PERFORMANCE OF STUTTERERS ON DICHOTIC CV TEST

Reg.No.M9818

Independent Project as a part fulfilment of first year M.Sc, (Speech and Hearing), submitted to the University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING

MYSORE 570 006

MAY 1999

कर्मण्येवाधिकारस्ते मा फलेषु कदाचन ।

मा कर्मफलहेतुर्भूर्मा ते संगोऽस्त्वकर्मणि ।।

Dedicated
to

Daddy,

Mummy
and

Piyoush

Some feelings remain unspoken as words are not enough to describe them

CERTIFICATE

This is to certify that this Independent Project entitled : **PERFORMANCE OF** STUTTERERS **ON DICHOTIC CV TEST** is the bonafide work in part fulfilment for the degree of Master of science (Speech and Hearing) of the student with Register **No.M9818.**

Mysore
May, 1999

Dr. (Miss) S. Nikam
Director
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Mysore 570 006.

CERTIFICATE

This is to certify that this Independent Project entitled : **PERFORMANCE OF STUTTERERS ON DICHOTIC** CV **TEST** has been prepared under my supervision and guidance.

Mysore
May, 1999

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DECLARATION

This Independent Project entitled : **PERFORMANCE OF STUTTERERS ON DICHOTIC CV TEST** is the result of my own study under the guidance of Dr.Asha Yathiraj, Reader in Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 1999

Reg. No.M9818

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You are so nice. Thanx Anita didi for everything.

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"Bhabi' your blessings are the most precious gift I have.

' SU' Saristha Unatti, Distance makes hearts grow fonder". Because of you all, I still believe in true friendship.

Krithika, Chandan, thank you for helping me in my analysis. You both make a lovely pair. All the best for your future.

Savitha -Thanx for helping me through data collection. You are a wonderful friend. Be the same.

Uma - I am glad that you are there.........

Gems and Pearls - wish you were here.

Archu, Smita - Happy ! at last yourname is there. It is difficult to find nice people like you, going to miss you and our samrat treats.

Vandana - All the best! for your future exams. Do well. Got it!

Chanchal - You are a real brain eater but still adorable.

Trend setters -I miss Us.

Prarthana, Hope your delusions of grandeur continue. Did you understand?

Katte (MR), you have all the symptoms to be put into this catgory. Thanx for being a good friend.

My sincere thanx to Rajalakshmi Akka, for giving shape to my project

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INTRODUCTION

Stuttering is a speech disorder which has been defined as involuntary hesitations, repetitions and prolongation of sounds (Bloodstein, 1993). According to Curlee (1993), it affects about 5% of the population and the incidence is highest during the pre-school years. For at least 20% of these children, stuttering would persist.

Various theories of stuttering have been put forward but different theorists have not arrived at a concensus regarding the cause of stuttering. These different views have lead to different assessment procedures and different remediation techniques. Researchers who believe in organic causation of stuttering use feedback techniques, whereas who think of psychological causation use techniques based on learning principles for remediation.

Theories of stuttering which deal with its causation, may be divided into three major groups:

Psychoanalytic theories - These stem from the Freudian theory of "psychosexual development". Under this we find "Repressed need hypothesis (Fenichel, 1945) which claims that stuttering block is a purposeful, goal directed act that performs a function of resolving conflicts of neurotic individual.

Learning Theories - According to these theories, stuttering behaviour can be grouped under classical and operant conditioning. These are thus based on stimulus response theories of learning that behavioural scientists have developed through several decades of experimentation. Under these are Sheehan's Approach Avoidance Theory (1953), Wishcner's instrumental avoidance theory (1950).

Both the above sets of theories, are considered as functional because there is no organic lesion.

Organic Theories : By the beginning of 1970, there was change in outlook on the nature of stuttering. Some speech pathologists were convinced that there are subtle organic influences which contribute to origin of stuttering. It suggests that stutterers exist, who exhibit some type of organic dysfunction or who have proclivity to such organicity.

The few theories under these are :

Genetic inheritance (Andrews and Harris, 1964; Johnson, et al. 1959).

Unusual latent tetany (Johnson et al. 1959).

Atypical performance on neurophysiological tests (Lindslay, 1940; Sayles, 1966).

Lack of cerebral dominance (Curry and Gregory, 1969).

Dysfunction of auditory processing and perceptual abilities (Hall and Jerger, 1978; Toscher and Rupp, 1978).

Theories of lack of cerebral dominance and dysfunction of auditory processing have received considerable attention under the organic origin of stuttering.

Intracarotid injection of Sodium Amytal, Wada Test (Jones, 1966).

Electroencephalographic techniques (Moore and Haynes, 1980).

Monitoring of cerebral blood flow (Wood et.al, 1980).

Dichotic listening (Curry and Gregory, 1969; Rosenfield and Goodglass, 1980).

Dichotic listening has been used extensively as it is a non-invasive technique. In the normal population, with speech stimuli, higher scores are obtained from the right than from the left ear resulting in a right ear advantage, Kimura, 1963; Berlin et al. 1973). A consistent left ear advantage (LEA) for non-verbal input has been reported (Curry and Gregory, 1969; Kimura, 1964). Kimura, 1964 attributed this Right ear advantage to specialisation of left hemisphere for speech and language processing.

A number of investigators have suggested bilateral or reversed representation of auditory and motor speech language areas in the brain for people having stuttering (Orton, 1928; Travis, 1931). Some say there might be a bilateral motor control and this creates dyssynergy of motor impulses to paired muscles involved in phonation and articulation (Moore and, Haynes, 1980). Many investigations have been taken up to find cerebral dominance theory dichotic listening tests in stutterers. Curry and Gregory (1969) showed smaller REA in stutterers. Strong etaL(1983) got the results which supported the lesser evidence of right ear advantage in stutterers. This was done using dichotic CV test.

Hall and Jerger (1978) and Toscher and Rupp (1978) used staggered spondiac words and synthetic sentence identification and demonstrated that stutterers presented evidence of central auditory deficiency within the brainstem. On the other hand Blood and Blood (1989) suggested that a subgroup of stutterers may present with some type of auditory processing deficits.

But some researchers have got contradictory results as well. Using dichotic tests, Dorman and Porter (1975); Quinn (1972) and Slorach and Noehr (1973) showed that stutterers don't show any difference in the results. Hawver (1978) used low pass filter speech test and showed that stutterers got similar results as shown by normals.

The present study was takenup to find the performance of stutterers on dichotic CV tests developed by Yathiraj (1994).

Need for the Study :

According to Hall and Jerger (1978) there is a subgroup of stutterers who exhibit auditory processing deficit due to a lesion in auditory pathway. This study aims at providing evidence to support the above hypothesis by finding performance of stutterers on a dichotic CV test.

The present study intends to find the effect of different lag times on the scores of dichotic CV in stutterers.

Apart from this present study is undertaken at finding the relation between severity of stuttering and the scores on dichotic CV test in stutterers.

According to Blood (1985), different kinds of stuttering (psychogenic or due to auditory processing deficits) may react differently to same kind of therapy approach. Thus dichotic C V testing will help us in differentiating the two groups and thus suggest appropriate therapeutic intervention procedures.

REVIEW OF LITERATURE

Stuttering has always been considered as a mystery and this is the fact whey there are different theories explaining the cause for stuttering. Bloodstein (1993) stated "It is impossible to believe all the authoritative theorists are observing the same phonomenon". Extensive research efforts have been undertaken to identify the underlying etiology or etiologies of stuttering. Much of this research can be categorised into organic and functional theories.

Among organic theories of stuttering are those which talk about auditory dysfunction in stutterers. The impetus for comparing auditory function of stutterers with non-stutterers has arisen from two major theories about etiology and possible site of lesion for stuttering behaviour.

Some researchers like Jerger and Hall, 1978 and Gregory, 1964 have used measures of auditory function to investigate cerebral dominance of language. This pertains to the theory proposed by Orton (1928) and Travis (1931) that stutterers donot develop complete dominance of left hemisphere for language and/or for control of the motor activity of the speech mechanism. Differences between stutterers and non-stutterers would suggest a possible site of lesion in the cortical area.

However, other researchers like Dietrich et al,(1995) have used measures of auditory function to investigate possible abnormality along the auditory pathway. This pertains to a hypothesis that stuttering is related to problems with auditory feedback during speech production. Since a majority of stutterers have normal hearing sensitivity, any problems with auditory feedback are more likely to be related to deficits in the central rather than the peripheral auditory system.

