PERCEPTION OF RHYTHM IN MUSIC

Register No. M. 9902

A Dissertation submitted in part fulfillment for the second year M.Sc. (Speech and Hearing), University of Mysore, Mysore

All India Institute of Speech and Hearing
Mysore 570 006

May 2001

CERTIFICATE

This is to certify that the Dissertation entitled **"PERCEPTION OF RHYTHM IN MUSIC"** is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Register No. M. 9902.

Director
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Mysore
May 2001

CERTIFICATE

This is to certify that the Dissertation entitled **"PERCEPTION OF RHYTHM IN MUSIC"** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

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DECLARATION

This dissertation entitled **"PERCEPTION OF RHYTHM IN MUSIC"** is the result of my own stud}' under the guidance of Dr. S.R Savithri, Reader and Head of the Department. Speech Science, AIISH, Mysore, and has not been submitted at any other University for the award of any diploma or degree.

Mysore   Register No. M 9902

May 2001

Dedicated

to

Amma, Appaji and

My dear Ajji

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CHAPTER I

INTRODUCTION

Suprasegmentals are those traits of speech whose domain extends beyond a single element. It serves to link and connect low level segmental information to higher levels of syntactic structures in speech. According to Haggard (1975), "prosody carries direct phonetic cues to certain semantic and grammatical classes; it therefore serves to restrict the search process, whereby contact is made between the cognitive and the acoustic representation". Prosodic features are linguistic abstractions in the mind of the speaker and listener. The four suprasegmentals are stress, intonation, juncture and rhythm.

Rhythm is derived from the Greek word "Rhuthmos" where "Rhu" means flow. It is defined as a pattern of movements which occur with more or less temporal regularity. Rhythm is a certain swing or balance in bodily movement, music or a verb phrase (Encyclopedia Britannica, 1965). In Sanskrit literature rhythm means metrical movements determined by various relations of long or short stressed vs. unstressed syllables. Rhythm can also be understood as being the pattern of time intervals which elapse between the occurrence of stressed syllables. Rhythm is different than tempo. Tempo is the rate at which utterance is spoken.

There is a tendency to speak languages with a fairly regular time or a rhythmic unit. The rapidity with which the syllables are spoken depends upon the length of the units. Rhythm is said to promote fluency. Rhythm assists in rapid speech production, by providing a means for us to anticipate upcoming movements. The rhythmic array or pattern in continuous speech helps to construct a general outline of the prosodic contour in upcoming speech whereby the listeners movements also tend to be in synchrony with the syllabic rhythm of speech of the speaker.

According to Bruner (1973), the role of rhythm in promoting fluency is enhancing speed, efficiency, and anticipation of upcoming movements of speech - all this being a criteria for motor skill learning.

Pike (1945) used the term isochrony to refer to a patterned time program, underlying speech sequences. In stress time isochronies, the stressed syllables follow each other at approximately equal or fixed number of intervals. In syllable timed languages the stress occuo after equal number of syllables. In music, stress patterns occur with regularity. Where stress, occurs on every syllable, the rhythm so produced is one foot. In two feet rhythm, the stress occurs on every alternate syllable and so on.

The studies conducted in investigating the perception and production of rhythm in speech have focussed on establishing either stress timed or syllable timed isochronies in various languages {Russian (Zlatoustava, 1975); English (Martin, 1979; Nakatani, et al., 1981; Fant, et al., 1989); Spanish (Pointon, 1980; Dauer, 1983); Brazilian Portuguese (Roy, 1981); French (Wioland and Wenk 1982; Cutler and Butterfield, 1992); Swedish (Garding, and Erikson, 1989); Italian (Farnetani, 1990; Arabic, Polish, Argentinian, Finnish, Japanese, Indonesian and Yoruba (Millar, 1984); Tamil (Balasubramaniam, 1990); Kannada (Savithri, 1995)}.

In the past, some studies have been done on rhythm of prose and poetry. Martin (1979) studied perception of rhythm in English using 36 basic sentences which were six syllabic nonsense sequences of /a./. Either vowel in the sentence was abandoned or shortened by about 50, 90 or 130 msecs. by computer edited routines. The sentence was intact. It was concluded that the effect of time distortion of the stimulus and target reaction time were mainly by changes in stimulus induced expectancy and not changes in processing time. The expected input to perception was acoustically intact utterances in both its rhythmic and segmental aspects, these aspects were not perceived independently.

Lehiste (1979), studied the perception of duration of four intervals separated by stressed segments including listeners. They were asked to identify one of the four intervals as longest and one shortest for a round presentation. The results indicated that those with large differences in duration were not perceptible and hence the concept of isochrony may be more perceptual than what is produced in actual speech. This was in support of his own study conducted in 1977, where the results also indicated that the isochrony can be integrated into the grammar of English at the syntactic level.

