from non-stutterers by an average order of magnitude ranging from well under one tenth to about three tenths of a second.

In some of these studies subjects were asked to respond with words (or) nonsense syllables. Only those utterance judged by the experimenters to be fluent were retained for analysis. The trouble with such observations is that they lead to the unanswerable question of whether the observed delay in phonation is a cause, a result, (or) a minimal form of stuttering. In search of less ambiguous data, most investigators have therefore resorted to the use of isolated vowels such as /a/ (or) /^ /.

Although stutterers rarely appear to have difficulties with isolated speech sounds, it is agreeable that because even saying vowels is a form of speech activity, the task is not totally free from the possible influence of stuttering. For this reason few studies have been elicited non-linguistic phonatory responses such as throat clearing and phonation on inspiration. In two of the studies stutterers were found to be slower than non stutterers; in a third the difference approached significance.

Simple reaction time have been examined in children with stuttering. Generally these data suggests that stuttering children exhibit longer and more variable vowel initiation and termination times than non-stuttering children. Simple reaction time studies which measures total response time are difficult to interpret unambiguously because the locus (or) loci of the apparent delay in information transmission (or) processing can not be inferred.

The phonatory reaction time investigations of stuttering children have been restricted to the studies of a single speech like response, vowel production, vowel gestures, especially in an experimental paradigm which lack linguistic meaning and motor complexities. Word production presumably would be more complex both linguistically and motorically.

The inclusion of non speech phonatory reaction tasks would help us to determine whether the reported phonatory reaction type dififerences in stutterers are speech specific. Finally measurement of a limb sensorymotor response, such as finger reaction time, would help determine if the reaction time impairment is specific to the phonatory systems (or) if it reflects a more general characteristic of stutterers sensorimotor responses.

VIT AND VTT STUDIES IN CHILDREN WITH STUTTERING:

Cross and Luper (1979) compared the voice reaction times (VRT) in groups of 5 years old and 9 year old stutterers with those of non-stuttering children in the same age ranges. Their results suggested that, for both age groups, the mean voice reaction times of the stutterers was significantly longer than those of the non stutterers. Cross and Luper also reported that in both the stutterers and non stutterers VRT's were shorter in 9 years olds than in 5 years olds. The adult stutterers studied by Cross and Luper had faster mean reaction times than did either group of children. It appeared that VRT decreased with age in both the stuttering and non-stuttering groups. In their study the subjects phonated /^/ as quickly as possible upon hearing a 1000 Hz tone. Of the stutterers, five year olds had the longest VRTs with a mean of 562 ms, nine year olds means were the shorter at 351 ms and adults had the shortest VRT with a mean of 300 ms. Considering the stutterers together, the five year olds VRT differed significantly from the nine year olds VRT and from the adult VRT, with no difference between the nine year olds and adults. Cross and Luper (1979) concluded that neuromuscular maturation underlies the improved VRT over time in both stutterers and nonstutterers.

Cullinan & Springer (1980) Opined that the stuttering results from laryngeal dysfunction and said that stutterers have difficulties in their early speech development. They studied VIT & VTT in response to series of short segments of 1000 Hz puretone auditory signal in stuttering & Non-stuttering children in the age range of 5.8 to 11.7 years. The effects of random rewarded & non- reward on the phonatory response times also were studied. The experimental group consisted of 20 children, 11 of whom had other speech and / or language problems in addition to stuttering and 9 of whose only communication disorder was stuttering. The control group consisted of 20 normal speaking children matched with stuttering group for sex and age.

Children with speech and or language problems in addition to stuttering were found to have significantly longer voice initiation and termination times than the normal speaking children. The children with stuttering as the only speech problem generally did not differ significantly from the normal speaking children in phonation times. The results also indicated that older stuttering children have longer voice initiation times than do non-stuttering children, younger stuttering children do not. They concluded that the differences observed in the phonatory behavior of adult stutterers are more a reflection of habituated compensatory phonatory adjustments in response to disfluencies than they are indicators of an etiological key to stuttering (Schmitt and Cooper, 1978). They also opined that stutterers who have phonatory problems in the earlier years are the one's who continue to stutter as they grow older, whereas those who do not exhibit these phonatory differences in the early years are the one who either spontaneously recover from stuttering (or) respond more, favourable to management. Voicing times for responses following non-rewarded responses tended to be shorter than those for response following rewarded responses for both the groups.

In a study conducted by Murphy and BaumGarmer, (1981) voice initiation time (VTT) and voice termination time (VTT) was measured in seven stuttering and eight non-stuttering children ranging in age from 4 years 6 months to 6 years 10 months. The experimental task was the production of /a/ in response to a 1000 Hz pure tone. These stimulus tones ranged from 1 to 3.9 sec duration and were recorded at 7.50 i p / s from the output terminal of a Grason-stadler audiometer (model # 1701) on to a high quality tape using a wollensak tape recorder (model AV # 1420). The order of the tones was randomized inorder to minimize any order effects and the interstimulus interval was field constant at 14 sec .In addition, a 2000 Hz pure tone with a 250 msec duration was recorded on to the tape 2 second prior to the onset of each 1000 Hz tone, serving as an alerting signal.

The stimulus tape was presented through the tape channel of the audiometer to the subjects right earphone at 75 dB SPL. An audiorecording of the subjects phonation of /a/ was obtained with both an Electro voice microphone held 2 inches (5 cm) from the subjects mouth and a Tandberg tape recorder. Output from the audiometer and the subjects response were recorded in the tape. These tapes were recorded at 7.50 ips and were analyzed using a storage oscilloscope and a sound and vibration analyzer.

Voice Initiation time was defined as the period of time elapsmg between the onset of auditory stimulus and the onset of the subjects response of /a /.as displayed on an oscilloscope. Voice termination time was defined as latency between termination of the stimulus tone and the point at which the oscilloscope signal decreased by 90%. No statistically significant differences were found between two groups with respect to either VIT (or) VTT. In addition, no apparent relationships were present among VIT, VTT (or) stuttering severity.

Till, Reich, Dickers and Seiber (1983) compared the simple reaction times of thirteen stuttering and thirteen non-stuttering children matched individually for age 8.10 to 12.6 years, sex and handedness. The reaction time stimulus in all response condition was the offset of a 1000 Hz puretone. Two of the experimental condition required button pressing responses, one using the left fore finger and the other the right. The remaining 4 experimental conditions required phonatory responses. The non-speech phonatory responses consisted of inspiratory phonation and expiratory throat clearing, the speech like phonatory responses required abrupt initiation of the isolated vowel /ʔʌ/ and the word upper /ʔʌpɚ/.

Children with Stuttering found to be slower and more variable than the normal children only during phonatory initiation of throat clearing and production of the word /ʔʌpɚ/. The results were compared to previous reaction time investigations with both children and adults and related to certain factors which potentially can influence sensorimotor pathways prior to and during speech. The groups did not differ significantly on initiation reaction time for either inspiratory phonation (or) /ʔʌ/ production. Lack of significant group /ʔʌ/ differences for stuttering children in this study implies that further development of stuttering problem may result in more temporal disintegration of sensorimotor events required for vowel initiation. The phonatory tasks also differed on the ingressive / egressive airflow dimension Two of the three egressive tasks showed significant group differences, whereas the ingressive task did not results suggested that motoric complexity of a reaction time task may be an important consideration in reaction time experiment.

RELATION BETWEEN FINGER REACTION TIME AND VOICE REACTION TIME IN STUTTERING AND NON-STUTTERING CHILDREN AND ADULTS.

Considerable attention in the literature has focused on the speech movement patterns of stutterers. Data from various investigations indicate that the perceptually fluent and disfluent utterances of some stutterers are characterized by errors in timing of articulatory movements (Disimoni, 1974; Hand & Luper, 1980; Starkweather & Myers, 1979; Zimmermann, 1980a, 1980b) of vocal onset (Agnello, Wingate & Wendell, 1974; Conture, McCall & Brewer, 1977; Freeman & Ushijima, 1978; Hilhnan & Gillbert, 1977), and the interaction among levels of the speech processes (Ford, 1975; Metz, Conture &Colton, 1976; Perkins, Rudas, Johnson & Bell, 1976).

Simple reaction time has been used extensively to investigate the nature of motor organization and execution. Since the task involves a single predetermined stimulus and motor response, manual reaction time is indicative of the time interval through the neural and mechanical components of a movement at a fundamental level of response organization. It is proposed that if atypical manual as well as speech related reaction time are observed for some stutterers and if the correlation between them are high than interference in a common motor control system is implicated. Moreover, if atypical reaction times are observed, for very young children who stutter, then constitutional factors may account, in part, for the observed movement behavior differences.

Cross & Luper (1983) evaluated the relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. In their study nine stutterers and nine non-stutterers at each of three age levels (5 years, 9 years & 18 years & above) responded to the onset of 1 KHz tones by depressing the index finger of their preferred hand on a response key. Finger reaction time (FRTs) were measured to the nearest millisecond & compared to the voice reaction times (VRTs) obtained from the same subject. Voice reaction task is initiating vowel /^/ in response to 1kHz tone. They found that increased speed and stability of the finger reaction times were observed as a function of age for both groups. The stutterers as a group exhibited mean FRTs which were significantly longer & more variable than those of the non-stutterers at each of these three age levels. High correlations also were found between the finger & voice reaction scores for both the stutterers and the non-stutterers. Results support the interference that some stutterers may exhibit difficulty in the consistent execution of motor control strategies common to both speech and non speech movements.

The decrease in the manual reaction times with increased ages is consistent with the voice reaction time performance for the stutterers & non-stutterers (Cross & Luper, 1979). These results also parallel to the developmental pattern of simple reaction time for normal speakers (Czudner & Rourke, 1972; Elliot, 1970; Goodenough, 1935; Jones, 1931: Rourke & Czudner, 1972). Maturation of central processes involved in the organization & execution of motor behavior, however, appears to be of importance (Dustman & Beck, 1966; Elliot, 1970; Magladery, 1959; Weiss, 1965).

Reich et. al (1981) proposed that the slower reaction times are the resultant of heightened arousal levels associated with speaking tasks. If developmental stuttering factors such as situational speaking arousal were involved, the relative reaction time performance of the adult stutterers should have been poorer than that of younger children, since arousal could be expected to increase with age and more frequent experience of speech failure. Starkweather et al., (1981), using the frequency of percieved stuttering moments as a criterion measure, reported a non-significant negative correlation between finger reaction time & stuttering severity. Cooper & Allen

(1977) reported that stutterers exhibited poor timing control accuracy than non-stutterers for repetitive speech and manual tasks.

A study by Bishop, Williams and Cooper (1991a) explored the performance of young stutterers & nonstutterers on vocal & manual tasks of 3 levels of complexity in a simple reaction time paradigm. Subjects were five stutterers & five non stutterers in each of 4 age groups (3.0-5.9, 6.7-7.4; 8.0-8.11; 9.1-10.11) pairs of subjects (stutterers & control) were matched to within 3 months of age. They were classified in to mild, moderate, severe using stuttering severity index for children & stuttering prediction instrument by qualified speech & language pathologist. Experimental group were matched with control subjects for gender, age, race & school placement. An examiner screening sought to eliminate subjects with other known speech or language disorders. The vocal task was to initiate vowel /a / and words cow and cow boy to a visual cue (light) and manual task was to lift a finger in response to the visual cue.

Children with stuttering had significantly slower reaction times (RTs) than non stutterers. Changes in vocal & manual RTs followed a parallel course of improvement with age for both groups. These data suggests that speech & manual processes are not independent, unrelated functions of the motor control system at least as motor-control system of the stutterer, may be a decreased or diminished capacity for speed in initiating manual & vocal responses.

The manual / vocal ratios of stutterers and non stutterers were not significantlly different and essentially did not change with age. The finding is not in keeping with increased VRT relative to MRT at older ages as suggested by cullinan& Springer (1980). and Starkweather et al, (1984).

Differences between performances of stutterers and non stutterers increased with complexity. Variability of performance of stutterers on manual task was not affected by task complexity; in contrast, variability of performance was significantly greater for stutterers under six years on the most complex vocal tasks. Data from this study suggest that consistency of response programming was similar for older stutterers and non stutterers on both vocal & manual tasks & that it was independant of task complexity. In contrast, variability of RTs of Young stutterers on vocal tasks increased with complexity, where as variability of performance on young non stutterers increases with complexity only for manual tasks. Their data suggest that performing demands of all vocal and manual tasks were within the capacity of the motor control system of older children but were not for younger children.

Although it might be expected that older stutters because of increased length of stutterering experience, would be more likely to react to speech production with excess tension & there by perform more poorly on vocal tasks than on manual tasks. Actually, younger stutterers demonstrated a greater vocal/ manual RT difference than older stutterers. This may indicate that the less mature system of the young stutterers reacts more to the stuttering speech experience than the older, more mature system.

Bishop, Williams and Cooper (1991b) conducted one more study as an extension of their previous study. Subjects were 6 stutterers, six articulation disorder and six normal speaking children in the age group of 3.0-4.11; 5.0-6.11; 7.0-8.11; 9.1-10.11. Twenty four matched triads of young children with articulation disordered stuttering & normal speech were tested for reaction time on a series of I,2,or3 component vocal & manual tasks. Effects of age & task complexity on vocal / manual performance were assessed. The vocal task and manual task were same as that of their previous study.

Data suggested that the slowness of reaction time (RT) performance is not "stutter specific". Children with stuttering and articulation disorders had significantly slower RTs than children with normal speech. Vocal and manual RTs followed a parallel course of improvement with all age groups. Young stutterers (aged 3 & 4 years) showed significantly more response variability of reaction time than articulation disordered children on simple manual tasks and on complex vocal tasks.