STUTTERING AND AUDITORY FEEDBACK

The notion that stuttering might be due to a defect in the auditory feedback mechanism subserving speech production has been investigated since years. Surveys by Harms and Malone (1939) and Backus (1938) noted a low prevelance of stuttering in schools for the deaf. Soonafter the delayed auditory feedback (DAF) paradigm was developed in early 1950s several investigators (Black, 1951; Adamczky, 1959) showed that while non-stutterers develop disfluencies under DAF, stutterers show fewer disfiuencies. Research finding strongly implicating the auditory feedback mechanism is the fact that stutterers show increased fluency when external noise masks their own speech (Dewar et al.1979).

Stuart et al.(1997) reported the effect of monoaural and binaural alternations in auditory feedback on stuttering frequency, in 11 participants. They read aloud under non-altered auditory feedback (NAF) and monoaural and binaural conditions of frequency altered feedback (FAF) and delayed auditory feedback (DAF, 50 msec, delay) at a normal speech rate. Relative to the NAF condition, reductions in stuttering frequency of approximately 60% - 75% were found with the altered auditory feedback conditions. These findings showed similar results as in previous studies by Kalinowski et al. (1993). They even correlated speech rate with delayed auditory feedback and showed that speech rate did not play a significant role.

Stark and Pierce (1970) investigated whether stutterers would produce deviate responses in a simple oral activity such as lip closure under delay used auditory feedback conditions. The delayed auditory feedback had the same effect among both the stutterers and non-stuttererrs. However, the normal, non-delayed, auditory feedback paradigm caused longer lip closures and other errors among stutterers. This finding shows that delayed auditory feedback even effects non-speech activities in stutterers.

The next main component of auditory feedback system is acoustic reflex.

Acoustic Reflex

One component of the total auditory monitoring system, the acoustic reflex, has come under particular scrutiny becauseof its intimate relation to vocalization. The stapedius muscle contracts during vocalization. Hall and Jerger (1978) compared the acoustic reflex to external sound in stutterers and controls. Reflex threshold was equivalent in the two groups, but reflex amplitude was smaller in the stuttering group.

Schilling and Biener (1959) found bilateral threshold differences in 26 out of 112 stutterers that they studied. They considered this as a diagnostic clue of organic central disturbance. Hannley and Dorman (1982), however failed to note any difference between the stutterers and non-stutterers. Shearer and Simmons (1965) investigated stapedius muscle activity in stutterers and non stutterers during on going speech. They observed that stapedius muscle activity tended to parallel vocalization in non-stutterers. In stutterers however parallellism was less consistent. At times, the onset of stapedius activity seemed to be delayed relative to the onset of vocalization. But the differences between groups were not striking.

Phase Disparity Between Air and Bone Conducted Tone

Another approach to the question of intrinsic abnormality in the stutterers auditory monitoring system is to study phase disparities between air and bone conducted tones. In 1957.Stromsta did a study in which stutterers and normal speakers listened to an air-conducted tone introduced to the ear and to a bone conducted tone until a critical adjustment was achieved at which no sound was audible to them.

There was a significant difference between stutterers and non-stutterers in the relative phase angle of air and bone conducted sound at 2000 Hz. Using a similar method, Stromsta (1972) noted an unusual phase disparity between stutterers left and right ears. The stutterers adjusted the amplitude and phase of the two air conducted tones, heard at either ear, until they cancelled an identical bone-conducted tone. At the point at which cancellation was achieved, the air-conducted tones of the two ears had a phase disparity at several frequencies that was twice as wide for the stutterers as for the non-stutterers.

Gregory (1964) in a study of neurophysiological integrity of auditory feedback system in stutterers, found no difference between them and normal speakers on binaural in phase and out of phase median plane localisation tests at different intensities and frequencies. This findings of this study thus contradicts the findings of above study.

CENTRAL AUDITORY DYSFUNCTION

A number of investigators have attempted to explore the question whether defects in auditory feedback mechanism of stutterers may be only part of a more comprehensive disorder of function in their central auditory perceptual mechanism. This was done using both conventional clinical audiometric measures and testing techniques developed specifically to assess central auditory disorder.

In 1959, Rousey et al. observed that stuttering children perform less than non stuttering children in localizing sounds in space. Gregory (1964), further pursuing audiometric studies, contended that there was no significant difference between adult stutterers and non-stutterers in tests of sound localization, binaural loudness balance and understanding of speech distorted by frequency filtering, Kamiyama (1964) and Asp (1968) supported Gregory's findings.

Jerger and Hall (1978) assessed the central auditory function in ten stutterers and ten non-stutterers for seven auditory procedures. These were acoustic reflex threshold, acoustic reflex amplitude function, PI/PB for monosyllabic words, performance intensity function for synthetic sentence identification, synthetic sentence identification with ipsilateral competing message (SSI-ICM), synthetic sentence identification with contralateral competing message (SSI-CCM) and Staggered spondee words. This finding suggests that stutterers scores were depressed on acoustic reflex threshold, synthetic sentence with ipsilateral competing message, and staggered spondee "words. Stutterers evidence central auditory processing deficit and pattern of deficit suggest a disorder at the brainstem level. Toscher and Rupp (1978) found that stutterers and fluent speakers perform in similar manner on SSI-CCM. But they found a difference in performance of stutterers and non-stutterers on SSI-ICM. Their findings were critisized due to the fact that they used non-standard competing message for their tests. Further there was no simultaneous analysis of acoustic reflex or auditory brainstem evoked response.

Liebetrau and Daly (1981) undertook an investigation to determine the significant differences in auditory processing and perceptual abilities between three groups of stutterers. These consisted of school age male subjects who were (i) six organic stutterers (exhibited two-three or more neurophysiological signs), *(ii)* six functional stutterers (iii) six fluent speakers. Dichotic listening and masking level difference tasks were administered to them. It was seen that organic stutterers performed significantly poorer on masking level difference and functional stutterers performed more like controls (fluent speakers). This finding intends to state that stutterers are a quite heterogenous group.

Wynne and Boehmler (1982) tested central auditory function in fluent and disfluent normal speakers (normal non-fluent)

SSI-ICM at 20 dB message to competition ratio was used with male college students. All subjects had intact peripheral hearing and had no know history of stuttering. Disfluent population had part word repetitions. Even disfluent normal speakers had lower scores on SSI-ICM. Apart from such results which provide an evidence of brainstem level disorder in stutterers, there are also other research findings which are contradictory in nature.

Hawver (1978) failed to find any difference between stutterers and non-stutterers on low-pass filter speech test. Hannley and Dorman (1982) tested twenty individuals with SSI materials who had completed fluency training program at the Hollins communication research institute. Their stutterers fell near the mean of normal performance. However one could easily argue that the stutterers whom they tested had completed fluency training and thus possibly behaved like normal speakers. It is not known whether fluency training programs alter the manner in which competing messages are processes at the brainstem level.

Hageman and Greene (1989) investigated auditory processing in ten adult stutterers and ten non-stuttering adults using a competing message task derived from revised token test (RTT) and the RTT itself. Quantitative and qualitative (pattern analysis) measures of each group's performance were examined across and within listening conditions. Stutterers were found to perform significantly poorer than non-stutterers on competing message tasks, but qualitative performance did not differ across groups. The scores obtained by stutterers fell on the lower side of the normal range of scores.

According to the above authors, the breakdown in efficiency could occur at level of brainstem or reticular activating system (RAS) and may involve attention allocation. Kramer et al. (1987) also obained similar results as Hageman and Greene (1989). They tested 10 stutterers and non-stutterers for MLD and evaluated them on SSI-ICM under message competition ratio of 0, -10, -20 dBs. No significant difference on SSI-ICM task was seen between groups but stutterers performed significantly poorer on MLD than non-stutterers. These results show that stutterers process auditory verbal information less efficiently but non-differently than non-stutterers.

Brainstem Evoked Responses in Stutterers

Brainstem evoked responses have also been evaluated on stutterers by several experts. Newman et al. (1985) recorded brainstem evoked responses of right and left ears of active stutterers, recovered stutterers and non-stutterers. Both male and female adults served as the subjects the brainstem evoked responses were obtained at click rates of 11.1 and 71.1 clicks/sec. The latencies of waves I, HI and V were measured. The auditory systems of subjects were stressed using a rapid rate of 71.1 clicks/sec. The latency of wave V was used as the measure of the stress condition. Stutterers did not differ significantly from non stuttereers. Recovered stutterers did not differ significantly from active stutterers and difference between ears was not significant. The one main effect that was significant was sex. Females had significantly faster rates of neural transmission than do males which may be an evidence supporting larger incidence of stuttering in males.

