LATERALITY IN STUTTERERS

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DEDICATED TO

MY GUIDE WHO HAS BEEN A

CONSTANT SOURCE OF INSPIRATION TO ME

CERTIFICATE

This is to certify that this Dissertation entitled : LATERALITY IN STUTTERERS is a bonafide work in part fulfillment for the final year M.Sc, (Speech and Hearing) of the student with Reg. No. M 9506.

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DECLARATION

I hereby declare that this Dissertation entitled : LATERALITY IN STUTTERERS i.e the result of my own study under the guidance of Dr. S.R. Savithri, Professor and Reader, in the Department of Speed Science, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other Diploma or Degree.

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CHAPTER I

INTRODUCTION

The fluency disorder, stuttering has been a "complicated multidimensional jigsaw puzzle with many pieces still missing. It is also a personal, social and scientific problem with many unknowns".

(Van Riper, 1982)

Wingate (1964) proposed a three part standard definition of stuttering. The first part denotes, the core features of stuttering which have universal applicability, the second and third parts identify the accessory and the associated features respectively. According to Wingate (1964), the term stuttering means:

1. (a) Disruption in the fluency of verbal expression which is (b) Characterized by involuntary, audible or silent repetitions or prolongations in the utterance of short speech elements, namely sounds, syllables and words of one syllable, (c) These disruptions 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 appearance of being speech related struggle.

3. Also there are not infrequently (f) indication of the presence of an emotional state ranging from a general condition of excitement or tension to more specific emotions of a negative nature such as fear, embarrassment, irritation or like.

4. The immediate source of stuttering is some in-coordination expressed in the peripheral speech mechanism.

Several interesting theories have been put forth to explain the occurrence of dysfluencies in speech. Stuttering has been viewed as caused by organic/psychological problems or by learning.

Orton (1927), Travis (1931) and Bryngelson (1935) putforth cerebral dominance theory, according to which stuttering is attributed to inability to achieve the laterality which disturb the synchronization of timing patterns from both hemispheres to their muscle groups. West (1943) views stuttering as a mild or latent form of epilepsy called pyknolepsy which could be precipitated by various kinds of stress or a mild form of subclinical cerebral palsy. Stuttering also came to be viewed as a neurogenic disorder (Szondi 1932, Seeman 1934, Rosenbeck 1985). Evidence for this comes from the neuromuscular difficulties and the imbalance in the functioning of the sympathetic and parasympathetic system.

The middle of 20th century saw the advent of many psychogenic views of stuttering. Johnson (1955) advanced diagnosogenic theory, according to which stuttering develops due to misdiagnosis made by the parents. Shames and Sherrick (1963) have identified stuttering as an operant behaviour and state that it is a learnt behaviour which gets reinforced initially and persists.

Brutten and Shoemaker (1967) consider stuttering as failure or disruption of fluency resulting from emotional arousal that has become associated with speech and speech related stimuli through a process of classical conditioning. Bloodstein (1969) proposed anticipatory struggle hypothesis.

Lee and Black (19) came out with interesting findings on subjecting the stutterers and non-stutters to different delays (in duration) in auditory feedback conditions. There was evidence for the possibility of delayed auditory feed back mechanism in stutterers which lead to dysfluencies. Wingate (1969, 70, 76, 79, 84) has called stuttering as a prosodic disorder. This was based on the finding of significant relationship between stuttering and linguistic stress.

Freeman and Ushijima (1970) reported some distinct patterns of laryngeal abnormalities in stutterers. Studies based on voice onset time, voice and speech initiation also indicate laryngeal abnormalities in stutterers. Van Riper (1982) summarized several sources of evidence for emphasizing that timing disruptions in the programming of movement of speech muscles leads to stuttering. Though several views prevailed over the years, it is still believed by many researchers (Moore and Haynes 1980, Moore and Lorendo 1980, Moore 1984, Strub, Black and Naeser 1987, Fitch and Batson 1989) that a reversed or absence of dominance is the root cause of the problem in stutterers. Various neurophysiological measures have been used to explore cerebral dominance in stutterers which include EEG (Moore and Haynes 1980, Moore and Lorendo 1980, Moore 1984, Strub, Black and Naeser 1987, Fitch and Batson 1989), Dichotic tasks (Curry and Gregory 1969, Liebetrause and Daly 1981) Tachistoscopic studies (Moore 1976, Hood and Haynes 1983), and Regional cerebral blood flow (Wood, Stump and McKeehan 1980).

The results of these studies indicate poorer performance by stutterers and support the theory that stuttering may be related to anomolous cerebral dominance both as functional as well as structural based. However, there results are equivocal and need to be supported further. In this context, the present study is planned. The aim of the present research is to investigate the laterality, if any, present in stutterers by means of evaluating reaction time to the speech stimuli presented in right/left ears. If laterality difference is found it would support the theory of cerebral dominance.

CHAPTER II

REVIEW OF LITERATURE

"I speak of it as an arrested state of neural development. The complete maturation for **a** highly corticalized, one sided gradient for smooth verbal expression does not attain in young dysphemic whose "stuttering" is apparent at the time of speech onset. The mechanism of central ambilaterality attains, thus making it difficult for the peripheral speech muscles to function in a synchronised manner".

(Bryngelson, 1943)

This opinion has persisted all through these years and several methodologies have been evolved to investigate laterality in stutterers. In the following section, studies under various methodologies will be reviewed.

1) Handedness:

One of the strong arguments used as an etiological factor is stuttering has been the finding of an unusually high incidence of left handedness among stutterers. (Bryngeleon 1939, Hecan and Ajuriaguerra 1964, Geschwind and Behan 1984).

Hecan and Ajuriaguerra (1964) examined a group of 90 stutterers, and reported that on a test of manual dominance, 30% were strongly right handed and 15% were strongly left handed, but 55% showed poor or incomplete lateralization. However, Kennedy (1945) said that it is a chance factor that handedness and language have same dominance, as these are two different entities and have different genetic origin.

2) Neurophysiological Measures:

With the advent of neurophysiology and its language implications several neurophysiological tools have been used to explore the cerebral dominance of stutterers (Knott and Tjoseen 1934).

EE6 Studies:

EEG has been used as an effective measure of dominance by means of suppression of the alpha waves. Greater suppression is seen in the hemisphere dominant for a particular task.

Moore and Haynes (1980) studied alpha hemispheric asymmetries of normal speaking males, normal speaking females and male stutterers with EEG during exposure to connected speech and connected nonlinguistic stimuli. Stutterers showed significantly less alpha in their right hemisphere for both verbal and non-verbal tasks. The findings were suggestive of possible variables affecting hemispheric processing and suggested that stuttering may be a result of linguistic segmentation dysfunction. That is, as right hemisphere is not dominant for segmentation task its dominance leads to a segmentation dysfunction and hence stuttering.

Moore and Lorendo (1980) studied alpha hemispheric asymmetries of non-stuttering males, nonstuttering females and stuttering males with electroencephalographic procedures during exposure to two lists of one-syllable words which the subjects were required to recall following presentation. One word list contained low-imagery words while the other contained high-imagery words. Thirty subjects comprised the experimental sample. Ten were non-stuttering males, ten were non-stuttering females in the age range of 18-30 years. Stuttering males were found to have significantly less alpha in their right hemispheres suggesting right hemispheric processing strategies. Differential hemispheric asymmetries for words of high or low-imagery were not observed.

Moore (1984) conducted a single subject double reversal experimental design to study the use of EMG biofeedback on dysfluent behaviours of a right handed male stutterer. A systematic decrease in EMG amplitude accompanied a progressive approximation of increased verbal complexity resulting in increased fluent behaviour. EEG data gathered during pre and post treatment sessions appeared to covary with changes in fluency with right hemispheric alpha suppression associated with greater dysfluency and left hemispheric alpha suppression with decreased dysfluencies. These are relative to stutterer's adoption of differing behavioural production strategies for fluent speech that are associated with hemispheric information processing strategies.

Strub, Black and Naeser (1987) studied two left handed siblings with developmental stuttering. The methods of study included speech and language evaluation, neurological and neuropsychological examinations, dichotic listening, auditory evoked responses, electroencephtalogram and CT scan assymmetry measurements. The data from each sibling showed evidence of anomalous cerebral dominance on many of the variables investigated. The CT scan measurements showed atypical asymmetries, especially in the occipital regions. These findings support the theory that stuttering may be related to anomalous cerebral dominance, both on functional as well as structural bases.

