EAR-TO-EAR LATERALIZATION OF AUDITORY IMAGE IN STUTTERERS AND NORMALS

BY

Reg. No. 9

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A dissertation submitted in part fulfilment for the degree of master of science (Speech and Hearing), University of Mysore, 1984.

CERTIFICATE

This is to certify that the dissertation entitled "Ear - to - Ear Lateralization of Auditory Image in Stutterers and Normals" is the bonafide work in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No.9

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CERTIFICATE

This is to certify that the dissertation entitled "Ear - to - Ear Lateralization of Auditory Image in Stutterers and Normals" has been prepared under my supervision and guidance.

GUIDE

DECLARATION

This dissertation is the result of my own study undertaken under the guidance of Dr. M.N. Vyasamurthy, Lecturer 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.

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ABBREVIATIONS

Cps	:	Cycles per second
CV	:	Consonant Vowel
dB	:	Decibel
(I_{R-L})	:	Amount of intensity required to shift the fused auditory image from right ear to left ear.
(I_{L-R})	:	Amount of intensity required to shift the fused auditory image from left ear to right ear.
L.E.	:	Left Ear
R.E.	:	Right Ear
S	:	Subject
S	:	Subjects
s		
SL	:	Sensation Level
SSW	:	Staggered Spondiac Word Test
SRT	:	Speech Reception Threshold.

CHAPTER–I

INTRODUCTION

Moore and Weidner, 1975). Right handed individuals also exhibit left ear advantage (LEA) indicating right hemisphere processing for nonverbal acoustic functions (Milner, 1962; Kimura, 1964; Channey and Webster, 1966; Berlin and Mc Neil, 1976).

But, when this dichotic listening technique is used for stutterers they exhibited an absence, reduction or reversal of right ear advantage, i.e. there is lot of controvery. Some investigators could not demonstrate right ear advantage in stutterers (Curry, Gregory, Quinn, 1972). Some investigators have not found any ear preference difference when they tested normals and stutterers. (Slorach & Noehr, 1973; Kimura, 1963; Gruber and Powell, 1974; Dorman and Porter, 1975). Based on EEG study Moore and Haynes, (1980) have recently reported that stutterers use right hemisphere for both verbal and nonverbal stimuli.

Nandur (1976) reported that stutterers and trained musicians did not show any ear preference in nonverbal task, whereas the normal males or females have shown significant ear preference in nonverbal task.

In the light of the above mentioned studies it seems logical to think that normal subjects have ear preference whereas the stutterers may or may not have ear preference in dichotic listening tasks. Historically investigators have searched for physiological differences between stutterers and nonstutterers (Van Riper, 1971). One empirical and theoritical emphasis has been that stutterers may lack cerebral dominance when compared to normal population (Orton, 1927; Travis, 1931). After many years this cerebral dominance hypothesis enjoys renewed interest (Moore, Haynes, 1980).

Central auditory function in stutterers too have been tested by investigators. The evidence of central auditory deficiency has been also found in stutterers (Toscher and Rupp, 1978; Hall and Jerger, 1978, Liebefran and Daly, 1981).

Psychophysical tests and audiological tests like Dichotic listening. Masking level difference (MLD), staggered spondiac word test acoustic reflex amplitude function, synthetic sentence Identification and Ipsilateral competing message, synthetic sentence identification with contralateral competing message have been used to assess the central auditory function in stutterers.

Any lesion in the central auditory system has been reported to interfere interaural intensity difference for intra cranial lateralization (Pinheiro and Tobin, 1969, 1971).

Schoeny (1968) has observed an asymmetry of the two ears for the magnitude of intensity required to lateralize the tone

INTRODUCTION

A popular theory concerning stuttering contends that stuttering results from incomplete cerebral dominance; that too much language in the nondominant hemisphere results in an interhemispheric rivalry causing speech disfluency. This thesis was initially formulated by Orton (1928) and Travis (1931) and was repopularized by Jones (1966).

For decades scientists have believed that the two cerebral hemispheres in humans are specialized to perform different function. The initial indication of possible functional difference came from the studies of the effects of damage to the one side of the brain (Broca, 1865; Wernicke, 1875). Typically patients with left hemisphere damage have difficulty in linguistic tasks whereas those with right hemisphere lesions often demonstrated little or no linguistic impairment.

A well established inferential means of determining hemispheric specialization is the dictotic listening technique (Berlin and Lowe, 1972; Kimura 1961; 1963; Moore and Weidner, 1975). The technique consist presentation of two different stimuli in each ear. Generally, when confronted with dichotically presented linguistic stimuli normal right handed subjects indicated a right ear preference and which suggest a left hemisphere appears more specialized for nonlinguistic stimuli that are presented dichotically because subjects evidence a left ear preference (Knox and Kimura, 1970; Kimura, 1973).

Some investigators have used a tachistoscopically presented visual stimuli (Hines, 1972; Mc Keever and Huling, 1971; Mc Keever, Suberi and Van Deventer, 1972; Moore and Weidner 1974; Moore, 1976). These studies show a right visual field preference for linguistic materials in normal speaking subjects indicating left hemisphere processing and a left visual half field preference for nonlinguistic stimuli (visual spatial tasks) suggesting a right hemisphere advantage.

Another method of studying hemispheric specialization is anaesthize temporarily one hemisphere by injecting sodium amytal into the internal carotid artery (Wada, 1949). This procedure typically results in a transient aphasia if one hemisphere that specializes in linguistic processing (usually the left) is temporarily anaesthesized.

A more recent technique for studying hemispheric processing in the monitoring of cortical blood flow (Risberg and Ingvar, 1973). Increased cortical blood flow has been observed in the left hemisphere during linguistic tasks and in the right hemisphere when the subject is engaged in perception of music (Carmon et al 1975).

The monitoring of averaged evoked responses (ARR) during visual and auditory stimulation has also been used as an index of hemispheric asymmetry. Mc Adam and Whitaker (1971) and Callaway and Harris (1974) have shown that AER amplitude is increased over the left hemisphere as compared to the right hemisphere during verbal tasks.

Relative amount of left wave (alpha) activity (8-13 Hz) is an indicator of hemispheric asymmetry. When the stimulus is presented, the amplitude of left wave is reduced or suppressed (Adrian and Mathews, 1934). Final asymmetry is inferred by observing the differential is inferred by observing the differential suppression over the right hemisphere for visual, spatial and musical activities, Moore and Haynes (1980) studied three groups of subjects - normal speaking males, normal speaking females, and male stutterers with EEG technique. The result indicated that stutterers showed significantly less alpha suppression in their right hemispheres for both verbal and nonverbal tasks. This indicated that stutterers were processing both kinds of information into the right hemisphere, sex differences were also observed by the authors.

Aw stated earlier in dichotic listening the normal right handed subjects tend to show right ear advantage (REA) indicating left hemisphere processing for verbal and linguistic materials (Berlin and Lowe, 1972; Kimura, 1961; 1962; 1963;

from the ear to the median plane. It has been reported that the right ear required less intensity than the left ear for median plane lateralization for normal subjects.

In order to validate the existance and magnitude of the reported ear bias Vargo and Carhart (1972) conducted an experiment on 10 normal subjects. They also reported an ear bias for median plane lateralization. Result showed that slightly less intensity was required in the left ear than in the right ear to achieve a midline experience. But the magnitude of the observed differences in intensity between the ear was not statistically significant. Moreover, it was of opposite polarity to that reported by Schoeny (1968).

Reviewing the previous investigators (Von Bergaijk, 1962; Diamond et al 1964, 1967; Bekesy (1967), Boca et al 1967; Pinheiro and Tobin, 1969, 1971; Cullen et al) it is evident that cortex is involved in the task of lateralization.

Meena Devi (1967) tested 15 right handers and 10 left handers. Two kinds of stimuli - CV syllables (pa, ba, ka, ga, ta, da) and pulsed tones were used as stimuli in the experiment. In right handers significant difference in the amount of intensity was required to shift the fused auditory image of CV syllables. The intensity required to shift the fused auditory image for CV syllables in left handers was not studied.

Many tests to assess the central auditory function have been used with stutterers and nonstutterers.

The present investigation was undertaken to determine whether significant difference exists in Ear to Ear lateralization test between adult stutterers and age and handedness matched nonstutterers (normals).

The present study aims to answer the following:-

(I) Will there be any significant difference in shifting the auditory image of the CV syllables from right ear to left ear and vice versa in normal subjects.

(II) Will there be any significant difference in shifting the auditory image of the music stimuli from right ear to left ear and vice versa in normals.

(III) Will there be any significant difference in shifting the auditory image of CV syllables from right ear to left ear and vice versa in stutterers.

(IV) Will there be any significant difference in shifting the auditory image of the music stimuli from right ear to left ear and vice versa in stutterers.

BRIEF PLAN OF THE STUDY

Six CV syllables pa, ba, ka, ga, ta, da by a male good speaker are to be recorded on cassette. The speaker will be instructed to speak these syllables continuously keeping the intensity constant. There should be no variation in the duration between the two syllables.

Western music is to be recorded in the same cassette. These two stimuli (verbal and nonverbal) will be used throughout the study.

Two groups of subjects will be selected for the study. Group A, consists of non stutterers (normals) and Group B, consists of stutterers.

All the subjects of Group A and Group B should meet the following criteria - (I) They should be right handers (II) They should have the hearing sensitivity within 25 dB HTL for frequencies 500, 1000, and 2000 Hz (The difference between the thresholds of the two ears not exceeding 10 dB). (III) Age range should be between 16 to 30 years.