In order to find intactness of brainstem auditory pathway, Stager (1990) carried out a study on ten male stutterers and ten male non stuttereres. All the subjects had normal hearing sensitivity. He used the following measures to evaluate the intactness of auditory brainstem (1) Interpeak latency between wave I and Wave V (ii) Amplitude ratio greater than 1 between wave V, wave I (iii) Latency shift in wave V between low and high stimulation rates. The mean of stutterers did not differ from non-stutterers. Half the stutterers demonstrated latencies greater than two standard deviations from non-stutterers means on at least one measure. This reveals that stutterers might have deficit at brainstem level.

In any event, there is some evidence that stutterers may show a performance deficit on tests designed to assess central auditory function at the brainstem level. But an important consideration is that abnormalities in central auditory function may produce deleterious effects on speech production only during the dynamic process of ongoing speech. Such abnormalities may not be detected when the subject is merely engaged in passive listening. Abnormality may be maximally manifest only by dynamic measurement during speech production (Hall and Jerger, 1978).

STUTTERERS AND CEREBRAL DOMINANCE

The most significant contribution to relation between stuttering and cerebral dominance has been from Orton (1928) and Travis (1931) who proposed Orton- Travis thesis. The nerve impulses which activate the body's voluntary muscles come from the two halves of cerebrum, the left cerebral hemisphere controlling the muscles on right and vice-versa, Orton (1928) and Travis (1931) reasoned that a mechanism had to exist for synchronizing the nerve impulses from two halves of the brain. Otherwise the nerve impulses from would arrive at two halves of speech organs at two different times, interfering with their smooth functioning. No difficulty would be apparent in gross movements of these structures but rapid precise coordination of speech would tend to breakdown. Synchronization came about because one half of the brain was normally dominated over the other. In other words, the dominant hemisphere determined the precise moment when both hemispheres would fire their impulses to right and left sides of speech mechanism.

Stutterers differed from normal population only in lack of a safe margin of dominance of one hemisphere over the other. So the result is a conflict between the hemisphere, inadequate synchronization of nerve impulses to the paired speech muscles and a predisposition to stuttering. Many children go through a state of disfluency because language has not yet lateralised to the appropriate hemisphere. As the child grows older, this process becomes complete and disfluency disappears. However a subgroup retain their abnormal bilateral representation and continue to stutter.

Another hypothesis was given to support deviant cerebral dominance in stutterers, called as the segmentation dyfunction hypothesis. This hypothesis discussed dysfluency as a result of stutterers being more reliant on right hemispheric processing or use of non-segmental (time dependant) processing strategies for both the perception and motor programming of language. The investigations done to confirm these hypotheses can be broadly divided into non-auditory and auditory.

NON-AUDITORY INVESTIGATIONS TO DETERMINE CEREBRAL DOMINANCE

Handedness as a Study of Laterality

As a result of Orton (1928) and Travis (1931) thesis, many investigators addressed the prevalence of right and left-handedness among stutterers, contending that if stuttering were a disorder due to abnormal cerebral laterality, such an abnormality should be reflected in a different matrix of handedness between stutterers and non-stutterers. Bryngelson (1935) interviewed 700 stutterers. He found that stutterers are most likely to be ambidextrous (4:12 times, more in stutterers) and to have had their handedness shifted. There have been studies giving contradictory results (Johnson and Duke, 1975; Johnson and King, 1942), where they did not find any significant difference in handedness by fluent and non-fluent speakers. Due to varying definitions of handedness, and varying methods of ascertaining the presence/absence of stuttering in populations, investigators derived conflicting data and arrived at disparate results.

Electromyographic Studies

Travis (1931) hypothesized that stuttering results from the asynchromies in the arrival of nerve impulses in bilaterally paired jaw muscles. In 1934 Travis presented electromyographic (EMG) data recorded from the left and right masseter muscles of twenty four adult stutterers and non-stutterers. He reported that stuttering subjects were strikingly similar. Another EMG investigation (Steer, 1937) support Travis's findings. It was believed that competition between the cerebral hemispheres during motor speech behaviour resulted in out of phase arrival of action potentials that disrupted speech.

In a study by Steer (1937) neural response timing was compared for twelve adult stutterers and twelve matched normal speakers on to verbal tasks and one non-verbal task (lip closure) in response to visual and auditory stimuli. Auditory stimuli was presented to left and right ears, visual stimuli was presented to both eyes. The time between presentation of the stimuli and the EMG activity from orbicularis oris superior muscle was recorded. Significant difference in auditory mode was found between neural response timing of stutterers and non-stutterers. Stutterers had slower neural response time.

McFarland and Moore (1982), using a double reversal single subject experimental biofeedback design demonstrated reduction of laryngeal electromyographic (EMG) activity with a corresponding decrease in disfluency. Hand and Haynes (1983) found vocal and manual reaction times to real words. 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.

One of important investigations that contributed to a re-thinking of role of cerebral dominance in stuttering was by Williams in 1955. He failed to find significant differences in bilateral amplitude or timing of action potentials between the two sides of the jaw. Differences that were found were attributed to the excessive muscular tension and different patterns of jaw movements accompanying stuttering. Thus EMG differences were viewed as a consequence of stuttering rather than its cause.

Monitoring of Cerebral Blood Flow

An investigation to study cortical blood flow with stutterers was conducted by Wood et al. (1980). Using a non-invasive technique as described by Stump and Williams (1980) two stutterers were subjected to cerebral blood flow measurements while reading aloud. During one condition they read aloud while under influence of halopacidal, which resulted in improved fluency. Both the stutterers showed higher Broca's area flow in the right compared to the left hemisphere, during stuttering. Both showed higher Wernicke's area flow in left compared to right hemisphere, however during stuttering. During reading aloud without now showing a left hemisphere advantage. This result suggests that stutterers exhibit conventional left cerebral dominance for speech reception, but inadequate left cerebral dominance for speech production.

Alpha Recording

Pinsky and McAdam (1980) tested five adult stutterers and five fluent speakers with dichotic CV. Alpha recording over both hemispheres during performances of cognitive tasks, contingent negative variation with either an articulatory or bilaterally symmetrical response and readiness potential with the same responses. All subjects showed consistent patterns of cerebral laterality indicative of localization of speech functions in left hemisphere.

It has been shown that there is increased suppression of alpha brain wave frequency (8-13 Hz) over the hemisphere primarily processing specific kind of information under specific task condition. One advantage of this procedure is that it can be used to study hemispheric processing over time using a variety of stimuli, including more natural units of language (phrases, sentences, connected discourse). So this method has been used extensively to verify cerebral dominance.

An early investigation suggesting lack of cerebral dominance was reported by Douglass (1943) and replicated by Knott and Tjossen (1943). They found that stutterers as a group have alpha recordings present less frequently in their right occipital areas compared to their left occipital areas during silence, while non-stutterers evidenced just the opposite.

Moore and Haynes (1980) compared the alpha hemispheric asymmetries of normal speaking males and females with that of male and female adult stutterers. Stutterers showed significantly less alpha in their right hemisphere for both verbal and non-verbal tasks. These findings support a segmentation dysfunction hypothesis. Moore et al. (1982) showed stuttering males demonstrated right hemispheric alpha suppression across stimulus words and tasks as contrasted with left hemispheric alpha suppression for non-stuttering males and females. Male stutterers also recognized fewer words than non-stuttering subjects across arousal categories.

Similar findings are also shown by other investigators Moore and Lang, 1977; Moore and Lorendo, 1980 . These findings may reflect the right hemisphere's shorter span for verhal short-term memory. Boberg et al. (1983) gathered hemispheric alpha asymmetry data from anterior and posterior brain sites before and after treatment Prior to treatment, stutterers showed less alpha over the right posterior frontal region for verbal tasks, while after treatment there was less alpha over the left posterior frontal region. It suggests that there is decreased inhibitory control of right hemisphere at posterior frontal region by left hemisphere during speech in stutterers.

