PERCEPTION OF MUSICAL RHYTHM IN STUTTERERS

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Certificate

This is to certify that this dissertation entitled **"Perception of musical rhythm in Stutterers"** is bonafide work in part fulfillment for the degree of **Master of Science (Speech and Hearing)** of the student **(Register No. 02SH0008).**

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This is to certify that this dissertation entitled **"Perception of musical rhythm in Stutterers"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier in any other University for the award of any Diploma or Degree.

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This is to certify that this dissertation entitled **"Perception of musical rhythm in Stutterers"** is the result of my own study under the guidance of Dr. S. R. Savithri, Reader and Head, Department of Speech and Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other University for the award of any Diploma or Degree.

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TO. . . . .

AAI & BABA..

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CHAPTER I

INTRODUCTION

The suprasegmental features of a language are those properties of speech sounds that appear simultaneously with the phonetic features, but are not confined to phonetic segments and instead are overlaid or superimposed on syllables, words, phrases and sentences. Although much information in speech is conveyed by the segmental phonemes, the prosodic features carry additional information. It includes intonation, stress, rhythm and juncture (pause) or phrasing. Listener's perception of suprasegmental features is dependent on the acoustic cues of vocal fundamental frequency, intensity and/or overall temporal pattern (Fucci & Lass, 1999)

Segmental independence holds that duration of a suprasegmental unit such as a syllable or foot is only minimally dependent on its segments. The duration of a segment is determined by the duration of its suprasegmental unit, and its identity but not directly by the specific prosodic context responsible for suprasegmental unit duration. Both the assumptions are made by various versions of the isochrony hypothesis and syllable-timing hypothesis (Lehiste, 1977). Santen &Shih (2000) studied the concept of suprasegmental timing, segmental independence and suprasegmental mediation. The validity of these assumptions was studied, using the syllable as suprasegmental unit in American English and Mandarin Chinese. They concluded that there is a doubt that suprasegmental units play important predictive and explanatory roles as phonological units, and that the concept of suprasegmental timing is less promising.

Prosody may serve as the interface between the low level segmental information and higher levels of grammatical structures in speech (Pisoni & Sawusch, 1975). Prosody carries direct phonetic cues to certain semantic and grammatical classes. Therefore it serves to restrict the search processes whereby contact is made between cognitive representation and acoustic representation (Haggard, 1975). Haggard further hypothesized that this restrictive role of prosody may take either of two forms or both the prosodic information could be additive, i.e., it may simply add together with information present at various levels to make the processing, recording and decision making more rapid and more accurate, and prosody influences the allocation of processing capacity in terms of power, temporal location and duration. In such a system, prosodic information, appropriately used, would serve as an interface or control function to ensure the most efficient strategy for a given long term processing demand. If this hypothesis is true, its converse would hold good that inappropriate use of prosody in perception would significantly reduce processing efficiency (i.e., contribute to auditory processing deficiencies) while dysprosodic production would stress listeners perceptual processing and/or degrade comprehension of the intended message.

One aspect of prosody is rhythm. Prosodic rhythm may be defined as the perception of a patterned time program underlying sequences of speech. Rhythm refers to the pattern of stress on a string of syllables/utterances. The rhythm in speech gives shape to the sentence, an idea of length of a sentence and melody. Rhythm has three basic elements namely timing, duration, and intensity and also eight subsiding concepts which are pulse, tempo, number, timing, duration, loudness, metre and phrasing.

Rhythmic and segmental perception are not independent (Martin, 1979). We characterize the input to speech production by a string of discrete and independent segments. However, when a segmental string is encoded into an intact sentence, the acoustic consequences are neither discrete nor independent. The acoustic realization of the string depends upon the identity of the segments themselves and the effect of local context or coarticulation (Cooper, Delattre, Liberman, Borst &Gerstman, 1952; Liberman, Delattre, Cooper& Gerstman, 1954;Ohman, 1966) and also the effects of prosody. Both tempo and segment identity are manifested in the acoustic realization of the segments. These factors cannot be separated during production. Any given temporal difference modulates the segments to some degree so that the resulting string carries information about both tempo and segmental identity. Studies on prosodic features in the languages of India are few. Authors like Ohala (1977). Balasubramanian (1980) Haynes & Lahiri (1991), Nayak (1980), Krishnabhatta (1985) and Karki (1986) have investigated prosody in Hindi, Tamil and Kannada.

Savithri (1995) studied rhythm in Kannada. In her study twenty-two listeners were asked to say whether they perceived any rhythm on the sentences. If so, they were told to identify the rhythm by tapping on the syllables with rhythmic beats and to say the cues they used to choose the syllables to which to tap. It was found that not all listeners perceived a rhythm to which they could tap and those who did perceive some rhythm, varied in their choices of cue identification.

Rhythm in speech is not regular. However, when it is poetry or music one finds a regular rhythm. The fact that music has regular rhythm is well known. Investigations have also been conducted on the biologic substrates of music perception. Music does not ordinarily involve cross modality activity. Accordingly, we can expect that musicians would reveal an increase in the extent to which they use the right hemisphere for unitary musical tasks; it's a fact that musicians are more strongly right hemisphered for unitary musical tasks. It is supported by the studies by Gorden, (1978), Gaede, Parsons & Bertera, 1978, Gates & Bradshaw, 1977, Johnson, 1977, Zatorre, (1978). It can be expected that with increased musical experience, musicians and nonmusicians would build up a balanced representation of musical function. More complex musical motives would be treated in a unitary fashion, while relational processes bind them together.

In 1736, it was noted that a man who lost his speech following "a violent illness" retained the ability to sing hymns (Benton &Joynt, 1960). It was yet another 100 years before researchers began investigating the unique musical capacities of the right hemisphere. Milner (1962), for e.g. reported that her patients had impaired musical discrimination following right temporal lobectomy.

In the Indian context perception of rhythm in music has been studied in normals with respect to musicians and nonmusicians. Rhythm perception was studied by Odekar (2001) in 32 normal non musician adults. Results showed no significant difference between the performances of the two ears during monaural presentations. This may indicate some amount of cross hemispheric activity and equal ability of each ear in handling rhythm perception when the melodies were presented in the absence of any competition. Significantly greater number of subjects perceived the rhythm structure presented to the left ear and in dichotic paradigm suggesting left ear-right hemisphere superiority in the perception of rhythm.

Stuttering is considered to be a disorder of rhythm. Travis (1931), Ortan (1927) and Brynglson (1935) put forth the Cerebral Dominance Theory. According to the Cerebral Dominance Theory, the language-processing center is normally located in the left hemisphere of the brain. Therefore, the left side of the brain is the more dominant side, used for processing speech. In persons who stutter, however, one of these things could be happening: the hemispheres of the brain are struggling to gain dominance of the speech center or the speech center is Located in the right hemisphere which is inadequate for processing language, or the pathways for speech start in the left hemisphere and a jog through the right hemisphere rather than staying on the left hemisphere of the brain. This suggests that stutterers use inefficient pathway of talking. This insufficiency shows up as hesitations, repetitions, blocks and other behaviours associated with stuttering.

If there is a left ear advantage in rhythm processing and if stuttering is a resultant of reverse Cerebral Dominance, then it could be hypothesized that stutterers should have right ear advantage in rhythm processing task. It would be interesting to see if stutterers have difficulty in perceiving musical rhythm. In this context, the present study was planned. It investigated the perception of musical rhythm and ear preferences in stutterers. It was hypothesized that perception of musical rhythm would be lateralized to left ear. Specifically musical rhythms of Carnatic classical music were used in monaural and dichotic conditions.

CHAPTER II

REVIEW OF LITERATURE

Rhythm can be understood as the pattern of time intervals that elapse between successive accented syllables. Rhythm is the structural support of a musical composition. It dictates the perceived motion of the piece through note lengths and accents. Rhythm is the element of time in music. (Since music is an art that exists solely in time, rhythm controls ultimately all the relationships within a musical work). According to Boyden (1956), rhythm forms the first element from which music is composed, followed by melody, harmony and tone colour. And hence, it plays an important role in regulating and ordering the time relationships of tones.

Concept of rhythm in music

In the western music, Deri (1968) delineates there sub components: beats, measure and meter. The flow of time is divisible into measures which are of equal duration and are marked off by regularly occurring beats. The note/ syllable at this pulse is made more prominent than surrounding sounds by means of increased loudness, pitch or duration or combination of some/ all of these parameters. These measures are grouped together in phrases of seven measures.

In western music, the rhythmic regularization takes place in following ways as given by Leeuwen (1999)

- Regularization of tempo,
- Regularization of sounds per measure, and

- Regularization of measures per phrase.