Each subject will be tested in the following manner:

(I) CV Syllables: The recorded CV syllables will be presented dichotically at 20 dB SL. Subjects will be required to report complete ear lateralization of the fused auditory image. At first the intensity of the signal would be kept constant in left ear. The intensity in the right ear will be raised in 1 dB steps until the subject: hears completely in right ear. Next, the intensity in the left ear will be increased until the auditory image etc. shifts to left ear. The amount of intensity required to shift the fused auditory image from right ear to left ear will be obtained.

Similarly, a fused auditory image will be found at left ear first then it will be shifted to right ear. The amount of intensity required to shift the fused auditory image from left ear to right ear will be obtained.

II. Music: The recorded western music purely nonverbal in nature will be played dichotically at 20 dB SL. The same above mentioned experiments will be repeated.

DEFINITIONS:

II DICHOTIC STIMULATION:

Dichotic listening usually involves the simultaneous presentation of two different auditory stimuli, one to the subject's right ear and other to his left ear (Broadbent, 1954; Kimura, 1961, 1963).

II) DIOTIC LISTENING:

In diotic listening both ears are stimulated by the sound source. In most cases the sound source is external, the perception is experienced as "out there" and the judgement is referred to as localization.

III) <u>LATERALIZATION Vs. LOCALIZATION:</u>

The terms lateralization and localization have been used interchangeably in the literature. Usually, "localization" refers to position of a sound source in one's immediate sound field. The "lateralization" on the other hand, has been reserved for intracranial sound images (Sullivan, 1967; Berlin and Lowe, 1972).

IV) <u>SHIFTING THE FUSED AUDITORY IMAGE FROM RIGHT EAR TO LEFT EAR:</u>

A fused auditory image is generally formed when the stimuli are presented at equal sensation level (20 dB SL) to both the ears. Gradual increase in the intensity in right ear will shift the image, right ear. Now, by increasing the intensity of the stimulus in the left ear, the fused image can be shifted to right ear.

V) <u>SHIFTING THE FUSED AUDITORY IMAGE FROM LEFT EAR TO RIGHT EAR:</u>

A fused auditory image is generally formed when the stimuli is presented at equal sensation level (20 dB SL) in both the ears. Gradual increase in the intensity of the stimulus in left ear, will shift the image to the left ear. Now, by increasing the intensity of the stimulus in the right ear, the fused image can be shifted to right ear.

VI) INTER AURAL INTENSITY DIFFERENCE:

The difference in intensity between the dichotic signals that is needed to lateralize the sound image to the test ear.

VII) $I_{R - L}$

The amount of intensity required to shift the fused auditory image from right ear to left ear.

VIII) $I_{L - R}$

The amount of intensity required to shift the fused auditory image from left ear to right ear.

IX) CEREBRALITY:

Cerebrality refers to the typical human ability of asymmetric specialization of the two hemispheres for verbal and nonverbal functions.

X) STUTTERERS:

Stutterers are those whose speech is characterized by repetitions, hesitations, and prolongations of sounds and syllables with or without secondaries. They should have been so diagnosed by a qualified speech pathologist.

CHAPTER-II

REVIEW OF LITERATURE

REVIEW OF LITERATURE:

CEREBRAL DOMINANCE:

The Cerebral hemispheres are paired organs. The anatomic appearance of the two hemispheres is more or less symmetrical. Functionally there is a considerable degree of symmetry, each hemisphere serving the opposite side of the body for many motor and sensory functions. In the human, however, several functions are distributed between the hemispheres in a distinctly asymmetrical fashion. The tendency for one of the cerebral hemispheres to predominate in certain functions has been termed as cerebral dominance (Benson and Geschwind, 1968).

The two hemispheres, of the human brain are connected through interhemispheric pathways. They also receive information from and send information to the brain stem. Most of the programming and processing of language is done in the hemispheres. Almost all the right handed individuals have majority of their language in their left hemisphere. A lesion in the left hemisphere of 99% of right handed individuals results in aphasia; the lesion in the right hemisphere does not (with few exceptions). It is not known how language comes to reside primarily in one hemisphere. Language is usually fairly well lateralized by the age of 8 years (reviewed by Satz et al 1975).

CEREBRAL DOMINANCE AND STUTTERING:

The theory that a lack of cerebral dominance creates a mistiming of motor impulses to the bilateral speech muscles and thus produces stuttering was first formulated by Stier (1911) and by Sacks (1924).

A popular theory concerning stuttering contends that stuttering results from incomplete cerebral dominance; that too much language in the nondominant hemisphere results in an interhemispheric rivalry, causing speech dysfluency. This thesis was initially promulgated by Orton (1928) and Travis (1931) and was repopularized by Jones (1966).

R.K.Jones (1966), a neurosurgeon was preparing to operate on 4 patients who had stuttered severely since childhood, but who had recently developed brain pathology, and he had decided to use a new technique pioneered by Wada (1949). The technique consisted of injecting sodium amytol directly into first the right and then the left carotid arteries while the patient is conscious and talking. As Wada and Rasmussen (1960) demonstrated, when this drug is introduced into the system in this way, a temporary aphasia results, provided the artery serving the dominant hemisphere of the brain is the one injected.

To this surprise Jones found that all four of the stutterers developed transient aphasia when drug was injected into either in the right or left carotid arteries thus indicating that they had a bilateral certical control of speech, that these were "speech centers" in both hemispheres. Jones then performed his surgery on the damaged hemisphere and found that complete remission of stuttering took place in all his patients. After recovery he administered the sodium amytol as before and discovered that now the exstutterers became aphasic only when one artery was injected and (the one serving the nonoperative hemisphere). They no longer had certical representation for speech in both hemispheres but only in one. Jones remarks that "the results on stammering of a one sided operation for unrelated lesions in these four patients were quite starting and can only be explained by the view that stammering is associated with an interference by one hemisphere with the speech performance of the other. No occurance of stuttering was noted after periods ranging from 15 months to 3 years.

DICHOTIC LISTENING:

There are various techniques to determine cerebral dominance. One of them is dichotic listening.

Broadbent's (1954) and Kimura's (1961, 1963) dichotic tests are very well known. Many authors wrote these tests which essentially consist in simultaneous and different stimuli on messages fed to each one of the ears, after presenting for instance the two different degits or words together, the examiner asks the subject what the number of the word he heard was.

The reason for enthusiastic reception of such a test probably was the acceptance of the fact that each hemisphere was receiving a different message, in spite of the division of the auditory pathways in both hemispheres. If only one message was repeated, therefore the ear that received it was dominant and the opposite side of the brain was considered to be the dominant hemisphere. This was because functionally auditory pathways act as crossed pathways.

When Dichotic listening (Broadbent, 1954) of speech was presented to normal right handed subjects tend to report the stimuli presented to the right ear more accurately than stimuli presented to the left ear (Kimura, 1967). Because the pathways from the ears to the cortex are primarily crossed the right ear advantage has been interpreted as an indication of left hemisphere dominance for auditory verbal recognition.

The right ear preference has been typically observed for verbal and linguistic materials under dichotic testing (Berlin and Lowe, 1972; Kimura 1961a, 1961b, 1963; Moore and Weidner, 1975).

Blumstein, Goodglass and Tarter (1975) employing a test retest experiment contend that 85% of normal right handed males have a right ear advantage (REA) in dichotic listening and that any such test contains 15% misclassified subjects.

Left ear advantage (LEA) indicating right hemisphere processing for nonverbal acoustic functions have been reported (Milner, 1962; Kimura, 1964; Channey and Webster, 1966; Berlin and Mc Neil, 1976).

DICHOTIC LISTENING IN STUTTERERS:

Curry and Gregory (1969) employed dichotic listening to investigate stutterers. They tested 20 adult stutterers (19 Male and 1 Female) and 20 appropriate controls. All were the allagedly right handed. They employed several dichotic tasks, one of which was Dichotic Word Test. This involved the recognition of pairs of consonant - vowel - consonant words of high familiarity, presented in groups of 6 pairs with 0.50 sec separating each pair. After each group of 6 words had been presented the subjects attempted to recall the 12 different words, in any order and without any concern of which words had been presented to any particular ear. There were 12 groups of 6 pairs in the test. The anticipated right ear superiority was sufficiently less for stutterers than for nonstutterers. 75% of nonstutterers had right ear scores than were higher than their left; that was true for only 45% of the stutterers.

Quinn (1972) also investigated dichotic listening in stutterers. His method was similar to that of Curry and Gregory; neither evaluated the order of report. He examined 60 right handed stutterers (53 male and 7 female) and matched controls. He noted no difference between the two groups but did observe that 12 individual stutterers had left ear scores that were higher than right ear scores.

Slorach and Noehr (1973) examined 15 stutterers age 6.25 - 9.0 years. They dichotically presented digit pairs and tested not only the free recall of degits but also the performance on instructed order of report from particular ears. The stutterers did not differ from controls.

Kimura (1963) failed to find significant differences between ear performances on dichotic listening tasks presented to 7 - 9 years old girls.

Gruber and Powell (1974) dichotically examined 28 right handed children stutterer and controls using degit pairs. They failed to find significant inter-ear-differences for either group. The subjects report was that of free recall.

Dorman and Porter (1975) evaluated 16 right handed adult stutterers (12 males and 4 females) and compared them to 20 controls (10 males, 10 females). Subjects had to write in response to nonhuman speech consonant - vowel dichotic stimuli.

There was no difference between stutterers and nonstutterers.