Lehiste (1985) did a study on rhythm of poetry and prose. This study was undertaken in order to tap the rhythmic structure of spoken language and metric structure of poetry. The difference between the rhythmic units used in English prose and poetry were not really very great. The trochaic feet that were in the focus of this study appeared to be realized in very similar ways, regardless of whether the materials were produced in poetry or prose. This was thought to indicate that the rhythmic constraints on spoken language is superimposed by a specific form operatedwithin the structure provided by the suprasegments of that language. Benguerel and D'Arcy (1986) constructed four tests in which each stimulus consisted of sequences of six clicks or six syllables; each test contained time warped stimuli. The warping was non-linear and progressive. Native speakers of English, French and Japanese were asked to rate each sequence as accelerating, regular or decelerating. Results indicated that for a range of parameter values of the time warping parameter, stimuli were perceived as regular. However, most of the stimuli were not acoustically isochronous, but decelerating. The native language of listeners, the nature of the stimulus and the order of the tests did not have any significant effect on the results.

The role of hemispheric processing in the perception and production of various prosodic features especially in terms of the durational aspects of speech has been studied in normals as well as in brain damaged population. It is generally accepted that the right hemisphere of the normal right-handed subjects is dominant for processing intonation contours of short sentences (Blumstein and Cooper, 1974), and melody (Borod and Goodglass, 1980; Kimura, 1964). In the domain of music a left ear superiority has been reported for the identification of emotional tone of short musical passages presented dichotically (Bryden, Lee and Sugarman, 1982).

Music does not ordinarily involve cross modal activity. Accordingly, the fact that musicians are more strongly right hemisphered for unitary musical tasks supports the prediction that musicians would reveal an increase in the extent to which they use the right hemisphere for these tasks. Johnson (1977), Johnson et al. (1977), Gaede et al. (1978), Gates et al. (1977), Bever et al. (1974), Bever (1983) reported that non-musicians process music better in the left ear and musicians recognize melodies better when presented to the right ear. In terms of perception of rhythm, Gordon (1978) found a right ear advantage for both musicians and the subjects untrained in music. The perception of rhythm with reference to Indian music has not been studied. In this context, the present study was planned. The objectives of the study were two fold and as follows:

1. Perception of rhythm in music in normal individuals
2. The role of cerebral hemispheres in the perception of rhythm in normal individuals.

Specifically the perception of different ta:|as in Indian music was studied.

**

CHAPTER II

REVIEW OF LITERATURE

Rhythm is said to be the essence of all natural phenomena. All purposes involve movement and movement includes the dimensions of time and space (Srinivasa, 1967). Rhythm can be understood as the pattern of time intervals that elapse between successive accented syllables.

Concept of rhythm in music:

Rhythm is fundamental, both in creation and perception of music. 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 relationship of tones.

In the description of the overall rhythmic structure of the Western music, Deri (1968) delineates three 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 occuring 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, according to Leeuwen (1999), the rhythmic regularisation takes place in the following three ways:

Regularisation of tempo

Regularisation of sounds per measure

Regularisation of measures per phrase

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

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

c) Lava : Laya is equivalent to the concept of tempo in Western music. The 'vilambita laya" stands for slow 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.

Tali - A rhythmic stress/ gha:ta, indicated by a clap

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

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.

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

(i) Chatushra: Consists of four ma:tras / four aksharas, the first akshara being the ghata

(ii) Tishra: Consists of three aksharas the first akshara indicated by a gha:ta

(iii) Khanda: Consists of five aksharas, the first and the third akshara being accented,

(iv) Mishra: Consists of seven aksharas. The most common ta:la of which has accents on the first/ourth and sixth akshara.

(v) Sankirna: Consists of nine aksharas.

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

Perception of rhythm in music:

Many theories have been proposed to explain the perception of rhythm in music. 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. This way, even a layman should have some awareness of beats which keeps developing through experiences with music. Chaitanyadeva viewed perception of rhythm as a recurrence of attention at specified instances in time. According to him, rhythm perception is 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 phenomenon called "subjective rhythm" (Woodrow, 1951). This rhythmic structure so perceived is called the metrical accent.

The theories that explain perception of rhythm can be broadly classified into the expectency theories and the recent entrainment models.

The expectancy hypothesis initially proposed by Meyer (1956) was researched by many authors and musicologists. Simon and Summer (1968) reviewed music perception as an extrapolation task, where the listener predicts future patterns based on analysis of the current pattern. Povel et al.(1985) proposed that in perceiving a metrical accent, listeners induce an internal clock or "innate expectancies" (Narmour, 1990). It is this clock which guides the points of anticipator)' attention of the listener to promote the perception of rhythm.

The entrainment model proposed by Large and Kolen (1996), states that the perception of metrical structure is a dynamic process where the temporal organization of external musical events synchrosises or entrains a listener's internal 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 pattern in terms of its phase and period, generating a receptive field. The unit responds to event onset occuring within this field and ignores the rest.