Rhythm covers everything pertaining to the time aspect of music, as distinct from the aspects of pitch, i.e., it includes the effects of beats, accents, measures, grouping of notes and into beats, grouping of beats into measures, grouping of measures into phrases, etc. When all these factors are judiciously treated by the performer we feel and say that the performer possesses a sense of rhythm, in music.

Concept of ta:la in music

In Indian music ta:la (time measure) has a very important role. It is a medium for expressing rhythm through logical and systematic method, and is not just 'keeping time'. A ta:la is a rhythmic structure consisting of a definite pattern that rotates in a cyclic manner, each cycle being called an 'a:vritti'. The various aspects of ta:la are as follows (Ghosh, 1968):

a) Martra (metrical accents/subdivided beats): Matras are equally spaced sub divisions of the ta:la. They can be stressed or unstressed. The total number of ma:tras in each cycle of a ta:la varies according to the specific constructions of the specific ta:la.

b) Anga: Ma:tras of a ta:la are grouped into different duration or sections, each section called the anga.

c) Laya: Laya is equivalent to the concept of tempo in western music. The "vilambita laya" stands for show tempo, the 'madhyama laya' is akin to medium tempo and the 'dhruta laya' means fast tempo.

d) Tali, khali and sam: In Indian music, folk or classical, there is a system of keeping time either by clapping/ with the help of gongs and bells to maintain the correctness of the rhythmic outline.

e) Tali: A rhythmic stress/ gha:ta, indicated by a clap.

f) Kha:li: A soundless unaccented beat indicated by a movement of a finger.

g) Sam: A point of highest stress in a ta:la cycle. It is the closing point of a ta:la of a:vrtti indicating its completeness and contentment.

h) Ja:ti: The ta:las are grouped into five ja:tis namely:

1. Catusra: Consists of four ma:tras/ four akshras, the first akshara being the ghata. **1**234 **1**234
2. Tisra: Consists of three aksharas the first akshara indicated by a gha:ta. 123 **1**23
3. Khanda: Consists of five aksharas, the first and the third akshara being accented. **1**23**4**5 **1**23**4**5
4. Misra: Consists of seven aksharas. The most common ta:la of which has accents on the first, fourth and sixth akshara. **1**23**4**5**6**7 **1**23**4**5**6**7
5. Sankirna: Consists of nine akshras.

Hence ta:las arise with various combinations of aksharas or ma:tras.

Perception of rhythm in Music

Many systems within our body are based on rhythm eg: Cardiovascular system and the Nervous system. Though evidence is inconclusive, it is possible that the natural internal rhythms of our nervous system play a key role in the brains ability to perceive musical rhythm (Epstein, 1995). Different theories are put forth to show how people respond to rhythm. According to Deri (1968), the rhythm perception does not come about by intellectualizing the musical experience but by becoming aware of the bodily or physical response to rhythmic stresses. The way, even a layman should have some awareness of beats which keeps developing through experiences with music.

The motor theory described by Lundin (1953) centers around the idea that rhythmic responses are dependent on the action of the voluntary muscles. According to this theory our perception of rhythm is based on our response to our own sequential voluntary muscle activity, eg: voluntary muscle response to music is our natural tendency to tap our feet or hands to the beat of the song. Chaitanyadeva (1967) viewed perception of rhythm as a recurrence of attention at specified instances of time. According to him rhythm perceptions affected by personal factors as it is highly subjective and not a mere objective division of time.

Early research in the perception of rhythm indicated that even isochronous unaccented beats may elicit the experience of alternating strong and weak pulses, a phenomena called 'subjective rhythm' (Woodrow, 1951). This rhythmic structure so perceived is called the metrical accent. The rhythmic structure of tonal music is so closely allied to its metrical organization that (rhythm and meter) are identical. In this view our experience of musical rhythm depends on the periodic stress supplied by a regularly recurring meter.

The theories that explain perception of rhythm can be broadly classified into the expectancy theories and the recent entrainment models. The expectancy hypothesis was researched by many authors and musicologists. Simon and Summer (1968) reviewed music perception as an exploration task, where the listener predicts future patterns based on analysis of the current pattern. Povel & Essens (1985) proposed that in perceiving a metrical accent, listeners induce an internal clock or "innate expectancies". It is this clock which guides the points of anticipatory attention to the listener to promote the perception of rhythm.

The entrainment model proposed by Large & Kolen (1996), states that the perception of metrical structure is a dynamic process where the temporal organization of external musical events synchrosis or entrains a listener's interval processing. With the help of a mathematical model and network they explain that during the process of entrainment, abstract oscillatory units in our central nervous system are synchronized to the periodic incoming rhythmic patterns in terms of its phase and period, generating a receptive field. The unit responds to event onset occurring within this field and ignores the rest.

Cognitive theories link music perception and cognition. In Lerdahl & Jackendoff s generative theory (1983), a rhythm with it's a pattern of phenomenal accent function as a perceptual input to the metrical accent. Hence the listener is able to extract a regular pattern of metrical accent from the stress pattern in the raw signal, even if phenomenal accent information is missing or ambiguous. They also view rhythm perception as being a holistic and gestalt activity.

Ivry and Hazeltine (1985) believe that rhythm perception is tied in with a motor functioning. They also proposed production to be linked to perception tasks through a common timing mechanism and opined that repeated production activities promoted better and more accurate internal representation for perception.

Hence, all theories focus on an internal timing mechanism in rhythm perception. Ivry (1996), Mangels (1998), Nichelli (1996) have hypothesized cerebellum to operate as an internal clock that serves to time precise temporal relationships between events in both motor and perceptual domains. The prefrontal cortex is believed to perform supportive functions associated with acquisition, maintenance, monitoring and organization of temporal intervals in working memory.

Role of the cerebral hemispheres in music

Some authors have emphasized the importance of the right hemisphere in music while the others have pointed to the importance of the left. However, it may not be that one cerebral hemisphere is dominant for music but rather that both hemispheres are involved. The left hemisphere may take a greater role when the sequential and analytic aspects of music are more important, the right hemisphere may be superior when the sound gestalt is emphasized.

Gorden (1978) said that the processing may rely on the left cerebral hemisphere if its time dependent, but when simultaneous or time independent functions are involved processing may rely on the right hemisphere. These contrasting processing strategies determines the differential laterality effects in musicians and non musicians.

Bever and Chairello (1974) found right ear superiority for musician subjects and a left ear superiority for musically naive subjects for recognition of melodies. Its seen that there is no ear preference for short excerpts taken from longer melodies. Bever and Chiarello (1974) claimed that the musicians can organize a melodic sequence in terms of the internal relation of its components so a left hemisphere dominance is seen for such analytic functions in contrast to this the non musicians would have perceived the melody as gestalt, by relying o contour for recognition, so right hemisphere. Dominance is seen as its processed holistically.

There has been evidence of right hemisphere superiority for perceiving time of arrival of tones and to left hemisphere superiority for perception of temporal order. (Efron 1963) Musical rhythm as a separate function has received little attention in laterality experiments inspite of the fact that the perception of rhythm in a melody will not remain same when separated from the melody.

Wagner & Hannon (1981) did a study where the subjects were 10 faculty and 10 student musicians and 10 faculty and 10 student non musicians listened to a series of melodies and excerpts in one ear and to a series of different melodies in the other ear. They found that for student musicians there was a right ear/ left hemisphere advantage for melody recognition, while for student non musicians, the situation was the reverse. The reason for this finding could be, the effect of training on the performance of musicians. A trained person can treat musical stimuli in an analytic or sequential fashion; where the left hemisphere plays a role. In contrast if the person has no musical training, the components of the music are no longer important, hence the right hemisphere would tend to mediate.

Bryden, Ley & Sugarman (1982) did a study where they presented tonal sequences differing in emotional quality. Subjects listened to a specified ear and judged the emotional tone of the stimulus heard at that ear. Accuracy was better for identifying the emotional tone of stimuli presented to the left ear. This left ear advantage was greatest where the target and competing stimuli were of different effect.

Murray (1986) studied ear advantages for CV syllables for 28 right handed individuals in a target monitoring dichotic task. Ear dominance for dichotically presented tones was also found out. The results indicated right ear advantage for for CV syllables and a left ear dominance for the tone task, with a significant shift toward right ear dominance when the frequency difference on the tones was large. The results suggest that spatial complexity does play a role in the emergence of the right ear advantage for speech.

Recognition of melodies is facilitated by rhythmic grouping of the notes Dowling, Lung & Herrbold (1987). In a normal music situation, perception depends on the synthesis of pitches and rhythms and thus, both processes are involved not in terms of the specialization of one hemisphere 'dominant' for music but as an interaction of both hemispheres, each operating according to its own specialization in the complex process of music perception.