Sussman and Mac Neilage (1975) employed a dichotic listening paradigm and another paradigm pursuit auditory tracking. They contendended that dichotic listening tested elements of laterality pertaining to speech perception whereas the tracking paradigms tested speech production. This paradigm involved matching a tone in one ear to an externally varied tone in the other ear. The former tone was altered by transducer attached to the tongue or jaw. The subject varied this tone appropriately moving the tongue or jaw. Subjects were required to match this transducer related tone to the externally varied tone. The authors tested right handed male and female stutterers and nonstutterers for laterality pertaining to speech perception. (dichotic listening) and speech production (tracking paradigm). They noted a right ear advantage (REA) for both nonstutterers and stutterers on the dichotic study. Stutterers did not differ from nonstutterers in laterality related to the verbal hearing. On the tracking paradigm normals had a right ear advantage whereas stutterers did not (i.e. nonstutterers best altered the transducer tone when they heard it in the right ear and had to match it against the externally varied tone in the left as opposed to having the transducer tone in the left and the externally varied tone in the right). This indicated a left hemisphere dominance for nonverbal output. Stutterers did not demonstrate this laterality for nonverbal output.

Why is so much contradiction in these studies; Some authors have found that stutterers have normal laterality, others do not. While reviewing dichotic tests Rosenfield (1980) opines that "stuttering may well be a syndrome complex and not a unitary homogenous disturbance. The above studies tested different variables and different stimuli. Perhaps the above authors were in error by mixing males with females since the prevalence of stuttering differs so much among males vs. females. Since many children loose their stutter perhaps it is an error to mix children or adolescents with adults in these experimental paradigms. Since handed - ness is an issue in stuttering perhaps one should not mix strongly right handed stutterers with stutterers of any other handedness".

The study of Goodglass and Rosenfield (1980) was well controlled. They evaluated strongly right handed adult male stutterers on a dichotic consonant vowel (human speech) paradigm and on a melody dichotic paradigm. 19 right handed male stutterers and 20 matched controls were tested. All were right handed in all areas of Edinburgh Handedness Inventry (Oldfield, 1971) native speakers of English and had no known hearing loss. The mean age of the stutterers was 26.8 years while that of controls was 26.1 years. The mean grade levels were 14.8 and 14.9 respectively.

Subjects were tested in a quiet room and heard the music and consonant vowel tapes appropriately counterbalanced.

For the consonant tape they were told that they would hear two different syllables simultaneously, each taken from a set of six syllables (pa, ta, ka, ba, da, ga). These six syllables were on the top of the answer sheet. They then binaurally heard the syllables. The subjects wrote the two syllables which they heard first. The subjects were instructed to always write two syllables, even if they had to guess.

For the music tape, the subjects were told that they would hear two different melodies simultaneously followed by four binaural melodies which were separated by 3 sees pauses. They had to match each of the dichotically presented melodies with one of the four binaural melodies by marking on an answer sheet the appropriate letter (A, B, C, D) corresponding to position of binaural melody in the sequence. They were instructed to guess when uncertain.

The findings of this study (Goodglass and Rosenfield, 1980) confirmed the findings of Curry and Gregory (1959) i.e. More stutterers than the normals failed to have a left ear (right hemisphere) advantage for melodies. Group analysis of ear advantage for consonant vowel stimuli failed to distinguish stutterers from controls.

EAR PREFERENCE FOR MUSIC:

Nandur (1976) developed a test based on his pilot study. The test consisted of Western classical tunes, purely instrumental in nature with no verbal component. It was considered as nonverbal stimuli. The reason for selecting these tunes were to reduce the familiarity and thus it makes difficult for the subjects to identify.

The test had 13 events out of which 10 were test events and 3 were control events. In each test event one ear received a constant piece of tune and the other ear received the distorted version of the constant tune and two other distorted tunes, one at a time in a dichotic fashion. After listening to the whole event, the subject was asked to find out as to which one of the three distorted tunes resembled the constant piece of tune in the other ear. In the control event, the distorted version of the constant tune was not present and it was replaced by another distorted tune. The subject was expected to indicate that there was no resemblance between the constant and the three distorted tune.

First, each subject was presented 13 events and then the earphones were reversed and the whole tape was played back. The total number of correct identifications from 10 test events was converted into the Percentile scores.

Three groups of subjects were tested in his study - 50 normals (25 males and 25 females), 10 stutterers and 10 trained musicians. Their ear preference for music was compared.

The following conclusions were drawn:-

I) In normals there was a significant difference between the two ears for the perception of music.

II) Both normal males and normal females had a significant ear preference, however, the magnitude of preference was greater in males.

III) No significant difference between two ears in stutterers and trained musicians was found i.e. these groups did not exhibit a clear cut ear preference.

AUDITORY PROCESSING AND PERCEPTUAL OF ORGANIC AND FUNCTIONAL STUTTERERS:

Liebetrau and Daly (1981)'s investigation was undertaken to determine whether significant differences in auditory processing and perceptual abilities exist between (1) stutterers as a supposedly homogeneous group when compared with controls (2) two differentiated sub-groups of stutterers and (3) either of the stuttering sub-groups when separately compared with controls. Dichotic listening and masking level difference (MLD) tasks were administered to the two groups of school age stutterers and an age matched nonstuttering control group. Stuttering subjects were differentiated into organic and "functional" sub-groups on the basis of neurophyeholological test performances. Organic stutterers performed significantly poorer than did controls on one MLD experimental condition. Functional stutterers performed more like control subjects than like organic stutterers.

CENTRAL AUDITORY FUNCTION IN STUTTERING:

Hall and Jerger (1978) have assessed Central Auditory Function in 10 stutterers and 10 nonstutterers. The performance of the two groups was compared for seven audiometric procedures including acoustic reflex threshold, acoustic reflex amplitude function, performance intensity function for synthetic sentence identification, synthetic sentence identification with ipsilateral competing message, synthetic sentence identification with contralateral competing message and the staggered spondaic word test. Relative to the control group, the performance of the stuttering group was depressed on three procedures - the acoustic reflex amplitude function, synthetic identification with competing message and staggered spondaic word test. As a group, stutterers presented evidence of central auditory deficiency. The pattern of the test results suggest a disorder at the brainstem level.

Toscher and Rupp (1978) assessed central auditory function in stutterers and nonstutterers using synthetic sentence identification test (Speaks and Jerger, 1965). The performances were compared. An analysis of variance revealed that the performance of the stuttering group was significantly poorer (0.01 level of confidence) than that of the nonstutterers on the Ipsilateral Competing Message Subtest.

Many of the other tests too suggest a neurological dysfunction within the central auditory apparatus as at least one of the underlying causes of dysfluency.

LATERALIZATION VS. LOCALIZATION:

The terms lateralization and localization have been used interchangeably in literature. Usually "localization" refers to position of a sound source in one's immediate sound field, "lateralization" on the other hand, sound images. The arbitrary nature of this distinction may be demonstrated as a function of instructions to the patient.

Position a Bone Conduction vibrator on the subjects midline forehead with ears occluded. Then give one or two alternative sets of instructions (A) Close eyes. . . . point to an imaginary movable loudspeaker which a producing the tone in question or similarity. (B) Indicate some point on or within the confines of the skull at which the sound seems to be located. In either instance the subject routinely follows directions with ease in (A) pointing to some spatial location (localization) and in (B) selecting a site on the cranium (lateralization) (Sullivan, 1967).

INTERAURAL INTENSITY RELATIONS FOR MEDIAN PLANE LATERALIZATION:

Under conditions of binaural earphone listening a diotic acoustic stimulus results in the perception of a unitary image within or immediately adjacent to the head at the mid-sagittal plane. This phenomenological experience can be made to lateralize toward either ear by simply adjusting the inter-aural intensity between earphones. Thus, increasing or de-creasing intensity in sufficient magnitude to oneearphone will cause the image to lateralize toward or away from that side.

Intracranial lateralization behaviour has been used to study binaural auditory processing in time intensity trades as a theoritical model for binaural release from masking (Hafter, 1971) and clinically in gaining diagnostic information on auditory brain stem lesion (Jerger, 1960, l959; Carhart, 1969, Groen, 1969).

Vargo and Carhart (1972) used 10 normal adults, who adjusted signal intensity at one ear at .25 and 2 KC/S to achieve a mid sagittal image with the same train of 0.5 sec pulses at 60 dB SPL in the other (fixed-level) ear. 10 judgements were made for each frequency at each of two sessions 1 week apart. Ear order (L-R) was counterbalanced within each session. Ear order was not found to be significant. A standard deviation of about 5 dB indicates that an interaural intensity difference of 10 dB should adequately describe the range of normal behaviour in this task.

EFFECT OF FREQUENCY AND AURAL ACUITY ON LATERALIZATION:

In an experiment applying signal detection rating to the study of auditory lateralization (Elfner and De I'Aune, 1969) the sensitivity to a shift of sound image left or right of centre seemed to be facilitated at lower frequencies. Mills (1960) had reported a frequency effect, but Elfner and Tomsic (1968) did not. In comparing his interaural intensity threshold data with interaural intensity differences produced by the minimum audible angle (m.a.a.) about the median plane, Mills found that the earphone data agreed with the Freefield data over the/range from 1.5 - 6 Kc/S. At about 6 Kc/S, the freefield interaural intensity differences increased and the interaural intensity thresholds decreased. Elfner and De l'Aune (1969) also noted slight differences in sensitivity for right and left direction of shift when the subject had binaural differences in absolute thresholds.

Elfner and De L'Aune (1977) used rating method to determine sensitivity to intensity produced lateral shifts in a binaurally fused and centred auditory image. Stimuli were pure tones at 0.5, 1, 2, 4, or 8KC/S at 30 dB SL. A significant trend was found for the higher frequencies to yield diminished sensitivity. No effect of interaural intensity threshold imbalance was observed on the detectability of R Vs L direction of the shift. However, S_s with audiometric imbalance of $\geq$ 5.dB performed at a significantly higher level than those with symmetric audiograms at the test frequency.