Citing the finding of Agnello, Wingate and Wendell (1974) that stuttering children have longer voice onset times (VOTs) than do non stuttering children. Adams & Hayden (1976) suggested that slowness in starring voicing apparently is present early in the stutterers history & therefore, has not evolved out of a long history of stuttering. They acknowledge, however, that VOT (the time elapsing between the release of a stop consonant vowel utterance is not the same thing as VIT. This difference in VOT & VIT makes it difficult to draw conclusions concerning childrens VITs on the basis of VOTs. If children with stuttering are found to have longer VITs and VTTs than non stuttering children it might be asked whether the longer times are the result of stuttering behaviour or a reflection of a casual factor of stuttering.

Adams & Hay den (1976) acknowledged the possibility that the act of stuttering, "frequently marked by excessive constriction and tension in the speech mechanism, makes the quick initiation of phonation difficult to achieve." Initiation & termination of vowel /a/, a task which would appear to minimize the likelihood of stuttering.

Fluency in the speech of the children is reported to be adversly affected by the presence of anxiety or negative emotion. Brutten & shoemaker (1967) for example, have suggested that fluent speech behaviour requires a evidence of disorganisation when the speaker experiences negative emotion to interfere with the quick initiation & terminaton of voicing. On the other hand, at least one negative emotion, frustation, which has been cited often as resulting in decreased speech fluency (Vanriper 1973) has been shown to enhance some responses. On more complex tasks however, it has been said that such frustation will result in impaired performance (Schmeck & Bruiting. 1968; Libb, 1972).

Much interest has been shown recently in the hypothesis that laryngeal dysfunction is a casual factor in stuttering (Wingate, 1969b ;Adams and Reis.l971,1974;Freeman and Ushijima,1975; Perkins, Rudas, Johns & Bell, 1976; Starkweather Hirschman and Tannenbaum,1976; Conture, Mc Call &Brewer,1977).

Initiating voice as fast as possible in response to a signal involves.

1) Preparatory set to respond, 2) The perception of a stimulus and 3) The activation of both respiratory and laryngeal muscles.

Posturing the speech mechanism for the onset of an isolated voiced vowel requires muscular adjustments in the respiratory, laryngeal and articulatory system. In the respiratory system, these adjustments result in the optimization of thoracic muscle tension. Optimal muscle tension levels in turn, facilitate rapid generation of sufficient subglottal pressure for phonation initiation (Baken et al., 1979). Articulatory adjustments result in achievement of supra laryngeal vocal-tract posture appropriate for the required response (eg. Isolated vowel /a/). Posturing activity within these systems will occur simultaneously.

Further more it is likely that the nature of the posturing activity within any system is in part a function of the qualitative interaction between systems. For example, there may be differences in respiratory and laryngeal coupling for the onset of voiced versus voiceless vowels. In addition, articulatory posture may affect laryngeal posturing i.e constricted open vocal-tract configuration

Watson & Alfonso(1983) emphasized that posturing defects in stutterers would delay initiation of the response. For example, the latency of vibration onset for stutterers may be prolonged if the vocal folds are hyper adducted with excessive tension or abnormally postured (i.e simultaneous adduction and abduction) Freeman and Ushijima,(1978). Hyper postured vocal folds would likely result in abnormally high levels of glottal resistance and, therefore the need for higher levels of subglottal pressure, whereas abnormally postured vocal folds would prevent the accumulation of sufficient subglottal pressure to initiate vibration. Finally, markedly constricted articulatory posture increases supra glottal pressures and thus may prolong vibration onset latencies. According to Watson &Alfonso delayed reaction time values in these instances would reflect postural rather than initiation defects.

ADAPTATION (PRACTICE) EFFECT:

Johnson and Knott (1937) issued the first published report of the observation that a reduction in stuttering usually takes place in successive oral readings of the same material. Johnson and Inners (1939) reported that stuttering tends to be very marked during the first few readings and becomes progressively less so, generally reaching a limit beyond which repeated readings have little (or) no further effect. Most of the reduction that is to take place will be evident in most cases by the fifth reading on the average. This decrease in stuttering is roughly 50 percent of the frequency of stuttering in the initial reading.

Among the basic facts that have been noted are (i) rate of adaptation decreases with an increase in the time interval between successive reading, (ii)

The length of the passage does not seem to be an important factor, (iii) There is relatively little transfer of the adaptation effect to readings of different material, (iv) Adaptation is only temporary, if the passage is read again after an interval, the frequency of stuttering will have increased again in amounts varying with the length of the interval and will be fully restored to its original level with a few hours, (v) This spontaneous recovery of stuttering has been of exceptional interest to those to whom it has appeared analogus to the spontaneous recovery of a conditioned response following experimental extinction trials, (vi) The adaptation effect is found in children with stuttering as well as in adults with stuttering, (vii) Although it has been studied chiefly in oral reading, it has also been demonstrated in spontaneous speech by various means, (viii) In general, during adaptation there is a reduction in various types of disfluencies (Part-word repetition, Word repetition, Phrase repetition, etc.) although some differential effects have been shown to occur in individual cases.

Wingate (1966) reported that the problem of stuttering includes a focal defect in the form of a difficulty in controlling vocalization and making quick adjustments in the articulatory mechanism while attempting to co-ordinate respiration and phonation. Co-ordination of respiration, phonation and articulation in stutterers is more skilled in repeated reading.

Wischner (1956) stated that reinforcement which serves to maintain the stuttering behavior is diminished during successive reading of the same material. Johnson (1967) found that stutterers anxieties about stuttering are reduced through deconfirmation of their expectancies. Eisenson (1958) opined that repeated reading establishes an aiticulatory and vocal set appropriately for the next trial. According to Blood stein (1972) adaptation effect is due to greater ease and communication in the server ordering of speech movements through rehearsal of the motor plan.

The experimental task of Adams and Hayden (1976) required the subjects to start and stop phonation as quickly as possible upon hearing each member of series of 1000 Hz pure tones appear and disappear. The series of 1000 Hz pure tones contained three trains of tones. There were three tones to a train with a one minute interval between adjacent trains. Each train consisted of a pure tone .an interval, the second tone, another interval and third tone. Results showed that both stuttering and non stuttering groups improved (shortened) their voice initiation and termination times from the beginning to the end of the experiment. The most straight forward explanation for this improvement would involve attributing it to practice since subjects had to perform VIT and VTT tasks repeatedly.

Only few studies (Adams and Hayden ,1976; Cullinan and Springer, 1980; Cross and Shadden,1977) have been done on evaluating a adaptation or practice effect in VIT and VTT task. Further reaction times for both stutterers and non-stutterers have been shown consistently to improve with repeated trials (Starkweather et. al, 1976). Adams & Hay den's (1976) results using auditory cueing demonstrate improvement in reaction time with practice for both groups of subjects. Cross & Shadden (1977) also report improved voice reaction times on successive trial for stutterers & non-stutterers, while stutterers tend to improve more slowly in the reaction task, they do attain what appear to be 'optimum' response times by approximately 10-15 trials (Cross, Shadden & Luper, 1979). In contrast Cullinan and Springer (1980) did not found any significant differences in VRT between the trials.

MINIMUM RE A CTION TIME FOR PHONA TIONINITIA TION

Glottal width, response modulations, lung volume & sex:

Phonation may be initiated from various glottal width (Hirose. & Gay, 1973; Werner Kukuk & Von leden, 1970), therefore phonatory reaction times were studied as a function of the extremes of prephonatory vocalfold position from abducted to fully approximated. Further, because of concomittance of respiration with phonation (Hoshiko, 1965, Hixon.1973) & the apparent influences of the respiratory phase on non-vocal reaction times (Weiss, 1960; Gaskill, 1928; Buschsbaum & Callaway, 1965, Beh & Nix- James, 1974), the Phonatory reaction time also were investigated with respect to different lung volumes. Vocal responses to an auditory stimulus were somewhat shorter than to a somesthetic stimulus. Malinowski, 1967, Maccoby & Jacklin, 1974 reported sex differences in laryngel reaction time and had attributed to the laryngeal anatomy. They reported slower RTs for females and encouraged additional investigation of phonatory reaction time as function of sex.

In a study by Izdabski & Shipp (1978), the maximum speed at which voluntary vocal and digital responses can be initiated was investigated in 15 male & 15 female neurologically normal adults using simple reaction time

(RT) methodology. All subjects were pertained to respond as quickly as possible to stimulus onset following a computer controlled preparatory interval. Voluntary minimal RTs for phonation initiation were studied as a function of,

(1) Stimulus type (Auditory & Somethetic)
(2) Pre phonations vocal fold position (Abducted & adducted)
(3) Subject lung volume (75%, 50% & 25 %)

The average minimal vocal RT across subjects was 195msec and the fastest record vocal RT was 120 msec. Although vocal responses to an auditory stimulus were some what shorter than to somesthetic stimuli, neither those differences nor the RTs between sexes were statistically significant except that females had shorter vocal RTs from an abducted pre phonates vocal position. Shorter vocal reaction times were obtained when phonation was initiated at mid lung volume extremes and for both sexes the average digital RTs were significantly shorter than vocal RTs.

Latency of Vocalization Onset for Stutterers and Non-Stutterers under Condition of Auditory and Visual Cueing.

Moravek & Langova (1962) described stuttering blocks as a prephonational tones that results from excessive laryngeal muscular activity and poor propnoceptive feedback. Other investigators have indicated that some form of phonatory system dysfunction may exist for stutterers.

Starkweather, Hirschman and Tannenbaum (1976) demonstrated that stutterers have slower phonation onset times under conditions of visual cueing across a wide varrety of syllables.

McFarlane & Prins (1978) reported that stutterers were slower than non-stutterers for initiating lip muscle activity (EMG) for speech like tasks when stimuli presented via an auditory mode but not when stimuli were presented visually. Most of these studies have used auditory cues to signal subjects responses therefore it was of interest to determine whether stutterers "slowness" was related to auditory cueing rather than to an overall motor (or) specific laryngeal dysfunction.

Slower phonation onsets for stutterers under some condition of auditory cueing were found in the study conducted by McFarlane & Shipley in 1983. The presence of slower voice reaction times in stutterers under auditory cueing does not directly specify the reason for this slowness. This slowness could be caused by auditory factors, motor phonations factors, integrative factors, learned factors, Psychological factors (or) other factors.

Sussman's (1974) findings with a specialized application of dichotic listening (Pursuit auditory tracking) suggest that stutterers as a population have less distinct lateralization of speech related, auditory sensorimotor integration than non-stutterers. Neilson & Neilson's (1979) report that stutterers and non-stutterers perform comparably for visual tracking tasks while their performances differ for auditory tracking tasks. Stuttering is reduced under conditions that eleminate (or) reduce auditory cues (Bloodstein, 1949; Cherry & Sayer, 1956; Garber & Martin, 1977).

Age & Task complexity variables in reaction time measures

Psychology, Physiology & Motor control have an extensive body of literature on reaction time dating back to the 1930s. The majority of these studies have recorded slower reaction time. Several studies have investigated vocal / speech reaction time on tasks that were presumed to represent different levels of complexity (McKm'ght & CullinaiL 1987; Peters et al., 1989; Reich et al.. 1981; Starkweather et al., 1976; Till et al.. 1983). Results of these studies suggested that the motoric complexity of a task influenced response time.

Although there is general agreement that vocal reaction time of various stuttering population is slower than that of control subjects, age differences in voice reaction time (VRT) performance are not clear cut. Findings on differences and or similarities between stutterers & non stutterers on performances of manual & vocal tasks have been equivocal. If stuttering is primarily a reflection of an overall slowness or inefficiency of the motor control system, then both vocal & manual reaction times (RTs) and manual/ vocal ratios should follow a parallel course of development with increasing age. If stutterer vocal RTs do not improve parallel to manual RTs over age & non stutterers RTs do, this would point to either speech/ specific or developmental factors that slow VRT at older ages. If stuttering is a manifestation of general slowness of the motor control system, increasing task complexity should affect vocal & manual RTs in a similar manner for both stutterers & non stutterers.

INITIA TION VERSUS EXECUTION TIME

Most investigations comparing the latency of stutterers to that of controls have focused on the time between a signal to respond and the onset of the response. This interval may be considered the initiation time, an interval that includes premotor planning and motor initiation in contrast to the execution time which is the interval between the first and last event in a serially ordered response.

Since stutterers evidence most of the disfluencies during the initiation of phrases rather than within phrases, it was interesting and surprising that initiation times for the fluent utterances were not significantly longer than those for the controls, while execution times were significantly longer. Execution time has not been explored in many studies, but the study conducted by Borden (1983) revealed longer execution time for sever stutterers than mild stutterers which suggest that some stutterers need more time to co-ordinate serially ordered events regardless of whether they involve speech (or) hand co-ordination. Differences in co-ordination pattern may be found to relate to the slowing of execution, even when fluent.

Physiological bases of acoustic laryngeal reaction time.

The hypothesis that stutterers have difficulty controlling rapid initiation and termination of voicing is shared by most physiologically based models of the disorder (Adams, 1974, 1978 ; Schwartz, 1974; Vanriper, 1982; Wyke, 1971; Zimmerman, Smith & Hanley, 1981).

Two observation supports this hypothesis,

1. Stutterers show greater frequency of dysfluency and less adaptation when reading aloud passages containing both voiced and voiceless segments than passages containing only voiced segments (Adams & Reis, 1971, 1974; Adams, Riemenschnieder, Metz & Conture, 1975).

2. Physiological data based on fiberoptic viewing of the vocal folds (Conture. McCall & Brewer, 1977) & recordings of electromyographic (EMG) signal from intrinsic laryngeal muscles (Freeman & Ushijima, 1978; Shapiro, 1980) reveal evidence of abnormal laryngeal activity during stutterers dysfluent utterances.

LRT values are not independent of the interaction of respiratory & articulatory activities with the larynx. With respect to the former, variability in prephonatory chest wall posturing described by Baken, Cavallo and Weissman (1979) & by Baken, Mc Manus & Cavallo (1983) may affect laryngeal activity.