Cognitive theories link music perception and cognition. In Lerdahl and Jackendoff s generative theory (1983), a rhythm with its pattern of phenomenonal accent funtions 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 (1995) 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 organisation of temporal intervals in working memory.

Role of hemispheres in perception of music:

Many authors have probed into establishing a cerebral hemispheric superiority for perception of music. A left ear superiority has been reported for the identification of emotional tone of short musical passages presented dichoticalry (Bryden, Ley and Sugarman, 1976). Much research has focussed on ear asymmetries of musicians and non-musicians. Bever and Chiarello (1974) suggested that non musicians perceived musical note sequences as wholes/ gestalts and processed them most efficiently in the right hemisphere. They also tested trained musicians on a dichotic presentation of Western tonal sequences and found greater accuracy for melodies presented to the right ear. Hence musicians are said to process information best in left cerebral hemisphere in an analytical fashion.

Johnson, Bowers, Gamble, Lyons, Presbrey and Vetter (1977) tested a total of 87 college students. Each subject was given a sequence of six notes in one ear. a different sequence of six notes in another ear, then four six note sequences in both ears from which the subject was to identify, the two sequences heard before in one or the other ear. Trained musicians who were able to transcribe the music made fewer errors in recognition of conventional melodies when presented in the right ear. However, they demonstrated more errors in the recognition of the random note sequences. Other subjects, even though able to read music made play instruments and more errors across all types of stimuli, when the stimuli were presented in the right ear.

Johnson (1977) gave a dichotic listening task involving melodies, to 32 musicians and 32 non-musicians. The subjects task was to decide which of the melodies played dichotically was akin to the one played binaurally immediately after the dichotic presentation. The musicians as a group demonstrated the right ear superiority, while the non-musician group performed better in the left ear. Additionally, the left handed subjects in both groups showed smaller amounts of ear asymmetry than their right handed counterparts. This result was attributed to the possible existence of two subgroups within this population- true left handers and those with cortical organisation of the right handers.

Gates and Bradshaw (1977), conducted six experiments to investigate the detection the pitch, rhythm and harmony changes in music perception. In terms of reaction times, the left ear was faster, but the right ear more accurate in detecting rhythm changes. The ears did not differ significantly in detecting changes in harmony. Also, leaving out a few female non-musicians, the right ear was more sensitive for unfamiliar melodies, and the left ear was mere attuned for familiar memories.

Gordon (1978) found right ear superiority for 24 musicians as well as 24 non-musicians on a dichotic listening paradigm using melodies each differing only in rhythm. The task required the subject to indicate both the rhythms presented simultaneously on a special answer sheet after the cessation of each melodic pair. No ear advantage was found for groups of subject for the dichotic melodies test differing in pitch pattern. He concluded that left hemisphere was superior in perceiving the rhythmic cue and that rhythm was perceived most in an analytical, time dependant sequential manner.

Wagner and Hannon (1981) tested 10 faculty and 10 student non- musicians. All subjects had to listen to a series of melodies(some recurring and non- recurring) and excerpts(some actual and some not) in one ear and after a rest, to a different series of melodies in other ear. The task involved detecting recurring versus non-recurring melodies, actual versus non-actual excerpts. Student musicians demonstrated a right ear advantage as opposed to the student non-musicians who showed a left ear superiority in melody recognition. Neither faculty group showed any ear preference. This result was explained as being brought about by the physical maturation factor along with the development of functionally more integrated approach to the task as a result of education and/or experience.

The differences in results of various studies from the one conducted by Gordon (1978) may be attributed to differences in the nature of musical pieces selected, nature of the task given to the subject and the mode of response ellicited. It is also clear from these studies that it is the nature of cognitive processing that should be concentrated upon with regards to ascertaining the role of hemispheres in perception and not just whether the stimuli is verbal or non-verbal.

The methods used in various studies of music perception include:

> Perception of equal intervals
> Just noticeable differences
> Identification of melody and rhythm presented monotically
> Identification of melody and rhythm presented dichotically
> Reaction time in perception of melodies when presented dichotically.

There are culture differences in perception of music. According to Dowling et al.(1987), Cuban musicians and non musicians perceive and cognitize music in a different way as compared to the North Americans. He attributed this difference to the differences in psychophysiological make up of the two disparate cultures.

The present study addresses the issue of perception of Indian musical rhythms by individuals and ear advantages if any in the perception of rhythm in Indian music.

**

CHAPTER III

METHODOLOGY

Experiment I

Material: Two sets of test material were prepared. The rhythm structures selected were four ta:las, one each from 'Chatushra'. 'Mishra', 'Khanda' and ' Tishra' ja:ti of ta:las. Each set consisted of eight different melodies. Each of the ta:la selected was represented in two of the melodies in each set. The details are presented in table 1. These melodies were hummed (sung as 'la la') by a trained singer for 40 seconds duration, each of which was audio recorded monoaurally using a Sony tape deck with an 'H legend' microphone. The melodies were hummed to avoid phonetic and semantic influences.