EAR TO EAR LATERALIZATION OF AUDITORY IMAGE:

Meena Devi (1977) conducted an experiment to see whether there exists any significant difference in shifting the fused auditory image from right ear to left ear and vice-versa for right handers and left handers.

15 right handers and 10 left handers served as subjects in her study. Pulsed tones (500 Hz - 4 KHz) and GV syllables (pa, ba, ka, ga, ta, da) were used as stimuli.

The stimuli were always presented dichotically at 20 dB SL. A fused auditory image was formed in right ear first, by increasing the intensity of the signal in right ear. This image was later shifted to the left ear. The amount of intensity required to shift this fused image to left ear was found out. Similarly, a fused auditory image was formed in left ear first and then it was shifted to right ear. The amount of intensity required to shift the image from left ear to right ear was also obtained. The obtained results for right ear to left ear lateralization and left ear to right ear lateralization were compared. The data were analyzed separately for both right handers and left handers. The conclusions drawn were as follows:-

(I) In right handers, there was no significant difference in the amount of intensity required to shift the fused auditory image of the pulsed tones(500 Hz and 1 KHz)from right ear to left ear and vice-versa.

(II) In right handers, there was a significant difference in the amount of intensity required to shift the fused auditory image of the pulsed tones (2 KHz and 4 KHz) from right ear to left ear at high frequencies.

(III) In left handers, there was no significant difference in the amount of intensity required to shift the fused auditory image of the pulsed tones at all frequencies tested (500 Hz - 4 KHz).

(IV) There was a significant difference in the amount of intensity required to shift the fused auditory image of CV syllables from right ear to left ear and vice-versa, in right handers.

(V) No significant difference was found in the performance of right handers in shifting the auditory image from right ear to left ear and vice-versa for both the nonverbal and verbal stimuli (pure tones and CV syllables).

(VI) The study has suggested that there is involvement of cortex in lateralization task.

CHAPTER-III

METHODOLOGY

METHODOLOGY

SUBJECTS:

The study is comprised of twelve normals and ten stutterers. For easier analysis and comparison normals are termed as Group A and stutterers are termed as Group B. Group A consisted of 9 males and 3 females, ranging their age from 17 years to 21 years (Mean = 18 years). Group B consisted of 9 males and 1 female ranging their age from 18 years to 21 years (Mean = 18.2).

The criteria for selecting the subjects were the following: (A) They should be right handers. (Handedness was determined by asking the subject how he/she would brush teeth, comb hair, use hammer and write) (B) Their hearing threshold level should be within 25 dB, for the frequencies 500, 1000 and 2000 Hz. (C) The difference between the thresholds of the two ears should not be greater than 10 dB.

RECORDING OF THE TEST MATERIALS: Two kinds of test stimuli were used in the study. They were (I) C.V. syllables and (II) Music.

(I) C.V. Syllables: Pa, ba, ka, ga, ta, and da were recorded in the cassette. Tape recorder used was philips F.5112 Stereo Cassette deck.

A male speaker spoke these syllables, keeping the intensity constant. The V.U. meter of tape recorder, gave the indication, so that the intensity was kept constant. The speaker was asked to keep the duration between two syllables constant. The recording was done for about 20 minutes.

(II) Music: For the second part of the experiment. Western music was recorded in the same cassette used for C.V.Syllables. The recording was done through Stereo tape recorder for about 40 minutes. The stimuli were considered nonverbal.

EQUIPMENT AND TEST ENVIRONMENT:

Mainly two instruments are used in this experiment namely a dual channel clinical Audiometer (Beltone 200-C) and a tape recorder(Philips F 5112 Stereo Cassette deck).

The operating control and rear jack pannel of the audiometer is shown in figure-1 and figure-2 respectively. The audiometer was equipped with dynamic earphones Telephonics Type TDH-49.

The tape recorder was used to record the test material and it was played, while testing. The output of the tape recorder was connected to the input "tape" jack of the audiometer (fig.2). The connection was done through a cable. The presentation levels in each ear could be controlled separately.

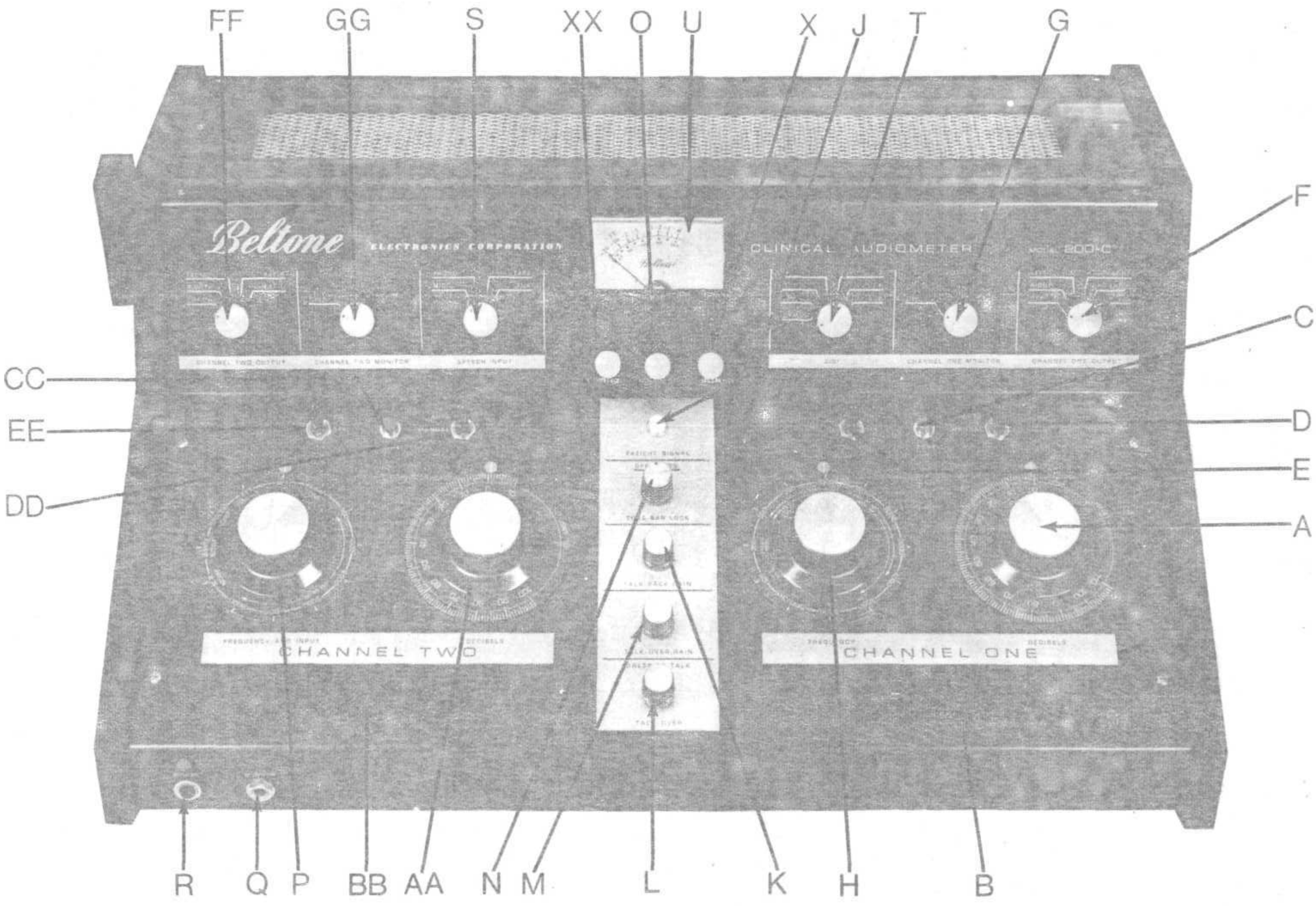

FIGURE 2.1 ILLUSTRATION, OPERATING CONTROLS

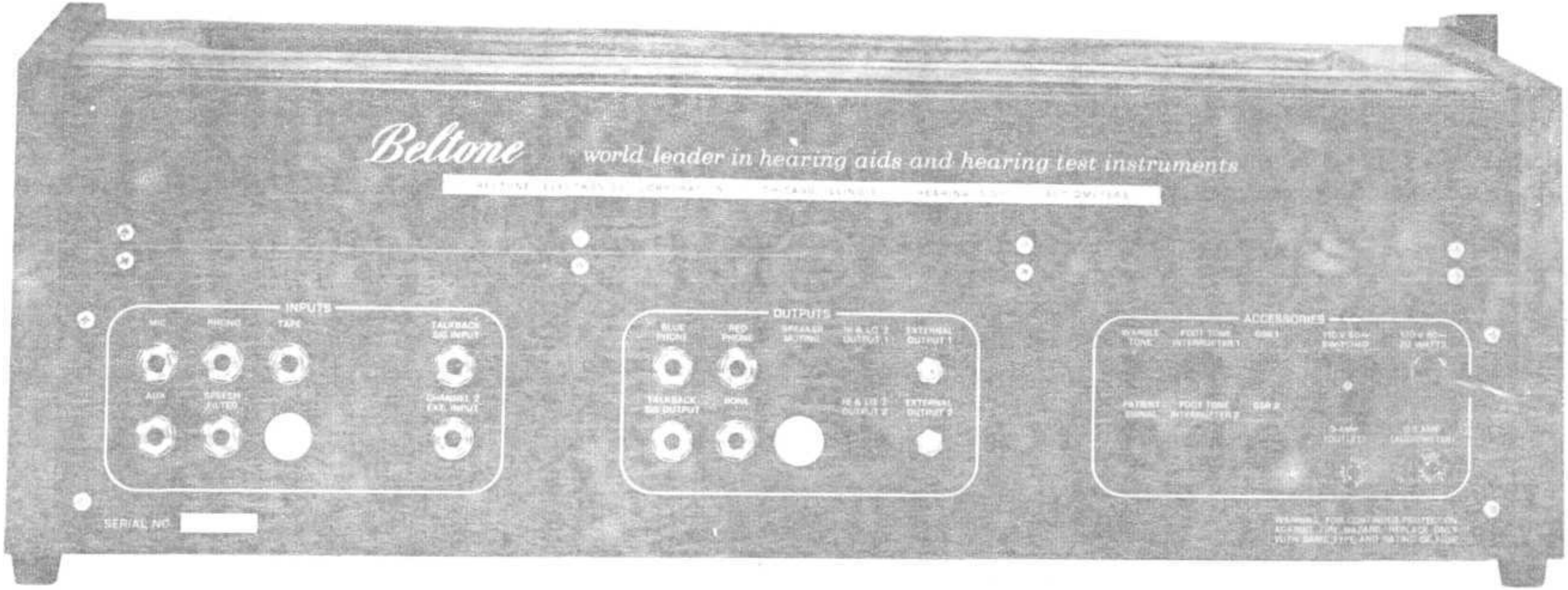

Fig 2: ILLUSTRATION, REAR JACK PANEL

Testing was always conducted in two sound treated room set-up which fulfilled the levels prescribed for audiometric purposes.