Wang, Jongman & Serens(2001)studied dichotic perception of Mandarin tones by native and non native listeners to study the lateralization of lexical tone. 20 adult normals served a subjects. They were asked to identify which tone they heard in each ear. Right ear advantage was seen in native Chinese, Mandarin speakers whereas no significant ear preference was present in nonnative, American listeners. The results indicated that Mandarin tones are predominantly processed in the left hemisphere by native Mandarin speakers, whereas they are bilaterally processed by American English speakers with no prior tone experience.

It has been reported in literature that dichotic listening experiments have indicated temporal resolution of rhythmic nonverbal auditory sequences is lateralized in the speech hemisphere.

Natale, (1977) conducted a study to demonstrate that the perceptual processing of rhythmic (hierarchic) auditory stimuli which is non linguistic in character is mediated by the speech hemisphere. He took a total of 52 subjects who were presented with dichotic pairs of rhythms followed by the recognition of four test rhythms binaurally presented. The results suggested left hemisphere lateralization of auditory non linguistic temporal rhythms which are a part of an adapted speech processing system that is auditory as opposed to phonetic nature. The findings suggested that temporal rhythms analysis of speech is the preliminary holistic stage of the analysis by synthetic model of speech perception.

Gordon (1978) carried out a study with twenty four adult non musician subjects on a dichotic listening test of melodies each differing only in rhythm. Right ear advantage was seen in the subjects, suggesting left hemisphere dominance. There results imply that in the melody test right hemisphere was not superior than the left. But in one of the other rhythm tests left hemisphere was superior to the right for melody recognition based on rhythm cue. It might be because its not the stimuli per se which governs hemisphere dominance but rather cognitive functioning required by the left and right hemisphere in order to process them.

Zatorre, (1978) conducted a study of dichotic recognition test. He presented it to 24 musicians and 24 non musicians. The stimuli consisted to melodic, random diatonic and random chromatic melodies (previously rated as to melodic content). The results showed left ear advantage for melodies in both musicians and non musicians. The ear advantage were constant with the amount of memory and load imposed on the recognition task, and across the 3 types of melodies. The pattern of individual scores did not reveal differences between sub groups. The findings imply that melodies are processed by the right hemisphere regardless of specific training.

Odekar(2001) studied perception of musical rhythm in normal right handed 32 adults between the age range of 18-25 years. Two sets of test material were used by using Catusra, Tisra, Misra, Khanda ta:las. Each subject was presented with the rhythms monaurally with the headphones and were asked to do table tapping in accordance to the rhythm heard. Percent times each ta:la, tapped appropriately when presented to the right and left ear was analyzed. Latency of the response to each rhythm when given to the right and left ear was also found out. Four pairs were dichotically presented. Analysis included rhythm to which tapping resembled. Ear advantage if any in the perception of various ta:las by structure. Results showed no significant difference between the performances of the two ears during monaural presentations. This may indicate some amount of cross hemispheric activity and equal ability of each ear in handling rhythm perception when the melodies were presented in the absence of any competition. Significantly greater number of subjects perceived the rhythm structure presented to the left ear and in the dichotic paradigm suggesting left ear-right hemisphere superiority in the perception of the rhythm.

Perception of rhythm in stutterers

Stuttering affects many individuals, but there is no agreement on acceptable treatment or etiology. One of the theory relates to a disturbance of cerebral laterality (Orton & Travis, 1929). Dichotic listening (Kimura, 1961) is a technique used to study cerebral laterality in stuttering, but there are conflicting results. Among dichotic tests lateralization of a non verbal function music which usually yields left ear advantage is totally ignored (Kimura, 1964).

Any deviation from the norm in cerebral Iaterlizaiton might also be presumed to affect both left and right ear dominant functions and the comparison of both might result in a more sensitive measure of cerebral dominance in the subject population which concern us.

Curry and Gregory (1969) tested 40 adults, 20 stutterers and 20 non-stutterers on a monotic verbal listening task and 3 dichotic listening task, one verbal and 2 non verbal. The subjects were in the age range 18-30 years. All were right handed individuals. Stutterers showed higher left and right ear scores as well as different scores between ears on the dichotic verbal task than did non stutterers. 75% of non-stutters obtained higher right ear scores on the dichotic verbal task, whereas 55%of the stutterers obtained scores in the left ear. No differences were found between the two groups on other tasks.

Perin & Eisenson, (1970) used verbal dichotic task to test the hemispheric processing in stutterers. Results showed reduction, absence or reversal of the right ear advantage that has been found to reflect left hemispheric processing for speech perception.

Quinn (1972) used dichotic word test, that revealed a significant reduced directional ear effect in stutterers and significantly "large minority' of stutterers as compared to non stutterers showing reverse dominance. Sussman & MacNeilage (1975 a,b) have found that stutterers do not show a significant right ear advantage on pursuit and tracking tasks, which are designed to test hemispheric specialization for speech production, when a tone is controlled by a speech articulator.

Dorman & Porter (1975) studied 16 adult right handed, stutterers and 20 nonstuttering controls. They tested them with dichotic nonsense- syllable test to determine hemispheric Lateralization for speech. The results indicated right ear advantage in syllable identification which was of similar magnitude to those found in normals. These data confirm that there is no difference in cerebral speech lateralization for stutterers and non stutterers.

Sommers, Brady, & Moore (1975) conducted a study on 39 stutterers and 39 normal speakers to check their ear preferences by using dichotic words and digits. Stutterers showed significantly less of the normal right ear preference for dichotic words and digits than non stutterers. The results are related to an early notion that stuttering may be related to mixed dominance.

Brady & Berson (1975) studied 35 stutterers and 35 non stutterers in a dichotic listening task. Some stutterers showed left ear preference, others showed same amount of right ear preference as that of normals. This suggest that a subset of stutterers may have an anomaly in the Lateralization of speech function than non stutterers.

Moore (1976) used bilateral tachistoscopic procedure to investigate the visual half field preferences of 15 stutters and a group of 15 normal controls in the age range of 17-29 years. Stimulus words were of 4 pairs which were photographed vertically on 35mm projector slides. The subtask was a one response free recall task. Statistical analysis indicated a right visual half field preference for the control group. In contrast, a significant visual half field preference was not revealed for the stuttering group. However, further analysis revealed that a significantly larger population of stutterers demonstrated a left visual field preference, indicating reverse cerebral processing for stuttering group.

Rosenfield & Goodglass (1980) did a study on 19 right handed male stutterers and twenty right handed male non-stutterers. All had normal hearing performances. The stutterers and normals were matched for age and education. The dichotic tape was used. The music tape was a copy of Kimuras original dichotic music tape (Kimura 1964).The stimuli consisted of twenty dichotic pairs of melodies, the first two pairs were practice trails each melody was taken from a solo passage of a classical concert. Following the presentation of each dichotic pair, four separate melodies were binaurally presented and the subject was asked to identify the two which had played dichotically. Subjects were told that they would hear two different melodies simultaneously following four seconds later by four binaural each of the dichotically presented melodies. One of the four binaural melodies had to be marked on answer sheet the letter (ABCD), corresponding to the position of the binaural melodies in a sequence. The subjects were told to guess when uncertain. There were a total of thirty six dichotic pairs in the music tape. The results showed that stutterers had weaker lateralization in musical perception. There was absence of statistically significant degree of left ear lateral ization for melodies in stutterers.

Liebetrau & Daly (1981) did a study to determine the significant difference in auditory processing and perceptual abilities between stutterers as a homogenous group, two differentiated sub groups of stutterers, and either of the subgroups when separately controlled with controls. Dichotic listening and MLD tasks were administered to two groups of stutterers and an age matched non-stuttering control group. Two groups were obtained: organic stutterers who performed significantly poorer on MLD and functional stutterers who performed more like control subjects.

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

Blood, Blood & Newton (1986) did dichotic digits testing on 9 stutterers and 9 nonstutterers under conditions of free recall and directed attention. Analysis indicated right ear preference for both groups and no ear preference in the free recall and directed listening conditions. Pinsky & Dale (1980) did experiment on five adult stutterers and five fluent speakers in the perception of dichotic listening with CV pairs. All the subjects showed consistent patterns of cerebral laterality indicative of localization of speech function in the left hemisphere. So, it does not infer that stutterers have faulty cerebral laterality.

Richard, Strub, Black & Naeser (1987) did dichotic testing in siblings (one female and a male) stutters using CV (Changing consonant/ changing vowels). Results showed a very small non significant right ear advantage. The possible reasons for such divergent findings may reside in varying dichotic verbal stimuli (i.e. syllables, digits, words) and response tasks (i.e. single response mode, multiple response mode) employed in each investigations.

Jayanthi (1997) conducted a study on 8 stutterers and 8 normals within the age range of 17-40 years. Stimuli words were chosen using Kannada dictionary and verbs. She controlled

3 factors- length, abstractness and occurance of the words. Familiarity tests were done. Words were audio presented one after the other through headphones into one of the ears. Reaction time analysis and linguistic analysis was done. Results indicated significant difference in right and left ears in normals. Longer in the left ear of normals but not in stutterers indicating that stutterers lack cerebral dominance and dominance is distributed in both the hemispheres equally than left. Stutterers longer reaction times for tasks used indicated motor programming deficit or central planning or encoding defect. Stutterers have greater problem in processing linguistically complex stimuli when compared to normals.