Moore and Haynes (1980) found that comprehension of connected verbal discourse was unaffected in males stutterers who demonstrated reduced alpha recordings in the right hemisphere. A finding which could also reflect the right hemisphere's superiority in processing semantic aspects in language. After analyzing the alpha hemispheric asymmetries of male stutterers, Moore and Haynes (1980) stated "stuttering may emerge when both hemispheric programming of segmental linguistic units is in the right hemisphere. These processing differences may be related to an inability, under certain circumstances, to handle the segmentation aspect of language. This may suggest the importance of linguistic segmentation as it relates to motor programming in some stutterers".

McFarland and Moore (1982) recorded alpha hemispheric asymmetries in before and after treatment sessions. Results revealed right hemispheric alpha suppression during baseline (relatively high frequency of stuttering) with a gradual and consistent suppression of left hemispheric alpha as fluency increased. The results show that following treatment that increases fluency, stutterers apparently show a shift to more segmental, left hemispheric processing strategies as seen influent speakers. Pinsky and McAdam (1980), when treating their data as categorical did not support the contention that hemispheric alpha assymetry pattern differs between stutterers and non stutterers. This finding is in contradiction to findings of above study.

CT Scan and PET Scan

Strub and Black (1987) tested two siblings with stuttering for speech, language evaluation, neurological and neuropsychological examinations, dichotic listening, auditory evoke responses, electroencephalography and CT scan asymmetry measurements. The data showed anomalous cerebral dominance on variables investigated. CT scan showed atypical asymmetries especially in occipital regions.

Fox et al. (1996) used PET Scan and showed that stuttering induced widespread over activations of the motor system in both cerebrum and cerebellum, with right cerebral dominance. Stuttered reading lacked left lateralised activations of the auditory system which are thought to support the self monitoring of speech selectively deactivated on frontal temporal system implicate in speech production.

This implicates that stuttering is a disorder affecting the multiple neural systems used for speaking.

WU et al. (1997) using PET scan showed that stutterers showed significantly higher 6FDOPA uptake than normal controls in medial prefrontal cortex, deep orbital cortex, insular cortex, extended amygdala, auditory cortex and caudatetail. Elevated 6FDOPA uptake in ventral limbic cortical and subcortical regions is compatible with the hypothesis that stuttering is associated with an overactive presynaptic dopamine system in brain regions that modulated verbalization.

The above data suggest that disfluent verbal behaviour may result from hemispheric processing differences. These processing differences may be related to an inability, under certain circumstances to handle the segmentation aspects of language.

AUDITORY INVESTIGATIONS TO DETERMINE CEREBRAL DOMINANCE

Auditory tests have played important roles in stuttering research, as a sensitive measure of cerebral dominance for language. These fall into two categories: Auditory evoke potentials and dichotic listening.

Auditory Evoke Potentials

When processing verbal stimuli stutterers appear to show more variable interhemispheric relationship. So auditory evoke potentials are used as a measure of auditory activity. This is a non-invasive technique and gives precise data Averaged auditory evoked responses have been used by Ponsford et al. (1975) to investigate hemispheric differences between stutterers and non-stutterers. Potentials were evoked with meaningful words embedded in phrases. Results indicated that in normals the responses were most different in the left hemisphere. Stutterers showed a reversal in this trend with greater differences in right hemisphere and greater variance among subjects.

Dietrich et al. (1995) recorded mid-latency responses from ten males who stutter and ten controls using a variety of filter passbands in response to clicks presented binaurally at various rates. The latency of Pb wave was found to be significantly shorter in group of subjects who stutter. This suggest a lesion within thalamic portion of the reticular system where Pb wave was generated.

Zimmerman and Knott (1974) used the contingent negative variation (CNV) to investigate hemispheric differences in stutterers and non-stutterers. Two control conditions with non-verbal stimuli (tones) requiring a non-verbal responses were compared with two experimental conditions in which meaningful linguistic stimuli (words) were used. In one experimental condition subjects indicated whether or not they thought they would stutter on the word presented by pushing keys marked 'yes' or 'no'. In the second experimental condition, subjects were instructed to speak each word upon signal. Results revealed differences between groups for frontal electrodes placed over Brocas area on left and its contralateral homologue on the right. They thus showed interhemispheric variability and consistently larger shift in left hemisphere than in right.

There are studies where contradictory results have also been obtained. Pinsky and McAdam (1980) used CNV to get average evoked responses. In their study non-linguistic stimuli were used (1 KHz tone) under two response conditions. One condition required subject to press the button with each thumb simultaneously when a tone stopped. For the second condition subjects uttered the same fluent word each trial at the termination of the tone. They concluded that their results provided insufficient evidence to support hemispheric asymmetries between stutterers and non-stutterers with their CNV method.

Ferrand et al. (1991) did simultaneous measurments of P300 brain potentials, laryngeal positioning movements prior to vocal fold closure and onset of vocal fold vibration in ten stutterers and ten non-stutterers. No significant differences were found in vocal motor or P300 responses. The two groups appeared to be using a similar patterning.

Though most of the studies do report a difference in the auditory evoked responses between stutterers and non stutterers, a few contradict this finding. Differences in behavioural tasks between studies may well account for the disparity conclusions reached. For example, saying fluent words may activate different processing strategies in stutterers than saying disfluent words. Thus the task itself may be a variable.

Dichotic Listening

In dichotic listening paradigm different sounds are presented simultaneously to the two ears. The listener must report everything that he hears, from both ears. Since the sounds are simultaneous, it is presumed that the listener must alternate attention between the two ears, placing one percept in short-term memory while attending to the other, and the vice versa. When normals were tested in the dichotic paradigm, there is a slight advantage for certain sounds delivered to right ear and for other sounds delivered to left ear. Kimura (1963, 1964) was the first to demonstrate that verbal signals such as words or digits are more accurately reported from the right ear (i.e. left hemisphere than from the left ear (i.e. right hemisphere) after simultaneous dichotic presentation. The reverse is true for melodies (Kimura, 1964).

The fact that dichotic paradigm demonstrates an asymmetry for verbal materials in favour of the hemisphere ordinarily dominant for language suggested, at least to some investigators, that dichotic listening tests might provide a relatively simple test of Orton-Travis thesis (1928, 1931). If stutterers are, indeed, lacking in suitable hemispheric dominance for language, this fact should be readily revealed by a proper dichotic test.

One of the earliest investigations in dichotic listening was by Curry and Gregory in 1969. They tested twenty adult stutterers (nineteen males, one female) and twenty appropriate controls. All were stated to be right handed. The authors employed several dichotic tasks, one of which was dichotic word test. This test involved the recognition of pairs of highly familiar consonant-vowel consonants (CVC) words presented in groups of six pairs with 0.5 sec separating each pair. After each group of six word pairs had been presented, the subjects attempted to recall the twelve different words, in any order, and without specifying the particular ear. 75% of non-stutterers had right ear scores that were higher than their left ear. This was true for only 45% of the stutterers. The mean of absolute difference between two ears in non-stutterers was twice as greater as that seen in stutterers.

Sussman and McNeilage (1975) employed a dichotic paradigm and a persuit auditory tracking paradigm. Their experiment involved matching the frequency of a variable tone in one ear to the frequency of an externally varied tone in the other ear. The authors tested right handed male and female stutterers and non-stutterers for laterality pertaining to speech perception (dichotic listening) and speech production (tracking paradigm). They noted a right- ear advantage for both non-stutterers and stutterers on the dichotic studies. Thus, the stutterers did not differ from non-stutterers in laterality on the speech perception task. Results indicated a left hemisphere "dominant" for non-verbal output The stutterers failed to demonstrate such laterality for non-verbal output.

Tsunoda and Moriyama (1972) performed the Tsunoda's cerebral dominance test and standard audiometry on fifty seven adult Japanese stutterers. 79.3% of normal controls, showed a preference for vowels in the right ear and a preference for non-verbal sounds in the left ear but this pattern existed only for 39.6% of stutterers. Among 29.6% showed dominance of vowel sounds in left ear and of non-verbal sounds in right ear (opposite to normals). This finding suggested that among stutterers there is a subgroup in whom stuttering may be due to abnormal cortical function resulting from minimal brain damage. No information was provided about the subject's handedness and age.

Blood and Blood (1989) compared eighteen male and eighteen female stutterers of age range 18-36 years, and right handed with a matched control group. All the subjects were right handed. Subjects had to respond to a thirty six item dichotic word (meaningful) test using a gestural, double response paradigm. Results revealed a significant difference between stuttering and controls in the magnitude of ear preference. No significant difference between male and female stutterers was found, in a recent study by Dietrich (1997) on eleven stutterers on the measures of dichotic sentence identification, they were found to have significant difference between the ears.