Baken et al., (1983) reported no significant differences between stutterers and non-stutterers with respect to onset latency (or) pattern of prephonatory adjustments. It is possible to determine the contributions of respiratory and laryngeal activities to stutterers difficulty initiating voice rapidly by minimizing contributors of articulatory dynamics and analyzing simultaneous respiratory and laryngeal kinematic data.

Study by Watson & Alfonso (1987) revealed that slow LRT valued demonstrated by sever stutterers reflect infrequent and delayed initiation of poorly organized respiratory and laryngeal events. Mild stutterers always executed well organized events during and after all foreperiods. Improvement in their acoustic LRT values as a function of increasing foreperiod can be related to improvements in the frequency of initiation and timing of prephonatory events and there is delayed initiation of respiratory events.

According to them, observation of physiological defects in both the respiratory and laryngeal system in mild and sever stutterers is a cause for prolonged acoustic LRT values.

MANUAL REACTION TIME STUDIES IN CHILDREN WITH STUTTERING & NORMAL CHILDREN

The delay that stutterers often manifest in their vocal reaction times is very small, but the regularity with which researchers have obtained this finding is nevertheless impressive. Some adopt the view that it reflects some type of overall neuromotor defects in stutterers make up. Investigations of manual reaction time studies may reveal more about this possibility, but the studies that have been published till date have been so inconsistent in their outcomes that it already seems clear that if any lag in manual reaction time exists, it is not comparable to the delay in vocal reaction.

Several methodologies were adopted to compare the manual reaction time in children with stuttering and normal children using tasks such as finger pressing , touching the panel board in response to an auditory signal. Studies done to compare manual reaction time between normal children and children with stuttering revealed both significant difference as well as non significant difference in manual reaction time. The findings of Cross & Luper , (1979) , Cross & Luper (1983) Long & Pindzola (1985), Bishop, Williams & Cooper (1991) on manual reaction time studies on children with stuttering and non stuttering children are equivocal as VRT studies.

Voice Reaction time studies on adult stutterers:

Adams and Hayden (1976), Cross and Luper (1979) reported that stutterers were significantly slower than normal subjects in initiating and terminating phonation in response to auditory signal. Stutterers shortened VTTs and VTTs from trial to trial was observed and attributed to practice effect since subjects had to perform voice initiation and termination tasks repeatedly.

Two explanation for the result can be stated,

1. It is possible that the act of stuttering, frequently marked by excessive constriction and tension in the speech mechanism. This makes the quick initiation of phonation difficult to achieve.

2. Delay in voicing prompts the speaker to repeat and prolong oral articulatory gestures until a stable vocal tone has been achieved.

Reich, Till & Goldsmith (1981) study compared the reaction times of 13 stutterers and 13 non-stuttering adults for forefinger button pressing, non speech vocal initiation and speech mode vocal initiation. The reaction time stimulus in all response conditions was the offset of a 1000 Hz pure tone. Two of the experimental conditions required button pressing with the right and left fore fingers. The remaining 4 responses required vocal fold vibration. The non-speech vocal activity consisted of inspiratory phonation and expiratory throat clearing. The speech mode vocal activity required production of isolated vowel /ʌ/ & the word /ʌpɤ/. The result indicated that stuttering and non-stuttering adults differed significantly in tasks requiring speech phonation. Longer speech LRT exhibited by the stutterers reflect learned anticipatory fears of phonatory initiation and maladaptive prephonatory muscular sets.

Starkweather, Franklin Smigo (1984) found that stutterers were significantly slower in both speech task (phonation of 'uh' in response to offset of tone) and non-speech task (pressing button) than non stutterers, the correlation between voice and manual reaction times were not significant.

Peters, Hulstijn & Starkweather (1989) reported that,

1. Reaction times of stutterers increase under conditions that increase the motoric complexity of speech production.
2. The effect of increased motoric complexity on reaction time is stronger for stutterers than for non-stutterers, particularly when the response is made with little time to prepare in advance
3. The additional time stutterers need to respond in a reaction time task is located more in the early subintervals of the response than in the later ones

4. The effects of increased motoric complexity are more pronounced for subintervals of the reaction time located more towards the beginning of the response. This suggests that, stutterers have difficulty in programming the motor commands.

In an experiment conducted by Venkatagiri, (1981) a group of 10 adult stutterers and a 10 group of adult non-stutterers produced prolonged version of the /a/ sound using voice and in a whisper in response to 1000 Hz tone stimuli. The results showed that stutterers and non-stutterers did not differ in RT for other voiced (or) whispered /a/. The stutterers, however exhibited significantly longer RT to produce voiced /a/ than whispered /a/.

The above review highlights about the different voice reaction studies and to some extent about the manual reaction studies in children. Few voice reaction studies on adults were also been discussed. The review also throws light on disparity of the results on reaction time studies . Hence this study is aimed to investigate the voice initiation time and voice termination in normal children and in children with stuttering and also to focus on the performance of these subjects in repeated trials.

CHAPTER 3

METHODOLOGY

Subjects :

Subjects were divided in to two groups, Experimental group and Control group.

Experimental group:

It consisted of fifteen children with stuttering in the age range of 6 to 9 years. (Mean age: 7.3 years; 8 males and 7 females).

Control group:

It consisted of fifteen normal speaking children, matched for age, gender, handedness and educational level. (Mean age : 7.3 years; 8 males and 7 females).

The subjects in normal and stuttering population were divided in to three age groups as 6 to 7 years, 7 to 8 years, 8 to 9 years. Each age group consisted of five subjects.

Prior to the experiment, all the subjects in both experimental and control group were evaluated and found to have normal hearing, intelligence, articulation, language ability, voice quality , intensity and normal ability to inspire a large amount of air sufficient to maintain his/her phonation for not less than 8-10secs. No subject had any history of drug use, neurological dysfunction (or) cranio-facial anomalies. The presence (or) absence of speech

/language/voice and hearing problems and the diagnoses of stuttering were made by a qualified speech and language pathologist using appropriate tests. All stutterers were identified as being in mild to severe range using the stuttering severity instrument (SSI) for children (Riley, 1972). Since the severity was not considered as a factor in the study ,all the subjects with mild to severe were considered.(9 mild. 3 moderate and 3 severe and each age group consisted of 3 mild , 1 moderate and 1 severe).

Experimental stimuli and instrumentation

The task used in this study was initiation of phonation and termination of phonation of vowel /a /in response to an auditory stimuli. The auditory stimuli used in this study were a low frequency auditory stimuli produced by an instrument. The instrument and it's operation is shown in the fig 1,2, and 3. There were two stimuli for each trial, one was provided at the beginning of the experiment and the other was provided 3 - 6 seconds after the first stimulus had occurred, for initiation and termination task respectively. This inter-stimulus interval was varied to overcome the anticipatory effect.

An audio recording of the auditory stimuli and subjects phonation of /a/ was obtained with unidirectional microphone (model Alcom Aud 80,600 ohms) held at 5 cm from the subject's mouth and stimuli source. Microphone was connected to the speech interface unit. The software program, speech science lab (SSL,Vaghmi) was used for analysis of VIT and VTT. Subject's phonation

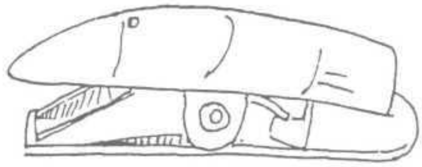


figure :1
The instrument used for the production of auditory stimuli

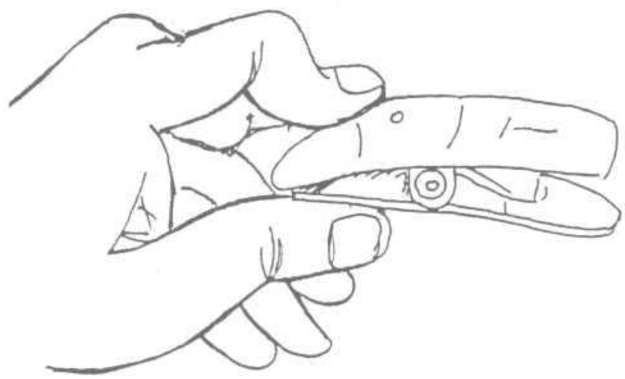


figure :2

The operation of instrument for VIT task

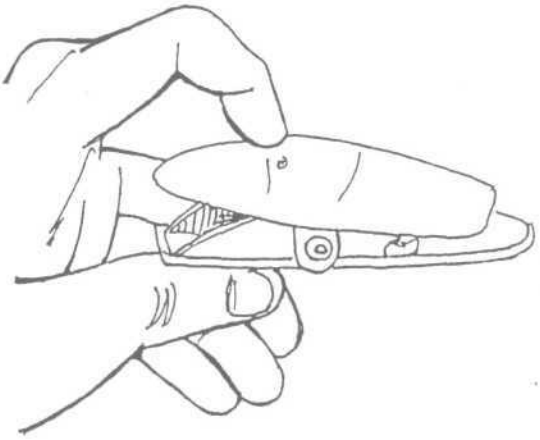


figure :3.

The operation of instrument for VTT

signal was displayed as waveform in the (500 MHz pentium III) computer screen and the auditory stimuli was displayed as burst in the waveform .The schematic block diagram of the instrumentation set up is shown in the figure 4.

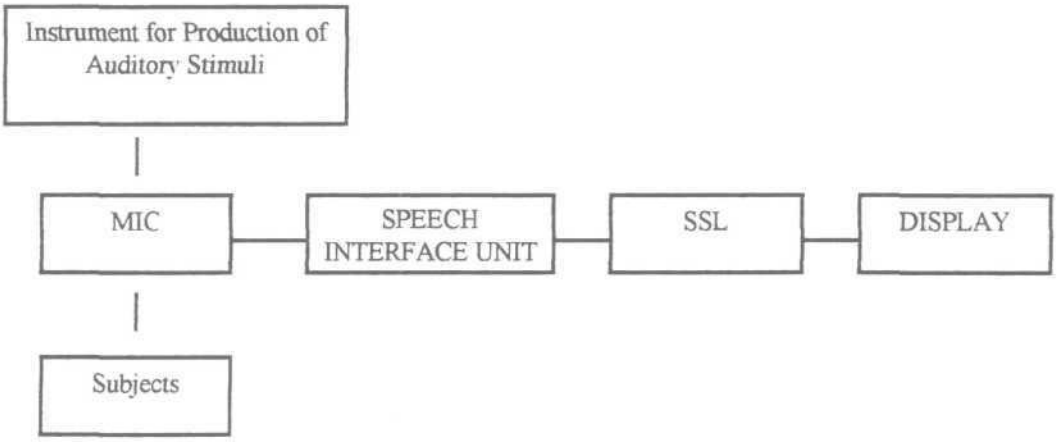


Figure 4 : Schematic Block diagram of instrumentation setup during the Experiment.

Procedure

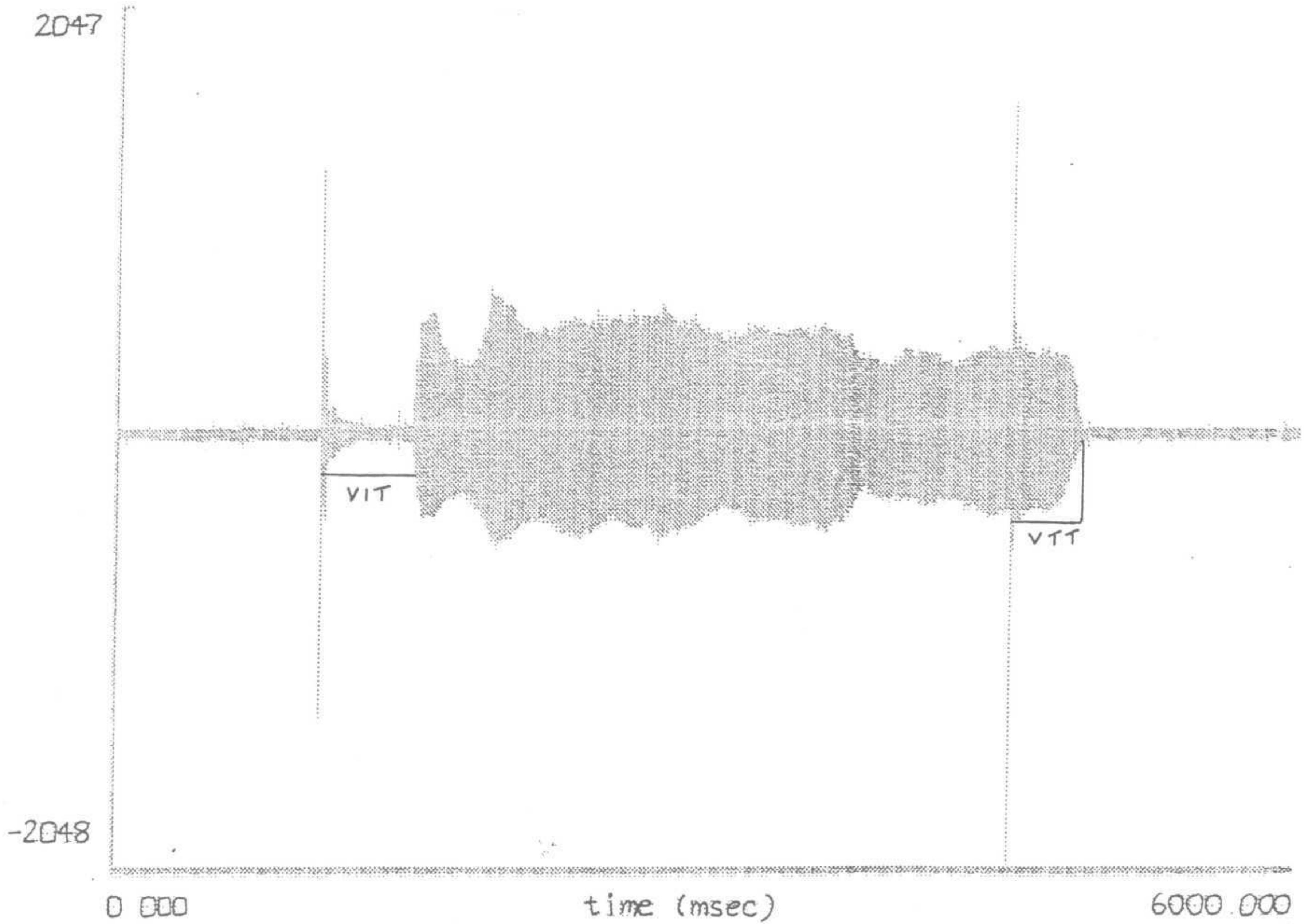
The experiment utilized simple reaction time paradigm. Subjects were tested in the speech pathology lab of All India Institute of Speech and Hearing. They were given instruction followed by a demonstration of the task in language appropriate for the subjects age and comprehension ability. They were instructed to say /a/ as quickly as possible when they hear the first stimuli and to sustain saying /a/ for some time and to stop saying /a/ as rapidly as possible when they hear the second stimuli. Auditory stimuli were presented without any visual cue. If the subject had no questions and followed directions

practice trials, the experiment was carried out. If the child did not respond appropriately during the practice session, the instructions were repeated and practice trials were repeated until the child was able to understand the task The experimenter repeated instructions during the experiment if it appeared necessary.