Anitha & Anjali (2004) conducted a study in 6 right handed male stutterers in the age range of 17-29 years to check the hemisphere dominance by using 1- foot and 3- feet songs hummed as la la la. It was presented at normal rate, slow rate and fast rate. Results showed left ear advantage in the subjects showing right hemisphere dominance for musical perception. The subjects could tap to the 1- foot but not to the 3- feet suggesting that the rhythms in songs were more complex for the subjects and hence were unable to perform. This result support the cerebral dominance theory in that subjects with stuttering showed reverse laterality. However, no ear differences were observed when the rhythm was presented at altered rates. Hence the hypothesis that stutterers may perform better in the right ear at slow rates and worst at fast rates was not valid. The present study aims in understanding the perception of musical rhythm in stutterers and also to know the ear preferences in them for the perception of musical rhythm.

There has been three hypothesis put forth on prosodic processing. Klouda, Rodin, Graff-Redford &Cooper (1988) hypothesized that all prosodic information are processed by right hemisphere and are integrated across corpus callosum with linguistic representations.

Van Lancker (1980) theorized that linguistic prosody is processed by the left hemisphere and emotional prosody is controlled by the right hemisphere. Van Lancker & Sidtis (1992) hypothesize that frequency related parameters are lateralized to the right hemisphere and temporal parameters to the left hemisphere. Their theory is supported by several studies (Van Lancker & Sidthis, 1992; Baum, 1998, Sarah, Prakash & Savithri, 2000; and Sarah, 2000). If this hypothesis is accepted then in normals rhythm processing should take place in the left/right hemisphere. In contrast, in stutterers, if lateralization problems occur, rhythm processing should take place in the left hemisphere. In this context, the present study was planned. It investigated the perception of musical rhythm and ear preferences in stutterers.

CHAPTER III

METHOD

Experiment I: Monaural presentation

Material: Two sets of test materials were prepared. The rhythm structures selected were four ta:las from Catusra, Misra, Tisra and Khanda. The details are presented in table 1. These melodies were hummed (sung as la la) in the raga 'Maya:ma:lava gaula' by a trained singer for 15 seconds duration, each of which were recorded in the Cool Edit Pro Syntrillium software. The melodies were hummed to avoid any kind of phonetic and semantic influences. All the ta:las were on beat (starting from the first syllable).

Sl.No.	Rhythms	Structures
1	Tisra	123123
2	Catusra	12341234
3	Misra	1234567 1234567
4	Khanda	1234512345

Table 1: Material for experiment I.

Subjects: Two groups of subjects participated in the study. Group I consisted of ten normal right handed non musicians. Group II consisted often individuals with stuttering. All of them were right handed non musicians with the age range of 18-30 years.

Procedure: The recorded ta:las were edited using the Cool Edit Pro software to obtain a single continuous signal for 10 seconds. Subjects were tested individually. Subjects were presented with the rhythms monaurally through the headphones. They were instructed to listen to the rhythms carefully and to indicate the beats or rhythm of each melody by table taps. These table taps were audio recorded using Philips tape recorder. The melodies were presented to the right ear first on 50% of the subjects and to the left ear in the remaining subjects.

Analysis: The percent times each ta:la was tapped appropriately by the subjects when presented in the right ear and left ear was calculated. The appropriateness of the tapping was judged by perceptual analysis by the experimenter.

Experiment II: Dichotic presentation

Material: The test material consisted of twelve pairs of ta:las. (Table 2) Each ta:la was represented three times in combination with the other ta:las. These pairs were aligned to be presented to right or left ear alone using the two tracks of Cool Edit Pro Syntrillium Software. An example is shown in Figure 1

Sl.No.	Right ear	Left ear
1	Catusra	Khanda
2	Catursra	Tisra
3	Catursa	Misra
4	Khanda	Catursra
5	Khanda	Tisra
6	Khanda	Misra
7	Misra	Catursra
8	Misra	Tisra
9	Misra	Khanda
10	Tisra	Catusra
11	Tisra	Khanda
12	Tisra	Misra

Table 2: Material for experiment II.

Subjects: The subjects were the same as in experiment I.

Figure 1: Example of a dichotic presentation.

Procedure: Subjects were presented with the dichotic stimuli routed through the Cool Edit Software with earphone at a comfortable level. They were instructed to tap on the table in accordance with the rhythm which they perceived. These taps were audio recorded with a Philips tape recorder.

Analysis: The data was analyzed for the following:

a) The rhythm to which the tapping pattern resembled.

b) Ear advantage if any in the perception of various rhythmic structures.

T- test and Walsh test was administered to find out the significant difference between groups and ears.

CHAPTER IV

RESULTS

Experiment I: Monotic presentation

The results indicated that in general stutterers (group II) identified rhythms better compared to normals (group I). Within ears, normals identified rhythms presented to right ear better than those presented to left ear, while stutterers identified rhythms presented to left ear better than those presented to right ear. Table 3 shows the average percent correct response and figure 2 shows the percent correct identification.

Ear	Group I normals	Group II Stuttering
Right	87.5	77.5
Left	70	82.5
Average	77.75	80.0

Table 3: Average percent correct responses in normals and stutterers.

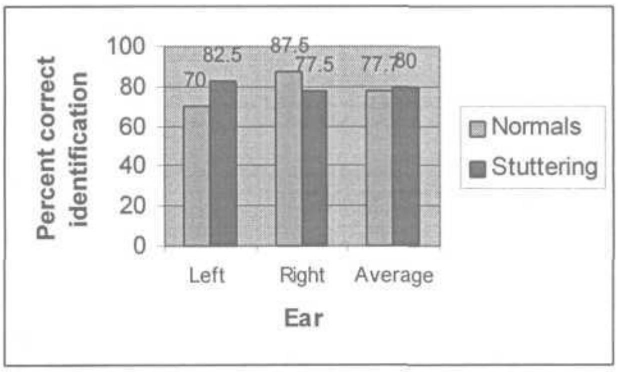

Figure 2: Percent correct identification of ta:las.

In general, subjects in group II identified ta:las better than those in group I. However, subjects in group I identified ta:las better when it was presented to right ear compared to those in group II. T- test indicated no significant difference between groups and ears. Table 4 shows the results of T- test. Figures 3 to 6 show percent identification on all four ta:las.

Ear	Group	Mean	S.D	T	Result
Left	I	0.75	0.438	0.419	NS
	II	0.825	0.384		
Right	I	0.875	0.33	0.245	NS
	II	0.775	0.42		
Left	I	0.75	0.43	0.156	NS
Right	II	0.7	0.33		
Left	II	1.07	1.49	0.225	NS
Right		0.7	0.42		

Table 4: Results of T- test.

Tisra ta:la: Stutterers identified Tisra rhythm better than normals. Also, stutterers identified Tisra rhythm better when it was presented to the left ear, while normals identified the rhythm better when it was presented to right ear. Walsh test showed no significant difference between normals and stutterers when the rhythm was presented to either ear.

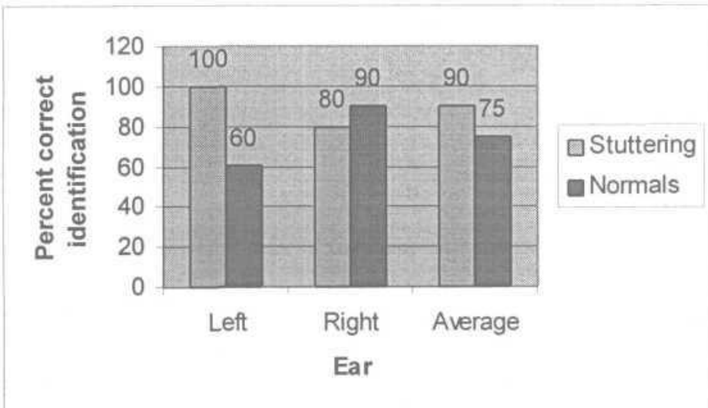

Figure 3: Percent identification of Tisra ta:la.

Catusra ta:la: Both the groups identified rhythms equally. However, stutterers identified Catusra rhythm better in left ear, while normals identified it better in right ear compared to the other ear. Walsh test showed significant difference between the groups when the rhythm was presented to both the ears.