Strong and Frick (1983) administered dichotic CV listening task to ninety right handed boys, in age group of five years, seven years, nine years. Half of the subjects in each group were stutterers and half non-stutterers. Two and a half times, as many stutterers as non-stutterers were found to display either left ear advantage or no ear advantage.

Blood (1985) investigated seventy six stutterers and seventy six non-stutterers of age range seven to fifteen years using dichotically presented synthetic syllables. Results revealed that although the direction of ear preferences was the same for stutterers and non-stutterers the magnitude of ear preferences scores for the two groups were significantly different. 55% of the stutterers showed right ear preference. Three types of stutterers surfaced as a result of dichotic ear preference scores : Right ear preference; no ear preference and left ear preference. The subjects having right ear preference formed the largest group followed by the ambilateral group and those with the left ear preference formed the smallest group. The study suggested that stutterers as a group are extremely heterogenous and suggest that data analysis may also lead to contradictory results. According to them reporting mean data for stutterers in dichotic listening paradigms is in appropriate without subgroup or individual data analysis. .

Though a number of studies provide evidences for cerebral processing asymmetry in stutterers, there are other studies that contradict these findings. Quinn (1972) investigated dichotic listening in stutterers using a method similar to that of Curry and Gregory (1969). Quinn examined sixty right handed stutterers (fiftythree males, seven females) and matched controls. He detected no reliable difference between the two groups. He observed that twelve stutterers had left ear scores that were higher than right ear scores; only two non-stutterers had this reversal. Dorman and Porter (1975) also reported similar findings. They evaluated sixteen right handed adult stutterers (twelve males and four females) and compared them to twenty controls (ten males, ten females). The subjects had to write down the responses to synthetically generated consonant vowel dichotic stimuli. There was no significant difference between stutterers and non-stutterers.

Manning and Riensche (1976) tested auditory assembly abilities of thirty stuttering and thirty non-stuttering first to fourth grade children matched for age, grade level, sex and misarticulations. They were presented with meaningful and non-meaningful CVC syllables with four silent interphonemic intervals (100, 200, 300 and 400 msec). There was no significant overall difference between the performance of the two groups.

Pinsky and McAdam (1980) tested five adult stutterers and five fluent speakers in a dichotic listening paradigm. All individuals were right handed except one, who had stated to be "weakly right handed". The degree of right handedness was not commented upon. The authors failed to find a significant difference between stutterers and the non-stutterers.

Slorach and Noehr (1973) examined fifteen stutterers, aged six to nine years. They presented dichotic digit pairs and tested not only the free recall of digits but also the performance on instructed order or report from particular ears. The stutterers scores were similar to those of controls. Gruber and Powell (1974) tested twenty eight right handed fluent and dysfluent children using dichotic digit pairs. They failed to find significant interear differences for either stutterers or controls free recall reports. At this point, one should note that since 4% of children stutterer, whereas only 1% of adults stutterer, the mechanism or type of stuttering among children might be different from that among adults.

FACTORS AFFECTING RESULTS ON DICHOTIC TESTS

The studies on dichotic tests show a vast amount of contradictory findings. There are a variety amount of factors which contribute to these findings. In evaluating this research, it is well to bear in mind that dichotic listening results are influenced by an array of contaminating variables. It is important, to ascertain handedness of the subjects. Stating that subjects are right or left handed is not as meaningful as the administration of a detailed handed questionnaire (Oldfield, 1971).

The order in which subjects are instructed to report sounds is the another variable (i.e. right ear first, left ear first, or either ear first). Most investigators who have controlled this variable have noted that there is a greater index of cerebral laterality when subjects are instructed to report first from the left ear and then from the right ear. When a sound is reported second, it must be held in short-term memory. Perhaps the signal from right ear/left hemisphere survives short-term storage better than that of left ear. It is important to direct the subject to report a particular ear first as free report might yield biased results (Bryden, 1967; Goodglass and Peck, 1972).

Another variable is the stability of dichotic ear advantage over time. Blumstein et al. (1975) reported that as many as 30% may change ear dominance when retested. Thus consistency between test and retest is an important dimension in studies of cerebral laterality. The stimuli used also effects the results. Moore (1976) pointed out that stutterers seem to differ from non-stutterers when investigators employ meaningful verbal stimuli like words or digits rather than meaningless CV or other stimuli. Stutterers show better scores with meaningful stimuli.

The dichotic listening paradigms test evaluates cerebral laterality in the steady state. They do not evaluate laterality in dynamic state of speech production. This may be very important in investigation of stuttering. The abnormality of stuttering may not be static, that is, it may only appear during speech or perhaps only at certain times in speech production (Hall and Jerger, 1978).

There are contradictory findings in literature. These findings have been interpreted as providing evidence that stutterers may be inefficient at task employed.

It is possible that although we may be gaining information about the way stimuli are being processed in dominant hemisphere, we may also be examining the manner in which our subjects are reacting to the tasks and storing information and their overall processing abilities (Blood and Blood 1989).

The severity of stuttering, the attentional bias and method of scoring, type of stimuli may alter dichotic listening responses in stutterers (Blood, et al. 1986). Some studies employed only males and some both males and females. It is possible that because the incidence of stuttering is so different, females may process differently from their male counter parts. Females were reported to have significantly faster rates of neural transmission than do males which could be related to difference in incidence of stuttering (Newman et al. 1985). Blood and Blood (1989) reported that there was no significant difference between male and female stutterers in magnitude of ear preference ona dichotic task. McGlone (1980) in her review concluded that men may have less pronounced laterlisation than women. Some contradictory findings can be attributed to this. Apart from this dichotic ear preferences should be related to variables such as onset of stuttering, stuttering severity, stuttering frequency results in therapy and spontaneous remission (Blood, 1985).

Above studies reveal that evaluation of stutterers on dichotic tasks may lead to a variety of results. Most of the above studies reveal that stutterers show significantly reduced scores on such tasks. But there are several others indicating stutterers to show similar performance as nonstutterers. All these differences in results, from different investigations, may be due to variety of factors like sex, age, severity of stuttering, attention level or even statistical techniques used. So to evaluate any of these studies, one should keep all above factors in mind.

METHODOLOGY

SUBJECTS

Subjects were twenty young adult male stutterers within the age group of seventeen to thirty years. There were five mild, nine moderate and six severe grade stutterers as determined by stuttering severity index.

The criteria for subject selection were as follows :

1) No history or complaint of hearing loss.
2) No report of chronic otologic problems or neurological problems.
3) Subjects were right handed.
4) Subjects should have had no previous experience with dichotic listening.
5) Subjects should have had basic education and could at least identify consonants either in Kannada/English.

To ensure normal peripheral auditory function, the subjects had to have fulfill the following criteria:

1) Have 15 dB HL or better pure tone air conduction and bone conduction thresholds for the frequencies 250 Hz -8 kHz and 250 Hz to 4 kHz respectively.

2) Have speech reception thresholds (SRT) within ±10 dB of average thresholds at three frequencies (500 Hz, 1 kHz, 2 kHz).

SRT was established using W-22 word list in English developed by Hirsh et al (1952) or Kannada version developed by Rajshekhar, (1976), depending on the language to which the subject was familiar.

3) Have speech identification scores of 90% or more at 40 dB SPL (SRT). The material developed and standardised by Mayadevi (1974) was used.

4) On monotic presentation of CVs used in present study they should have scored at least 90% correct scores in the each ear separately.

DICHOTIC MATERIAL USED : Dichotic material consisted of thirty randomised pairs of stop-consonant vowel (CV's) /pa/, /ba/, /ta/, /ka/, /da/, /ga/ in which each of the initial consonant appeared in all possible combinations. The dichotic CV test developed by Yathiraj (1994) at CID St.Louis was used. The CV's were generated simultaneously or with a particular lag time as in the manner described below:

1) ***At 0 msecs, onset*****:** Both the ears were presented with stimulus simultaneously.

2) ***With a 30 msecs left ear lag*** : Here the syllable in left ear was presented after a lag period of 30 msecs when compared to the right ear.

3) ***With a 30 msecs right ear lag :*** Here the syllable in right ear was presented after a lag period of 30 msecs compared to the left ear.

4) ***With a 90 msecs left ear lag*** : In this condition, the syllable in left ear was presented after a lag of 90 msecs. in relation to the right ear.