The noise levels inside the room at octave intervals were measured using Sound Pressure Level Meter (Bruel and Kjaer type 2203 with Octave filter set Bruel & Kjaer type 1613) and a condensor microphone(Bruel and Kjaer type 4145). The noise levels have been presented in Appendix 'A'.

CALIBRATION OF THE AUDIOMETER:

The audiometer was calibrated to ANSI 1969 specifications,using Bruel and Kjaer equipment. The headphones (Telephonics TDH-49) of Beltone 200-C was coupled to the condensor microphone (B & K type 4145) of the SPL meter (B&K type 2203) with its associated octave band filter set (B & K type 1613) by means of a standard 6 cc coupler. The SPL output of each earphone of both the channels 1 and 2 were checked at octave band intervals from 250 Hz to 8000 Hz (Appendix B).

Audiometer was checked for its linearity. Frequency calibration was done by coupling first, the TDH-49 earphones of the audiometer to the condenser microphone (B & K type 4145) of the SPL meter (B & K type 2203) with its associated octave band filter set (B & K type 1613) by means of 6 cc coupler. The output of the SPL meter was then fed to the frequency counter (Radart type 926 B) to check its frequency calibration at different frequency settings.

Harmonic distortion of the signals was checked at one octave higher than the test frequency signals and was found to be less than 3% distortion.

Calibration of the audiometer was done once in fifteen days.

PROCEDURE:

Each subject was tested as follows:-

Right and left ear pure tone thresholds for 500, 1000 and 2000 Hz were determined. Pure tone average was calculated.

S.R.T. was determined by using spondee words (Standardized by Swarnlatha for english and developed by Mythili for Kannada).

Further, Ear to ear lateralization test was conducted for (I) CV syllables and (II) Music.

For both CV syllables and music I_{R-L} and I_{L-R} were obtained as follows:-

(I) C.V.Syllables:

The subject was instructed "at first, you will hear speech sounds like pa, ba, ka, ga, ta, and da in both the ears simultaneously. Later, when you hear these sounds in right ear, raise your right finger, or, when you hear these sounds in left ear, raise your left finger. When you can not decide in which ear you are hearing the sounds, do not raise your finger. Raise your right finger or left finger only when you are sure that you have heard the sounds in right or left ear, respectively. Do you have any doubt?"

Obtaining I_{R-L} : The C.V. syllables through tape recorder were fed to the audiometer and the subject heard these syllables through earphone.

1. At first the stimuli were presented simultaneously to both the ears at 20 dB above the SRT.

The intensity of right ear and left ear signals were controlled by channel one and channel two respectively. Let the dial readings of right ear and left ear be X_1 and Y_1 dB respectively. At this time the subject will be hearing centrally or in both the ears.

2. Now the intensity in right ear was raised in 1dB steps (keeping the intensity constant in the left ear at Y_1, dB, until the subject had indicated that the sound image had lateralized to his right ear. The dial reading of the right ear was noted down. Let it be X_2 dB.

3. Now the intensity in the left ear (which was at Y_1 dB) was raised in 1 dB steps keeping the intensity constant in the right ear at X_2 dB until the subject indicated that the sound image had lateralized to his left ear. The dial reading of left ear was noted down. Let it be Y_2 dB.

4. The intensity required to shift the fused image from right ear to left ear $I_{R-L} = (Y_2 - Y_1)$dB, was calculated.

Obtaining I_{L-R}: The test procedure to obtain I_{L-R} is similar to that of obtaining I_{R-L} except that the image was first formed in the left ear. However, the procedure was as follows:-

1. C.V. Syllables were presented at 20 dB above the SRT to both the ears. The dial readings of right ear and left ear were noted down. Let it be X_1 and Y_1 db respectively.

2. The sound image was first formed in the left ear. This was done by raising the intensity in the left ear until the subject had indicated that the sound image had lateralized to his left ear. Let the dial reading of the left ear be Y_2 dB.

3. Next, the intensity in the right ear (which was at X_1 dB) was raised, keeping the dial of left ear at Y_2 dB.

The intensity was raised until the image had shifted from left ear to right ear. Let the dial reading of right ear be X_2 dB.

4. The intensity required to shift the image from the left ear to right ear i.e. $I_{L-R} = (X_2 - X_1)$ dB was calculated.

(II) Music:

The subject was instructed as follows: - "Initially you will hear music in both the ears. Later, when you hear music in right ear, raise your right finger. Or when you hear to your left ear, raise your left finger. If you cannot decide as to which ear you are hearing the music, do not raise your finger. Raise your right finger or left finger only when you are sure that you have heard music in your right or left ear respectively. "Do you have any doubt?".

Obtaining I_{R-L}

1. The music was presented simultaneously to both the ears at 20 dB above the SRT. Let the dial readings of right ear (channel one) and left ear (channel two) be X_1 and Y_1 dB respectively. At this time the subject will be hearing centrally or in both the ears.

2. The intensity of the signal in the right ear was increased, keeping the intensity constant at 20 dB above SRT in the left ear (Y_1 dB). Intensity was increased in 1 dB steps until the subject indicated that the sound image had lateralized to his right ear. The dial reading of right ear at this level was noted down let it be X_1 dB.

3. Now the intensity in the left ear (which was at Y_1 dB) was raised in 1 dB steps keeping the intensity constant in the right ear at X_2 dB until the subject indicated that the sound image had lateralized to his left ear. The dial reading of left ear was noted nown. Let it be Y_2 dB.

4. The intensity required to shift the image from right to left i.e. $I_{R - L} = (Y_2 - Y_1)$ dB, was calculated.

<u>Obtaining</u> $I_{L - R}$: The test procedure to obtain $I_{L - R}$ is similar to the procedure of obtaining $I_{R - L}$ except that the image was first formed in the left ear. However, the procedure was as follows:-

1. The stimulus was presented at 20 dB above the SRT in both the ears. The dial reading of right ear and left ear were noted down. Let it be X_1 and Y_1 dB respectively.

The sound image was first formed in the left ear. This was done by raising the intensity in the left ear until the subject had indicated that the sound image had lateralized to his left ear. Let the dial reading of the left ear be Y_2 dB.

3. Next the intensity in the right ear (which was at X_1 dB) was raised, keeping the left ear's dial at Y_2 dB. The intensity was raised until the subject indicated that the sound image had shifted from left ear to right ear. Let the dial reading of right ear be X_2 dB.

4. The intensity required to shift the fused image frow the left ear to right ear i.e. $I_{L-R} = (X_2 - X_1)$ dB was calculated.

The experiment was repeated in the same setting to check the reliability of the experiment, i.e. I_{R-L} and I_{L-R} were found out twice for both CV syllables and music.

Tn order to see that there is any channel difference in the audiometer; four normals were tested. At first, channel 1 was used for right ear and channel 2 was used for left ear. I_{R-L} and I_{L-R} were found out. Then right ear intensity was controlled by channel 2 and left ear channel was controlled by channel 1. Again I_{R-L} and I_{L-R} were found out. No significant difference between two channels was observed.

Since there was no intensity difference, all the studies were done with fixed channels viz. Right earphone was controlled by channel 1 and Left ear phone was controlled by channel 2.

CHAPTER-IV

RESULTS

RESULTS:

Results of this experiment are described in the following steps: (I) Finding the channel difference i.e. an attempt was made to find whether there is difference between two channels of the audiometer. (II) Results obtained from Group A subjects, (III) Results obtained from Group B subjects (stutterers).(IV) Comparison of the results obtained from Group A and Group B subjects.

I. FINDING THE CHANNEL DIFFERENCE: To determine whether there is difference between two channels of the audiometer or not, 4 normal subjects were tested using the two stimuli CV syllables and music.

Firstly, right ear intensity was controlled by channel 1 and left ear intensity was controlled by channel 2. Two readings were taken to find I_{R-L} and I_{L-R} for both stimuli. Means of these two readings were found out.

Secondly, right ear intensity was controlled by channel 2 and left ear intensity was controlled by channel 1. Similarly two readings were taken to find I_{R-L} and I_{L-R} fOr both stimuli. Means of these two readings were found out (Table-1).

From the Teble-1a and 1b it is evident that the error due to the channel differences ranged from 0 dB to 3 dB. Since this error was negligible, the subsequent studies were done using channel 1 for right ear and channel 2 for left ear.