Fitch and Batson (1989) compared hemispheric alpha wave suppression in stutterers and non-stutterers while participating in auditory verbal, auditory-nonverbal, visual-verbal and visual-nonverbal tasks. 12 right handed stuttering males between 10-15 years of age were taken. 75 monosyllabic nouns and verbs and an audio-taped presentation of 75 puretone and narrow band noise were presented. The results indicated no hemispheric asymmetry for non-stutterers in any of the conditions. However, significant assymmetry was found for stutterers in all conditions.

Ingham, Fox, Ingham, Zamaripa, Martin, Jerabek, Cotton (1996) using PET measurements studied resting-state regional cerebral blood flow (CBF) in 29 right handed men, 10 of whom stuttered. PET images were analyzed by sampling 74 regions of interest, 37 per hemisphere. These placements were guided both anatomically and physiologically. Results revealed no significant between-group differences in CBF values. Analysis by a laterality index found a weekly significant between group effect that was isolated to five regions, four of which are implicated in speech and hearing. These findings do not support recent suggestions that developmental stuttering is associated with abnormalities of brain blood flow at rest. Rather, they indicate an essentially normal functional brain terrain with a small number of minor differences in hemispheric symmetry.

3) Dichotic Tests:

These are tests frequently used to asses dominance of a particular hemisphere for a particular stimuli. In normale, majority of the time a left hemisphere dominance (right ear advantage) is obtained.

Curry and Gregory (1969) tested 40 adults, 20 stutterers and 20 non-stutterers, on a monotic verbal listening task and three dichotic listening tasks, one verbal and two non-verbal. The subjects were in the age range of 18-30 years, all were right handed individuals. Stutterers showed higher left and right ear scores as well as difference scores between ears on the dichotic verbal task than did non-stutterers. 75% of the non-stutterers obtained higher right ear scores on the dichotic verbal task, whereas 55% of the stutterers had higher left ear scores. No differences were found between the two groups on the other tests.

Liebetrau and Daly (1981) undertook an investigation to determine the significant differences in auditory processing and perceptual abilities between 1) stutterers as a supposedly homogenous group, 2) two differentiated sub groups of stutterers, 3) either of the subgroups when separately controlled with controls dichotic listening and MLD tasks were administered to two groups of school age stutterers and an age-matched non-stuttering control group. Two groups were obtained 1) Organic stutterers who performed significantly poorer on MLD and functional stutterers who performed more like control subjects.

4) Tachistoscopic Studies:

Moore (1976) used bilateral tachistescopic procedure to investigate the visual half-field preferences of 15 stutterers and a group of 15 normal controls in the age range of 17-29 years. Stimulus words were of four pairs which were photographed vertically on 35mm projector slides. The subjects task was a one-response, free recall task. Statistical analysis indicated a right visual half-field preference for the control group. In contrast, a significant visual half-field preference was not revealed for the stuttering group. However, further analysis revealed that a significantly larger proportion of stutterers, demonstrated a left visual half-field preference, indicating reversed cerebral processing for the stuttering group.

Hood and Haynes (1983) studied linguistic processing by the right and left cerebral hemispheres in 10 adult male stutterers and 10 matched nonstutterers. Subjects performed on a lexical decision task in which non word and real word stimuli were presented tachitoscopically to the right and left visual hemifields. Vocal and manual reaction times to real words were measured to assess hemispheric participation in processing linguistic information. The stuttering group exhibited a left visual field efficiency or right hemisphere preference for this task and were slower in both vocal and manual reaction times.

5) Regional Cerebral Blood Flow Studies:

Wood, Stump and McKeehan (1980), found increased blood flow in the left Brocas area in the non-stuttering normals while in stutterers, there was an increase in flow in the right Brocas area during a motor task indicating reverse laterality in stutterers.

Thus, a general conclusion which can be drawn from the above studies, though not unequivocally believed, is that stutterers as a special population have reversed or mixed cerebral dominance.

6) Reaction Time Studies:

Motor performance has been used by researchers to tap central nervous system performance. Reaction time studies, are the most commonly cited ones in literature to assess motor performance. The implications of these studies generally vary from an overall defective or slow motor programming to involvement of higher programming deficit in stutterers.

While going through literature, one can appreciate the clear change in trend in terms of the reaction time studies their interpretation and implication in the special population of stuttering. Though initially these studies were used as a means of studying laterality in stutterers, later they were used as independent tools to measure motor performance in stutterers. Results of these studies also lead to a corresponding increase in physiological studies (EMG, EEG, etc.). Simultaneously a parallel school of thought arose which considered a higher programming as a cause for longer reaction time in stutterers. More recently, stuttering is considered as a phonological encoding defect.

Wingate (1976) reviewed conditions which enhance fluency in stutterers and concluded that all these techniques had a tendency to produce speech that prolonged and emphasized vocalization. This led to a spate of research on laryngeal behaviour in stutterers. This was followed by a number of studies on vocal reaction time of stutterers and to compare these reaction times to those of nonstutterers. In an attempt to verify Wingate's hypothesis, Adams and Reis (1971) tested the hypothesis that frequency with which vocalization must be initiated in a given speech segment and the frequency of disfluency are positively related. Two passages were constructed. One passage was composed entirely of voiced speech sounds (all-voiced passage). The other contained both voiceless and voiced sounds (combined passage). Thus, in reading the later material, subjects had to effect more "off-on" phonatory adjustments that in the all voiced section. Apart form this difference, the passages were closely matched along several other linguistic and phonetic parameters. Fourteen stutterers performed five massed oral readings of each passage. The subjects aged from 15-26 years. Statistical analysis showed that there was significantly less stuttering and more rapid adaptation associated with the all-voiced material. The findings support the hypothesis. This study was later replicated but was nonetheless criticized on a number of methodological grounds.

Studies on Vocal Reaction Time:

Adams and Hayden (1976) tested the hypothesis that stutterers have difficulty initiating and terminating phonation independent of the acts of running speech and stuttering. 10 young adult stutterers served as the experimental group. They were matched as a group for age and sex with 10 normal speakers. Subjects from both groups were tested individually. The experimental task required that subjects start and stop phonation as quickly as possible upon hearing each member of a series of 1000 Hz pure tones appear and then disappear. Subjects vocalizations were permanently recorded on an optical oscillograph. Results showed that both groups improved their voice initiation and termination times from the beginning to the end of the experiment. Typically however, stutterers were significantly slower than the control subjects on most of the temporal measures.

Two explanations for this results were as follows:

1) It is possible that the act of stuttering, so frequently marked by excessive constriction and tension in the speech mechanism, makes the quick initiation of phonation difficult or 2) The delay in voicing prompts the speaker to repeat and prolong his oral articulatory gestures until a stables vocal tone has been achieved.

Starkweather, Hirschman and Tannenbaum (1976) did a study in which 11 stutterers and matched controls were asked to produce as quickly as possible each of 26 different syllables following a visual stimulus. Three trials were given for each syllable. Responses were filtered to remove supraglotally produced sounds, and the time between the visual stimulus and the onset of vocalization was measured by a voice-operated relay and a computer's internal clock. The results suggested that stutterers are slower in initiating vocalization across a wide variety of syllables, and the difference averages about 65 msec. Furthermore, when phonological conditions delayed voice onset by a comparable amount, the stutterers gained enough time so that no significant differences were observed between the two groups. The results are interpreted as suggesting that auditory dysfunction cannot be a cause for slower vocalization reaction time in stutterers but that either vocal dysfunction or a lack of cerebral dominance may be responsible for these differences.

However, in their zeal to confirm Wingate's hypothesis these studies failed to control for the possibility that stutterers might have had slower reaction times in non-laryngeal behaviour as well. This led to the study of laryngeal physiology during the stuttered speech interval to consider the possibility that stutterers may not have the same level of speech motor control that non-stutterers **have.**

Studies on Laryngeal Physiology:

Freeman and Ushijima (1978) measured laryngeal muscle activity during fluent and stuttered utterances via electromyography. Subjects were four adult males ranging from mild to severe stutterers in the age range of 22-47 years. Five intrinsic laryngeal muscle activity (Posterior Cricoaretynoid, interaretynoid, cricothyroid, thyroaretynoid) were measured. Analysis revealed that stuttering was accompanied by high levels of laryngeal muscle activity and disruption of normal reciprocity between abductor and adductor muscle groups. Results demonstrate the existence of a laryngeal component in stuttering and showing a strong correlation between abnormal laryngeal muscle activity and moments of stuttering.