5) ***With a 90 msecs. right ear lag :*** Here the syllable in right ear was presented after a lag onset of 90 msecs as compared with left ear.

Prior to each list, a 1 KHz calibration tone was recorded.

INSTRUMENTATION :

The audiological testing was carried out on a clinical audiometer (Madsen OB 822) coupled to acoustically matched earphones (TDH-39) MX-41AR ear cushion and bone vibrator (radio ear B-71).

For the dichotic CV test, the audio cassette consisting of dichotic stimuli, was played on a tape recorder (Phillips 160 W). The signal from the tape recorder was fed to tape input of the audiometer. The audiometer Madsen OB 822 was calibrated regularly to conform ANSI, 1992 (Appendix-A).

PROCEDURE FOR SUBJECT SELECTION

All the subjects underwent the audiological testing i.e.pure tone audiometry and speech audiometry. This included air conduction testing, bone conducting testing, speech reception thresholds, speech identification testing. If they passed the selection criteria then they were presented with monotic presentation of the test material. Subjects were selected only if they got 90% scores in the rnonotic presentations.

- <u>Procedure to carryout dichotic CV</u> :

Subjects were then presented dichotic CV test through earphones. The VU meter was adjusted to the 1 kHz calibration tone. The dichotic stimuli was presented at 70 dB HL. The score sheets were provided in Engish or Kannada depending on which language subjects were familiar with [Appendix B (a);(b)j.

INSTRUCTION

The subjects were instructed to circle the two CV's heard (from six forced choice alternatives) after each presentation. They were also told to guess if they were ^Appendix-B (a),(b)J unsure of the correct answers. Subject responses were scored.

SCORING OF RESPONSES

Subject responses were scored in terms of single correct scores (total number of correct responses individually for right or left ear). The double correct responses were also scored (i.e. when subject correctly reported both the stimuli presented to two ears).

The raw data was subjected to statistical analysis. Where mean, range and standard deviation were calculated. Mann-Whitney U test (Kanji, 1993) was done to find out if there was any significant difference between these results and those obtained for normal population (Lakshmi, 1996). Same test was used to compare results obtained between mild, moderate and severe stutterers and dichotic CV test. This was done to note whether severity of stuttering affected the test results.

PSYCHOLOGICAL TESTING

Subjects underwent a psychological evaluation. This consisted of case history taking, clinical interview and administration of EPI (Eysenck and Eysenck, 1974) by a qualified psychologist. This was done to ensure normal psychological functioning.

RESULTS AND DISCUSSION

The data obtained from stutterers on dichotic CV test was analysed and the results are discussed. Analysis was done to reveal information on :

I Comparison of right vs. left ear.

A) At a particular Lag Times

a) Among the stutterers

b) Stutterers vs Normals

B) Across the Lag Times

a) Among the stutterers

b)Stutterers vs normals.

II) Double correct scores

a) Among the stutterers

b)Stutterers vs normals..

III Effects of severity of stuttering on dichotic CV test scores.

I Comparison of Right vs. Left Ear Scores

a) *Within the lag times*

The raw data from twenty stutterers was computed for single correct scores for both the ears. The scores of each ear was also averaged. The mean, standard deviation, range was calculated for the above scores. The Mann-Whitney's U test (Kanji, 1993) was used to check the significance of difference between scores obtained from each ear. The scores obtained from stutterers and normative population by Lakshmi (1996), was also compared using Mann-Whitney's U test (Kanji, 1993).

Table 1 : Mean scores and standard deviations, level of significant ear difference shown by stutterers and normative data obtained by Lakshmi (1996).

Lag onset time	Ear	Mean scores Normal	Mean scores Stutrs.	SD Normal	SD Stutrs.	Level at which significant Normal	Level at which significant Stutrs.
0 msec	Right	19.3	13.25	4.38	3.72	0.01	ISIS
	Left	14.8	12	5.21	3.21		
30 msec (right)	Right	20.9	15.65	4.27	5.8	0.01	N S
	Left	15.8	14.75	2.26	3.24		
30 msec (left)	Right	18.3	14.25	4.37	5.27	NS	NS
	Left	19.2	13.3	4.56	4.58		
90 msec, (right)	Right	22	14.2	4.47	4.04	0.05	0.01
	Left	20.2	18	5.72	4.4		
90 msec(left)	Right	20.3	13	5.09	5.05	NS	0.01
	Left	21	17	5.07	4.78		

NS = Not significant:

Table 2 : Comparison of single correct scores between stutterers and normative scores (Lakshmi, 1996) at various lag times.

Lag time	Group	Ear	Mean scores	Level at which significant
0 msec.	N	Right	19.3	0.01 level
	S		13.25	
	N	Left	14.8	0.05 level
	S			
30 msec. right lag	1ST	Right	20.9	0.01 level
	S		15.65	
	N	Left	15.8	0.05 level
	S		14.75	
30 msec. left lag	1ST	Right	18.3	0.01 level
	S		14.25	
	1ST	Left	19.2	0.01 level
	S		13.3	
90 msec right lag	N	Right	22	0.01 level
	S		1472	
	N	Left	20.2	0.01 level
	S		18	
90 msec left lag	N	Right	20.3	0.01 level
	S		15	
	N	Left	21	0.01 level
	S		17.12	

N = Normals; S = Stutterers.

i) At 0 msec.

a) ***Scores obtained within stutterers***: Right ear scores were found to be greater than left ear scores but this difference was not statistically significant.

b) ***Comparison of scores between stutterers and normative data:*** Scores obtained from the stutterers were compared with those of normative data obtained by Lakshmi (1996). As is evident from Table 1, there was a significant right ear advantage in normative data by Lakshmi (1996). However in stutterers the right ear advantage is not significant. This reveals that the stutterers differ from normals with respect to auditory processing..

Table 2 reveals stutterers show reduced scores for right as well as left ear when compared with normative data by Lakshmi (1996). This difference between the scores is significant at 0.01 level for right ear and at 0.05 level for the left ear. This finding goes in hand with previous research finding by Curry and Gregory (1969), Blood and Blood (1989), Strong and Frick (1983), Tsunoda and Moriyama (1972), Dietrich (1997). This finding again suggests that stutterers are inferior to normals in auditory processing.

ii) At 30 msec.

a) ***Scores obtained within stutterers****:* At this lag time, the stutterers again showed higher scores in the right ear immaterial of the ear in which the lag was presented. However the difference was not statistically significant as shown in Table 1.

b) ***Comparison between stutterers and normals***: Lakshmi (1996) found that normals at 30 msec. Lag time had a right ear advantage. This right ear advantage was significant in the right ear lag condition but not in the left ear lag condition. On the other hand the stutterers showed a right ear advantage which was not significant, highlighting the fact that they process auditory stimuli differently when compared to the normals. In addition the stutterers got depressed scores as compared to normals. This difference was significant for both the ears (Table 2).

According to Moore and Haynes (1980), the reduction in scores shown by stutterers and the lack of a clear ear advantage reflects "phoneme deficiency" disorder. This may be related to stutterers more dependency on right hemispheric processing unlike normals. Right hemispheric processing strategies are considered less efficient to the left hemispheric processing strategies. These results may also be due to unclear cerebral dominance (Orton, 1928; Travis 1931).

Curry and Gregory (1969) also indicated that stutterers score were significantly reduced on dichotic tests. Other findings also support the results obtained from the present study (Blood and Blood, 1989; Tsunoda and Moriyama, 1972; Dietrich, 1997).

iii) At 90 msec.

a) ***With in stutterers :*** At 90 msec, lag condition a significant left ear advantage was seen (Table 1). This left ear advantage between the two ears was found to be significant at 0.01 level no matter whether lag was in right or left ear.

b) Comparison between stutterers and normative data : The normative data by Lakshmi (1996) revealed that her subjects had a significant right ear advantage in the 90 msec, (right) lag condition. However the difference was not significant in left ear lag condition. Table 1 shows that at 90 msec, lag condition stutterers show a significant left ear advantage which is opposite, to the ear advantage shown by normative population (Lakshmi, 1996).

Lakshmi's (1996) data on normative population showed a consistent right ear advantage at all the lag times. But stutterers in present study showed a significant ear advantage at 90 msec, and at no time did they show a significant right ear advantage. Their scores were reduced significantly in comparison with normals (Table 2). Since the stutterers did not have the usual findings of showing preference for the lagging ear (in 90 msec, lag condition) it indicates that stutterers are notable to take an advantage of lag effect. Stutterers may not be able to divide their attention between two ears. This may be because of **a** breakdown of efficiency at level of reticular activating system (RAS) which allocates attention (Hageman and Greene, 1989).