The practice trials were given ten minutes prior to the experiment. The entire task consisted of 10 experimental trials with the time interval varied from 15 to 20 seconds after each trial. These ten trials were taken to see the motoric learning or Practice effect in the experimental task among the groups.

In this study, VIT was defined as the amount of time (in milliseconds) that elapsed between onset of the first auditory stimuli (first burst) and the initiation of the subject's phonation (onset of wave) as displayed on the computer screen. VTT was defined as the amount of time (in milliseconds) that elapsed between onset of the second auditory stimuli (second burst) and the termination of the subject's phonation(offset of wave).The waveform of subject's phonatory response to the auditory stimuli is shown in the fig.5.

Thus Voice Initiation Time and Voice Termination Time were measured for normal children and children with stuttering and the data obtained was tabulated. Independent sample 't test' was used to determine the VIT and VTT differences between normal and stuttering population and also between different age groups. Paired 't test' was used to determine the significant difference between VTT and VTT within each age group in both normal and in stuttering population. The mean VTT and VTT of the first trial to the last trial for all the subjects in each age group were calculated and plotted in the graph to determine the practice effect of VTT and VTT across ten trials. The results of the present study follows this chapter.



52(a).

Figure : 5 The wave form depicting VIT and VTT

CHAPTER 4

RESULTS

The data obtained from the normal children and children with stuttering were analyzed,

1. To compare Voice initiation time (VIT) and Voice termination time (VTT) of normal children with those of children with stuttering in the age range of 6-9 years.
2. To compare VIT and VTT between different age groups (6-7 Vs 7-8 years,7-8 Vs 8-9 years, 6-7 Vs 8-9 years) in both normal children and in children with stuttering.
3. To compare between voice initiation time (VIT) and Voice termination time (VTT) in normal children and in children with stuttering.
4. To study the possibility of adaptation effect or practice effect in children with stuttering and normal children in VIT and VTT task across ten trials.

1) Comparison of "voice initiation time (VIT)" and "voice termination time (VTT)" between normal children and children with stuttering

Mean VIT and VTT scores were computed for each subjects in each age group 6-7, 7-8 and 8-9 for normal children and children with stuttering. The VIT and VTT means and standard deviation for normal and stuttering group for each age group are presented in table 1 and 2 respectively.

Table 1 : Mean and Standard deviation (SD) of voice initiation time (VIT) for children with stuttering and normal children in relation to age variable (VIT in msec)

Variables	Voice Initiation Time						
	Normal			Stuttering			
Age (in *years)*	No. of Subjects	Mean	SD	No. of Subjects (N)	Mean	SD	Probability
6 - 7	5	489.34	105.74	5	496.39	170.35	t=0.13 p>0.05 not signi-ficant
7 - 8	5	481.72	89.83	5	484.08	98.45	t=0.03 p>0.05 not signi-ficant
8 - 9	5	461.39	107.51	5	466.51	115.25	t=0.07 p>0.05 not signi-ficant

Table 2 : Mean and Standard deviation (SD) of voice termination time (VTT) for children with stuttering and normal children in relation to age variable (VTT in msec)

Variables	Voice Termination Time						
	Normal			Stuttering			
. Age (in *years)*	No. of Subjects (N)	Mean	SD	No. of Subjects (N)	Mean	SD	Probability
6-7	5	371.51	107.77	5	374.53	77.68	t=0.05 p>0.05 not signi-ficant
7-8	5	369.59	93.73	5	369.87	80.84	t=0.008 p>0.05 not signi-ficant
8-9	5	364.65	82.15	5	366.79	76.44	t=0.04 p>0.05 not signi-ficant

Inspection of raw data showed that both stutterers and normals exhibited a large trial to trial variation in VIT and VTT as indicated by a larger standard deviation. The mean VIT and VTT values and Standard Deviation are shown in table-1 and table-2 respectively. The mean scores are obtained based on 10 trials from 5 normal and 5 stutterers each in the age group 6-7, 7-8 and 8-9 years.

Independent sample 'f test was used to compare the mean voice initiation and termination time of normal children with those of children with stuttering. The results of the independent sample "t" test are also depicted in table-1 and table-2. Inspection of individual data revealed that some stutterers exhibited longer mean voice initiation time and termination time than normal counterparts .but as a group the difference was very negligible in each age group. Statistical analysis revealed non significant difference ($p>0.05$) in voice initiation time and voice termination time between normal children and children with stuttering within each age group.

Over all comparison of mean VIT and VTT between normal children and children with stuttering.

Over all mean VIT and VTT scores were computed for all subjects in normal and in children with stuttering ranging in the age from 6 to 9 years. The overall mean and standard deviation of VIT and VTT for normals and stutterers are displayed in table 3 and 4 respectively. Though the overall mean VIT and VTT was longer in some children with stuttering compared to normal group, as a group the difference existed between them was small.

Table 3 : Over all mean and standard deviation (SD) of voice initiation time (VIT) for children with stuttering and normal children (VIT in msec)

Variables	Voice Initiation Time						
	Normals			Stuttering			
Age (in *years)*	No. of Subjects (N)	Mean	SD	No. of Subjects (N)	Mean	SD	Probability
6-9	15	477.48	101.35	15	482.33	131.34	t=0.34 p>0.05 not signi-ficant

Table 4 : Over all mean and standard deviation (SD) of voice Termination time (VTT) for children with stuttering and normal children (VTT in msec)

Variables	Voice Termination Time						
	Normals			Stuttering			
Age (in *years)*	No. of Subjects (N)	Mean	SD	No. of Subjects (N)	Mean	SD	Probability
6-9	15	368.58	92.76	15	370.39	77.92	t=0.03 p>0.05 not signi-ficant

Independent sample 't' test was administered to compare the overall mean VIT differences and VTT differences between normals and stutterers. Independent sample 't test' revealed a non significant difference (p>0.05) in VIT and VTT between normals and stuttering group.

2) Comparison of VIT and VTT between different age group in normal children and children with stuttering

The mean *VTT* and VTT was compared between different age groups for normals and stuttering group using Independent sample 't test'. Developmental trend for both VIT and VTT tasks was not seen in both normal and stuttering group. The results of the independent sample 't' test for mean VIT and VTT differences between different age groups for normals and stutterers are displayed in the table 5, 6, 7 and 8 respectively.

Table 5 : Mean and Standard deviation of voice initiation time (VTT) for different age groups in normal children (VIT in msec).

Age(in years)	No. of Subjects (N) '	Mean	SD	Probability
6-7 vs 7-8	5 5	489.34 481.72	105.74 89.83	t=0.12 p>0.05 not significant
7-8 vs 8-9	5 5	481.72 461.39	89.83 107.51	t=0.32 p>0.05 not significant
6-7 vs 8-9	5 5	489.34 461.39	105.74 107.51	t=0.41 p>0.05 not significant

Table 6 : Mean and Standard deviation of Voice Initiation Time (VIT) for different age groups in children with stuttering (VIT in msec)

Age (in years)	No. of Subjects (N)	Mean	SD	Probability
6-7 vs 7-8	5 5	496.39 484.08	170.35 98.45	t=0.14 p>0.05 not significant
7-8 vs 8-9	5 5	484.08 466.51	98.45 115.25	t=0.25 p>0.05 not significant
6-7 vs 8-9	5 5	496.39 466.51	170.35 115.25	t=0.32 p>0.05 not significant

Inspection of individual data suggested greater variability among subjects. Some older normal children and children with stuttering showed shorter mean VIT and VTT than younger normal children and children with stuttering, and some younger normals and stutterers exhibited shorter VIT and VTT than older normals and stutterers. The results of Independent sample 't test' revealed non significant difference ($p>0.05$) between different age group (6-7 vs 7-8, 7-8 vs 8-9 and 6-7 vs 8-9) in both normals and stuttering population for both *VTT* and VTT task.

Table 7 : Mean and Standard deviation of Voice Termination time (VTT) for different age groups in normal children (VTT in msec)

Age(in years)	No. of Subjects (N)	Mean	SD	Probability
6-7 vs 7-8	5 5	371.51 369.59	107.77 93.73	t=0.03 p>0.05 not significant
7-8 vs 8-9	5 5	369.59 364.65	93.73 82.15	t=0.08 p>0.05 not significant
6-7 vs 8-9	5 5	371.51 364.65	107.77 82.15	t=0.11 p>0.05 not significant

Table 8 : Mean and Standard deviation of Voice Termination Time (VTT) for different age groups in children with stuttering (VTT in msec)

Age(in years)	No. of Subjects (N)	Mean	SD	Probability
6-7 vs 7-8	5 5	374.53 369.87	77.68 80.84	t=0.09 p>0.05 not significant
7-8 vs 8-9	5 5	369.87 366.79	80.84 76.44	t=0.06 p>0.05 not significant
6-7 vs 8-9	5 5	374.53 366.79	77.68 76.44	t=0.15 p>0.05 not significant

3) Comparison between VIT and VTT in normals and in stutterers

Comparison between mean VIT and VTT in normal and in stuttering population within each age groups was done using paired 't test'. VTT and VTT was compared for each age group in both normal and in stuttering population. Table 9 and 10 shows mean and standard deviation of VIT and VTT in normals and in stuttering population for each age group.

Table 9 : Mean and Standard deviation of VIT and VTT for each age groups in normal children (VIT and VTT in msec).

Variable	VIT			VTT		
Age (in *years)*	No. of Subjects (N)	Mean	SD	Mean	SD	Probability'
6 - 7	5	489.34	105.74	371.51	107.77	t=4.81 PO.001 Highly significant
7 - 8	5	481.72	89.83	369.59	93.73	t=5.96 PO.001 Highly significant
8 - 9	5	461.39	107.51	364.65	82.15	t=5.45 PO.001 Highly significant

Table 10 : Mean and Standard deviation of VIT and VTT for each age groups in children with stuttering (VIT and VTT in msec).

Variable	VIT			VTT		
Age (in *years).*	No. of Subjects (N)	Mean	SD	Mean	SD	Probability
6 - 7	5	496.39	170.35	374.53	77.68	t=5.49 p<0.001 Highly Significant
7 - 8	5	484.08	98.45	369.87	80.84	t=7.39 p<0.001 Highly Significant
8 - 9	5	466.51	115.25	366.79	76.44	t=5.67 p<0.001 Highly Significant

The results of 'paired t test' showed that mean *VIT* of stutterers and normals were longer than VTT of stutterers and normals. Statistical analysis revealed that there is high significant difference (PO.001) between VTT and VTT for both normal and stuttering population in all 3 age groups.

Overall comparison between VTT and VTT in normal children and in children with stuttering

The overall mean and standard deviation of VIT and VTT were calculated for both normal and stuttering group and are presented in the table 11 and 12 respectively. The overall mean VIT and VTT was compared in both normal and stuttering group. 'Paired t test' was done to elucidate the significant difference between VIT and VTT. The overall mean VIT in normal and children with stuttering was longer compared to VTT in both the normal and stuttering group for all the age group. Statistical analysis revealed a high significant (PO.001) difference between VIT and VTT in both normals and stuttering population.