McFarlane and Prins (1978) compared neural response time (NRT) for 12 adult stutterers and 12 matched normal speakers in the age range of 28 years to 38 years, on two verbal tasks (production of [pæ]and [bæ]) and one oral, non-verbal task (lip closure) in response to visual and auditory stimulation. The auditory response stimulus was presented separately to the left and right ears, and the visual stimulus to both eyes. NRT was defined as the time interval between stimulus offset and the onset of electromyographic (EMG) activity from orbicularis oris superior muscle. Results show, in general, that stutterers are slow in NRT for all response tasks in both stimulus modes. Significant differences were found, however, for only the auditory mode. Analysis of the differences between and within groups for response tasks and stimulus modes indicative of timing disturbances in stutterers. The results of this study were noteworthy as the data suggested that a delay in reaction time could be accounted for by means of a limitation in motor programming and excecution or in terms of the type of sensory modality used. To answer this McFarlane and Shipley (1978) did another study the results of which revealed that stutterers motor performance is slower when auditory perception is involved in responding.

Around the same time (1978, 80) Sternberg, Monsell, Knoll and Wright performed simple reaction time tasks such as counting natural numbers, days of week etc; Results of all these studies indicated an increase in reaction time with longer sequences. This led to the claim that this increase in reaction time was due to programming (higher level) delay rather than a low level programming (motor delay) deficit.

Simultaneously choice-reaction tasks were studied by Klapp, Abbot, Coffmann, Greim, Snider and Young, (1979) where in the subjects had to press a Morse code key either for a short press ('dit[1] response) or for a longer key press 'dah' response. The subjects demonstrated a longer reaction time for the latter. This difference however, was not present on using the simple reaction task, thereby making Klapp conclude that different task measure different reaction times and that the prolonged reaction time in stutterers could be the result of programming deficits also.

Shapes (1980) based on previous studies hypothesised that: 1) each type of stutterers would exhibit a mode of laryngeal muscular dysfunction specific to that particular group, 2) each stutterer would demonstrate idiosynchratic laryngeal muscular behaviour and 3) the same aberrant laryngeal muscular behaviour described would be observed in all stutterers. Subjects were 3 males and one female ranging in age from 20-24 years. Hooked wire electrodes were inserted periorally and percutaneously.

The subjects were presented with: 1) reading task with and without fluency evoking technique and 2) the most feared sounds for each stutterers were placed initially and finally in an utterance and Electromyographic recording was carried out. Results revealed 1) excessive muscular activity during production of the utterance, 2) Poor coordination of muscles which commonly function reciprocally, and 3) inappropriate burst of activity before and during periods of acoustic silence. Results also revealed significant degree of difficulty in maneuvering the vocal cords approximately even for the production of fluent utterance in stutterers.

Zimmermann (1980), used cinefluorographic techniques to record articulatory movements during fluent and disfluent speech from four stutterers and control utterances from one normal speaker. Analysis of 11 perceptually disfluent utterances were reported. The results showed that the: 1) interarticulator positions occuring in both perceptually fluent and disfluent utterances of stutterere were unlike those in fluent utterances of normal speaker, 2) aberrant interarticulator positions preceded repetitive movements and static posturing, and 3) consistent interarticulator positioning preceded termination of an oscillatory movement. These patterns according to Zimmermann could be the result of possible neuromotor mechanism involved in dysfluency. It was suggested that reflex interactions among the muscles of articulation might account for some of these effects.

These studies confirmed the presence of abnormal muscle activity in stutterers by the presence of high, poorly timed, non-reciprocity of muscles, thereby forming an interesting explanation for the reaction time results described earlier.

Studies Comparing Manual and Vocal Reaction Time

Cross and Luper (1978) tested nine stutterers and nine non-stutterers at each of the three age levels (5 years, 9 years and 18 years and above), on response to the onset of twentyone 1KHz tones by depressing the index finger of their preferred hand on a response key. Finger reaction times were measured to the nearest millisecond and compared to the voice reaction time obtained from the same subjects. Results revealed an increased speed and stability of the finger reaction times as an inverse function of age for both groups. The stutterers, as a group, exhibited mean finger reaction times which were significantly longer and more variable than those of the non-stutterers at each of the three age levels. High correlation also were found between the finger and voice reaction scores for both the stutterers and non-stutterers. Results support the inference that some stutterers may exhibit difficulty in the consistent execution of motor control strategies common to both speech and nonspeech movements.

These finding were later challenged on methodological ground by Reich, Till and Goldsmith (1981) who compared the reaction times of 13 stuttering and 13 non-stuttering adults for forefinger button pressing, non-speech vocal initiation, and speech mode vocal initiation. The stutterers and non-stutterers were matched individually for age, sex and handedness. The reaction time stimulus in all response conditions was the offset of a 1KHz puretone. Two of the experimental conditions required button pressing with the right and left forefingers. The remaining four 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 the isolated vowels (ʌ) and the word (ʌpɚ). The results demonstrated that stuttering and non-stuttering adults differed significantly only on tasks requiring speech phonation. The results suggest that the longer speech wreaction time is exhibited by stutterers reflect learned anticipatory fears of phonatory initiation and maladaptive prephonatory muscle set.

Watson and Alfonso (1982) studied laryngeal reaction time and voice onset time between eight adult stutterers and eight normals in the age range of 18 to 38 years. The test stimuli presented was a 1 KHz puretone presented binaurally and a visual signal presented by an incadescent lamp located directly in front of the subjects. The duration of the reaction signal randomly varied from 1-3 sec in lsec increments. Subjects were instructed to begin phonation immediately at the offset of the reaction signal. Results revealed no significant group differences in larngeal reaction time and voice onset time values. Foreperiod duration and severity of the subjects taken were explained as possible causes for the obtained results.

A further detailed study was done by Watson and Alfonso (1983) on the effect of foreperiod and stuttering severity on laryngeal reaction time (LRT). The former was assessed by the use of 13 foreperiod durations. The latter was assessed by classifying experimental subjects as either mild or severe stutterers. The study was done on 10 adult stutterers and 5 adult nonstutterers Stuttering Severity Instrument (Riley 1972) was used to assess severity of stuttering. Results indicated that both factors significantly affected LRT values. Specifically, mild stutterers LRT values approached normal values as foreperiod increased, whereas severe stutterers LRT values remained significantly greater than normal values at all foreperiods. Delayed Laryngeal Reaction Time was indicated as due to differential posturing and/or vibration initiation deficit underlying stutterers delayed LRT values.

Borden (1983) studied severe stutterers aged 21-48 years matched by sex, age and general educational/occupational level and compared them with eight normals. Two response tasks namely, speech counting and finger counting was taken up. Results revealed severe stutterers to be significantly slower than control subjects in performing a speech counting task that was judged to be fluent and in silently counting on their fingers. For both counting tasks the time taken to execute the numerical series accounted for more of the difference between severe stutterers and controls than the time taken to prepare and initiate the task. Mild stutterers were not significantly slower than controls on either counting task.

Starkweather, Franklin and Smigo (1984) did a study to 1) assess whether slower reaction times of stutterers are related to the etiology of the disorder or whether they are a byproduct of it, and 2) to see if previously reported correlations between vocal and manual reaction times resulted from large number of trails. 14 adult stutterers and matched controls said 'uh' or pressed a button in response to the offset of tones varying randomly in duration. Ten trails were used. The stutterers were significantly slower in both speech and non-speech tasks, but the correlations between voice and manual reaction times were not significant. This suggested that stutterers slower reaction times may be obtained without using large number of trails and that the correlation between the two tasks may depend on the number of trails used. The stutterers showed a significantly larger difference between vocal and manual reaction times than the non-stutterers. This suggested that the slower reaction times of stutterers are not entirely a by-product of the disorder.

Horii (1984) studied four types of voice reaction times for eight adult stutterers and eight control subjects using a vocal shadowing paradigm. The subjects were in the age range of 22-34 years. A computer was used to generate auditory target stimuli and to control the timing and order of the stimulus presentation. The parameters were Voice Initation Time (VIT) and Voice Onset Time (VOT) and voice frequency-shift initiation and termination reaction times (SIT and STT). Results indicated that the stutterers were slower in Voice Initiation Time (VIT) but were as fast as their control subjects in Voice Initiation Time (VIT), Speech Initiation Time (SIT) and Speech Termination Time (STT). It was suggested that a laryngeal disco-ordination problem of stutterers lies primarily in the stage of adduction (turning on the voicing) rather than in the stage of abduction (turning off the voicing) or in finer frequency control at the larynx.