These findings are consistent with earlier studies which show that a subgroup of stutterers exists who do not show a clear cut ear preference or show a left ear advantage unlike normals (Curry and Gregory, 1969; Tsunoda and Moriyama, 1972; Sussman and McNeilage 1975; Blood and Blood, 1985). Curry and Gregory (1969) showed that only 45% of his stutterers showed right ear advantage as opposed to 75% in the normal population.

These finding may again show that stutterers process auditory stimuli differently. This supports the hypothesis of "phoneme deficiency" disorders in stutterers, put forward by Moore and Haynes (1980). The processing differences in stutterers may be related to an inability, under certain circumstances, to handle the segmentation aspects of language. This is because stutterers rely more on right hemispheric processing which has decreased capacity to process phonological information (Moore and Haynes, 1980).

B) ACROSS THE LAG TIMES

The scores obtained across different lag times were compared using Mann-Whitney's U test (Kanji, 1993).

Table 3 : Comparison of difference in average scores at simultaniety and across onset time asynchronies.

Lag ear	Comparison between lag times	Mean scores %age	SD	Level at which significant
	0 mses. 30 msec.	42.08 50.07	10.06 12.57	Not significant
Right	0 msec 90 msec	42.08 53.66	10.06 13.88	Significant at 0.01 level
	30 mses. 90 msec.	50.67 53.66	12.57 13.88	Not significant
	0 msec 30 msec	42.08 45.91	10.06 14.56	Significant at 0.05 level
Left	0 mses. 90 msec.	42.08 50.2	10.06 14.45	Significant at 0.01 level
	30 msec 90 msec	45.91 50.2	14.56 14.45	Not significant

i) **Within stutterers** : From table 3, it is evident that there was an increase in average scores (obtained by averaging right and left ear scores) as lag times were increased from 0 msecs. to 90 msec.

a) ***Between 0*** *msec* - ***30*** *msec.* - As onset time increased from 0 to 30 msec, there was an increase in scores which significant only in right ear lag condition

b) *Between 30 msec. - 90 msec.* - As onset time was increased from 30 msec, to 90 msec, there was an increase in scores but this increase was not significant.

c) ***Between 0 msec. - 90 msec.*** - Increase in onset time from 0 to 90 msec, lead to an increase in scores and this was significant in both left ear and right ear lag condition. Thus the scores showed steady increase with an increase in onset time.

ii) **Comparison between stutterers and normative data** : Results of normative data by Lakshmi (1996) show that scores increase with increase in lag times. There is significant increase when lag time and increase from 0 msec, to 90 msec, and from 0 msec, to 90 msec. But then lag times increase from 30 msec, to 90 msec, the increase in scores is not significant.

Results of present study also reveal the similar trend as in normals. This suggests that as onset time asynchrony increases, the perception of the test stimuli from two ears becomes easier. As the asynchrony increases, each stimuli could be perceived independently without getting contaminated by the stimuli from other ear.

II DOUBLE CORRECT SCORES

Raw data from twenty stutterers was computed for double correct scores. Mean, standard deviation and range was calculated. Comparison between double correct scores of stutterers and normals was done using Mann-Whitney's U test (Kanji, 1993).

Table 4: Double correct scores of stutterers and normative data by Lakshmi (1996) and level of significance

Lag time	Mean		SD		Range		Level at which signifi -cant
	S	N	S	N	S	N	
0 msec.	3.65	7.6	2.9	3.1	0-9	0-22	0.05
30 msec. (right)	5.5	11.65	3.17	3.4	1-12	0-22	0.01
30 msec (left)	5.65	10.2	3.86	4.27	1-14	4-29	0.01
90 msec. (right) ,	7.45	14.2	3.41	5.40	2-15	1-27	0.01
90 msec (left)	5.7	15.2	4.10	6.4	0-15	1-28	0.01

S = stutterers, N = normals

a) ***Within stutterers*** - as is evident from table 4, there is an increase in double correct scores with increase in lag time.

b) ***Comparison between stutterers and normals***- Table 4, reveals that even in normals there is a steady increase in double correct scores with increase in lag time.Standard deviation reveals that variability of the scores obtained from two groups is not very different.

Table 4 shows that there is significant difference between double correct scores obtained by stutterers and normative data by Lakshmi (1996). Stutterers showed significantly reduced scores. This again supports phoneme deficiency disorder hypothesis put forward by Moore and Haynes (1980).

IV EFFECT OF SEVERITY ON DICHOTIC CV TEST SCORES

Subgroups were formulated on the basis of severity of the stuttering containing five mild, nine moderate and six. severe stutterers. Mean was derived for these three groups for following :

a) Average single correct scores

b) Double correct scores

As with earlier section, Mann Whitney's U test (Kanji, 1993) was utilized to find the significant difference between scores obtained by subjects in each of the above three subgroups.

Table 5 : Comparison of single correct average scores (in %) across different severities of stuttering

Lag time	Severity	Average scores (in %)	Level of which significant
0 mscs	Mild Moderate	52.96 42.74	0.05
	Moderate Severe	42.74 32.65	0.05
	Mild Severe	52.96 32.85	0.01
30 msec Right	Mild Moderate	63.7 45.53	0.05
	Moderate Severe	45.53 39.96	0.01
	Mild Severe	63.7 39.96	0.01
30 msec Left	Mild Moderate	61.28 45.13	0.05
	Moderate Severe	45.13 30.51	0.05
	Mild Severe	61.28 30.51	0.01
90 msec Right	Mild Moderate	57.3 46.07	0.05
	Moderate Severe	46.07 29.08	0.01
	Mild Severete	57.3 29.08	0.01
90 msec Left	Mild Moderate	68.78 54.05	0.05
	Moderate Severe	54.05 36.9	0.01
	Mild Severe	68.7 36.9	0.01

Table 6: Comparison of double correct scores across different severities of stutterers.

Lag time	Severity	Double correct scores	Level of which significant
0 mscs	Mild Moderate	5.8 4.3	0.05
	Moderate Severe	4.3 3.3	0.05
	Mild Severe	5.8 3.3	0.01
30 msec Right	Mild Moderate	9.8 4.6	0.01
	Moderate Severe	4.6 3	0.05
	Mild Severe	9.8 3	0.01
30 msec Left	Mild Moderate	8.6 4.5	0.01
	Moderate Severe	4.5 3.5	0.05
	Mild Severe	8.6 3.5	0.01
90 msec Right	Mild Moderate	8.6 7.2	0.01
	Moderate Severe	7.2 5.5	0.01
	Mild Severe	8.6 5.5	0.01
90 msec Left	Mild Moderate	10.4 6.5	0.05
	Moderate Severe	6.5 5.4	0.01
	Mild Severe	10.4 5.4	0.01

Both for average single correct as well as double correct scores, there was decrease with increase in the severity of stuttering. This decrease in scores was statistically significant at all the onset time asynchronies for both average single correct and double correct scores (Table 5 and 6). Mild stutterers got the best scores and severe stuttering got the worst scores. This indicates that with increase in severity of stuttering, the auditory processing problem as measured by dichotic CV test, also increase.

The results are in concensus with those of Blood (1985). He found that the severe stutterers show more of left ear advantage as compared with mild and moderate stutterers. According to Blood and Blood (1986), severity of stuttering stuttering may alter the dichotic listening responses in stuttering. Moore and Haynes (1980), reported that it might be predicted that greater the severity of stuttering, the greater a stutterers dependency on right hemispheric processing. And it has been found that right hemisphere has decreased capacity to process phonological information.

In conclusion, analysis of results obtained from the present study revealed that:

1) There was a significant difference between right and left ear scores obtained by stutterers. They showed right ear preference though not significant at 0 msec; 30 msec (right), 30 msec. (left). But there was a significant left ear advantage at 90 msec, (right) and 90 msec. (left).

2) There was a significant increase in scores with increase in onset time asynchronies.

3) Severity of stuttering was seen to affect the scores obtained by stutterers. As the severity increased, scores decreased significantly.

4) Stutterers showed scores which were significantly reduced in comparison to those obtained by normals.