	Right ear		Left ear
1	Chatushra (on)	1	Mishra (off)
2	Tishra (off)	2	Chatushra (off)
3	Mishra (on)	3	Tishra (on)
4	Chatushra (off)	4	Mishra (on)
5	Tishra (on)	5	Tishra (off)
6	Khanda (on)	6	Khanda (on)
7	Mishra (off)	7	Khanda (off)
8	Khanda (off)	8	Chatushra (on)

On - on beat: la..la... (starting from the first beat)

Off- off beat: Ja..la... (missing the first beat)

Table 1: Rhythmic structures arranged for the two ears:

Subjects: 32 normal, right handed non- musicians in the age range of 18-25 years served as subjects.

Method: These recordings were subjected to acoustical analysis using 'CSL 4300 B' software. The time difference between metrical accents in the rhythm was measured using Fo and intensity curves extracted from the waveform. This was done to verify and compose the rhythmic structure of each melody.

Each subject was tested individually. Each subject was presented with the melodies monoaurally through headphones and was instructed to listen to the melodies carefully and indicate the beats / rhythm of each melody by table taps as early as possible into a microphone kept at a distance of 10 cms. The melodies were presented to the right ear first in 50% of the subjects and to the left ear first in the remaining subjects.

Analysis: The data was subjected to the following analysis:

1) The percent times each ta:la was tapped appropriately by subjects when presented in the (a) right ear (b) left ear and
2) The latency of the responses to each rhythm when presented in the (a) right ear and to the (b) left ear.

The appropriateness of the tapping pattern was judged by comparing it with the results of acoustic analysis of the original recording.

Experiment II

Material: The test material consisted of four pairs of melodies involving use of three rhythms, the talas of 'Chatushra', 'Tishra', and 'Mishra' Ja:tis. Each pair had two different rhythms set to the same melody. Each melody was hummed (sung as 'la la') for 40 seconds duration using a Sony tape deck with an 'H legend' microphone. The verification of the rhythmic structure was done using the " CSL

4300 B" software as in experiment I. These pairs of melodies were recorded dichorically using the software "Audiolab". The interval between the presentation of each pair was 10 seconds. The material hence consisted of the following rhythm pairs.

Rhythm pair	Right ear	Left ear
1 ab	Chatushra	Mishra
2 ab	Tishra	Chatushra
3 ab	Mishra	Chatushra
4 ab	Chatushra	Tishra

Table 2: Dichotic rhythm pairs

Subjects: Subjects were the same as in experiment I

Method: Subjects were presented with the dichotic stimuli routed through the Madsen OB 822 Clinical audiometer with TDH-39 earphones and MX 41- AR ear cushions at an intensity of 65 dB HL in both ears and were instructed to tap on the table in accordance with the rhythm which they perceived. These taps were recorded using a microphone kept at a distance of 10 cms.

Analysis: The data of Experiment II was analysed for the following:

a) The rhythm to which the tapping pattern resembled

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

The data was tabulated for further analysis.

**

CHAPTER IV

RESULTS

Experiment I

Figures 1-8 indicate the number of subjects able to perceive each ta:la in the on beat and off beat mode in the right and left ear. The percentages of subjects who could perceive the various taias are in table 3.

Talas	Right ear		Left ear	
	Raw score out of 32	Percent scores	Raw score out of 32	Percent scores
Chatushra On beat	27	84.3	26	81.3
Offbeat	25	78.1	25	78.1
Tishra On beat	28	87.5	28	87.5
Off beat	28	87.5	28	87.5
Mishra On beat	22	68.8	22	68.8
Offbeat	20	62.5	21	65.6
Khanda On beat	3	0.09	1	0.03
Offbeat	1	0.03	1	0.03