Long and Pindzola (1985) studied 10 stuttering and 10 nonstuttering children aged 4-8 years for a motor reaction task to simple and complex linguistic stimuli. The subjects reacted by pressing one of four panels on a touch sensitive board that depicted the appropriate semantic relationship in response to 30 simple and complex linguistic stimuli. There was a significant increase in the reaction time of both groups with increasing complexity. No significant differences were found in the reaction time between both the groups nor in the interaction between group and complexity.

It was concluded that stutterers and nonstutterers in this study did not differ in their reaction time nor in their processing time of linguistic material.

Thus, though contradictory results have been obtained, majority of these studies point unequivocally towards the fact that stutterers as a group have a longer reaction time than normals in all the activities. This delay in laryngeal reaction time has given support to the hypothesis that stutterers are likely to be neurologically less well equipped for speech than are non-stutterers.

Peters and Hulstijn (1987) recorded response in the laryngeal, articulatory and acoustic domain simultaneously and measured the time between the response signal and the onset of speech which was divided into two intervals: 1) the interval between the response signal and the first manifestation of physiological activity (to reveal programming difficulties), 2) the interval between the start of the first physiological activity and the onset of speech (in co-ordination in muscle movements). The aim of the study was to investigate whether a longer reaction time in fluent speech utterances of stutterers was the result of programming disorder.

The subjects taken were 11 male adult stutterers in the age range of 18-28 years and the control subjects were 10 male non-stutterers matched for age. The experiment followed a reaction time paradigm with two task conditions: an

Time in both groups, more so in stutterers. The analysis of subintervals indicated additional time taken by stutterers in responding at earlier parts of response particularly for long utterances. The results suggest difficulty in motor programming in speech behaviour in stutterers.

Postma, Kolk and Povel (1990) measured speaking rates of 19 stutterers and 19 nonstutterers for three speech conditions namely silent, lipped and overt. Two types of stimulus sentences were used: tongue twisters and matched control sentences. The data showed that stutterers were slower than nonstutterers for each combination of stimulus type and speech condition. The difference between stutterers and nonstutterers was larger for lipped speech than for silent speech and was strongest in the overt condition. These results suggested that speech planning is impaired in stutterers. Speech execution may be independently affected, or, alternatively, the planning impairment may have stronger repercussions with actual speech motor execution.

Ferrand, Gilbert and Blood (1991) evaluated aspects of central processing and simultaneous laryngeal function in stutterers and nonsutterers using a recently developed continuous flow model of phonatory reaction time. Simultaneous measures were made of P300 brain potential, laryngeal positioning movements prior to vocal fold closure, and onset of vocal fold vibration in 10 stutterers and 10 normals. The temporal ordering of these three events was evaluated and difference between the two groups examined. Results revealed no significant difference in the vocal motor or P300 response. Stutterers and nonstutterers appeared to be using a similar temporal patterning. This model could be used to obtain information regarding temporal aspects of central processing and laryngeal function.

Jancke (1994) compared 18 male stutterers and 16 male nonstutterers who were matched according to age and social status on the test words /kakakas/, /tatatas/ and /papapas/ with stress on the middle syllable at two different speech rates. Duration of phonation, voice onset time, and coefficients of variation were computed and analyzed. Results revealed that stutterers produced, even during nonstutterering periods, under repetitive articulation an enhanced variation of voice onset time and an increased variability for the duration of phonation associated with the production of the first syllable. Further, this experiment did not confirm the often reported difference in VOT and vowel duration between stutterers and nonstutterers. The present study supports the conclusion that the important difference between stutterers and nonstutterers may be in the relative temporal variability of their speech motor control across repeated trials (Adame, 1987: Wieneke and Janssen, 1987; Caruso, 1988).

Wijnen and Boers (1994) studied phonological encoding in nine stutterers and nine nonstutterers in a phonological priming experiment. In each trial, the subjects were required to utter one word from a set of five as fast as possible upon visual presentation of a related cue word. In the so-called homogeneous conditiones the response words were phonemically unrelated. Results revealed that nonstutterers had shorter speech onset latencies in homogeneous than in heterogeneous conditions and the difference was larger for the words sharing both consonant and vowel than for words sharing the initial consonant only. In most stutters a reduction of speech onset occurred only when the words shared both consonant and vowels. These results are taken to indicate that in stutterers the encoding of noninitial parts of syllables, particularly vowel, is delayed. The primary symptoms of stuttering-repetition or prolongation of syllable initial segments result from attempts at executing a syllable prior to the incorporation of correct vowel information in the articulation plan.

Nil (1995) investigated abnormal articulatory temporal coordination among adult stutterers. Five adult stutterers and four nonstutterers were instructed to produce repeatedly three target utterances embedded in different phonetic contexts. Closing gestures of the upper lip (UL), Lower lip (LL) and jaw (JA) were analyzed in terms of the temporal sequencing of movement onset and peak velocity. The results failed to support previous reports of an invariant articulatory sequencing pattern among normal speakers. The frequency of the UL-LL-JA sequency pattern depended not only on the nature of the bilabial consonant (/p/ or /m/) but also on the phonetic context surrounding the consonant.

Significant difference in peak velocity sequencing were found between the stutterers and the nonstutterer's for /sapapple/. The UL-LL-JA sequence pattern was more typical for the nonstutterers speech movements than for those of the stutterers. No differences between the two subject groups were found for any of the other two target utterances.

Sackin and Rustin (1995) compared fluent and stuttering children in three tasks (age: 10 years 11 months). The tasks were chosen to cover a range of abilities deemed necessary for producing fluent speech. These are (a) Production of voiced plosives varying in place of articulation, (b) Moving the lower lip to follow the movement of a sinusoidally varying target, and c) Making the minimum possible articulatroy movement either with or without attendant visual feed back. The tasks are indicative of (a) laryngeal/ supraglottal coordination (b) supraglottal movement alone and (c) use of kinesthetic feed back. The stutterers (a) produce longer voice onsets in the plosives, (b) had larger tracking errors, and (c) produced bigger minimal movements when no visual feed back was provided compared with fluent speakers.

Wieneke, Janssen and Brutten (1995) studied the hypothesis that the cause of speech disruption in stutterers is related to excessive variability in their speech motor system. However crucial for this is the contention that the excessive variability deemed to be causative stems from the central timing mechanism of the speech production system. 24 stutterers and 16 controls served as the subjects of this investigation. The subjects were required to emit 10 fluent productions of test sentence. In the baseline, the subjects were instructed to read the sentence. In the two experimental conditions, the subjects, were instructed to read the sentence. In the second experimental condition, the subjects were instructed to modify their speech rate according to a model presented to them on audiotape. During this, the vibrations of the vocalfolds were recorded by means of electroglottagraphy. Result reveals that there is a relation between the stuttering reducing effect of slowing speech and a normalization of the durational variability at the central level of the speech production system. This follow the data of previous findings (Wieneke and Janssen, 1991), that the timing variance associated with a central origin is indeed greater among stutterers than among normal speakers.

7) Linguistic Involvement in Stutterers:

Apart from evidence associated with deficits in the planning and execution of speech (Watson and Alfonso, 1983; 87; Peters and Starkweather, 1990) evidence also suggests that the onset, development, and occurrence of stuttering may be related to demands that language places on speech motor planning and execution.

Soderberg (1966) studied the relations of stuttering to word length and word frequency. 20 stutterers recorded nine ten - worded lists in the presence of a single listener. There were 17 boys and 3 girls ranging in age from 12 to 44 years. The word lists were composed of combinations of three levels of word length and three levels of word frequency. An attempt was made to equate the word lists for stress of initial syllable, grammatical function, and initial sounds of words. Results reveal greater stuttering to be associated with increases of word length and decreases of word frequency.

Tornick and Bloodstein (1967), Haynes and Hood (1978) gave the "overload hypothesis" according to which increase in linguistic complexity leads to overload of the linguistic motor system and disrupts fluency. Hence an investigation into linguistic processing efficiency or decoding was warranted to study the effect of linguistic factors on stuttering.

Linguistic involvement in the form of 1) late language onset and 2) Concomittent language and speech problems are commonly reported characteristics in stutterers to differentiate them from non stutterers.

Brown (1979) identified and discussed at considerable length four features namely grammatical class, initial sound, sentence position and word length with the occurrence of stuttering.