Table-la : I_{R-L} and I_{L-R} values for CV syllables from changing the channel of the audiometer. Key: R.E. - Right Ear; L.E. - Left Ear. I_{R-L} - intensity required to shift fused image from right ear to left ear; I_{L-R} - intensity required to shift the fused image from left ear to right ear.

	CV Syllables					
Sub. No.	RE Chan.l LE Chan.2 I_{R-L} (Mean)	RE Chan.2 LE Chan.l I_{R-L} (Mean)	Error due to diffe-rence in chann-els.	RE Chan.l LE Chan.2 I_{L-R} (Mean)	RE Chan.2 LE Chan.l I_{L-R} (Mean)	Error due to diffe-rence in channels.
1	6	6.5	.5	7	7.0	0
2	7.5	9.0	1.5	8.5	7.0	1.5
3	10.5	13.0	2.5	8.5	10.5	2.0
4	6.0	8.0	2.0	7.5	6.5	.5

Table-1b : I_{R-L} and I_{L-R} values for Music from chancing the channel of the audiometer. Key: R.E. - Right ear; L.E. - Left Ear. I_{R-L} - intensity required to shift fused image from right ear to left ear; I_{L-R} intensity required to shift the fused image from left ear to right ear.

Sub. No.	Music					
	RE Chan.l LE Chan.2 I_{R-L} (Mean)	RE Chan.2 LE Chan.l I_{R-L} (Mean)	Error due to diffe-rence in cha-nnels.	RE Chan.l LE Chan.2 I_{L-R} (Mean)	RE Chan.2 LE Chan.l I_{L-R} (Mean)	Error due to diffe-rence in Cha-nnels.
1	10	9	1.0	8.5	9.5	1.0
2	12.5	12.0	.5	12	15	3.0
3	13.5	14.0	.5	14.5	17.5	3.0
4	12.5	11.0	1.5	13.0	13.5	.5

II. <u>RESULTS OBTAINED FROM GROUP A</u>: Table 2 shows the intensity required to shift the fused image from right ear to left ear (I_{R-L})and the intensity required to shift the fused image from left ear to rioht ear (I_{L-R}) for both stimuli CV syllables and music in normals (Group A)

Table-2: Showing the amount of intensity required to shift fused auditory image from right ear to left ear (I_{R-L}) and fused auditory image from left ear to right ear(I_{L-R}) for CV syllables and music in normals (Group A)

Sl.No.	CV Syllables		Music	
	I_{R-L} (in dB)	I_{L-R} (in dB)	I_{R-L} (in dB)	I_{L-R} (in dB)
1	6	7	10	8.5
2	7.5	8.5	12.5	12.0
3	10.5	8.5	13.5	14.5
4	6	7.5	12.5	13.0
5	16.5	8.5	24.5	18.0
6	10	8.5	12.5	9.5
7	3.5	15.5	12.0	9.0
8	10.0	5.0	8.0	6.0
9	9.5	10.5	6.0	10.5
10	10.0	8.5	12.0	15.0
11	13.5	12.5	22.0	17.5
12	9.5	10.0	9.0	11.0
Mean (M)	9.37	9.20	12.87	12.04
Standard Deviation (S.D)	3.45	2.71	5.35	3.68

For CV syllables the means for I_{R-L} and I_{L-R} were found to be 9.37 and 9.20, respectively. The differences were not statistically significant. The SDs were found to be 3.45 and 2.71 for I_{R-L} and I_{L-R} respectively.

For Music, the mean values for I_{R-L} and I_{L-R} were found to be 12.87 and 12.04. The differences between these two means were not statistically significant. The SD for I_{R-L} was 5.35 and for I_{L-R} was 3.68.

The mean value for I_{R-L} for CV syllables was 9.37 and the mean value for I_{R-L} for music was found to be 12.87. These mean differences were statistically significant at 0.05 level. Normal subjects required significantly lesser intensity to shift the fused, auditory image from right ear to left ear for CV syllables than music. To shift the fused change for music from right ear to the left ear, normal subjects required more intensity.

Similarily the mean values for I_{L-R} for CV syllables was found to be 9.20 whereas for music it was found to be 12.04 Again, the differences between these two means were statistically significant at .05 level. i.e. normal subjects required significantly lesser intensity to shift the fused image from left ear to right ear for CV syllables than music.

III. RESULTS OBTAINED FROM GROUP B SUBJECTS:

Table-3A shows the amount of intensity required to shift fused auditory image from right ear to left ear (I_{R-L}) and from left ear to right ear (I_{L-R}) for CV syllables and music in stutterers.

For CV syllables the mean values for I_{R-L} and I_{L-R} were found to be 14.6 and 14.15 respectively. These mean differences were not statistically significant. The S.D. for I_{R-L} was 6.49 and for I_{L-R} was 9.89.

For music the mean values for I_{R-L} and I_{L-R} were found to be 15.95 and 14.80 respectively. The differences were not statistically significant. SDs were 10.62 and 11.13 respectively.

The mean values for I_{R-L} for CV syllables and I_{R-L} for music were found to be 14.6 and 15.95 respectively. These mean differences were not statistically significant.

Similarity the mean value for I_{L-R} - for CV syllables was found to be 14.15 and I_{L-R} for music it was found to be 14.8. Again, these mean differences were not statistically significant.

Table-3A: Showing the amount of intensity required to shift fused auditory image from right ear to left ear (I_{R-L}) and fused auditory image from left ear to right ear (I_{L-R}) for CV syllables and music in stutterers (Group B).

Sl.No.	CV Syllables		Music	
	I_{R-L} (in dB)	I_{L-R} (in dB)	I_{R-L} (in dB)	I_{L-R} (in dB)
1	10	8.5	7.5	10.5
2	8	5.5	8.0	5.5
3	14.5	4.5	9.0	11.0
4	25.5	22.0	17.0	17.5
5	16.5	22.0	17.0	19.0
6	14	7.0	10.0	8.0
7	9	15.0	18.0	19.5
8	7.5	5.5	14.0	4
9	25.0	34.5	44.0	42.5
10	16.0	17.0	15.0	10.5
Mean(M)	14.6	14.15	15.95	14.8
S.D.	6.49	9.89	10.62	11.13

In this group there was only one subject (subject No.9) who developed stuttering at later age (stuttering was not reported since childhood). He required more intensity to shift the fused auditory image from right ear to left ear and left ear to right ear, for both CV syllables and music. The reliability of his responses was checked twice.

Mean values for I_{R-L} and I_{L-R} for CV syllables and music are computed excluding this particular case.

Table 3B shows I_{R-L} and I_{L-R} values (with means) for CV syllables and music for nine subjects (subject No.9 is excluded).

Table-3B: Showing the amount of intensity required to shift fused auditory image from right ear to left ear (I_{R-L}) and fused auditory image from left ear to riaht ear (I_{L-R}) for CV syllables and Music in stutterers for only 9 subjects (excluding subject No.9).

Sl.No.	CV Syllables		Music	
	I_{R-L} (in dB)	I_{L-R} (in dB)	I_{R-L} (in dB)	I_{L-R} (in dB)
1	10	8.5	7.5	10.5
2	8	5.5	8.0	5.5
3	14.5	4.5	9.0	11.0
4	25.5	22.0	17.0	17.5
5	16.5	22.0	17.0	19.0
6	14.0	7.0	10.0	8.0
7	9.0	15.0	18.0	19.5
8	7.5	5.5	14.0	4.0
10	16.0	17.0	15.0	10.5
Mean	13.44	11.88	12.83	11.72

COMPARISON OF RESULTS OBTAINED FROM GROUP A AND GROUP B:

Observing the mean values of Table 2 and Table 3A, it can be interpretated that stutterers require more intensity to shift the image from right ear to left ear and vice versa for both CV syllables and music. The means are compared using t-test the results are as follows:-

1. The mean value for for CV syllables in normals was 9.37 whereas in stutterers it was found to be 14.6. These mean differences were statistically significant at .05 level.

2. The mean value for I_{L-R} for CV syllables in normals was found to be 9.20 whereas in stutterers it was found to be 14.15. These mean differences were not statistically significant.

3. The mean value for I_{R-L} for music in normals was found to be 12.87, whereas in stutterers it was found to be 15.95. These mean differences were not statistically significant.

4. The mean value for I_{L-R} for music in normals was found to be 12.04, whereas it was found to be 14.8 in stutterers. These mean differences were not statistically significant.

For quick reference, table 4 and Table 5 have been presented. Table 4 shows the t-values (Paired t - test was used to compare the performances within the groups). Table 5 also shows the t values (t-test was used to compare the performances between Group A and Group B).

Figure 13 represents the mean values of I_{R-L} and I_{L-R} for CV syllables and music in both the groups. Mean value is also calculated excluding the subject No.9 of Group B and shown in the graph.

Table-4: Shows the t values. Paired t-test was used to find whether these is significant difference in intensity required to shift the fused auditory image from one ear to other ear.

Key: N.S: Not significant - at .05 level.

S: Significant at .05 level but not at .01 level.

Group	Variable	Degree of	t - values
A	I_{R-L} (CV syllables) Vs I_{L-R} (CV syllables)	11	- .122 (N.S)
A	I_{R-L} (Music) vs I_{L-R} (Music)	11	- 0.898 (N.S)
A	I_{R-L} (CV syllables) Vs I_{R-L} (Music)	11	2.98 (S)
A	I_{L-R} (CV syllables) Vs I_{L-R} (Music)	11	3.27 (S)
B	I_{R-L} (CV syllables) vs. I_{L-R} (CV syllables)	9	-0.235 (N.S)
B	I_{R-L} (Music) Vs. I_{L-R} (Music)	9	-0.927 (N.S)
B	I_{R-L} (CV Syllables) vs I_{R-L} (Music)	9	0.526 (N.S)
B	I_{L-R} (CV syllables) vs I_{L-R} (Music)	9	.435 (N.S)

Table:5 - Shows the mean and t-values. t-test was used to determine whether means obtained from Group A and Group B are statistically significant or not.