Table 3: Percentage of subjects perceiving various ta:la:s

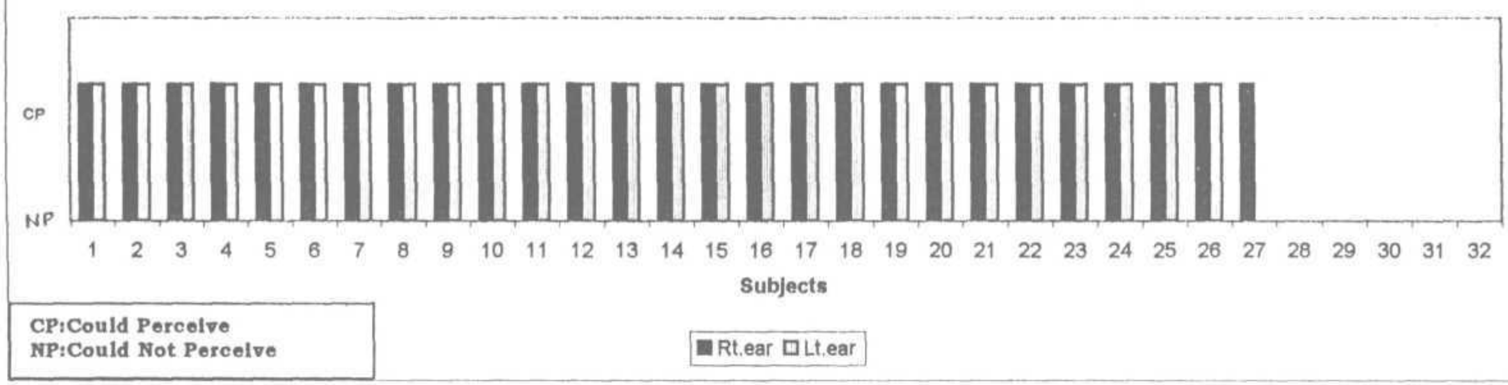


Figure 1: CHATUSHRA (ON-BEAT)

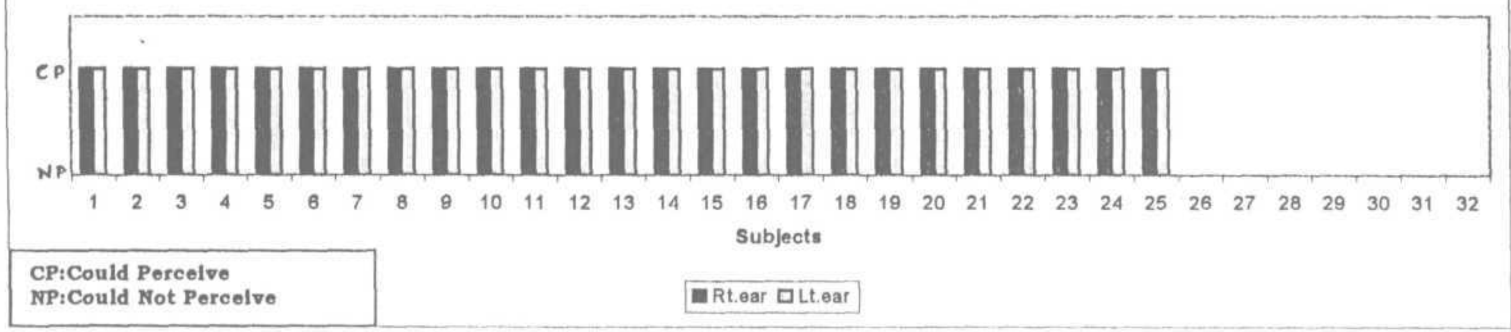


Figure 2: CHATUSHRA (OFF-BEAT)

15a

Figure 3: TISHRA (ON-BEAT)

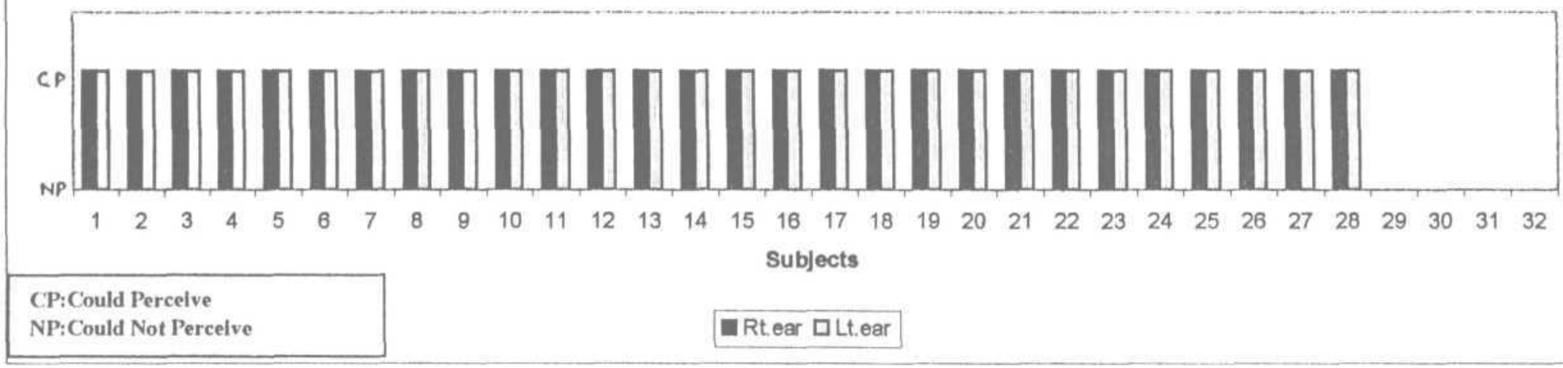


Figure 4: TISHRA (OFF-BEAT)