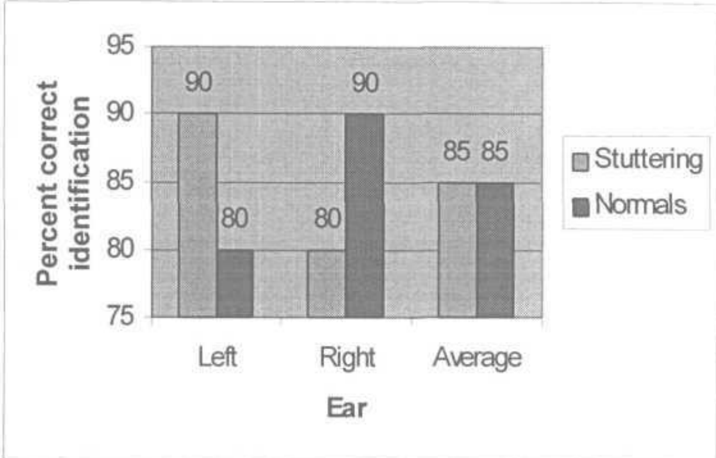

Figure 4: Percent identification of Catusra ta:la.

Khanda ta:la: Normals performed better than stutterers. Stutterers identified rhythm better when it was presented to right ear than when it was presented to left ear while normals identified rhythms better when it was presented to left ear than when it was presented to the right ear.

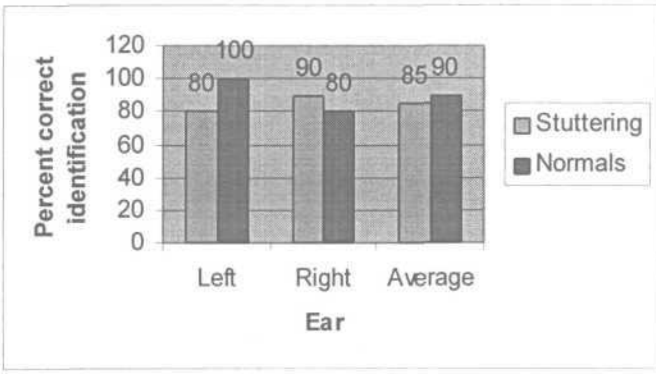

Figure 5: Percent correct identification of Khanda ta:la.

Misra ta:la: Normals performed better compared to stutterers. No significant difference between groups was observed, when the rhythm was presented to left ear. Also, no significant difference between ears was found in group II.

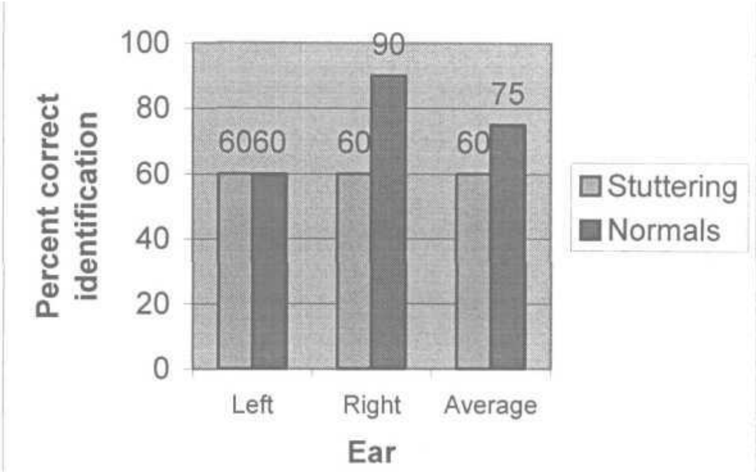

Figure 6: Percent correct identification of Misra ta:la.

Of the four ta:las,Misra ta:la was the most difficult to identify. Subjects of group I identified Khanda ta:la the best and subjects of group II identified Tisra ta:la the best. Table 5 shows the percent response for different ta:las. Walsh test showed significant difference between groups and ears.

Ta:la	Stutterers (Group II)			Normals (Group I)		
	Left	Right	Average	Left	Right	Average
Tisra	100	80	90	60	90	75
Catusra	90	80	85	80	90	85
Khanda	80	90	85	100	80	90
Misra	60	60	60	60	90	75
Average	82.5	77.5	80	75	87.5	81.5

Table 5: Percent response for different ta:las.

Experiment II: Dichotic presentation

Under dichotic presentation, normals performed better compared to stutterers. Further, both the groups identified rhythms presented to right ear better than those presented to left ear. Table 6 shows the average percent correct response to dichotic stimuli.

Ears	Stutterers	Normals
Left	28.33	33.33
Right	29.16	45

Table 6: percent correct response for dichotic stimuli.

Catusra (left ear-LE) and Khanda (right ear-RE), and Catusra (LE) and Tisra (RE): Under dichotic presentation of these two rhythms, stutterers perceived rhythms presented to the left ear better than those presented to right ear, while normals perceived rhythms presented to right ear better than those presented to left ear. Figures 7 and 8 show the identification of rhythms. Walsh test showed no significant difference between ears.

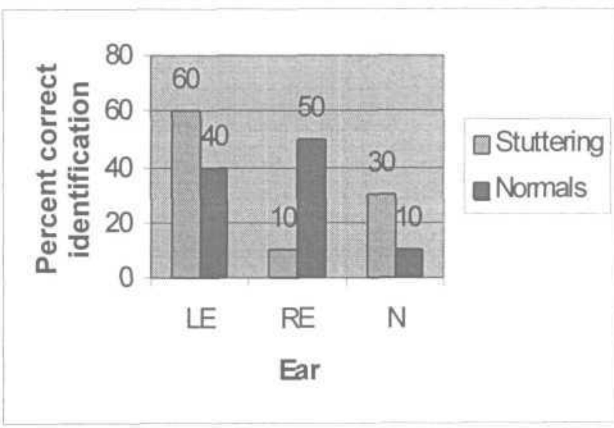

Figure 7: Percent identification under dichotic condition (Catusra-LE & Khanda- RE, N- not identified).

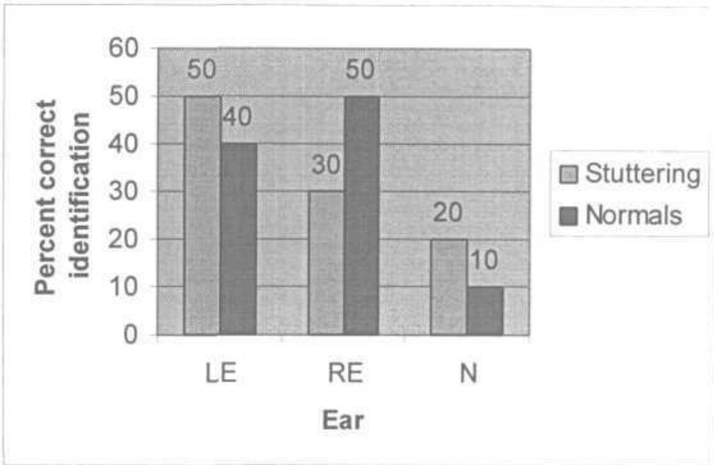

Figure 8: Percent identification under dichotic condition (Catusra-LE &Tisra-RE, N- not identified).

Catusra (LE) and Misra (RE): Both the groups did not identify any rhythm. However identification of rhythms presented to left ear was better than those presented to right ear in both the groups. Figure 9 shows the identification of rhythms. Walsh test showed no significant difference between groups.

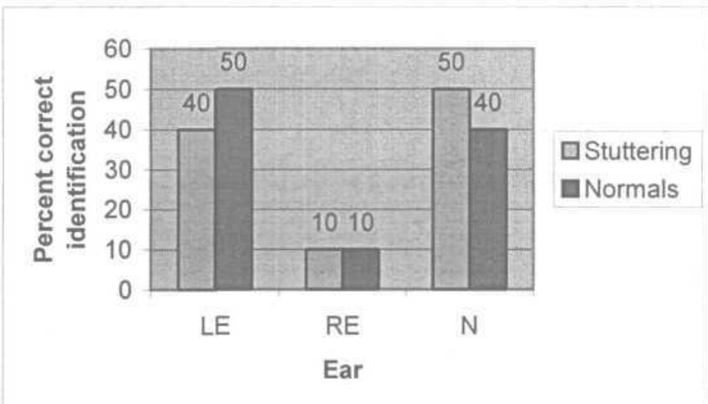

Figure 9: Percent identification under dichotic condition (Catusra-LE & Misra-RE, N- not identified).

Khanda (LE) and Catusra (RE): Both normals and stutterers identified rhythms presented to the left ear better than those presented to right ear. Figure 10 shows the identification of rhythms. Walsh test showed no significant differences between groups and ears.