Key :- NS - Not significant at .05 level

S - Significant at .05 level but not at .01 level.

	CV syllables			Music		
	Mean Group A	Mean Group B	t values	Mean Group A	Mean Group B	t values
I_{R-L}	9.37	14.6	2.41 (S)	12.87	15.95	-0.881 (N.S)
I_{L-R}	9.20	14.15	1.67 (N.S)	12.0	14.8	.823 (N.S)

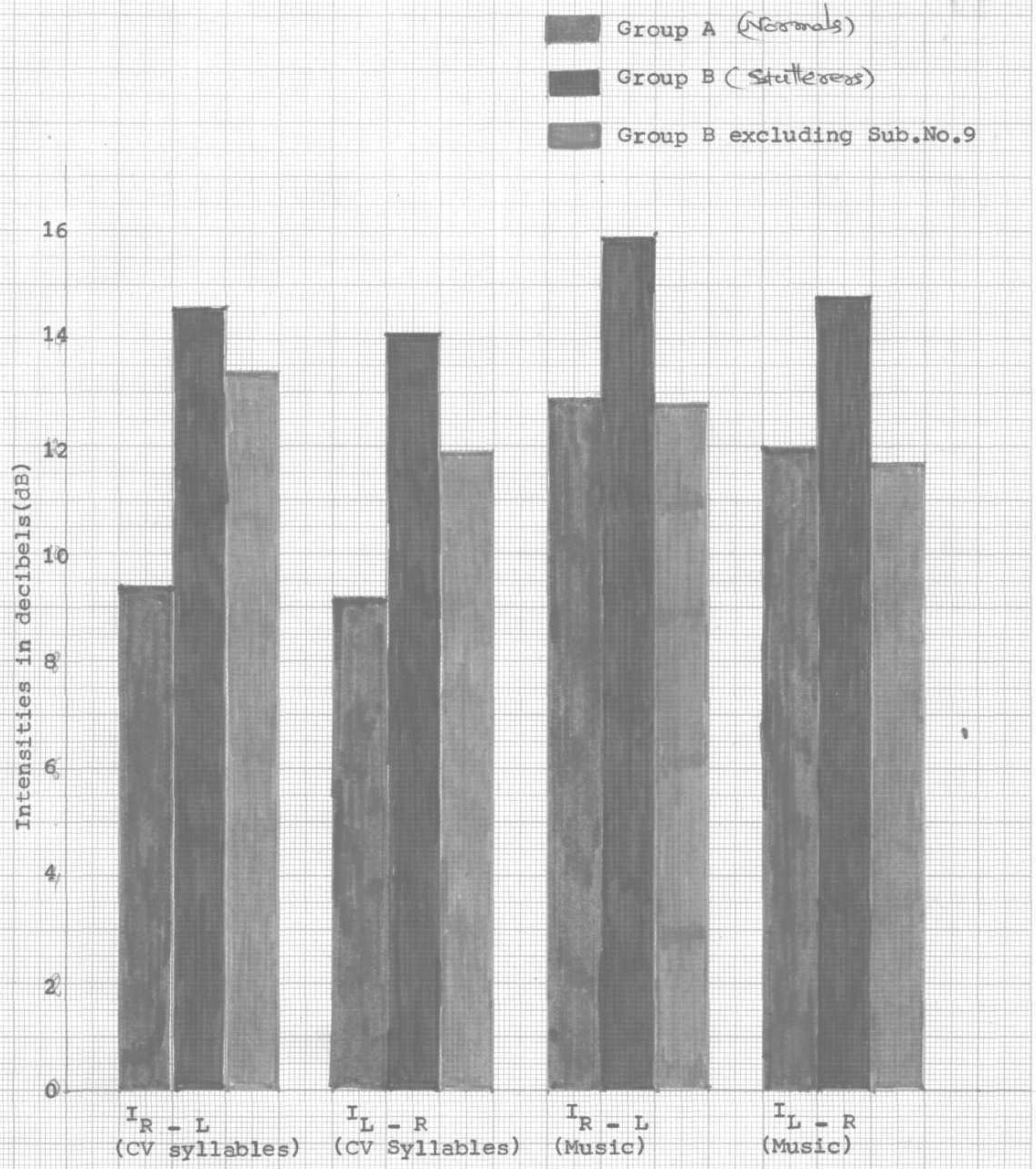

Figure:3: Mean values of I_{R-L} and I_{L-R} for CV syllables and music obtained from Group A, Group B and Group B subjects excluding the subject No.9.

CHAPTER-V

DISCUSSION

DISCUSSION

According to Orton (1928) and Travis (1931) stuttering results from incomplete cerebral dominance. The theory has been repopularized by Jones (1966). After many years cerebral dominance hypothesis enjoys renewed interest (Moore and Haynes, 1980). Handedness seem to be related with hemisphere specialization. Dichotic listening tests have been used to determine cerebral dominance. In such tests right ear preference has been typically observed for verbal and linguistic materials in most normal right handed persons (Berlin and Lowe, 1972; Kimura, 1961; Moore and Weidner, 1975). This right ear advantage indicates left hemispheric processing for verbal and linguistic stimuli. Similarily left ear advantage indicating right hemisphere processing for nonverbal acoustic functions in most normal right handed persons have been reported (Milner, 1962; Kimura, 1964; Channey and Webster, 1966; Berlin and Mc Neil, 1974). When dichotic listening tests were used with stutterers they exhibited an absence, reduction or reversal of right ear advantage for verbal or linguistic materials.

The evidence of central auditory deficiency has been recently reported in the literature (Toscher and Rupp, 1978; Hall and Jerger, 1978; Liebetrau and Daly, 1981). Pinheiro and Tobin (1969; 1971) opine that any lesion in the central auditory system may interfere inter-aural intensity difference for intra cranial lateralization. Therefore the present investigation was undertaken to see whether there is any significant inter-aural intensity difference for lateralization of auditory image in stutterers as compared to normals.

It has been reported that the cortex is involved in ear to ear lateralization of auditory image (Meena Devi, 1976).

Overstake (1979) in his book "Stuttering" — A new look at an old problem based on neurophysiological aspects emphasized the role of cerebellum and cerebral cortex in stuttering behaviour. According to him cerebellum is like a large computer that receives the information to act in a motor way. It computes the motor behaviours from muscle movements or patterns that have been learned and sends the resultant or computer readout to the cortex. The motor cortex is a project area of the brain from which nerve impulses are "fired" so to speak, to initiate muscle actions. The cerebral motor cortex carries out the motor behaviour as specified by the cerebellum. The cerebellum is a store house of learned or acquired muscle patterns, actions, behaviours etc. that have been learned or programmed in its cells. Speech is considered as one of the motor behaviours. Voluntary motor responses are ordered by the cerebral cortex. They are computed, programmed and initiated by the cerebellum. The finalized or computed information concerning the nature of motor action is forwarded to the motor cortex which follow the program. Speaking utilizes the muscles of the lips, jaw, tongue, soft palate or velum, pharynx, larynx etc. The actions of the muscles and muscle groups involved must be highly synchronized for speech to be appropriately emitted. Speech appears to be accomplished in the following manner. The association areas of the cortex are involved in receiving sensory stimuli, words etc, deciphering them and abstracting their meanings. There areas are concerned with the thinking process that occur. The person decides what he wishes to say. This message is sent to the cerebellum which programms that muscle behaviours necessary to send the message to speak. The muscle activities for the articulation of speech phonemes and the associated motor behaviours of breathing and langeal valving (phonation) are computed. The resultant or planned program is neurophysiologically transmitted to the cerebral motor cortex. The child between the ages of 2 - 4 pears stutters because his nervous system is not yet matured. Therefore, the cerebellum is not yet able to handle adequately or satisfactorily the flow of messages from the association areas of the cerebral cortex and convert them into refined synergic muscle patterns to be carried out by the cerebral motor cortex. The person who continues to stutter even beyond five years, is the child who has thought to behaviour change. This change can occur at any age at any time. All people think some words or sentences before they start talking whereas the people having stuttering do not think words ahead, nor do they think sentences ahead while trying to speak at the same time. For them speaking is behind or delayed in relation to thinking.

There are direct neural connections between the association or silent areas of the cerebral cortex, the parietal lobe etc. and cerebellum. In opinion of Overstake there is confusing state of affairs concerning messages to the cerebellum in terms of what is desired in the way of motor behaviours for speech output. The cerebellum as computer becomes jammed, so to speak so that phase relations are disturbed and muscle behaviours for speech is lacking in synergy. Therefore repetition, hesitation, prolongations and stoppages occur.

Overstake realizes that this theory is not the answer of all the questions regarding stuttering, but he desires to stimulate thinking along new lines of reasoning and facilitate new research and experimentation that will be eventually result in finding the correct answers of the problem.

The present study is an attempt to find whether there is any difference in the performances of normals and stutterers on ear-to-ear lateralization test.

The results of the present study show that there is significant difference between mean I_{R-L} for CV syllables required for normal subjects and the mean I_{R-L} for CV syllables required for stutterers. The stutterers recruired greater I_{R-L} values than normals. This finding suggests that the mechanism involved in shifting the fused auditory image for CV syllables from right ear to left ear may differ from that of the normal subjects. Does this indicate that in stutterers it will be difficult to shift the auditory image for CV syllables from dominant hemisphere (left hemisphere) to non-dominant hemisphere? Further studies on the same lines of the present investigation may throw some light on the above question.