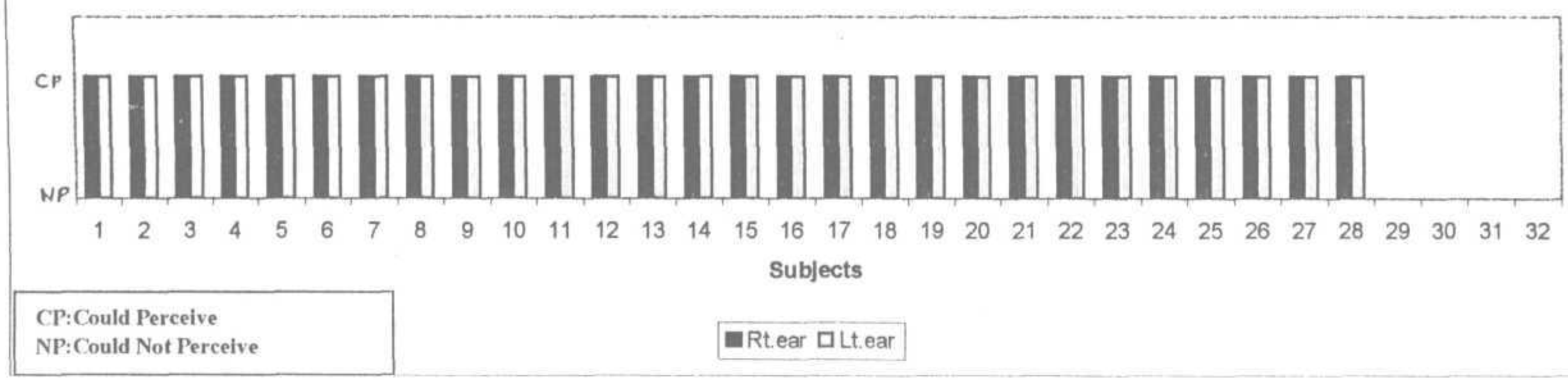


Figure 5: MISHRA (ON-BEAT)

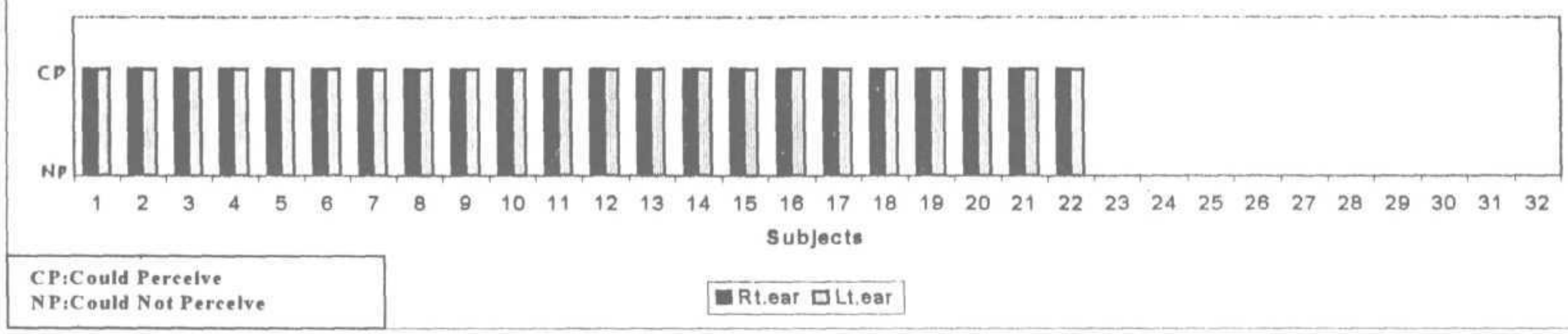
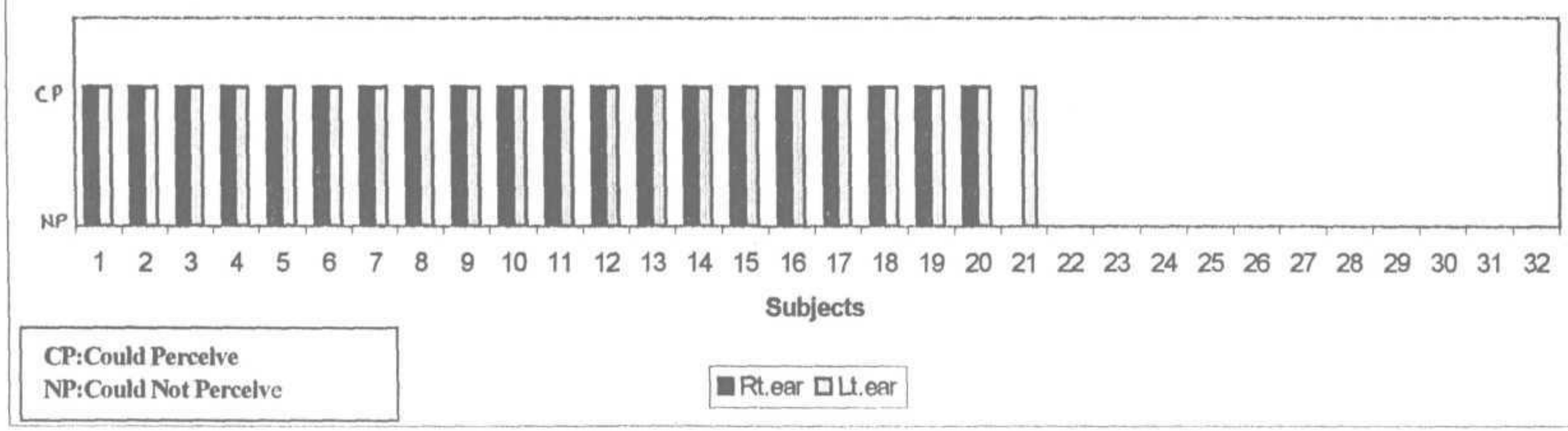