SUMMARY AND CONCLUSION

The present study was carried out to evaluate the performance of stutterers on a dichotic CV test. This was done to evaluate the hemispherical processing, as in the review of literature it has been reported that stutterers have abnormal cerebral dominance (Orton, 1928; Travis, 1931; Curry and Gregory, 1969; Hall and Jerger, 1978; Blood, 1985; Dietrich, 1997).

The subjects taken up for the study were twenty right handed male stutterers in the age range of seventeen to thirty years. They were no female subjects available for study. The subjects were divided to form three subgroups in stutterers based on severity containing five mild stutterers, nine moderate and six severe stutterers. None of the subjects had a history of any neurological involvement. Puretone and speech identification testing was done to ensure normal peripheral auditory functioning prior to administering the dichotic CV test. The CV test administered was developed by Yathiraj (1994) at CID, St.Louis. The task involved identification of dichotic nonsense syllables (CVs) at various onset time asynchronies. The lag times used in the present study were 0 msec; 30 msec; (right), 30 msec (left), 90 msec, (right), and 90 msec. (left).

This study aimed at getting information on:

1) The ear advantage seen in stutterers.
2) The comparison of scores obtained from stutterers and that reported from normative data by Lakshmi (1996).
3) The effect of onset time asynchrony on the dichotic CV test scores.
4) The effect of severity of stuttering on dichotic C V test scores.

Responses were scored in terms of single correct, double correct and average scores. Mean, standard deviation and range were calculated. Significance of difference was calculated using the Mann-Whitney-U Test (Kanji, 1993) for the following :

Scores obtained for right and left ear.

Scores obtained by stutterers and normative data given by Lakshmi (1996).

Scores obtained by stutterers at different lag times.

Scores obtained by mild, moderate and severe stutterers.

Results revealed the following :

1) Siutterers obtained significantly lower scores when compared to the normative data reported by Lakshmi (1996). This was seen across all lag times.
2) The stutterers showed a significant left ear advantage at 90 msec, (left) lag and 90 msec, (right) lag conditions. In the other lag conditions they showed a right ear advantge which was not statistically significant. This was contrary to results obtained from the normal population by Lakshmi (1996), where a significant right ear advantage was seen for all lag times.
3) There was an increase in scores as the lag times increased for the stutterers. This increase was significant when the lag time increased from 0 msec, to 90 msec, and from 0 msec, to 30 msec. But this increase was not significant when lag time increased from 30 msec, to 90 msec. A similar trend was seen in the scores obtained the data by Lakshmi (1996) on normals.

iv) The comparison of average scores of stutterers across severities, revealed that scores decreased as the severity increased. Mild stutterers got the maximum scores and severe stutterers got the least scores. This difference between scores obtained by mild, moderate and severe stutterers was statistically significant at all lag times.

All the above results reveal that stutterers show disturbed cerebral dominance. All of these findings indicate that all *OUT* subjects were homogenous. This finding is in contradiction with Blood's (1985) and Blood and Blood (1986) studies that report that stutterers are a heterogenous group. Thus the results support the Orton-Travis hypothesis (1928, 1931) and "phoneme deficiency" disorder, hypothesis (Moore and Haynes 1980). These results are in accordance with many previous research findings (Curryand Gregory, 1969; Blood and Blood, 1989; Strong and Frick, 1983; Dietrich, 1997). The test results of dichotic CV can also be used to provide information about the improvement seen due to therapy. Boberg et al. (1983) also cite the changes in alpha power after intensive therapy.

Future implications

This study could be replicated using a large sample as stutterers are a heterogenous population (Blood, 1985).

Performance of stutterers can be evaluated after and before the therapy. This would reveal if therapy affects the scores obtained by stutterers on dichotic test.

Even effect of different reporting strategies can be evaluated as it is thought to affect the scores (Blood, 1989).

Different reporting strategies like reporting the lagging syllable first or writing down the response are seen to affect the scores (Blood, 1989). So the effect of different reporting strategies on results of dichotic CV test can be evaluated.

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APPENDIX -A

Calibration of Audiometer

Both intensity and frequency calibration was done for puretone generated by the clinical audiometer (Madsen OB 822).

Intensity calibration for air conducted tones were carried out with the output of the audiometer set at 70 dB HL (ANSI, 1992). Through the earphones (TDH 39 with MX-41 Ar ear cushions). The acoustic output of the audiometer was given to a condenser microphone (B&K 4144) which was fitted into an artificial ear (B&K 4152). The signal from the artificial ear was then fed into a calibrated sound level meter (B&K 2209) with an octave filter set (B&K 1613) through a preamplifier (B&K 2616) using a half inch to one inch adapter (B&K DB 0962). The output SPL value are noted for frequencies 250 Hz through 8000 Hz and compared with the expected values according to ANSI standards, 1992. If there was a discrepancy of more than 2.5 dB, it was corrected by means of internal calibration.

Bone vibrator calibration - Radio ear B-71 (bone conduction vibrator) was calibrated for frequencies 250 Hz through 4000 Hz. The output of the audiometer was set at 40 dB HL. The output of the audiometer was set at 40 dB HL. From the bone conduction vibrator, the acoustic signal was fed to the artificial mastoid (B&K 4980). This output was then fed via a preamplifier to- the SLM (B&K 2209). A difference of more than 2.5 dB between the observed SPL value and the expected value (ANSI Standards, 1992) was internally calibrated.

Frequency Calibration : The electrical output of the audiometer was fed into the time/frequency counter (Radart 230) which gave **a** digital display of the generated frequency. If the difference between the dial reading on the audiometer and the digital display of **a** given frequency, exceeded + or - 3% (ANSI standards, 1992) of the characteristic frequency tested, then an interval calibration was done.

Linearity check: The linearity attenuator was checked. The intensity dial of the audiometer was set at maximum level and the frequency dial was set to 1000 Hz. The attenuator on the SLM was set at a level corresponding to the maximum level on the audiometer. The attenuator setting on the audiometer was decreased in 5 dB steps till 30 dB and the corresponding reading on the SLM was noted. For every decrease in the attenuator setting the SLM indicated a corresponding reduction.

Microphone calibration : A 1000 Hz tone at 70 dB HL was presented as the microphone input for microphone calibration. The VU meter gain was set so that the needle peaked at '0'. A one inch condenser mic. (B&K 4145) was connected to the SLM (B&K 1613). The output SPL was noted on the SLM on the linear scale was compared with the standards (Morgan, et al. 1979). If the reading exceeded 2.5 dB interval calibration was done.

Frequency response **characteristics of earphones** : The frequency response characteristics of the TDH 39 earphone was obtained using signal generator (B&K 1023), pressure microphone B&K 4145), frequency analyser (B&K 2107) and graphic level recorder (B&K 2616). The electrical output of the signal generator (B&K 1023) was fed to the headphone. The output picked up by microphone (B&K 4145) was fed to the frequency analyzer (B&K 2107). The output was recorded on graphic level recorder (B&K 2616).

APPENDIX-B(a)

Note: p,t,k,b,d,g- Any two of these sounds will be presented in both ears simultaneously. If possible mark both the sounds heard. In case both sounds cannot identified, then mark at least one of the sound heard.

p t k b d g	p t k b d g	P t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p tk b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g
p t k b d g	p t k b d g	p t k b d g	p t k b d g	p t k b d g

ಅನುಬಂಧ B(b)

ಸೂಚನೆ : ಪಟಕಬಡಗ ಇವುಗಳಲ್ಲಿ ಯಾವುದಾದರೂ ಶಬ್ದ ಎರಡೂ ಕಿವಿಗಳಲ್ಲಿ ಒಂದೇ ಸಮನಾಗಿ ಕೇಳುತ್ತಿದೆಯೇ. ಒಂದು ವೇಳೆ ಶಬ್ದ ಕೇಳಿಸಿದಲ್ಲಿ ಆ ಅಕ್ಷರವನ್ನು ಗುರುತಿಸಿ. ಒಂದು ವೇಳೆ ಕೇಳಿಸದಿದ್ದಲ್ಲಿ ಕೊನೆಯಪಕ್ಷ ಯಾವುದಾದರೊಂದು ಶಬ್ದ ಕೇಳಿಸಿದರೂ ಅದನ್ನು ಗುರುತಿಸಿರಿ.

Note: p,t,k,b,d,g- Any two of these sounds will be presented in both ears simultaneously. If possible mark both the sounds heard. In case both sounds cannot identified, then mark at least one of the sound heard.
heard.

ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
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ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ
ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ	ಪಟಕಬಡಗ