Table 11 : Overall mean and standard deviation (SD) of voice initiation time (VIT) and voice termination time (VTT) for normal children. (VIT and VTT in msec)

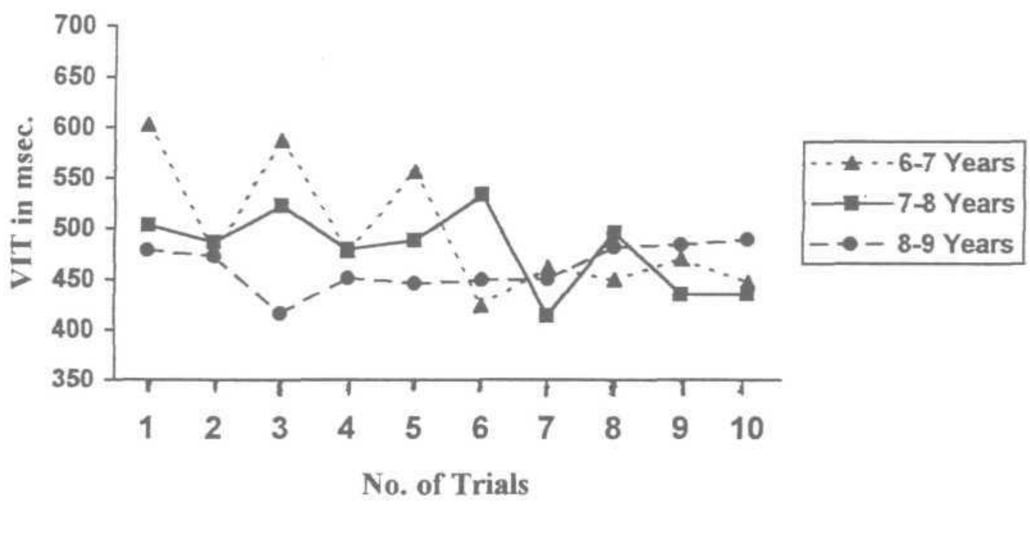
Variable	VTT			VTT		
Age (in *years)*	No. of Subjects (N)	Mean	SD	Mean	SD	Probability
6-9	15	477.48	101.35	368.58	92.76	t=9.27 p<0.001 Highly Significant

Table 12 : Overall mean and standard deviation (SD) of voice initiation time (VIT) and voice termination time (VTT) for children with stuttering (VTT and VTT in msec)

Variable	VIT			VTT		
Age (in *years).*	No. of Subjects (N)	Mean	SD	Mean	SD	Probability
6-9	15	482.33	131.34	370.39	77.92	r=10.46 *p<0.00l* Highly Significant

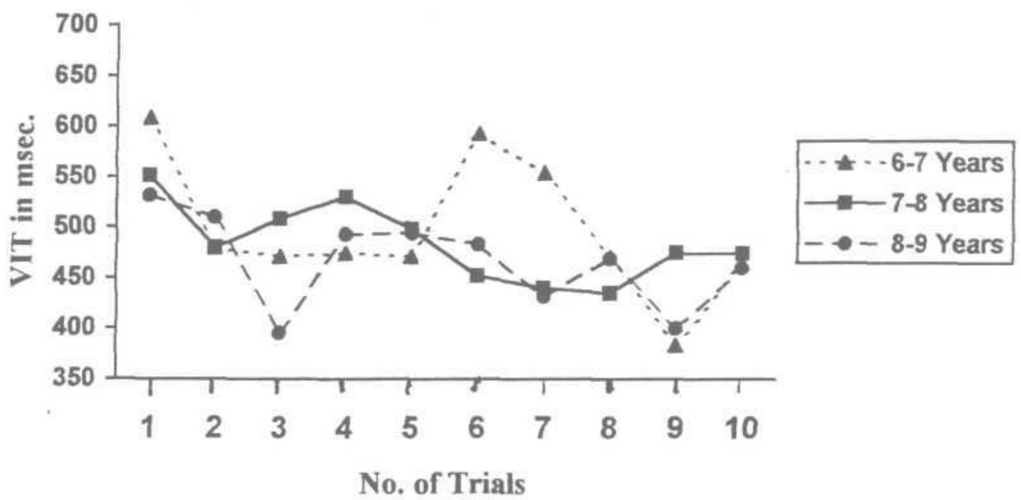
4) Practice effect (or) Adaptation effect in VTT and VTT tasks

Another interesting aspect in our study is to evaluate the presence of practice (or) adaptation effect within the ten trials. The mean VIT and VTT of first trial to me last trial for all the subjects in each age group were calculated and are plotted in the graph 1,2,3 and 4. Graph 1 and 2 shows the mean VTT and graph 3 and 4 shows the mean VTT from first trial to the last trial for normals and stutterers respectively.



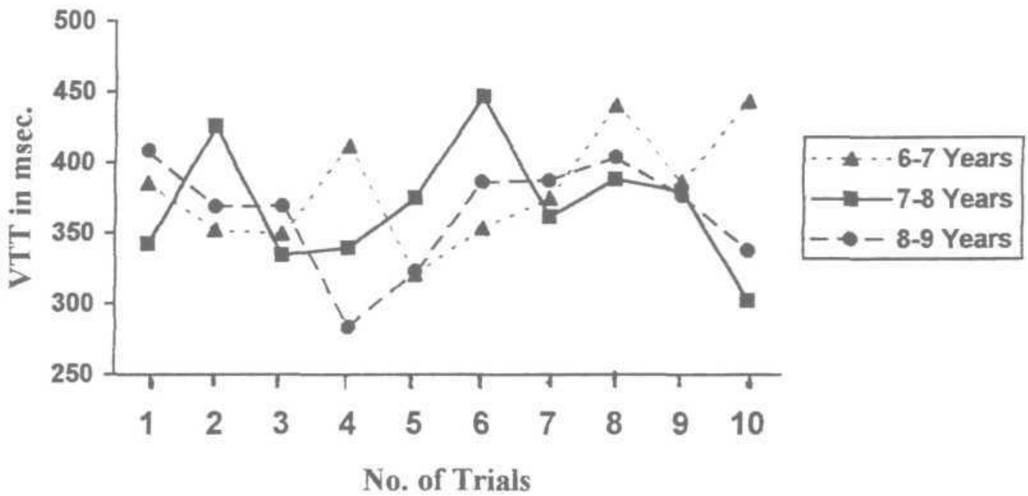
Graph 1 : VIT across ten trials in normal children (VIT in msec)

Graph 1 depicts the performance of normal children in the VIT task across 10 trials for all the three age groups. The mean for all the first trial to the tenth trial for VIT task was calculated for all the five subjects in each age group. In 6-7 years the practice effect (reduction in VIT across trials) was seen at the end of the trials. Practice effect in VIT task from first to fifth trial was inconsistent. Both increment and decrement in VIT was noted from first to fifth trial alternatively. Gradual decrement in VIT was noted at the end of trial when compared to initial five trials. In the case of 7-8 years , inconsistent reduction in VFT was observed till sixth trial and a sudden decrement in VIT was depicted after sixth trial. VIT in last two trials were reduced when compared to initial trials. The VTT across trials in 8-9 years showed that VIT decreased after second trial and slowly approximated the initial values as the trial increased.



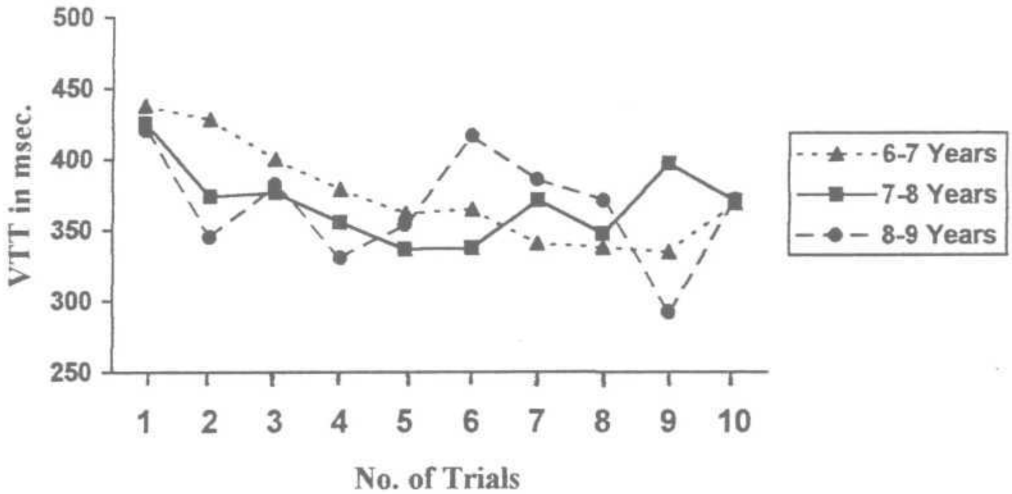
Graph 2 : VIT across ten trials in children with stuttering (VIT in mesec)

The graph 2 indicates VIT of children with stuttering across 10 trials for all three age groups. Consistent decrement in VIT across these ten trials were not seen in all the age groups. Compared to the first trial VIT was reduced in the last three trials in all the three age groups. 6 -7 years age group exhibited reduction in VIT from the first to the second trial which was consistent up to fifth trial. VIT increased during the sixth trial and again declined for rest of the trials. 7-8 years age group exhibited reduction in VIT from fourth trial to eighth trial and last two trials showed increased VIT. In 8-9 years reduction in VIT was noted during first three trials and inconsistent reduction in VIT was observed for rest of the trials.



Graph 3 : VTT across ten trials in normal children (VTT in msec)

Graph 3 shows the VTT across trials in all the three age groups of normal children. No consistent reduction of VTT across the ten trials was seen in all the age group. The 6-7 years age group children exhibited inconsistent reduction in VTT across ten trials and also exhibited longer VTT in last three trials compared to the initial trials. No consistent reduction of VTT was noted in the 7-8 years across trials. They exhibited reduced VTT in the last four trials compared to the initial trials. In 8-9 years, it was observed that there was decrement in VTT till fourth trial and after the fourth trial the VTT increased along the trials. VTT was reduced in the last two trials when compared to initial two trials.



Graph 4: VTT across ten trials in children with stuttering (VTT in msec)

Performance of children with stuttering in VTT task between trial to trial is displayed in the graph 4. VTT consistently reduced across trials except for the last trial in 6-7 years. In 7-8 years there was a constant decrement in VTT till sixth trial and a slight increment in VTT was observed from sixth trial to tenth trial. There was no consistent reduction in VTT task across ten trials observed in 8-9 years. Both increment and decrement in VTT was seen in this age group.

From the above findings it is evident that inconsistent reduction in VIT and VTT across ten trials was observed in all the three age groups in both normal and stuttering population. Reduction in VIT was observed only for few trials but not across all ten trials and some subjects depicted reduced VIT and VTT in last three trials when compared to initial trials for all the three groups in both normal and stuttering population. Therefore individual variability existed among subjects when practice effect was evaluated.

In summary the results of the present study revealed that

1. Non significant difference in VIT and VTT between normal speaking children and children with stuttering.
2. Non significant difference in VIT as well as in VTT between each age group in both normal and stuttering population (6-7 Vs 7-8, 7-8 Vs 8-9, and 6-7 Vs 8-9).
3. Significant difference between VIT and VTT in normal children and in children with stuttering.
4. Inconsistent reduction in VIT and VTT across ten trials was observed in all the three age groups in both normal and stuttering population. Reduction in VIT was observed only for few trials but not across all ten trials and some subjects depicted reduced VIT and VTT in last three trials when compared to initial trials for all the three groups in both normal and stuttering population. Therefore individual variability existed among subjects when practice effect was evaluated.

CHAPTER 5

DISCUSSION

1) VTT and VTT differences in Normal children and Children with Stuttering

The results of the present study further supports the findings of Cullinan and Springer, (1980), Murphy and Baumgartner (1981) and Till et al., (1981) that not all children who stutter exhibit slower voice initiation and termination times than children who do not stutter. The above studies have revealed that young children whose only speech problem is stuttering do not differ significantly in either VIT (or) VTT compared to non stuttering children. This is certainly not a definitive conclusion, because of small number of subjects were considered in the present study (15) and 9 inCutlinan and Springer study and 7 in Murphy and Baumgartner study. Also methodological differences are evident between these studies. Overall mean VIT and VTT revealed a non significant difference between normal children and children with stuttering.

However the results of this study is contradictory to the study of Cross and Luper (1979) ; McKnight and Cullinan (1987) ; Bishop, Williams and Cooper (1991a and 1991b), which reported that childhood stutterers are significantly slower in initiating and terminating vowel /a/ (longer VTT and VTT) when compared to control group. Although in the present study, some children with stuttering exhibited longer mean VIT and VTT than normal children, but as a group there was no significant difference observed.

In the present study, experimental group subjects were only stutterers and they did not had any other speech and language problem. Presence of other speech and language problems such as phonatory ,articulatory and language difficulty may have effect on voice reaction task as reported by cullinan and springer (1980). They opined that factors such as concomitant articulatory (or) language difficulties may contribute to longer voice initiation and termination times for some stutterers. Hence there was no significant difference between stuttering group and normal group in both VIT and VTT task in the present study.

The task used in the present study was initiation and termination of phonation of isolated vowel /a/ in response to an auditory signal. This is a very simple task and has less motoric complexity and hence the VIT and VTT values of stutterers approximated to normal values. Therefore most of the children with stuttering in the present study had normal VIT and VTT values as that of normal children .The results which has revealed significant difference on VIT task between normal children and children with stuttering have utilized the complex task in the experiments such as throat clearing and production of / Ap<9 / and has not found any difference in VIT between stutterers and normal children in simple task such as vowel initiation. This notion was even supported by Bishop, Williams and Cooper (1991a, 1991b) that children with stuttering performed slower on VRT experiment for more complex tasks than less complex tasks.

In this present study, there is considerable overlap between the performances of individual stutterers and non stutterers. This overlap in conjunction with the small number of subjects may have decreased the power of statistical group analysis substantially.

The degree of severity of stuttering subjects ranged from mild to severe and most of the subjects involved in the present study were mild stutterers. Variables such as severity of stuttering and fore period (time interval between warning cue and phonate cue) may also play a contributing factors for longer voice reaction time for some stutterers as evidenced by Watson and Alfonso (1983). Dembrawski and Watson (1991b). According to Watson and Alfonso (1983) LRT values approached normal values for mild stutterers as foreperiod increased (from 100 - 3000ms) whereas moderate and severe stutterers LRT values remained significantly greater than normal values. They concluded that mild stutterers may have only speech mechanism posturing difficulty and severe stutterers may have both posturing and vibration initiation deficit.

The present study did not incorporate any warning cue in the experimental design like several other studies (Adams and Hayden, 1976 ; Cross and Luper, 1979) but the stimulus interval between one trial to the next trial was 15-20 sec and the inter stimulus time interval between initiation and termination was varied between 3-6 seconds, since most of the subjects involved in the present study were mild stutterers, they would have adequately postured the speech apparatus required for phonation which might have helped them to quickly initiate and terminate phonation as like that of normal counterparts. This may be one of the cause of lack of significant difference between stutterers and normals.