Among the stutterers tested, one of the stutterers required considerably greater I_{R-L} and I_{L-R} values. This shows that there are individual differences in stutterers. Individual differences in stutterers are well documented. The present study also showed individual differences in stutterers. Interestingly, the stutterer who showed large individual difference had onset of stuttering at about 12 years unlike other stutterers in the group (all the remaining stutterers had early onset of stuttering).

Normal subjects show significant difference between I_{R-L} (CV syllables) and I_{R-L} (music). This difference in I_{R-L}

between CV syllables and music is not observed in stutterers.

Also, normal subjects showed significant difference bet-week I_{L-R} (CV syllables) and I_{L-R} (music). This difference is not observed in stutterers.

In other words, normal subjects require less intensity for shifting the fused auditory image of CV syllables from one ear to other ear and require more intensity for shifting the fused auditory image of music from one ear to another ear. The results show that the stutterers required more intensity for shifting the fused auditory image for both CV syllables and music i.e. their performance with regard to shifting the auditory image from one ear to another ear does not differ for CV syllables and music. Does this mean that the mechanism involved in shifting the auditory image from one ear to another ear for CV syllables and music is same in stutterers? Further study on the same lines of the present study may be undertaken to get the answer.

Perhaps it may be pointed out that the final judgement of lateralization is slightly impaired in stutterers as they required more intensity for shifting the fused image. It is believed that the final judgement of lateralization is done at the cortical level.

With the above discussion it may be inferred that some organic problem at the cortical level might be responsible as higher intensities were required for shifting the fused image in stutterers. The present study shows that there is some sort of organic involvement in stutterers at the cortical level.

CHAPTER-VI

SUMMARY & CONCLUSIONS

V

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SUMMARY AND CONCLUSION

The study is comprised of 12 normals and 10 stutterers. All the subjects of this study were right handers and they had normal hearing in both the ears. Their age ranged from 16 years to 30 years. Ear to Ear lateralization test was administered for all the subjects using recorded CV syllables (pa, ba, ka, ga, ta and da) and Western music as follows:-

At first the stimulus was presented simultaneously to both the ears at 20 dB above SRT. The intensities of right ear and left ear were controlled by channel 1 and channel 2 respectively. Let the dial readings of right ear be X_1 and Y_1 dB respectively (20 dB above SRT). At this time the subject heard the stimulus centrally. Now the intensity of right ear was raised in 1dB steps (keeping the intensity constant in left ear at Y dB) until the subject heard the stimulus in the right ear. The dial reading of the right ear was noted down. Let it be X_2 dB. Now the intensity of left ear was raised in 1 dB steps (keeping the intensity constant in the right ear at X_2 dB) until the subject lateralized the image in his left ear. The dial reading of left ear was noted down. Let it be Y_2 dB. The intensity required to shift the fused image from right ear to left ear $I_{R-L} = (Y_2 - Y_1)$ dB was found out.

Similarily the intensity required to shift the fused auditory image from left ear to right ear was also found out i.e. stimulus was initially presented at 20 dB above S.R.T. in both the ears. The dial reading of right ear (assumed X_1) and left ear (assumed Y_1) were noted down. Now intensity was raised in left ear keeping the right ear intensity (X_1) constant, until the image shifted to left ear. Let the dial reading of left ear be Y_2 dB. Next, the intensity in the right ear (which was at X_1 dB) was raised keeping the left ear's dial Y_2 constant. This intensity was raised until the subject indicated that the auditory image had shifted from left ear to right ear. Let the dial reading of right ear be X_2 dB. The intensity required to shift the fused image from the left ear to right ear (I_{L-R}) was calculated as(X_2 - X_1) dB.

This test was done using two types of stimuli namely CV syllables and western music. Each test was repeated in order to check the reliability of responses. The average score was considered.

The following conclusions were drawn from this study:-

1. There was no significant difference between the intensity required to shift the fused auditory image from right ear to left ear (C.V. syllables) and left ear to right ear (C.V. syllables) in normals.

2. There was no significant difference between intensity required to shift the fused auditory image from right ear to left ear (music) and left ear to right ear (music) in normals.

3. Normal subjects required significantly lesser intensity to shift the fused auditory image from right ear to left ear for CV syllables than the intensity required to shift the fused auditory image from right ear to left ear for music.

4. Normal subjects required significantly lesser intensity to shift the fused auditory image from left ear to right ear for CV syllables than the intensity required to shift the fused auditory image from left ear to right ear for music.

5. There was no significant difference between the intensity required to shift the fused auditory image from right ear to left ear (CV syllables) and left ear to right ear (CV syllables) in stutterers.

6. There was no significant difference between the intensity required to shift the fused auditory image from right ear to left ear (music) and left ear to right ear (music) in stutterers.

7. In stutterers there was no significant difference between the intensity required to shift the fused auditory image from right ear to left ear for CV syllables and intensity required to shift the fused auditory image from right ear to left ear for music

8. In stutterers there was no significant difference between the intensity required to shift the fused auditory image from left ear to right ear for CV syllables and intensity required to shift the fused auditory image from left ear to right ear for music.

9. Normals required significantly lesser intensity than the stutterers to shift the fused auditory image from right ear to left ear for CV syllables.

10. There was no significant difference in intensity required to shift the fused auditory image from left ear to right ear for CV syllables between normals and stutterers.

11. There was no significant difference in intensity required to shift the fused auditory image from right ear to left ear for music between normals and stutterers.

12. There was no significant difference in intensity required to shift the fused auditory image from left ear to right ear for music between normals and stutterers.

LIMITATIONS:

1. The present study was done on ten stutterers only.
2. Left handers were not included in the present study.

RECOMMENDATIONS:

1. It may be worthwhile to study the performance of subjects having central auditory dysfunction on the ear-to-ear lateralization test.

2. As the present study has revealed individual difference in stutterers more number of stutterers differing in the onset of stuttering may be tested.

3. The finding that the stutterers require greater intensity for shifting the fused image from one ear to another ear, should be confirmed by testing a large number of stutterers.

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APPENDICES

APPENDIX-'A'

- NOISE LEVELS IN AUDIOMETRIC ROOM, DB ref.0002 dynes/cm2.

A Net work	-	23 dB
B Net work	-	28 dB
C Net work	-	36 dB

OCTAVE BAND ANALYSIS

CENTRE FREQUENCY	LEVEL
125 Hz	25 dB
250 Hz	20 dB
500 Hz	19 dB
1000 Hz	19 dB
2000 Hz	10 dB
4000 Hz	12 dB

APPENDIX - 'B'

TDH-49 Earphone (with MX 41/ AR Cushion) output of Channel 1 and channel 2 of the Audiometer Beltone 200-C at different frequencies.

Frequency in Hz	ANSI-1969 reference equivalent thresh-old sound pressure levels at 80 dB HL	Channel 1 output in dB SPL	Channel 2 output in dB SPL
250	106.0	112	113
500	91.0	99	100
1000	87.0	96	95
2000	89.0	98	99
4000	93.5	99	100
6000	88.5	103	102
8000	91.0	97	96

APPENDIX C

Test-retest and average values for I_{R-L} and I_{L-R} for CV syllables and music for each subject of Group A.

Sub. No.	CV syllables						Music					
	I_{R-L} Ist trial	I_{R-L} 2nd trial	Average	I_{L-R} 1st trial	I_{L-R} 2nd trial	Average	I_{R-L} 1st trial	I_{R-L} 2nd trial	Average	I_{L-R} 1st trial	I_{L-R} 2nd trial	Average
1	7	5	6	6	8	7	10	10	10	10	7	8.5
2	7	8	7.5	8	9	8.5	12	13	12.5	13	11	12.0
3	9	12	10.5	8	9	8.5	9	18	13.5	11	18	14.5
4	6	6	6	7	8	7.5	12	13	12.5	10	16	13.0
5	16	17	16.5	9	8	8.5	25	24	24.5	18	18	18.0
6	10	10	10	9	8	8.5	13	12	12.5	9	10	9.5
7	3	4	3.5	17	14	15.5	12	12	12	9	9	9.0
8	10	10	10	4	6	5.0	8	8	8	6	6	6.0
9	8	11	9.5	11	10	10.5	6	6	6	10	11	10.5
10	11	9	10.0	8	9	8.5	12	12	12	15	15	15.0
11	13	14	13.5	12	13	12.5	21	23	22	18	17	17.5
12	10	9	9.5	10	10	10.0	8	10	9.0	10	12	11.0

APPENDIX-D

Test - Retest and average values for I_{R-L} and I_{L-R} for CV syllables and music for each subject of Group B.

Sub. No.	CV syllables I_{R-L} 1st trial	I_{R-L} 2nd trial	Average	I_{L-R} 1st trial	I_{L-R} 2nd trial	Average	Music I_{R-L} 1st trial	I_{R-L} 2nd trial	Average	I_{L-R} 1st trial	I_{L-R} 2nd trial	Average
1	10	10	10	7	10	8.5	7	8	7.5	10	10	10.5
2	8	8	8	5	6	5.5	6	10	8.0	5	6	5.5
3	15	14	14.5	4	5	4.5	9	9	9.0	10	12	11.0
4	24	27	25.5	20	24	22.0	19	15	17.0	17	18	17.5
5	15	18	16.5	22	22	22.0	17	17	17.0	20	18	19.0
6	15	13	14.0	6	8	7.0	10	10	10.0	9.0	7.0	8.0
7	8	10	9.0	17	13	15.0	18	18	18.0	20	19	19.5
8	7	8	7.5	6	5	5.5	14	14	14.0	4	4	4.0
9	25	25	25.0	34	35	34.5	45	43.0	44.0	42	43	42.5
10	16	16	16.0	15	19	17.0	16	14	15.0	10	11	10.5