Figure 6: MISHRA (OFF-BEAT)



15c

Figure 7: KHAṆḌA (ON-BEAT)

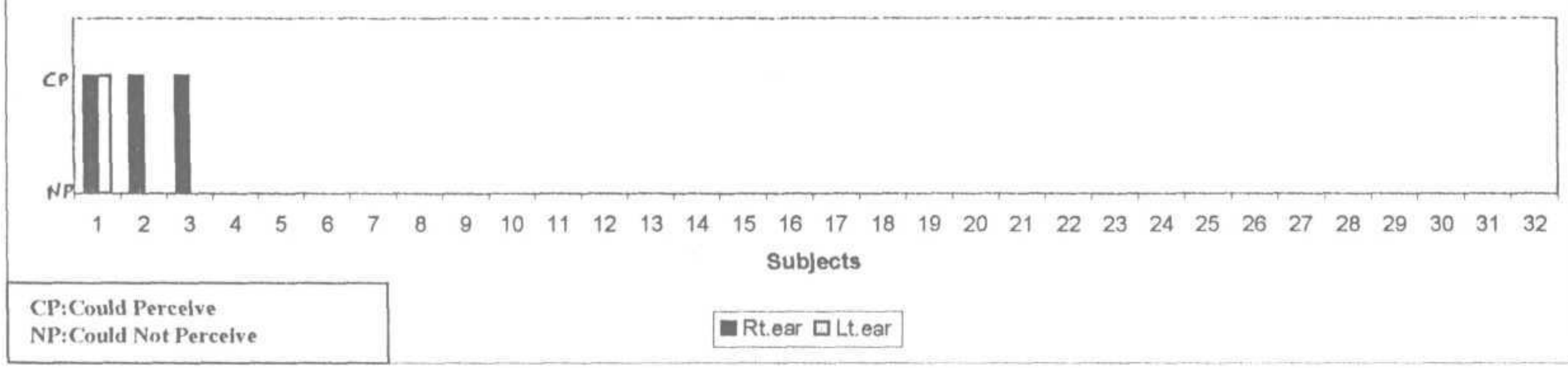
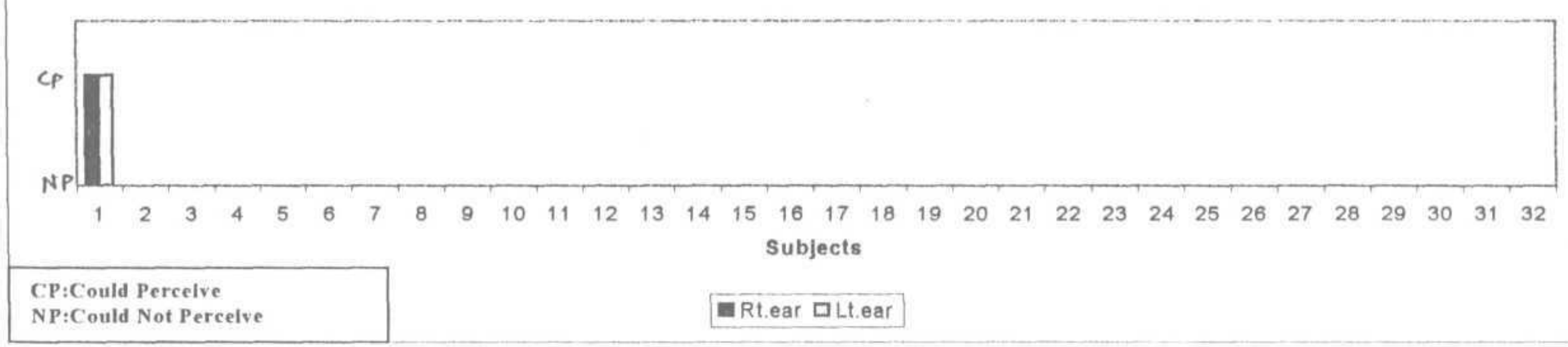


Figure 8: KHAṆḌA (OFF-BEAT)



15d

The data indicates that the Tishra and Chatushra Ja:ti ta:las were perceived better followed by Mishra Ja:ti. The number of subjects who could perceive the ta:la from Khanda Ja:ti were markedly less as compared to other ta:las. The subjects who could perceive a rhythm in one ear could also perceive it in the other ear, but for some exceptions. In general, the percentage individuals perceiving the on beat ta:las was greater than the off beat ta:las except for the Tishra Ja:ti. However, these differences were not statistically significant (paired T test for dependent samples). The average latency and the range of latency values obtained for the perception of each of the ta:las are in Table 4.