The results of the present study are further supported by Cullinan and springer (1980) whose findings revealed that stutterers under eight year of age did not differ significantly in VIT and VTT from the non stutterers whereas those above eight years demonstrated many significant differences. It suggests that in their early years stutteres may not be different from non stutterers in their ability to initiate and terminate phonation. Possibly these differences do develop with stuttering experience and the "differences observed in the phonatory behavior of adult stutterers are more a reflection of habituated compensatory phonatory adjustments in response to disfmencies than they are indicators of an etiologjcal key to stuttering" (Schmitt and Cooper, 1978).

Another possibility is that those stutterers who have phonatory problems in the earlier years are also the ones who continue to stutter as they grow older, whereas those who do not exhibit these phonatory differences in the earh' years and are the ones who either spontaneously recover from stuttering or respond more favourably to management (Cullinan and Springer 1980). This if it be the case .would result in greater difference between stutterers and non stutterers for the older than for the younger children. In any case, the results do not completely support the suggestions made by Adams and Hay den (1976) that slowness in starting voicing is present early in stutterers life. Therefore it's very important that factors such as age or years of stuttering experience and the presence or absence of other speech and / or language problems should be considered while evaluating stutterers and non stutterers on reaction tasks.

Results of present study supports the view that young stutterers, with relatively short histories of stuttering would be less likely to approach speech and speech like acts with excess muscular tension, these children ought to generate VIT and VTT values that would be indistinguishable from those produced by matched normal youngsters.

In the present study inspection of individual data revealed longer VIT and VTT in some stutterers. Although some subjects exhibited longer VIT and VTT, the difference in VIT and VTT between normals and stutterers as a group was not significant. Phonatory slowness in some stutterers may be because, some subjects involved in this study were moderate and severe stutterers whose reaction time would not have changed even as the inter stimulus time interval between initiation and termination task as well as time interval between trial to trial would have been varied or increased as evidenced by Watson and Alfonso(1983), hence the posturing deficit and initiation vibration defect in moderate and severe stutterers would have lead to voice reaction time difference between them and normal children.

Other reasons for phonatory slowneness may be because, the present study incorporated an auditory cue for VIT and VTT task, since stutterers exhibits difficulty in auditory sensory motor integration and disparities in auditory feed back. This would have resulted in phonatory slowness in some stutterers. Slower phonation onset for stutterers under conditions of auditory cueing were found in few studies (Adams and Hayden, 1976 ; McFarlane and Shipley, 1981).

Also initiating voice as fast as possible in response to a signal involves,

1. Preparation set to respond
2. Perception of stimulus and 3. activation of both respiratory and laryngeal muscles. These muscle's activation are said to be impaired in stutterers would have resulted in delay in VIT and VTT tasks. Bakker and Brutten (1989)

reasoned that stutterers incresed phonatory reaction time must be due to either lag in premotor acivity (ie. Percieving the signal and programming the response) or to slow laryngeal adjustment (posturing the larynx for phonation). Adams (1981) offered an explanation that stutterers may be slow to organize and transmit neural commands to their musculature specifically it was suggested that in addition to integration and sending commands more slowly, stutterers may also send inappropriate commands to the periphery. This would activate muscles in ways that could delay voicing. Bishop Williams and Cooper (1991) suggested that speech motor control system of the stutterer may possess diminished capacity for speed in initiating vocal responses. Zimmerman (1980 a,b) pointed out that inco-ordination of articulators as being an important contributor to stutterers tendency to respond more slowly in reaction time. Hence in the present study even though, some stutterers exhibited slower mean voice initiation time and mean voice termination time when compared to normal children, as a group the difference was not significant.

2) Developmental trend in VTT and VTT in children with stuttering and normal children

The relationship of stuttering to phonatory difficulties is complicated by the factor of age or years of stuttering experience and other associated problems. The results of the present study revealed no significant difference in VIT and VTT between different age groups in both stuttering and normal population i.e., developmental trend was not seen in both VIT and VTT tasks.

The results of the present study is supported by Bishop, Williams and Cooper (1991) who found no significant difference in vocal and manual reaction time between 6.7 to 11 years. The results of the present study however, contradicts the result of Cross and Luper (1979). They reported that VRT of five years old differed significantly from the VRT of nine year old children and from the adult VRT and with no difference between the nine year old children and adults. Cross and Luper (1979) considered the neuromuscular maturation that underlies the improved VRT over time in both stutterers and non stutterers

No significant difference between age group was seen because inspection of individual data in the present study revealed that some young normal children and children with stuttering showed faster mean VIT and VTT than older age groups and also some older normal children and children with stuttering exhibited faster VIT and VTT than younger age groups. Therefore, there was a greater variability between the age groups in terms of VIT and VTT in both normal and stuttering population. This may have been the cause of non significant difference between different age groups. The result of the present study also further supported by Smith and Kenney (1996) who reported that marginal decrease in the temporal variability in normal children between 7 to 11.2 years and also found that younger children did not necessarily showed longer duration of speech segment or greater variability than older children.

Some old subjects in both normal and stuttering population exhibited shorter VIT and VTT than young stutterers and normals this may be attributed to the reason proposed by Bishop, William and Cooper (1991) who suggested that programming demands of all vocal and manual tasks are within the complexity of the motor control system of older children but were not for younger children. Some Younger subjects in both groups exhibited shorter VIT and VTT than older subjects this may because, old stutterers react to speech production with excess tension and thereby perform more poorly on vocal tasks than young stutterers.

3) Difference Between VTT and VTT in normal children and in children with stuttering:

The result of present study revealed a significant difference between VIT and VTT in both normal and in children with stuttering. Both the groups exhibited longer VIT than VTT. This reveals that they have difficult}' in initiation of phonation ,but not in termination of phonation. This is also reflected in the studies of linguistic aspects in children with stuttering and adults that stuttering is more evident in initial position of syllables, words .and sentences but not in medial or final positions. This may have been a reason for faster VTT than VTT in stutterers.

Stutterers readiness to respond also plays an important role in VIT and VTT task. As in this experiment, the readiness to respond (or) preparatory set to respond to a stimuli for initiation task is immediate when compared to the termination task Therefore, stutterers and normals would have been more alert for the termination task than initiation task. This might have increased the stutterers readiness to respond to the stimulus quickly which would have lead the stutterers to terminate the phonation faster than initiation of phonation. There are other reasons attributed for VIT and VTT differences. Moravek and Langova (1967) proposed that central defect in stutterers is initial tonus (IT) which occurs prior to initiation of phonation. Initial tonus occurs in laryngeal musculature and involves more muscles than are normally required for phonation as well as greater than usual tension. Normal phonation is impossible, and as a result, the stuttererers increase their muscular efforts even more. This compensatory effort results in stuttering. The cause if IT is seen as a problem in motor speech commands which involves voicing. Cortical commands are intact but are 'deformed' by additon of commands for muscle tension. This deformation results from psychological stress and other factors. Yoshuki (1984) reported that stutterers were slower in VTT but not in termination. Baken et al., (1983) reported that stutterers utilize greater pre phonatory lung volume than non stutterers during the initiation of isolated vowel. This reflects about the delay of vocal fold closure for VIT task. Adams (1992) had reported that stutterers may be slow in initiating phonation because of a build up intra oral breath pressure during articulatory closure may raise the supraglottal pressure to a point where the difference between subglottal and supraglottal pressure is not sufficient to permit voicing. Since all these factors are evident for initiation task, the subjects finds it difficult to initiate phonation. But the same may not be applicable for a termination task. As the subject has started to execute the act of phonation .the stress and other factors described above will be minimized which made the subjects to be comfortable and to terminate as early as possible.

4) Adaptation or Practice effect in VTT and VTT task

In the present study, inconsistent reduction in voice initiation time and termination time has been noted in both children with stuttering and in normal children, from the first to tenth trial. This can be attributed to less number of trials. Since only ten trials were used in the present study the practice effect was not observed in some subjects. The stimulus time interval between initiation and termination task was varied between 3-6 seconds, and as well as

between trial to trial varied from 15-20 seconds. Reaction time improves as stimulus time interval between trial to trial increase. For short stimulus time interval between trials to trials the reaction time is slower or longer when compared to longer stimulus time interval between trials. This is because stutterers would not have had adequate time to posture speech mechanism necessary to initiate and terminate phonation quickly. Since the stimulus time interval was varied from trial to trial and as well as between initiation and termination task, there was no consistent reduction in VIT and VTT noted as
4 trial increased from first to tenth. Lack of consistent reduction in VIT and VTT is further supported by Till et al., (1981), who studied the phonatory reaction time for both normal children and children with stuttering reported that there was no significant practice effect for 12 trials in both simple and complex vocal tasks (initiation of isolated vowel and production of word / 3Ap<3 /.

Some subjects in both normal and stuttering population also exhibited reduction in VIT and VTT only for few trials but not across all the ten trials and also some subjects exhibited reduced VTT and VTT in last three trials when compared to initial trials .This can be attributed to the practice effect. It is also supported by Eisenon (1968), who opined that repeated vocal tasks establishes an articulatory and vocal set, which becomes automatic and also stutterers anxieties about the response task would have been reduced as the trial increase. Results of the present study is even supported by Adams and Hayden (1976) and Cross and Shadden (1977) who found that, VIT and VTT improved (shortened) from beginning to the end of the experiment. Wingate (1966) also opined that co-ordination of respiration, phonation and articulation in stutterers becomes more skillful in repeated tasks. The shortening of VTT and VTT across the trial may be due to greater ease in ordering of vocal movements by-successive rehersal of motor plan.

Therefore, individual variability existed among subjects when practice effect was evaluated. Adaptation or practice effect varies from individual to individual. Some of the subjects may require more trials to get adapted or practiced with the experimental task and some may require less number of trials to get adapted or practiced with the experimental task.

CHAPTER 6
SUMMARY AND CONCLUSIONS

The present study was undertaken to investigate the performance of children with stuttering and normal children on voice reaction time. The aim of this study was.

1. To compare Voice initiation time (VIT) and voice termination time (VTT) of normal children with those of children with stuttering in the age range of 6-9 years.
2. To compare *VTT* and VTT between different age groups (6-7 Vs 7-8 years, 7-8 Vs 8-9 years, 6-7 Vs 8-9 years) in both normal children and in children with stuttering.
3. To compare between voice initiation time and voice termination time in both normal children and in children with stuttering.
4. To study the possibility of adaptation or practice effect in VIT and VTT tasks across ten trials.

A simple reaction time paradigm was utilized in the study to determine the voice initiation time and voice termination time of normal children and children with stuttering. Fifteen children with stuttering (experimental group) and fifteen normal speaking children (control group) ranging in the age from 6 to 9 years served as subjects in this study.

The subjects in the experimental and control group were divided in to three age groups 6 to 7 years, 7 to 8 years and 8 to 9 years. Each group had five subjects. The children in the experimental and control group were matched for age, sex handedness and educational level. Since the severity was not considered as a factor in this study, all the subjects with mild to severe were considered. Presence of other speech language, voice, hearing defects were ruled out by qualified speech and language pathologist.

The response task for the subject was onset of phonation and termination of phonation of vowel /a/ in response to an auditory stimuli. The stimuli used in this study were a low frequency auditoiy stimuli produced by an instrument as shown in the figure 1,2,and3. There were two stimuli one was provided at the beginning of the experiment and the other was provided 3-6 seconds after the first stimulus had occured, for initiation and termination task respectively. The inter stimulus interval was varied to overcome the anticipator}' effect. Subjects were tested in the speech pathology lab of All India Institute of Speech and Hearing. They were instructed to say or phonate /a/ as quickly as possible when they hear the first stimuli and to sustain saying /a/ for some time and a stop saying /a/ as quickly as possible when they hear the second stimuli. Two practice trials were given 10 minutes prior to the experiment. The entire task consisted of ten experimental trials. The time interval between trial to trial was varied from 15-20 sec. Ten trials were taken to see the motoric learning in the experimental task . An audio-recording of auditory stimuli and subjects phonation was obtained. The software program, speech science lab (SSL, vaghmi) was used for analysis of VIT and VTT. The instrumentation set up is shown in the fig 4. Subjects phonation signal was displayed as waveform in the (500 MHz pentium III) computer screen and the auditor}' stimuli was displayed as burst in the waveform. In this study VIT was defined as the amount of time (in milliseconds) that elapsed between onset of the first auditory stimuli (first burst) and the initiation of subjects phonation (onset of the wave) as displayed in the computer screen. VTT was defined as the amount of time (in milliseconds) that elapsed between onset of the second auditor)' stimuli (second burst) and the termination of the subjects phonation (offset of the wave).The wave form pattern is shown in figure 5. Thus voice initiation time and voice termination time were measured for normal children and children with stuttering.

"Independent sample t test" was used to determine the VIT and VTT differences between normal and stuttering population and between each age group, and a "paired t test" was used to determine the difference between VIT and VTT within each age group in both normal and in stuttering population. Mean VIT and VTT of first trial to the last trial for all the subjects in each age group were calculated and were plotted in the graph to determine the practice effect.

The results of the study are as follows,

1. Non significant difference in VIT and VTT between normal speaking children and children with stuttering. Some stutterers exhibited slower *VYT* and VTT when compared to normal children but the difference was not significant.
2. Non significant difference in VIT as well as in VTT between each age group in both normal and stuttering population (6-7 vs 7-8, 7-8 vs 8-9, and

6-7 vs 8-9). Even though some old stutterers exhibited faster VIT and VTT man younger children but the difference was not significant

3. Significant difference was elicited between VIT and VTT in normal children and in children with stuttering in all the age group.
4. Individual variability existed when practice effect or adaptation effect was evaluated. Most of the subjects exhibited inconsistent reduction in VIT and VTT aross ten trials in all the three age groups in both stuttering and normal population and some exhibited reduction in VIT and VTT only for few trials but not across all ten trials and in some subjects reduced VIT and VTT was noted in last three trials when compared to initial trials.