1) content words (nouns, verbs, adjectives, adverbs) as compared to function words (articles, prepositions, conjunctions, pronouns).

2) words beginning with consonants (as compared to vowels).

3) Words occurring very early in a sentence.

4) Words that are five letters or longer, were considered as the ones which determine the loci of stuttering.

McLaughlin and Cullinan (1989) studied 10 male and 10 female stutterers for interaction between linguistic complexity and dysfluency. The subjects were in the age range of 4 1/2 to 5 years. Spontaneous language samples were used and these subjects also participated in modeling procedures employed to evoke four sets of utterances representing two levels of utterance length and two levels of linguistic complexity. Analysis indicated that greater rate of dysfluencies and 'stutterings" occurred for modelling tasks that evoked linguistically more complex utterances. However, sex and length of utterance appeared to be related, with male subjects having more dysfluency for shorter utterances.

Taken together, the work of Haynes and Hoods (1978), Gordon (1986) Ratner and Sih (1987) and Pearl and Bernthal (1988) appear to provide relatively consistent experimental support for a dysfluency - linguistic complexity relationship.

Peters and Starkweather (1990) summarized the findings with regard to language and stuttering as follows:

1) On an average, stuttering children are slightly but significantly slower in the development of language skills than closely matched non-stuttering children (Wall, 1977; Kline and Stark Weather, 1979).

2) Children whose language development is delayed often begin to stutter as language emerges, often during treatment (Patterson and Reed, 1981).

3) Stuttering occurs more often at points in the utterance that can be described in linguistic terms, specifically on words that are close to the beginning of the sentence (Wingate, 1976), on longer as compared to shorter utterances (Jayaram, 1984) and at major clause boundaries (Wall, Strakweather and Cairns, 1981).

4) Normal nonfluencies occur more often in syntactically complex sentences when and only when syntactic formulation precede their production (Gordon, Luper and Peterson, 1986).

Freeman, Watson, Chapman, Miller, Pool and Devour (1991) studied. 19 male stutterers in the age range of 26-66 years and 12 normal speakers in the age range of 23-59 years on linguistic performance using high - level production and comprehension processes. Responses used to record Laryngeal Reaction Time (LRT) differed in linguistic and motoric complexity. Results revealed that only linguistically impaired stutterers showed significant increases in LRT for complex responses. Findings of this study suggest that linguistic and motor processes affect the efficiency and fluency of speech motor control.

Hubbard and Prins (1994) studied the effect of word frequency and syllabic stress pattern on stuttering frequency on 10 adult stutterers and non stutterers in the age range of 19-62 years. Specially designed sentences were read orally by the subjects. Results revealed significant differences in stuttering frequency between sentences with low and high frequency words, but not between sentences with regular and irregular syllabic stress pattern.

The word familiarity effect seen in the above studies bears upon three recent hypothesis concerning the source of stutter events. Wingate (1988) proposed that lack of "synchrony" in word access and assembly (that is, encoding precipitates stutter events by causing a breakdown of coarticulation, particularly at word and syllable onsets. Postma and Kolk (1993), propose that people who stutter have a "deficit in the phonological encoding of an utterance, that is, in generating the articulatory plan". This deficit underlies the occurrence of encoding errors. They further suggest that the activation of "phonemic elements" is too slow among stutterers to support fluency at even average speaking rates, providing a rationale for the salutary effects on stuttering of slow - paced speech.

Perkins (1991) believes that the timing and fluency of an utterance are disrupted in persons who stutter when syllable frames are not ready for their segmental filters. The stutterers reaction with "time pressure to continue" is then necessary for the subsequent precipitation of stuttered events.

Howell and Au-Yeung (1995) studied a group of child stutterers (and their control) who varied in age and severity of their disorder to see if stuttering was caused due to phonological difficulty or Brown's factors such as properties of words (function or content), position of words, their length etc; In the analysis, the proportion of words stuttered for words in each phonological category are analysed so that any influence of Brown's factors might have to be removed. Results revealed that phonological difficulty does not appear to be a major factors governing the incidence of stuttering in children.

Thus, literature provides positive evidence for the presence of an active interaction between linguistic aspects and loci of stuttering. As a part of this, Word Association task is being studied for several years now in different language disrupted population.

WORD ASSOCIATION TASK

The word association test was introduced by Galton in (1879) as a probe of 'Mental anatomy'. There are several reasons to believe that Word Association tests may be useful in assessing lexical disintegration in Brain damaged subjects. It has been reported that;

1) Normals show predictable patterns of responses during word association task (Palermo and Jenkins, 1964).

2) The frequency of occurrence of words given as response in word association tasks parallels the frequency of usage of these words in general discourse (Homes, 1967).

3) Word association responses appear to be generated by the same mechanisms that produce words in running discourse (McNeill, 1966).

Thus, responses during word association tests reflect certain aspects of linguistic knowledge and these may be useful in delineating the language deficit that accompany a few affected population. These tests have been widely employed by researchers seeking to describe and to understand their population of interest (Nelson, 1977). Word association responses have been examined in both normal and clinical population from the perspectives of psychology, psychiatry, neurology, linguistics and speech pathology.

Studies on Word association have traditionally classified responses as either paradigmatic or syntagmatic. Syntagmatic responses are of a different grammatical class than the stimulus word in a sentence (eg: run-fast) Paradigmatic responses are of the same grammatical class and represent a parallel concept that would occupy the same position as the stimulus word in a sentence (eg: run-walk). To classify the paradigmatic - syntagmatic distinction some examples are listed from Lovelace and Cooley (1982).

STIMULUS WORD———————> TRUCK

Syntagmatic response: home, away fire, red

paradigmatic response: come, drive bus, train.

Extensive normative data have been collected on the word association responses of children, young adults and the elderly. Many researchers have administered Word Association Tasks on clinical population to see if characteristic linguistic patterns of response would emerge to differentiate such population from normals.

Studies on adults with Aphasia have been found to give fewer paradigmatic responses and more anomalous responses, although the proportion of paradigmatic and syntagmatic responses is similar to that of normals.

Although word association of normals, Schizophrenic and neurologically impaired adults have been extensively researched, little attention has been paid to the clinical population of stutterers. As of yet, there is no documentation comparing the proportion of paradigmatic and syntagmatic responses of stutterers with that of normal speakers.

Adams and Dietze (1965) compared the reaction time of stutterers and normal speakers to neutral and affect connoting items on a Word Association test. Subjects were instructed to write their responses in order to circumvent the problem of possible speech disruption. The stutterers were found to be significantly slower as a group on all words, than were the normal speaking controls.

Jensen, Markel and Beverung (1986) employed word association task as a replica of conversation to compare turn-taking behaviors of stuttering and normal speakers. Response latency, as timed by a stop watch was one dependent measure. Unexpectedly, severe stutterers were found to be significantly faster in responding than normal speakers.

In another study by Crowe and Kroll (1991) the response latency and response class for stutterers and non stutters was measured using word association task. No significant differences were found between groups on either response latency or response class measures. The clinical usefulness of word association task as a means of objectively examining avoidance behaviour in stutterers is therefore regarded as limited. However, stutterers were a highly heterogeneous group. The experimental group was found to be highly variable in terms of the time for response and the type of response.

Thus Word Association task affords the opportunity to assemble a profile of stutterers particular response latency and response class characteristics. Using reaction time in a word association task, the present study sought to investigate the laterality in stutterers.

CHAPTER - III

METHODOLOGY

Subjects:

The subjects chosen were eight stutterers (six males and two females) and eight normals (six males and two females) in the age range of 17-40 yrs. All the subjects were native Kannada speakers. The stuttering severity ranged from moderate to severe and none of the stutterers had any other speech or hearing problems.

Table I shows the subject details

SL. No.	AGE	STUTTERERS SEX	SEVERITY	SL. No.	NORMALS AGE	SEX
1	40	M	Severe	1	22	M
2	25	M	Moderate	2	22	M
3	23	M	Severe	3	23	M
4	27	M	Moderate	4	23	M
5	20	F	Moderate	5	22	F
6	22	F	Moderate	6	22	F
7	25	M	Severe	7	22	M
8	23	M	Severe	8	22	M

Material:

The stimulus words were chosen using Kannada dictionary and the two grammatical categories selected were nouns and verbs. These words selected were controlled for three factors, viz;

1) Length : Long vs Short

2) Abstractness : Abstract vs Unabstract and

3) Occurrence : Common vs Uncommon.