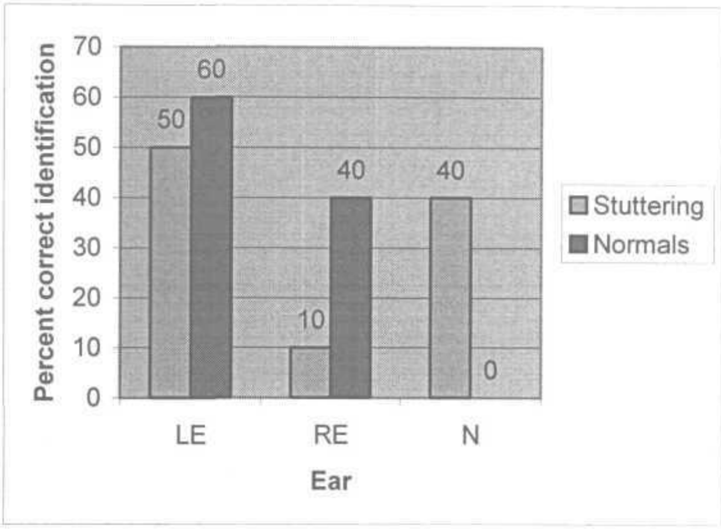

Figure 10: Percent identification under dichotic condition (Khanda-LE, Catusra-RE, N- not identified).

Khanda (LE) and Tisra (RE): No ear preference was observed in normals. Stutterers did not identify any rhythm presented to left ear. However, stutterers could identify Tisra ta:la significantly better than Khanda ta:la when Tisra ta:la was presented to the right ear. Figure 11 shows the identification of rhythms. Walsh test showed significant difference between ears in stutterers.

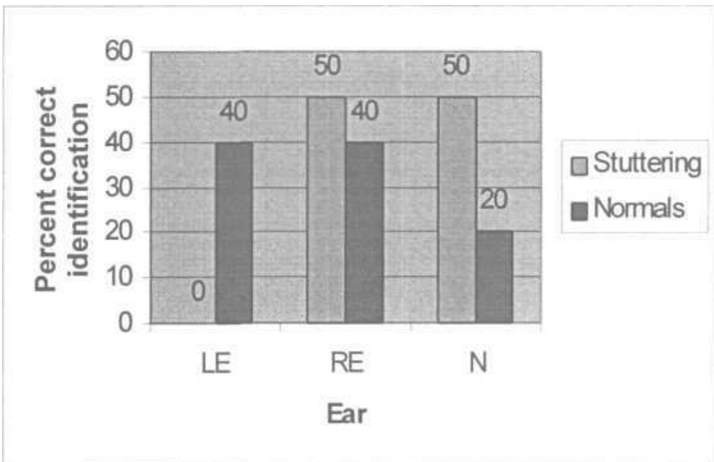

Figure 11: Percent identification under dichotic condition (Khanda-LE, Tisra-RE, N- not identified).

Khanda (LE) Misra (RE): None of the subjects identified any specific rhythm. However, both the groups identified rhythms presented to left ear better than those presented to right ear. Figure 12 shows percent identification of Khanda and Misra ta:las in dichotic presentation. Walsh test showed no significant difference in identification of rhythms in the left and right ears in both the groups.

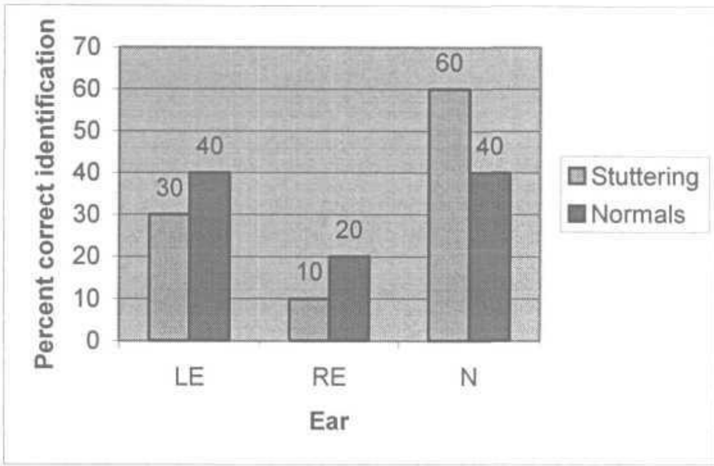

Figure 12: Percent identification under dichotic condition (Khanda-LE, Misra- RE, N- not identified).

Misra (LE) and Catusra (RE): Under this condition, stutterers identified rhythms presented to right ear better than those presented to left ear, while normals identified rhythms presented to right ear better than those presented to the left ear. Figure 13 shows correct identification of rhythms . Walsh test showed significant difference between ears in stuttering group.

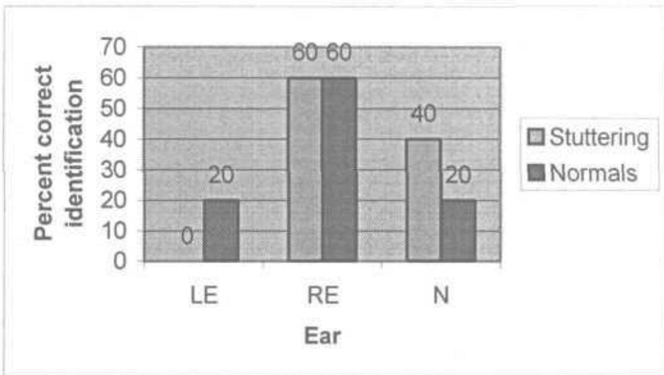

Figure 13: Percent identification under dichotic condition (Misra-LE, Catusra-RE, N- not identified).

Misra (LE) and Tisra (RE): Both the groups identified rhythms presented to right ear better than those presented to left ear. Figure 14 shows correct identification of ta:las in stutterers and normals in dichotic condition. Walsh test showed significant difference between ears in stutterers in that no stutterer identified Misra ta:la presented to left ear.

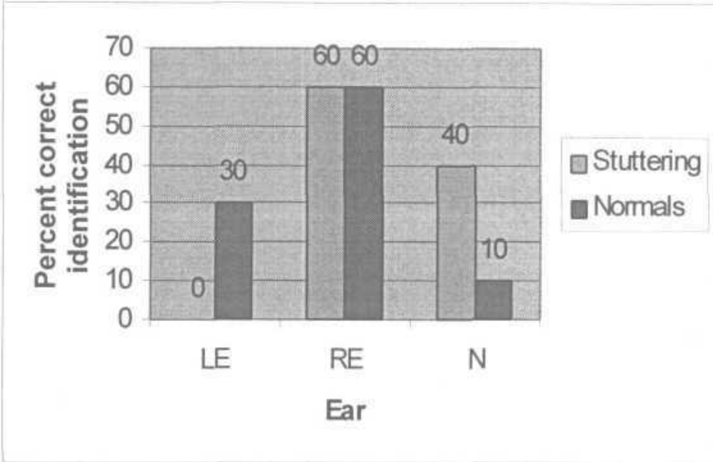

Figure 14: Percent identification under dichotic condition (Misra- LE, Tisra-RE, N- not identified).

Misra (LE) and Khanda (RE): Stutterers did not identify any rhythm. However, they identified when it was the rhythm presented to left ear and normals identified rhythms presented to right ear better than those presented to left ear. Figure 15 shows correct identification of ta:las in dichotic condition. Walsh test showed no significant difference between groups and ears.

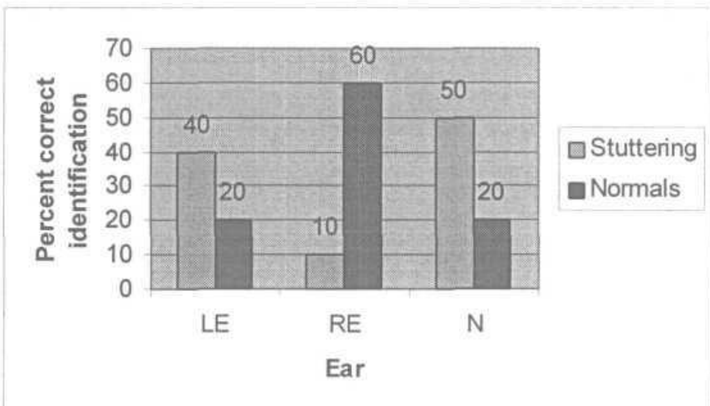

Fig 15: Percent identification under dichotic condition (Misra-LE, Khanda-RE, N- not identified).

Tisra (LE) and Catusra (RE), Tisra (LE) and Khanda (RE): Both the groups identified rhythms presented to right better than those presented to left ear. Figures 16 and 17 show correct identification of ta:las among normals and stutterers in dichotic condition. Walsh test showed significant difference between ears in normals.