In conclusion, it is very evident from this study that children with stuttering did not differ significantly from normal children in initiating and terminating the phonation. Experimental group subjects involved in this study were only stutterers and had not possess any other speech and language problem. It has been reported in many studies, presence of other speech and language problem affects the voice reaction time. Hence, presence of only 'stuttering' as a speech problem in the subjects would have lead to lack of significant difference in this study. The stimulus time interval between trials and inter stimulus interval between voice initiation task and voice termination task would have been adequate for the stutterers to posture the speech mechanism for phonation and to quickly initiate and terminate phonation as like that of normals. This may have been the cause of lack of significant difference in VIT and VTT. Possibly these differences in VIT and VTT do develop with stuttering experience and are more reflection of habituated compensator}' phonatory adjustments in response to disfluencies than they are indicators of etiological key to stuttering. The results of the present study supports the view that young stutterers with relatively short histories of stuttering would be less likely to approach speech and speech like acts with excess muscular tension ,these children ought to generate VIT and VTT values that would be indistinguishable from those produced by matched normal youngsters.

The developmental trend in VIT and VTT was not observed in both normal children and in children with stuttering , this could be because individual inspection of subjects data revealed that some young normals and stutterers exhibited faster VIT and VTT than older normals and stutterers and some older stutterers exhibited faster VIT and VTT than young subjects. This greater inter subject variability may have been the cause for non significant difference in VIT and VTT between different age groups.

Voice termination time is faster than voice initiation time in both stutterers and in normals. Factors such as auditory factors, motor phonatory factors, integration factors, psychological factors etc are evident for the initiation task, but the same may not be applicable for the termination task. If the subject has started to excute the act, the stress and other factors are minimized which makes the patient to be comfortable with the task and to terminate as early as possible. This may have been responsible for the significant difference between VIT and VTT in both normals and stutterers.

Subjects in both normal and stuttering population exhibited inconsistent reduction in VIT and VTT across ten trials, this can be attributed to less number of trials and to the variation of time interval between the initiation and termination tasks as well as between trials. Some exhibited reduction in VIT and VTT only for few trials and some showed reduced VIT and VTT in last trials when compared to the initial trials. This can be attributed to the fact that, repeated vocal tasks might have established an articulatory and vocal set appropriate for the stutterers to initiate and terminate the phonation quickly from trial to trial. Therefore individual variability also existed when practice effect or adaptation effect was evaluated. This depicts that adaptation effect seen in stuttering varies with individual to individual, some stutterers may require less number of trials to get adapted or some may require more number of trials to get adapted to the task.

Hence, from the results of the study it is evident that slowness in initiating and terminating phonation is not seen in childhood stutterers and it is not the only cause of stuttering. Other factors such as disco-ordination of phonation with articulation and respiration, psychological stress, selective phonetic and syllabic contextual programming defecits, defects in prosodic transition to stress syllable may contribute to the stuttering act. Presence of other speech and language problems such as articulation, language disorders, age or years of stuttering experience should be considered when comparing the stutterers and normals on reaction time tasks.

Suggestions for future research :

1. A larger sample may need to be considered for inductively drawing inferences from voice reaction time experiments in stuttering.
2. It would be interesting, if we subgroup stutterers and then perform similar simple reaction time experiment to test the phonatory abilities of stutterers
3. Simultaneous measurement in physiological (electromyographic) , aerodynamic and articulatory kinematic domains, integrated in to VRT paradigm would reveal the 'proximal' factors underlying the pathophysiology of stuttering.
4. Large number of trials can be implemented to study the possibility of adaptation effect in VRT paradigm.
5. Research on voice reaction time can be carried out in childhood stutterers with wider age range to determine the developmental trend in VRT experiments and also can be conducted in stuttering children with different degree of severity to evaluate the severity effect on VRT.

REFERENCES

Adams, M.R. (1974). A physiologic and aerodynamic interpretation of fluent and stuttered speech. *Journal of Fluency Disorders,* 1, 35-67.

Adams, M.R. (1978). Stuttering theory, research and therapy : The present and future. *Journal of Fluency Disorders,* 3, 139-147.

Adams, M.R. (1984). Laryngeal onset and reaction time of stutterers. In R.F. Curlee and W.H. Perkins (Eds.)., *Nature and treatment of stuttering :New directions* (pp. 89-104). SansDiego : College-Hill Press.

Adams, M. (1987). Voice onsets and segment duration of normal speakers and beginning stutterers. *Journal of Fluency Disorders,* 6, 133-140.

Adams, M.R., **and Hayden,** P. (1976). The ability of stutterers and non stutterers to initiate and terminate phonation of an isolated vowel. *Journal of Speech and Hearing Research,* 19, 290-296.

Adams, M., Freeman, F., and Conture, E. (1984). Laryngeal dynamics of stutterers. In R. Curlee and W. Perkins (Eds.), *Nature and treatment of stuttering : New directions* (pp. 89-129). San Diego: College-Hill Press.

Adams, M.R., Riemen Schnieder, S., Metz, D., and Conture, E. (1975).Voice onset and articulatory constriction requirements in a speech segment and their relation to the amount of stuttering adaptation. *Journal of Fluency Disorders,* 1, 24-31.

Adams, M.R., and Reis, R. (1971). The influence of onset of phonation on the frequency of stuttering. *Journal of Speech and Hearing Research,* 14, 639-644.

Adams, M.R., and Reis, R. (1974). Influence of onset of phonation on the frequency of stuttering. A replication and re-evaluation. *Journal of Speech and Hearing Research,* 17, 748-755.

Agnello, J., Wingate, M., and Wendell, M. (1974). Voice onset and voicetermination times of child and adult stutterers. *Journal of AcousticalSociety of America,* 56, 362.

Armson, J., and Kalinowski, J. (1994). Interpreting results of the fluentspeech paradigm in stuttering research. Difficulties in separating causefrom effect. *Journal of Speech and Hearing Research,* 37, 69-82.

Baken, R., Cavallo, S., and Weissman, K. (1979). Chest wall movementsprior to phonation. *Journal of Speech and Hearing Research,* 22. 862-872.

Baken, R., McManus, D., and Cavallo, S. (1983). Prephonatory chest wall posturing in stutterers. *Journal of Speech and Hearing Research,* 26, 444-450.

Bakker, K., and Brutten, G.J. (1989). A comparitive investigation of the laryngeal premotor, adjustment and reaction times of stutterers and nonstutterers. *Journal of Speech and Hearing Research,* 32, 239-244.

Beh, H.C., **and** Nix-James, D.R. (1974). The relationship between respiration phase and reaction time. *Psychophysiology,* 11, 400-401.

Bishop, J.H., Williams, H.G., and Cooper, W.A. (1991a). Age and task complexity variables in motor performance of stuttering and non stuttering children. *Journal of Fluency Disorders,* 16, 207-217.

Bishop, J.H., Williams, H.G., and Cooper, W.A. (1991b). Age and task complexity variables in motor performance of children with articulation-disorder, stuttering and normal speech. *Journal of Fluency Disorders,* 16, 219-228.

Bloodstein, O. (1949). Conditions under which stuttering is reduced (or) absent: A review of literature. *Journal of Speech and Hearing Disorders,* 14, 295-302.

Bloodstein, O. (1972). The anticipatory struggle hypothesis : Implications of research on the variability of stuttering. *Journal of Speech and Hearing Research* 15, 487-499.

Bloodstein, O. (1975). *A Handbook on stuttering.* Chicago : National Easter Seal Society for Crippled Children and Adults.

Bloodstein, O. (1975b). Stuttering as tension and fragmentation. In J. Eisenson (Ed), *Stuttering: A second symposium.* Newyork: Harper.

Borden, G.J. (1983). Initiation versus execution time during manual and oral counting by stutterers. *Journal of Speech and Hearing Research,* 26, 389-396.

Brutten, E.J., and Shoemaker, D.J. (1967). *The modification of stuttering :* Englewood cliffs, N J: Prentice Hall.

Buschbaum, M., and Callaway, E. (1965). Cited in Izdebsla, K., and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research,* 21, 638-651.

Caruso, A.J., Gracco, V.L., and Abbs, J.H. (1987). A speech motor control perspective in stuttering : Preliminary observations. In H.F.M. Peters and W.Hulstijn (Eds.). *Speech Motor Dynamics in Stuttering,* 245-258. Wien : Springer-verlag.

Cherry, E., and Sayer, B. (1956). Cited in Me Farlane, S.C., and Shipley. K.G. (1981). Latency of vocalization onset for stutterers and non-stutterers under conditions of auditory and visual cueing. *Journal of Speech and Hearing Research.2A.* 307-312.

Couture, E., Me Call, G., and Brewer, D. (1977). Laryngeal behavior during stuttering. *Journal of Speech aiid Hearing Research,* 20, 661-668.

Cooper, M.H., and Allen, G.D. (1977). Timing control accuracy is normal speakers and stutterers. *Journal of Speech and Hearing Research,* 20, 55-71.

Cross, D.E., and Luper, H.L. (1979). Voice reaction time of stuttering and non-stuttering children and adults *Journal of Fluency Disorders* ,4,59-77.

Cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 356-361.

Cross, D.E., and Shadden, B.B. (1977). Cited in Me Farlane, S.C., and Shipley, K.G. (1981). Latency of vocalization onset for stutterers and non-stutterers under conditions of auditory and visual cueing. *Journal of Speech and Hearing Research,!^,* 307-312.

Cross, D.E., Shadden, B.B., and Luper, H.L. (1979). Effects of stimulus ear presentation on the voice reaction time of adult stutterers and non-stutterers. *Journal of Fluency Disorders,* 4, 45-58.

Cullinan, W., and Springer, M. (1980). Voice initiation time and termination time in stuttering and non-stuttering children. *Journal of Speech and Hearing Research,* 23, 344-360.

Czudner, G., and Rourke, B. (1972). Cited in cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 356-361.

Disimoni, F. (1974). Preliminary study of certain timing relationship in the speech of stutterers. *Journal of Acoustical Society- of America,* 56, 697.

Dustman, R., and Beck, E. (1966). Cited in cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research,26,* 356-361.

Eisenson, J. (1958). Stuttering as perseverative behavior. In J. Eisenson (Ed.). *Stuttering : A symposium.* Newyork : Harper and Row.

Elliot, R. (1970). Cited in cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 356-361.

Evarts, E.V., Shinoda, Y., and Wise, S.P. (1984). Cited in Ludlow. C.L. (1991). Measurement of Speech motor Control processes in stuttering.In H.F.M.Peters, W.Hulstijn and C.W.Starkweather (Eds.), *Speech motor control and stuttering.Newyork:* Excerpta Medica.

Fletcher, J.M. (1928). *The problem of stuttering.* Newyork: Longmans Green.

Ford, G.S. (1975). Cited in cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research*, 26, 356-361.

Freeman, F. (1984). Laryngeal muscle activity of stutterers. In RF. Curlee and W.H. Perkins (Eds.), *Nature and treatment of stuttering: New directions* (pp. 104-116). San Diego : College-Hill Press.

Freeman, F.J., and Ushijima, T. (1975). Laryngeal activity accompanying the moment of stuttering : A preliminary report of EMG investigations. *Journal of Fluency Disorders,* 1, 36-45.

Freeman, F.J., and Ushijima, T. (1978). Laryngeal muscle activity during stuttering. *Journal of Speech and Hearing Research,* 21, 538-562.

Garber, S., and Martin, R. (1977). Effects of noise and increased vocal intensity on stuttering. *Journal of Speech and Hearing Research,* 20. 233-240.

GaskilL E.V. (1928). Cited in Izdebski, K., and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research,* 21, 638-651.

Goodenough, F. (1935). Cited in Cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non-stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 3 5 6-3 61.

Hand, R.C., and Luper, H.L. (1980). Durational characteristics of stutterers and non-stutterers fluent speech. Paper presented at the annual convention of the American Speech-Language Hearing Association. Detroit.

Harbison, D.C., Porter, R.J., and Tobey, E.A. (1989). Shadowed and simple reaction times in stutterers and non-stutterers. *Journal of the Acoustical Society of America,* 86, 1277-1284.

Hayden, P. (1975). The effects of masking and pacing on stutterers and non-stutterers voice and speech onset time. *Unpublished doctoral dissertation, Purdue University.*

Hillman, R.E., and Gilbert, H.H. (1977). Voice onset times for voiceless stop consonants in the fluent reading of stutterers and non-stutterers. *Journal of Acoustical Society of America,* 61, 610-611.

Hirano, ML, Kakita, Y., Kawasaki, H., Gould, W., Lambiase, A. (1981). Data from high-speed motion picture studies. In K. Stevens and M. Hirano (Eds.), *Vocal fold physiology* (pp. 85-94). Tokyo : University of Tokyo press.

Hirose, H., and Gay, T. (1973). Laryngeal control in vocal attack. *Folia Phoniatrica,* 25, 203-213.

Hixon, T.J. (1973). Cited in Izdebski, K., and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research.* 21,638-651.

Hoshiko, M.S. (1965). Cited in Izdebski, K., and Shipp, T. (1978). Minimal reaction time for phonatory initiation. *Journal of Speech and Hearing Research,* 21, 638-651.

Izdebski, K., and Shipp, T. (1978). Minimal reaction time for phonatory initiation. *Journal of Speech and Hearing Research,* 21, 638-651.

Johnson, W. (1938). The role of evaluation in stuttering behavior. *Journal of Speech Disorders,* 13, 85-89.

Johnson, W. (1942). A study of onset and development of stutterering. *Journal of Speech Disorders,* 7, 251-257.