Based on several combinations, five words in each category of stimulus words were selected as follows,

1) Long abstract Noun: Common (5), Uncommon (5)

2) Long abstract Verb: Common (5), Uncommon (5)

3) Long unabstract Noun : Common (5), Uncommon (5)

4) Long unabstract Verb : Common (5), Uncommon (5)

5) Short abstract Noun : Common (5), Uncommon (5)

6) Short abstract Verb : Common (5), Uncommon (5)

7) Short unabstract Noun : Common (5), Uncommon (5)

8) Short unabstract Verb : Common (5), Uncommon (5)

These words were persented to native Kannada speakers for a familiarity test and the words which fit the above criteria and were familiar were selected for the study. Thus, a total of words (40 nouns and 40 verbs) formed the material.

METHOD:

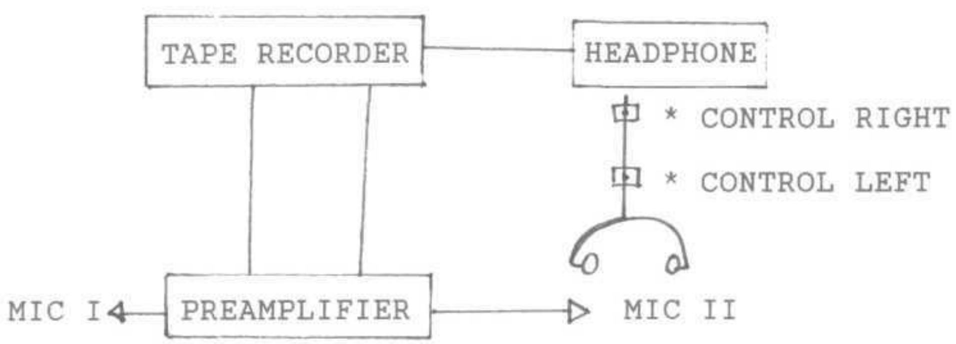


FIG. 1 : Instrumental set up

The subjects were seated in an acoustically sealed sound proof room. Before commencement of the experiment, the subjects were instructed as follows:

"Now you will be hearing a **word.** As soon as you hear it speak out the first word that you can associate with the word presented. For instance, if the word you **hear** is ORANGE you **can** say FRUIT, EAT etc. Try avoiding responding in sentences".

The words were audio presented one after another, through headphones into one of the ears. 50% of the subjects received the stimulus in the left ear first and the remaining 50% received in the right ear first. Two microphones were used. Both the mics were connected to the taperecorder which is in turn connected to the preamplifier. The experimenter used mic-1 to utter the words which were audio-recorded and was heard in right/left ear of the subject through the earphones which was connected through the tape recorder. The subject used the mic-2 to respond, which was also audio-recorded on the same cassette. Thus, the experiments utterance and the subjects responses were audio-recorded. Fig. 1 shows the experimental setup.

ANALYSIS: Two types of analysis were carried out.

1) REACTION TIME ANALYSIS: (Lower Case)

The DSP sonograph 5500 was used to measure the time taken to respond in msec. The stimulus was fed from the tape recorder to DSP sonograph 5500 and wave forms were obtained on the screen. The cursors were placed between the end of the stimulus word and the beginning of the response word and the time difference was measured. This gives the reaction time measure.

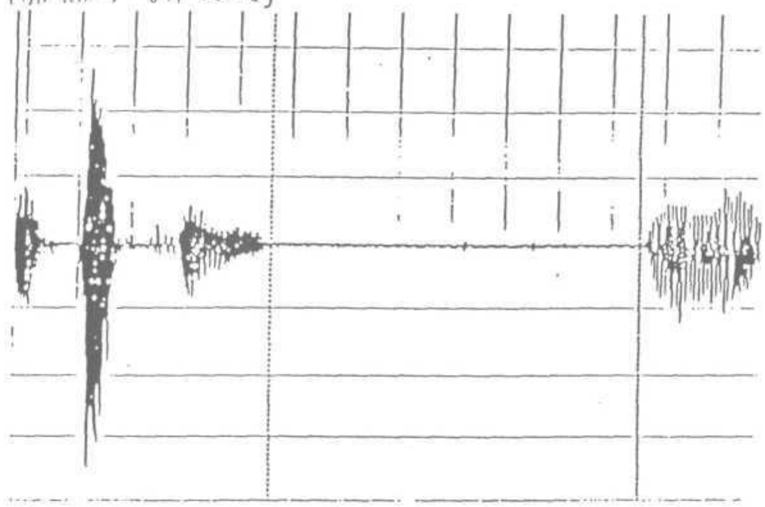


Fig 2. [illegible] REACTION TIME FOR THE WORD /kileki/ AND RESPONSE /mane/. [REACTION TIME IS THE TIME [illegible] [illegible] 691 msec]

2) LINGUISTIC ANALYSIS:

The response words were analysed as syntagmatic, paradigmatic and unspecified. A Syntagmatic response refers to responses that are of a different grammatical class than the stimulus word. A Paradigmatic responses refers to response which belong to same class as the stimulus word. Unspecified responses are those that fall under neither of the above categories. Syntagmatic response were assigned a value of '2', paradigmatic a value of '1', unspecified response were assigned a value of '0'.

Statistical Analysis:

The data was tabulated and "I" test was performed to study differences between the (1) mean reactions times when the stimulus was presented in right and left ears (2) mean reaction times of normals and stutterers (3) mean reaction times of nouns and verbs (4) mean reaction time of abstract and unabstract nouns/verbs (5) mean time of common and uncommon nouns/verbs (6) linguistic responses of normals and stutterers.

Also percent times the syntagmatic, paradigmatic, unspecified responses used by normals and stutterers were analyzed.

Chapter IV

RESULTS AND DISCUSSIONS

RESULTS:

I. Reaction Time: The mean reaction times were longer in stutterers compared to normals which was significant at 0.05 level. Table I shows the mean reaction time in normals and stutterers

Parameter	Mean	Significance
Control group	114	+
Experimental group	144	

Table I: Mean reaction time for control v/s experimental group (in msecs) and the significance of difference at 0.05 level.
(+ significant difference present).

For both the groups, the reaction time for stimulus presented to the left ear was greater than that to the right ear. However, t-test revealed the difference to be significant only in normals and not in stuttering population.

Table II: Shows the mean reaction time for both the ears. Also, the reaction times were significantly longer in stutterers compared to normals irrespective of the ear (Table III).

SL.No.	Parameter	Mean	Significance
1	Control right v/s Control left	108 120	+
2	Experimental right v/s Experimental left	141 146	-

Table II: Mean reaction time (in msec)for both the ears of the two groups and significance of difference.

SL.No.	Parameter	Mean	Significance
1	- Control right v/s Experimental right	108 141	+
2	Control right v/s Experimental left	120 146	+

Table III: Reaction time (in msecs) of experimental and control group and significance.

Figure 2 shows the reaction times which reveals that the control group's reaction time was shorter than the reaction times of the experimental group. Individual variations were evident in both the population. While experimental subject S1, S5, S6, S7, Ss have longer reaction times in the left ear others do not show the same. In the control group, reaction times for right ear of S3 and S5 are longer than that in the left ear.

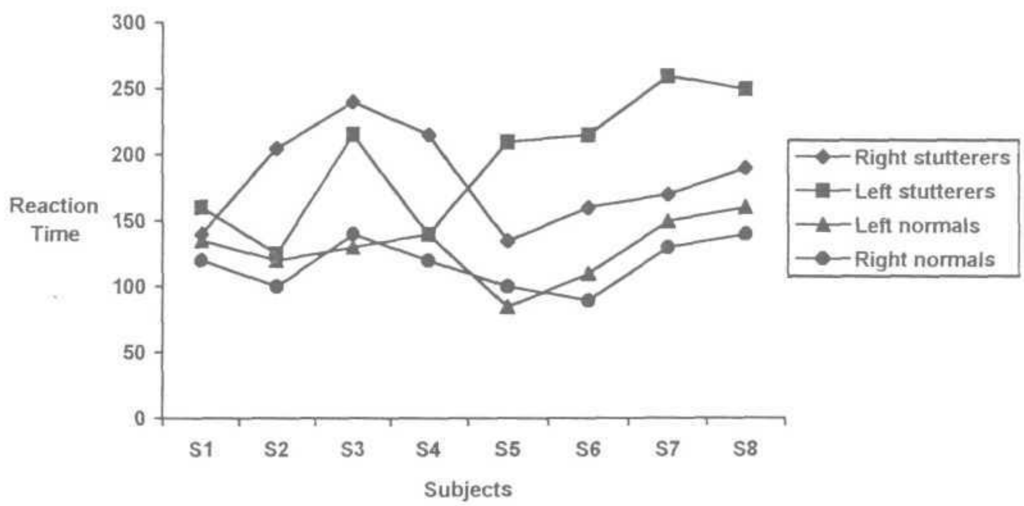


Figure 2: Reaction time (in msecs) of eight normals and eight stutterers for both the ears.