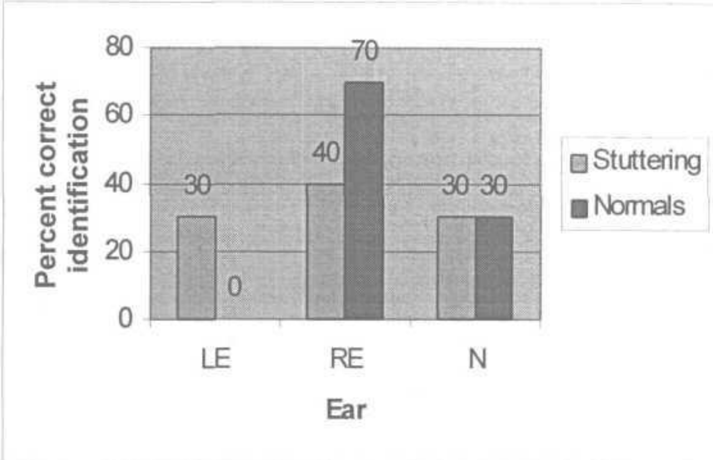

Figure 16: Percent identification under dichotic condition (Tisra-LE, Catusra-RE, N- not identified).

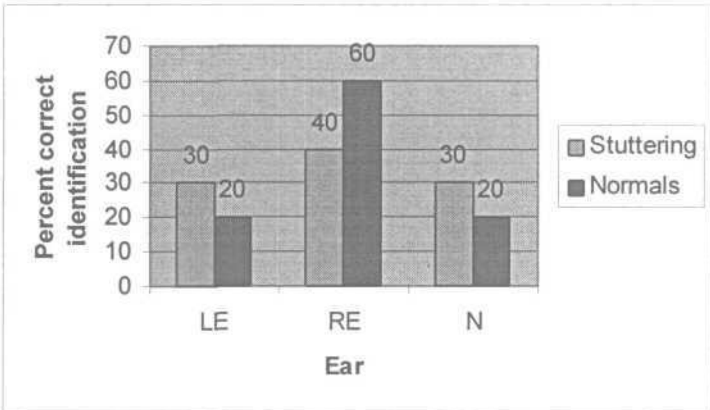

Figure 17:Percent identification under dichotic condition (Tisra- LE, Khanda-RE, N-not identified).

Tisra (LE) and Misra (RE): Under this condition, both groups did not identify any specific rhythm. Walsh showed no significant difference between ears and groups. T-test showed significant difference between groups in both the ears (Table 7).

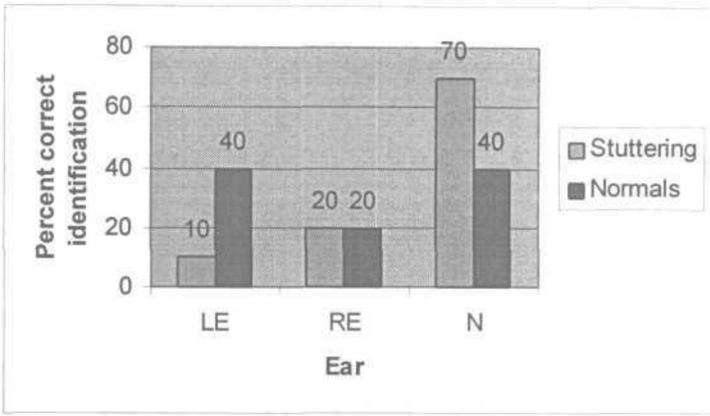

Figure 18: Percent identification under dichotic condition (Tisra-LE, Misra-RE, N- not identified).

Ears		Mean	S.D	T	Results
Left	Normal	2.11	0.735	0.007	S
	Stuttering	1.84	0.84		
Right	Normal	2.11	0.73	0.012	S
	Stuttering	1.85	0.83		
Not identified	Normal	2.10	0.74	0.12	NS
	Stuttering	1.85	0.83		

Table 7: T- values under dichotic presentation (S- significant NS- not significant).

To summarize, normals performed better than stutterers on a dichotic presentation task. Walsh test showed no significant difference between ears in both groups except for a few ta:las. Table 8 shows the results of T- test for ear differences in normals and stutterers. Walsh test indicated no significant difference between groups except for two of the ta:las.

Ta:las	SD in normals between ears	SD in Stutterers between ears	SD between groups
Chatusra and Khanda	NS	NS	NS
Catusra and Tisra	NS	NS	NS
Catusra and Misra	NS	NS	NS
Khanda and Catusra	NS	NS	NS
Khanda and Tisra	NS	NS	S
Khanda and Misra	NS	NS	NS
Misra and Catusra	NS	NS	S
Misra and Tisra	NS	S	**S**
Misra and Khanda	NS	S	NS
Tisra and Catusra	S	**S**	NS
Tisra and Khanda	NS	NS	NS
Tisra and Misra	NS	NS	NS

Table 8: Results of Walsh test (SD - significant difference, S-significant difference, NS- not significant).

DISCUSSION

The results indicated several points of interest. First of all under monotic presentation, no significant ear or group differences were found. However, in stutterers, left ear preference was observed, while in normals right ear preference was observed. The results are in consonance with that of Odekar (2001) who found no significant difference between ears. This may indicate some amount of cross-hemispheric activity and equal ability of each ear in handling rhythm perception when the melodies were presented in the absence of any competitive stimuli.

Second, Misra ta:la was the most difficult and Tisra and Khanda ta:las were the easiest to identify. This is not in consonance with the results of Odekar (2001) who found Tisra and Catusra ta:las to be the easiest to identify. The structure of Tisra ta:la is 1 2 3 1 2 3 ,i.e, beat on every third syllable and the structure of Khanda ta:la is 1 2 3 4 5, i.e., beat on first and fourth syllables. In a way both Tisra and Khanda ta:la are similar to the extent that a beat is there on the first and fourth syllable. This might be possible reason for the better identification of these ta:las.

Third, under dichotic presentation varying responses were observed. Table 9 summarizes these responses.

Stimulus		Response			
LE	RE	Normals		Stutterers	
C	K	K		C	
C	T	T		C	
C	M	N		N	
K	C	K		K	
K	T	N		N	
K	M	N		N	
M	C	C		M	
M	T	T		T	
M	K	K		N	
T	C	C		C	
T	K	K		K	
T	M	N		N	
Average percent response		L	R	L	R
		8.33	58.33	33.33	16.66
	N	33.33		50	

Table 9: Responses for dichotic stimuli (C-Catusra, K- Khanda, M- Misra, T- Tisra, N- not identified).

Fourth, it was observed that compared to normals stutterers were poorer in identifying dichotic rhythm. However, when they identified dichotic rhythms, they identified rhythms presented to left ear better than those presented to right ear. Normals identified rhythms presented to right ear better than those presented to left ear. Thus a left ear advantage in stutterers and a right ear advantage in normals was observed indicating a right hemisphere dominance in stutterers and a left hemisphere dominance in normals for rhythm.

The results that normals had right ear advantage are in consonance with the results of Gordon (1978). However, it is not in consonance with the results of Zatorre (1978) and Bever & Chairello (1974), Wagner & Hannon (1981) who found a left ear superiority. Rosenfield & Goodglass (1980) did a study on 19 right handed male stutterers and 20 right handed male non stutterers. The results showed weaker lateralization in stutterers in musical perception. There was a absence of statistically significant degree of left ear lateralization for melodies in stutterers. Curry & Gregory (1969) found out that there was no dominance, i.e., there were no ear preferences in dichotic non verbal tasks in stutterers. Murray (1986) presented dichotic tones and found that there was a right hemisphere, left ear dominance in stutterers, but he found a shift towards the right ear dominance when the frequency difference of the tones was large. The results suggest that the failure to find a relationship between speech and nonspeech task suggest that all perceptual asymmetries observed with dichotic stimuli cannot be accounted for by a single theoretical explanation.

Fifth, in normals, a wide difference was observed between the identification scores of ears (58.33-8.33 = 50), while in stutterers it was not so (33.33- 16.66 = 16.66). This probably indicates mixed laterality in stutterers. Curry and Gregory (1969), Perin & Eisenson (1970), Sommers, Brady & Moore (1975) used verbal dichotic task to test the hemispheric processing in stutterers. Results showed reduction, absence or reversal of the right ear advantage. Quinn (1972) used dichotic word test which revealed a significantly reduced directional ear effect in stutterers and stutterers also showed reverse dominance. Tachistoscopic studies indicated reverse cerebral processing for stuttering group (Moore, 1976). Liebetrau and Daly (1981) used dichotic listening and MLD tasks to determine significant difference in auditory processing and perceptual abilities between stutterers and non stutterers. The results suggested that there was no difference between the two groups in both the tasks, which suggest that there might be mixed laterality in stutterers.

The possible reasons for such divergent findings may reside in varying dichotic verbal stimuli (i.e., syllables, digits, words) and response tasks (i.e., single response mode, multiple response mode) employed in investigations.