Johnson, W. (1959). *The onset of stuttering.* University of Minnesota Press, Minneapolis.

Johnson, W. (1967). Cited in Bloodstein, O. (1995). *Handbook on stuttering,* (pp. 321). San Diego : Singular Publishing Group, Inc.

Johnson, W., and Knott, J.R. (1937). Studies in the psychology of stuttering : In. The distortion of moments of stuttering in successive readings of the same material. *Journal of Speech Disorders, 2,* 17-19.

Johnson, W., and Rosen, L. (1937). Studies in the psychology of stuttering. VI1. Effect of certain changes in speech pattern upon frequency of stuttering. *Journal of Speech Disorders, 2,* 105-109.

Johnson, W., and Inners, M. (1939). Studies in the psychology of stuttering : XIII. A statistical analysis of the adaptation and consistency effects in relation to stuttering. *Journal of speech Disorders,* 4, 79-86.

Jones, H. (1931). Cited in cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 356-361,

Kent, R.D. (1984). Stuttering as a temporal programming disorder, hi R.F. Curlee and W.H. Perkins (Eds.), *Nature and treatment of stuttering : New directions,* (pp. 283-303). San Diego : College-Hill press.

Klapp, S.T., Wyatt, E.P., and Lingo, W.H. (1974). Response programming in simple and choice reaction. *Journal of Motor Behavior,* 6, 263-271.

Levelt, W.J.M. (1989).Lexical acess in speech production : Stages versus Cascading .In H.F.M. Peters, W.Hulstijn, and C.W.Starkweather (eds.), *Speech motor control and stuttering* .Newyork.Excerpta Medica.

Libb, J.W. (1972). Cited in Cullinan, W.L. and Springer,M.T.(1980). Voice initiation and termination time in stuttering children and non stuttering children. *Journal of Speech and Hearing Research,* 23, 344-360.

Long, K.M., and Pindzola, R.H. (1985). Manual reaction time to linguistic stimuli in child stutterers and non stutterers. *Journal of Fluency Disorders,* 10, 143-149.

Ludlow, C.L. (1991). Measurement of Speech Motor Control processes in stuttering. In H.F.M. Peters, W. Hulstijn and C.W. Stark Weather (Eds.), *Speech motor control and stuttering.* Amsterdam : Elsevier / Exerpta Medica.

Maccoby, E.E., and Jacklin. C.N. (1974). Cited in Izdebski. K.. and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research,* 21, *638-651.*

Mackay, D.G. (1970a). Cited in Louis.K.O.(1979). Linguistic and motor aspects of stuttering.In N.J.Lass(Ed-), *Speech and Language. Achwnces in basic research and practice,Vol* 1, (pp. 89-210). Newyork : Academic press.

Mackay D.G., **and Soderberg,** G.A. (1970d). Cited in Louis.K.O.(1979). Linguistic and motor aspects of stuttering.In N.J.Lass(Ed.), *Speech and Language. Advances in basic research and practice .Vol* 1. (pp. 89-210). Newyork : Academic press. 12

Magladery, J. (1959). Cited in Cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research,* 26. 356-361.

Malinowski, A. (1967). Cited in Izdebski, K., and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research,* 21, 638-651.

Marsden, C.D. (1984). Cited in Ludlow, C.L. (1991). Measurement of Speech motor Control processes in stuttering.In H.F.M.Peters, W.Hulstijn and C.W.Starkweather (eds.), *Speech motor control and stuttering.*Newyork: Excerpta Medica.

Mc Call, G.N. (1975). Cited in Louis, K.O. (1979). Linguistic and motor aspects of stuttering. In N.J. Lass (Ed.), *Speech and Language. Advances in basic research and practice* (pp. 89-210). New York : Academic press.

McFarlane, S., and Prins, D. (1978). Neural response time of stutterers and non stutterers in selected oral motor tasks. *Journal of Speech and Hearing Research,* 21, 768-778.

McFarlane, S.C., and Shipley, K.G. (1983). Latency of vocalization onset for stutterers and non stutterers under conditions of auditory' and visual cueing. *Journal of Speech and Hearing Research*, *24*, 307-312.

McKnight, R., and Cullinan, W. (1987). Subgroups of stuttering children : Speech and voice reaction times, segmental durations and naming latencies. *Journal of Fluency' Disorders*, 12, 217-324.

Metz, D.E., Conture, E.G., and Colton, T. (1976). Cited in Cross. D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research*, 26. 356-361.

Moravek, M., **and Langova,** J. (1962). Some electrophysiological findings among stutterers and chatterers. *Folia Phoniatrica.* 14. 305-316.

Murphy, M., and Baumgartner, J. (1981). Voice initiation and termination time in stuttering and non stuttering children. *Journal of Fluency Disorders*, 6, 257-264.

Neilson, M., and Neilson, P. (1979). Cited in McFarlane. S.C., and Shipley, K.G. (1981). Latency of vocalization onset for stutterers and non stutterers under conditions of auditory and visual cueing. *Journal of Speech and Hearing Research,* 24, 307-312.

Perkins, W.J., Rudas, J., Johnson, L., and Bell, J. (1976). Stuttering : Disco ordinations of phonation with articulation and respiration. *Journal of Speech and Hearing Research, 19*, 509-522.

Peters, H.F.M., Hulstijn, W., and Stark Weather, C.W. (1989) Acoustic and physiological reaction times of stutterers and non stutterers. *Journal of Speech and Hearing Research, 32*, 668-680.

Peters, H.F.M.,Hulstijn,W., and Van Lieshout, P.H.H.M. (2000) Recent developments in speech motor research in to stuttering *.Folia Phoniatrica,* 52,103-119.

Reich, A., Till, J., and Goldsmith, H. (1981). Laryngeal and manual reaction times of stuttering and non stuttering adults. *Journal of Speech and Hearing Research,* 24, 192-196.

Rourke, B., and Czudner, G. (1972). Cited in Cross, D.E.. and Luper. H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research,* 26, 356-361.

Sawashima, M., and Hirose, J. (1981). Abduction-adduction of the glottis in speech and voice production. In K. Stevens and M. Hirano (Eds.), *Vocal foldphysiology* (pp. 329-346). Tokyo : University of Tokyo press.

Schemeck, R. R., and Bruning, J. L. (1968). Cited in Cullinan, W.L. and Springer,M.T.(1980).Voice initiation and termination time in stuttering children and non stuttering children. *Journal of Speech and Hearing Research,* 23, 344-360.

Schmitt, L.S., and Cooper, E.B. (1978). Fundamental frequencies in oral reading behavior of stuttering and non stuttering children. *Journal of Communication Disorders,* 11, 17-23.

Schwartz, M.F. (1974). The core of stuttering block. *Journal of Speech and Hearing Disorders,* 39, 169-177.

Schwartz, M.F. (1976). Cited in Louis, K.O. (1979). Linguistic and motor aspects of stuttering. In N.J. Lass (Ed.), *Speech and Language Advances in Basic Research and Practice* (pp. 89-210). New York : Academic press.

Schwartz, M.F. (1975). Author's response to Zimmermann and Allen, and Adams. *Journal of Speech and Hearing Disorders,* 40, 136-137.

Shames, G.H., and Sherrick, C.E. (1963). A discussion of non fluency and stuttering as operants behavior. *Journal of Speech and Hearing Disorders,* 28. 3-18.

Shapiro, A. (1980). An electromyographic analysis of the fluent and dysfluent utterances of several types of stutterers. *Journal of Fluency Disorders,* 5, 203-231.

Sheehan, J.G. (1958). Conflict theory of stuttering. In J.Eisenson *(Ed.).Stuttering* : A symposium .New york : Harper and Row.

Sheehan, J.G. (1975). Conflict theory and avoidance reduction therapy. In J. Eisenson (Ed.), *Stuttering: A symposium.* New York : Harper and Row.

Smith, B.L., and Kenny, M.K. (1996). A longitudinal investigation of duration and temporal variability in children's speech. *Journal of Acoustical Society of America,* 99, 2344.

Starkweather, C.W. (1982). Stuttering and laryngeal behavior. A review. *ASHA Monographs,* 21, 1-45.

Starkweather, C.W., Franklin, S., and Smigo, T.M. (1984). Vocal and finger reaction times in stutterers and non stutterers : Differences and co-ordinations. *Journal of Speech and Hearing Research, 21, 193-196.*

Sterkweather ,C.W. (1987). *Fluency and stuttering* .Engelwood cliffs. N.J : Prentice-Hall.

Starkweather, C.W., Hirshman, P., and Tannenbanm, R. (1976). Latency of vocalization onset. Stutterers versus non stutterers. *Journal of Speech and Hearing Research,* 19, 4 81 -4 92.

Starkweather, C.W., Hirshman, P., and Tannenbaum, R. (1981). Cited in Cross. D.E., and Luper. H.L. (1983). Relation between finger reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research.* 26, 356-361.

Starkweather, *CM'*., and Myers, N. (1979). Duration of subsegments within the intervocalic interval in stutterers and non stutterers. *Journal of Fluency Disorders,* 4. *205-214.*

Steinberg, S., Wright, C.E., Knoll, R.C., and Monsell, S. (1980) Motor programs in rapid speech : Additional evidence. In R.A. Cole (Ed.).. *Perception and production affluent speech* (pp. 507-524). New Jersey : Lawrence Erlbaum Associates.

Sussman, H. (1974). Cited in Me Farlane, S.C., and Shipley, K.G. (1981). Latency of vocalization onset for stutterers and non stutterers under conditions of auditory and visual cueing. *Journal of Speech and Hearing Research,* 24, 307-312.

Till, J., Reich, A., Dickey, S., and Sieber, J. (1983). Phonatory and manual reaction times of stuttering and non stuttering children. *Journal of Speech and Hearing Research,* 26. 171-180.

Travis, L. (1931). *Speech pathology:* New York : Appleton.

Travis, L.E. (1934). Dissociation of the homologus muscle function in stuttering. *Archs Neurol. Psychiat,* 31, 127-133. Chicago.

Van Riper,C. (1937d). The preparatory set in stuttering . *Journal of Speech Disorders ,2,* 149-154.

Van Riper,C. (1954). *Speech Correction* : Principles and methods . *3rd* ed, Englewood Cliffs, N.J : Prentice Hall.

Van Riper, C. (1971). *The nature of stuttering.* Englewood Cliffs, NJ : Prentice Hall.

Van Riper,C. (1973). *The treatment of stuttering* .Englewood Cliffs. N.J : Prentice Hall.

Van Riper, C. (1982). *The nature of stuttering.* Englewood Cliffs, N.J. : Prentice Hall, Inc.

Vendkatagiri, H.S. (1981). Reaction time for voiced and whispered /a/ in stutterers and non stutterers. *Journal of Fluency Disorders.* 6, 265-271.

Watson, B.C., and Alfonso, P.J. (1983). Foreperiod and Stuttering severity effects on acoustic laryngeal reaction time. *Journal of Fluency-Disorders.* 9. 183-205.

Watson, B.C., and Alfonso, P.J-. (1987). Physiological bases of acoustic LRT in non stutterers, mild stutterers and severe stutterers. *Journal of Speech and Hearing Research.* 30, 434-447.

Weiss, T. (1960). Cited in IzdebskL K., and Shipp, T. (1978). Minimal reaction times for phonatory initiation. *Journal of Speech and Hearing Research, 21,638-651.*

Weiss, R. (1965). Cited in Cross, D.E., and Luper, H.L. (1983). Relation between finger reaction time and voice reaction time in stuttering and non stuttering children and adults. *Journal of Speech and Hearing Research*, 26, 356-361.

Werner-Kukuk, E., and VonLeden, H. (1970). Vocal initiation. *Folia phoniatrica,* 22. 107-118.

Wijnen, F., and Boers, I. (1994). Phonological priming effects in stutterers. *Journal of fluency Disorders,* 19, 1-20.

Wingate, M.E. (1964). A standard definition of stuttering. *Journal of Speech and Hearing Disorders,* 29. 484-489.

Wingate, M.E. (1966). Prosody in stuttering adaptation. *Journal of Speech and Hearing Research*, 9, 550-56.

Wingate, M.E. (1969b). Stuttering as Prosodic transition defect. *Journal of Speech and Hearing Disorders,* 34,107-108.

Winkler, L., and Ramig, P. (1986). Temporal characteristics in the fluent speech of child stutterers and non stutterers. *Journal of Fluency Disorders,* 11,217-229.

Wischner, G.J. (1956). Stuttering behavior and learning : A preliminary theoritical formulation. *Journal of Speech and Hearing Disorders,* 15. 324-335.

Wyke, B. (1971). Cited in Watson, B.C.. AND Alfonso, P.J. (1987). Physiological bases of acoustic LRT in non stutterers, mild stutterers and severe stutterers. *Journal of Speech and Hearing Research,* 30. 434-447.

Zimmermann, G. (1980). Stuttering : A disorder of movement. *Journal of Speech and Hearing Research.* 23, 122-136.

Zimmermann, G.N. (1980a). Artidilatory dynamics of fluent utterances of stutterers and non stutterers. *Journal of Speech and Hearing Research,* 23, 95-107.

Zimmermann, G.N. (1980b). Articulatory behaviors associated with stuttering : A cinefiurographic analysis. *Journal of Speech and Hearing Research.* 23, 108-121.[W]

Zimmerman, G.N. (1984). Articulatory dynamics of stutterers. In R. Curlee and W. Perkins (Eds.), *Nature and treatment of stuttering* : *New directions* (pp. 131-147). San Diego : College-Hill press.

Zimmermann, G.N., Smith, A., and Hanley, J. (1981). Stuttering : In need of iinifying conceptual framework. *Journal of Speech and Hearing Research,* 24.25-31.

Zebrowski, P., Conture, E., and Cudahy, E. (1985). Acoustic analysis of young stutterers fluency. *Journal of Fluency- Disorders,* 10, 173-192.