II) Reaction time for various linguistic categories:

1) Abstractness: In general, the reaction times were longer for verbs compared to nouns and were longer for abstract **verbs** and nouns than for unabstract verbs and nouns. While significant differences between the mean reaction times of abstract and unabstract verbs were observed in normals, among stutterers T-test revealed significant differences between mean reaction times of abstract and unabstract nouns and verbs. Figure 3 shows the mean reaction times for nouns and verbs.

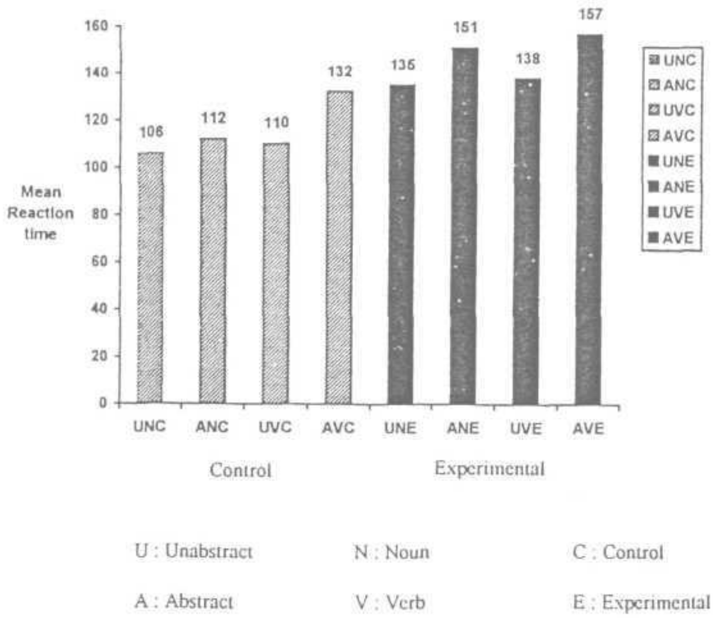


Fig.3: Mean reaction times (in msecs) for abstract and unabstract nouns and verbs.

III) Type of Response:

The percentage of syntagmatic responses were greater than the paradigmatic response in both the groups and the stutterers exhibited fewer paradigmatic responses than normals. Also, the unspecified responses (those which fall in neither of the above categories) were more in stutterers than in normals Table IV shows the percent of various kinds of responses.

Variable	Control	Experimental
Syntagmatic	47	70
Paradigmatic	38	19
Unspecified	5	11

Table IV: Percent of various responses.

Discussion:

The results revealed several points of interest. First of all, it was observed that while the normals showed significant difference between the reaction times of the two ears (with longer reaction times in the left ear) no such significant difference was found in stutterers. This is in consonance with the results of the studies by Curry and Gregory, 1969; Moore and Haynes, 1984; Stubs, Naeser and Black, 1987.

Significant difference between the reaction times of right and left ear and the shorter reaction time in the right ear of normals indicates a right ear advantage and a left hemisphere dominance. Absence of such significant difference (though shorter reaction times were found in the right ear) in stutterers indicates that stutterers, unlike normals may not have a clear ear advantage and thus a dominance. This also suggests a possible bilateral cerebral representation in stutterers. The results supports the theory of cerebral dominance (Orton and Travis, 1927, 1931) and absence of laterality in stutterers. However, it appears that this may be individualistic and not all stutterers show a lack of ear advantage. This indicates a heterogeneity among stutterers and supports the notion that there may be subgroups among stutterers.

Second, stutterers as a population have longer reaction times for verbal tasks. This results is in consonance with that of other studies (Adams and Reis, 1971; Adams and Hayden, 1976; Starkweather, Hirschman and Tannenbaun 1976; Cross and Luper, 1978; Reich, Till and Goldsmith, 1981; Watson and Alfonso, 1982, 1983; Border, 1983; Starkweather, Franklin and Smigo, 1985; Peters and Hulstijn 1987; Peters and Hulstijn and Starkweather, 1989). This increased reaction time could be indicative of a motor programing deficit (Adams and Hayden, 1976; McFarlane and Prins, 1978, Cross and Luper, 1978; Zimmerman, 1980; Peters and Hulstijn, 1987; Peters and Hulstijn and Starkweather, 1989). This may be a higher level planning or encoding defect.

Increase in reaction times can be explained by several models. According to Sternberg's (1978) model, in the first stage, phonological encoding comprises the creation of a fully specified articulatory program which has three subpocesses; viz:

1) selection of segments for a word or words
2) sequencing these segments within syllable frames and
3) fixation of internal and temporal parameters for each syllable.

Sternberg (1978) proposed a model for speech motor control as follows:

Phase 1: The programming stage

The motor plan (phonetic plan (Levelt, 1989)) is assembled by phonological encoding. Each motor plan consists of smaller units or stress groups. The total motor plan can be stored in a articulatory buffer awaiting further processing.

Phase 2: The retrieval stage

From the articulatory buffer the motor plan is retrived unit by unit. The more units in the motor plan, the more time retrieval takes.

Phase 3: The unpacking stage

Each unit or subprogram is unpacked for its constituents, which are motor commands for the different phonological elements (syllables) within a unit. The more complex a unit, the more is the time needed for unpacking.

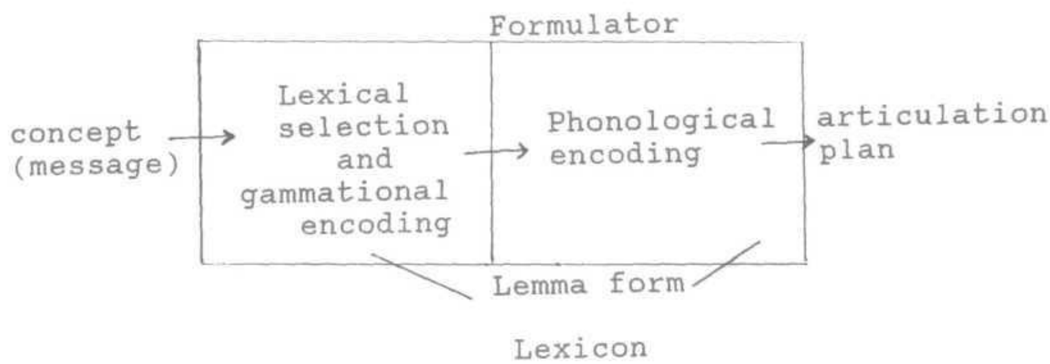
Phase 4: The command stage

Each individual motor command is delivered to the neuro-motor system and subsequently executed.

Speech motor programming with respect to stuttering has been investigated in detail by Peters, Hulstijn and Starkweather (1989). Their findings lends support to the assumption that stuttering may be associated with a deficit in speech motor programming.

Phonological encoding disruption has been cited as a possible cause of stuttering by Postma, Kolk and Povel, 1990, Feerand, Gilbert and Blood, 1991; Jancke, 1994; Wijnen and Boers, 1994. One could also speculate a lexical access problem involved as the task involved here is word association.

As lexical access could be defective and hence a major cause of stuttering, it is essential to understand the architectural organization of this process of lexical access.



Levelt (1989)

Fig:4 - Artitectural organisation of lexical access

There is a "formulator" receiving as input the (lexical) concept to be expressed and producing as output an articulatory plan for item usually as part of a plan for a larger utterance. The formulator contains two component processors. The first one takes care of selecting appropriate lexical item from the mental lexicon and of integrating it into developing syntactic structure. The second one generates an articulatory program for the selected lexical item on the basis of its stored phonological code and the developing context of the utterance as a whole.

Several theories have been proposed to explain lexical access. The most popular of these are the nodular two stage theories and the connectional theories which are explained below.