Sixth, if one observes the type of ta:las preferred, it appears that Tisra ta:la was not preferred except when it was presented in right ear along with Misra ta:la. Also, whenever Khanda and Misra ta:las were presented there was a confusion and no ta:la was identified. This might be probably because of the structure of the two tarlas. Khanda (1 2 3 4 5) has beats on the first and the fourth syllables and Misra (1 2 3 4 5 6 7) has beats on the first, fourth and the sixth syllables. A listener would perceive the same ta:la upto 5^{th} syllable after which it changes leading to a confusion and non identification of any ta:la.

The results indicate that the identification of rhythm was different in stutterers compared to normals and that there was a right hemisphere dominance or mixed laterality in stutterers.

The results of the present study are not comparable with those of any earlier studies as the stimuli used are different. In the present study musical ta:Ias are used and in other studies speech is used. There are three hypothesis on prosodic processing. Klouda, Rodin, Graff-Redford & Cooper (1988) hypothesize that all prosodic information are processed by right hemisphere and are integrated across corpus callosum with linguistic representations. Van Lancker (1980) theorized that linguistic prosody is processed by left hemisphere and emotional prosody is controlled by the right hemisphere. Van Lancker & Sidhtis (1992) hypothesize that frequency related parameters are lateralized to right hemisphere and temporal parameters are lateralized to left hemisphere. If this hypothesis is accepted, then in normals rhythm processing should take place in left hemisphere.i.e; there should be a right ear advantage. In the present study normals have a clear right ear advantage. But stutterers have a left ear advantage or mixed laterality. These results indicate that stutterers have problem in rhythm processing at least momentarily. Further, it would be interesting to study processing of dichotic speech signals in stutterers and normals.

CHAPTER V

SUMMARY AND CONCLUSIONS

Suprasegmental features of a language are those properties of speech sounds that appear simultaneously with the phonetic features, but are not confined to phonetic segments and instead are overlaid or superimposed on syllables, words, phrases and sentences. Although much information in speech is conveyed by the segmental phonemes, additional information is carried by the prosodic features. It includes intonation, stress, rhythm, and juncture (pause) or phrasing. Intonation refers to the movement of pitch and stress refers to the extra force or energy in speech. Rhythm is any regular event. Rhythm in speech is not regular. However, when it is poetry or music one finds a regular rhythm.

Stuttering is considered to be a disorder of rhythm and is attributed to lack of or reversal of cerebral dominance. If, stuttering is attributed to lack of cerebral dominance, the ear preference in stutterers would be different when compared to normal individuals. In this context, the present study investigated the perception of musical rhythm and ear preference in stutterers.

Two groups of subjects participated in the experiment. Group I consisted of 10 adult stutterers and group II consisted of 10 adult nonmusician normals in the age range of 18-30 years. The rhythm structures selected were four ta:las, from Catusra, Tisra, Misra and Khanda. The structures of the ta:las are as follows: Catusra-12341234 (beat on every 5th syllable), Tisra - 1 2 3 1 2 3 (beat on every 4th syllable), Misra- 1 2 3 4 5 6 7 (beat on every 1st, 4th and 6th syllable), Khanda-1 2 3 4 5 beat on 1st and 4th syllable) . The melodies were hummed in ra:ga Ma: yama:lava gaula as la la la by a trained singer which was stored in computer memory. Cool Edit Pro Syntrillium software was used for all editing and presentations . The subjects were presented with the ta:Ias in monaural condition and in dichotic condition. They were instructed to tap the ta:la perceived by them which were recorded and analyzed. The data was analyzed to find out the rhythm to which the tapping pattern resembled and ear advantage, if any, in the perception of various rhythmic structures. T- test and Walsh test was used to find out the significant difference between groups and ears.

The results indicated several points of interest. First of all under monotic presentation no significant ear or group differences were found. However in stutterers, left ear preference (82.5 % Vs 77.5%) was observed, while in normals right ear preference (70% Vs 87.5%)was observed. The results are in consonance with that of Odekar (2001) who found no significant difference between ears. This may indicate some amount of cross-hemispheric activity and equal ability of each ear in handling rhythm perception when the melodies were presented in the absence of any competitive stimuli.

Second, Misra ta:la was the most difficult (Group 1 -75%, Group II -60%) and Tisra and Khanda ta:las were the easiest to identify. This is not in consonance with the results of Odekar (2001) who found Tisra (Group I -75%, Group II -90%) and Catusra (Group I -90%, Group II -80%) ta:las to be the easiest to identify. The structure of Tisra ta:Ia is 1 2 3 1 2 3 ,i.e, beat on every third syllable and the structure of Khanda ta:la is 1 2 3 4 5, i.e., beat on first and fourth syllables. In a way both Tisra and Khanda ta:la are similar to the extent that a beat is there on the first and fourth syllable. This might be possible reason for the better identification of these ta:las.

Third, under dichotic presentation varying responses were observed. In general, it was observed that compared to normals stutterers were poorer in identifying rhythm. However, when they identified dichotic rhythms, they identified rhythms presented to left ear (33.33%) better than those presented to right ear (16.66%). Normals identified rhythms presented to right ear (58.33%) better than those presented to left ear (8.33%). Thus, a left ear advantage in stutterers and a right ear advantage in normals was observed indicating a right hemisphere dominance in stutterers and a left hemisphere dominance in normals for rhythm.

The results that normals had right ear advantage are in consonance with the results of Gordon (1978). However it is not in consonance with the results of Zatorre (1978) and Bever & Chairello (1974), Wagner & Hannon (1981). who found a left ear superiority. Rosenfield & Goodglass (1980) did a study on 19 right handed male stutterers and 20 right handed male non stutterers. The results showed weaker lateralization in stutterers in musical perception. There was a absence of statistically significant degree of left ear lateralization for melodies in stutterers. Curry and Gregory (1969) found out that there was no dominance, i.e., there was no ear preferences in dichotic non verbal tasks in stutterers.

Murray (1986) presented dichotic tones and found that there was a right hemisphere, left ear dominance in stutterers, but he found a shift towards the right ear dominance when the frequency difference of the tones was large. The results, that the failure to find a relationship between speech and nonspeech task suggest that all perceptual asymmetries observed with dichotic stimuli cannot be accounted for by a single theoretical explanation.

Fourth, in normals a wide difference was observed between the identification scores of ears (58.33-8.33 = 50), while in stutterers it was not so (33.33- 16.66 = 16.66).This probably indicates mixed laterality in stutterers. Curry and Gregory (1969), Perin & Eisenson (1970), Sommers, Brady & Moore (1975) used verbal dichotic task to test the hemispheric processing in stutterers. Results showed reduction, absence or reversal of the right ear advantage. Quinn (1972) used dichotic word test, which revealed a significantly reduced directional ear effect in stutterers and stutterers also showed reverse dominance. Tachistoscopic studies indicated reverse cerebral processing for stuttering group (Moore, 1976). Liebetrau and Daly (1981) used dichotic listening and MLD tasks to determine significant difference in auditory processing and perceptual abilities between stutterers and non stutterers. The results suggested that there was no difference between the two groups in both the tasks, which suggest that there might be mixed laterality in stutterers.

The possible reasons for such divergent findings may reside in varying dichotic verbal stimuli (i.e., syllables, digits, words) and response tasks (i.e.,single response mode, multiple response mode) employed in investigations.

Fifth, if one observes the type of ta:las preferred, it appears that Tisra ta:la was not preferred except when it was presented in right ear along with Misra ta:Ia. Also, whenever Khanda and Misra ta:las were presented there was a confusion and no ta:la was identified. This might probably because of the structure of the two ta:las. Khanda (12 3 4 5) has beats on the first and the fourth syllables and Misra (12 3 4 5 6 7) has beats on the first, fourth and the sixth syllables. A listener would perceive the same ta:la upto 5^{th} syllable after which it changes leading to a confusion and non identification of any ta:la.

The results indicate that the identification of rhythm was different in stutterers compared to normals and that there was a right hemisphere dominance or mixed laterality in stutterers.

The results of the present study are not comparable with those of any earlier studies as the stimuli used are different. In the present study musical ta:las are used and in other studies speech is used. There are three hypothesis on prosodic processing. Klouda, Rodin ,Graff-Redford &Cooper (1988) hypothesize that all prosodic information are processed by right hemisphere and are integrated across corpus callosum with linguistic representations. Van Lancker (1980) theorized that linguistic prosody is processed by left hemisphere and emotional prosody is controlled by the right hemisphere. Van Lancker & Sidthis (1992) hypothesize that frequency related parameters are lateralized to right hemisphere and temporal parameters are lateralized to left hemisphere. If this hypothesis is accepted then in normals rhythm processing should take place in left hemisphere.i.e; there should be a right ear advantage. In the present study normals have a clear right ear advantage. But stutterers have a left ear advantage or mixed laterality. These results indicate that stutterers have problem in rhythm processing at least momentarily. Further, it would be interesting to study processing of dichotic speech signals in stutterers and normals.

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