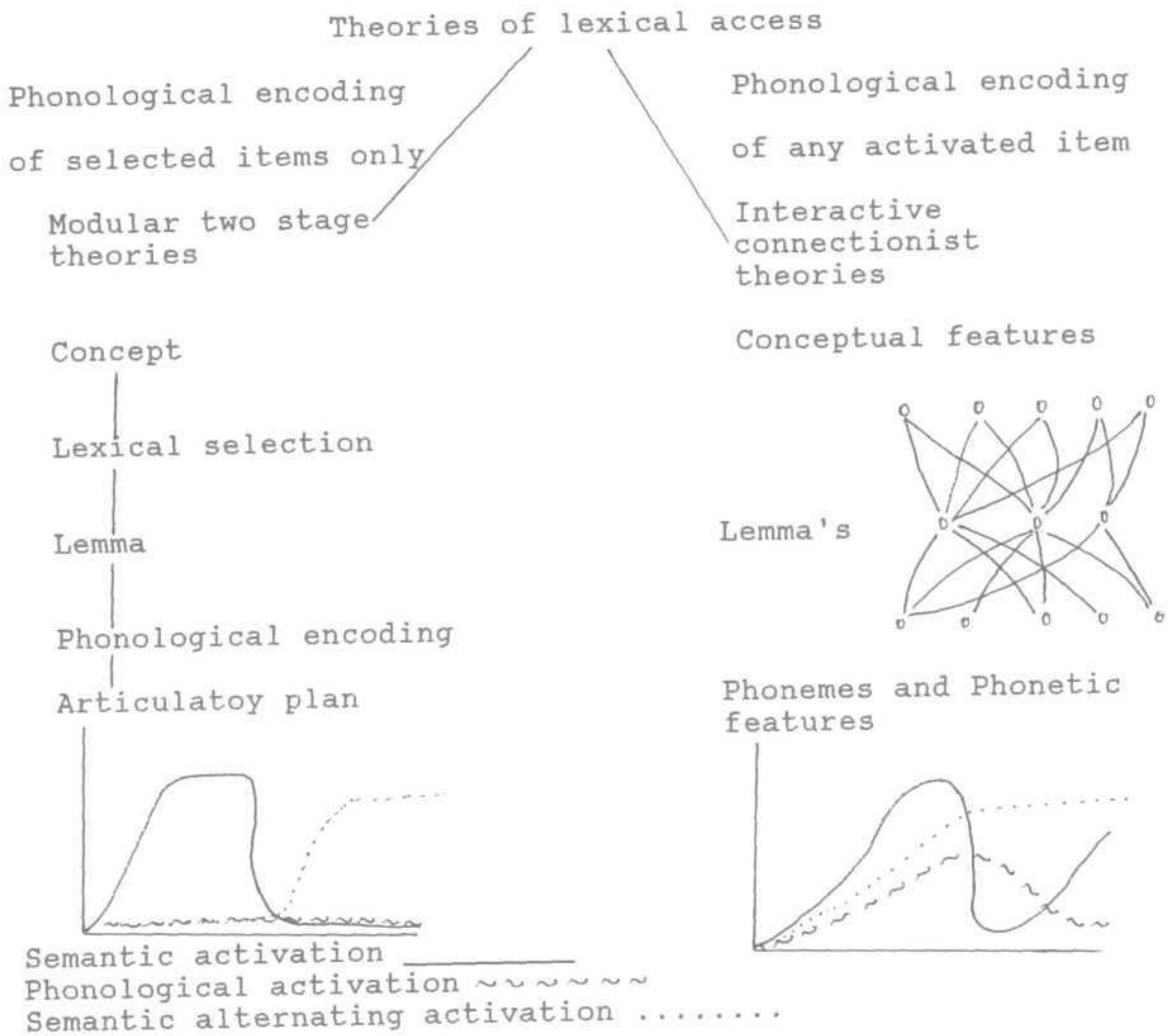


Fig. 5: Theories of Lexical Access

Both these models are general models not intended as an explanation of stuttering phenomena. Yet, they consider both incorrect as well as correct speech production. The studies by Kolk and Postma (1990) mentioned earlier can be considered as extension of these theories to explain the phenomena of stuttering.

Thus, this theory proposes that the lexical activation and phonological activation do not overlap and occur one after the other unlike the connectionist theories. A delay in reaction time in stutterers could be explained due to a delay in any one or both the stages.

The methodologies used for reaction time studies include simple reaction task which reveals high level on central programming or choice reaction task revealing low level programming deficit. The word association task used in this study is a simple reaction task and thus increased reaction time in stutterers could be a result of error of central planning.

Third, the results reveal significant differences between all linguistic categories in stutterers. In both stutterers and normals reaction times increased as linguistic complexity increased. This is in consonance with the results of the studies by Gordon, Luper, Peterson (1986); Freeman, Watson, Chapman, Miller, Pool and Devour (1991). However, this increase in stuttering population is significantly larger. This suggests that, though processing of linguistically complex material takes longer time, stutterers appear to have more difficulty than normals.

Fourth, no significant difference between normal and stutterers was found for the type of responses in the Word Association task. This result is in accordance with the study done by Crowe and Knoll (1991).

This indicates that the underlying linguistic disruption may be minimal in stutterers and the variation of stuttering episodes in speech could be due to extra linguistic factors such as conditioning, stress and other learned behaviour rather than an intrinsic linguistic disruption. However, further studies are warranted in this area.

Also, contrary to reports in literature (Nelson, 1977), both normals and stutterers in this study exhibited more syntagmatic responses than paradigmatic responses. This difference in response could possibly be attributed to the linguistic structure of Kannada. Further studies into the type of responses for a word association task is warranted.

To summarize, the results of the present study indicate a longer reaction time in stutterers, a possible bilateral cerebral representation, and a possible greater difficulty in stutterers in processing linguistically complex signal. These support the theory of cerebral dominance and the notion that stuttering could be a resultant of motor planing deficit. As the study revealed individual differences among stutterers it is suggested that further studies could be conducted considering specific subgroups of stutterers.

Chapter V

SUMMARY AND CONCLUSION

For decades now, researchers have been speculating on the causes for stuttering. Majority of the studies report increased reaction time for all tasks in stutterers. The cause of this has been attributed to reverse laterality or lack of cerebral dominance in stutterers. This study was designed to investigate the laterality in stutterers using reaction time in a Word Association task.

Eight stutterers and eight normals (six males and two females) formed the experimental and control group of this study. Stimulus material was prepared, which consisted of 40 nouns and 40 verbs which were chosen according to frequency of occurrence and abstractness in the language studied. These were presented to the subjects in a sound treated room with a total of 80 stimulus words being presented to each ear individually. The subjects were to respond verbally with any word which they could immediately associate with its stimulus word. The associated responses were audio recorded on CrO_2 tapes along with the stimulus word.

The responses were analysed for reaction time using DSP sonograph 5500. Reaction time was measured as the time difference between the offset of the stimulus word to the onset of the response word on the waveform. Linguistic analysis was also carried out to study the response category differences if any present in stutterers in comparison with normals.

Results revealed the following:

1) Significant differences were present in the reaciton time of the rignt and left ears in normals (longer reaction times in left ear) but not in stutterers indicating that stutterers lack cerebral dominance and the dominance is distributed equally in both hemisphere than to the left.

2) Stutterers have a longer reaction time for the task used in this study thereby indicating a possible motor programming defect or a central planning and encoding defect.

3) Stutterers have greater problem in processing linguistically complex stimuli when compared to normals.

4) Stutterers do not differ from normals in terms of response category in word association task indicating an intact underlying linguistic structure.

The results of this study throws light on the several variables that need to be controlled during a reaction time paradigm. It is evident that dichotic task is not a very favourable method for laterality assessment and more sophisticated methodology is required in conducting such studies.

In terms of rehabilitation, a programming error would shift the focus towards reduction in speech rate and prolongation of speech as this would reduce the information load and hence a breakdown. Relapse of stuttering commonly seen in most of the stutterers have been a source of puzzle for the researcher's and distress for the stutterers. An organic involvement would explain the occurrence of relapse more easily than if the cause is external. Hence while counselling stutterers these should be kept in mind to avoid over expectations and disappointments.

"If you root yourself in the ground, you can afford to be stupid. But if you move you must have mechanisms for moving and mechanism to ensure that the movement is not utterly arbitrary and independent of what is going on outside".

Particia Smith Churchland (1986).

It must be kept in mind where stutterers are concerned that the cause for the problem is beyond their control and hence proper understanding and an inquisitive mind is required to solve this puzzle.

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