Ta:las	Latencies in seconds			
	Right		Left	
	Average	Range	Average	Range
Chatushra On	3.148	2.462-4.121	3.459	1.487-4.632
Off	4.281	3.118-4.756	4.137	3.128-5.315
Tishra On	2.793	1.134-4.666	3.010	1.733-3.480
Off	2.824	1.765-5.118	3.989	1.250-4.773
Mishra On	5.114	3.231-7.416	5.467	3.499-8.134
Off	6.918	5.149-7.813	7.195	3.144-9.112
Khanda On	8.616	7.411-15.348	9.181	6.136-17.846
Off	9.113	7.910-18.251	9.684	8.121-17.250

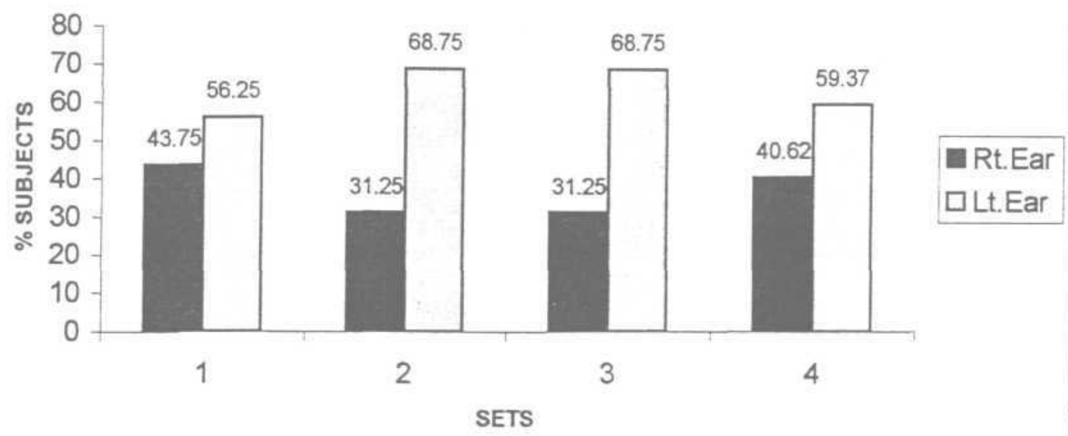
Table 4: Average values and range of latencies in seconds.

The Chatushra and Tishra ta:las had the least latency followed by Mishra and Khanda Ja:ti ta:las. The difference in average latencies between the on and off beat modes of each ta:la and the right and left ear were not significant.

Experiment II

The results of experiment II are presented in table 5. The relative lateralization of the four ta:las in the right and left ear for each subject is presented. The paired-T test for dependent samples indicated that a significantly greater number of ta:las of the left ear were perceived than those presented to the right ear. In figure 9, the percentage subjects tapping to the rhythmic structures of the right or left ear are shown. For all the ta:las, a left ear advantage was evident. The overall percentage of subjects perceiving the rhythmic structures i.e., structures presented to the left ear was 63.28% whereas the percentage of subjects perceiving the right ear rhythm was 36.71% indicating a left ear - right hemisphere superiority for rhythm perception.

Fig. 9 : % SUBJECTS TAPPING TO THE RHYTHMIC STRUCTURE OF RIGHT AND LEFT EAR



Subject	Right ear -Ta:las perceived out of 4 sets presented	Left ear -Ta.las Perceived out of 4 sets presented
1	3	**1**
2	2	2
3	1	3
4	4	0
5	0	**4**
6	1	3
7	1	3
8	4	0
9	0	**4**
10	0	**4**
11	4	0
12	0	**4**
13	3	**1**
14	0	**4**
15	2	2
16	0	**4**
17	3	1
18	4	0
19	1	3
20	0	**4**
21	1	3
22	0	**4**
23	2	2
24	2	2
25	2	2
26	1	3
27	2	2
28	1	3
29	0	**4**
30	1	3
31	**0**	**4**
32	0	**4**

Table5: Number of right and left ear ta:las perceived by subjects.

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CHAPTER V

DISCUSSION

In experiment I, the ta:las from Tishra, and Chatushra Ja:tis were perceived correctly by most subjects as compared to the ta:las from Mishra and Khanda Ja:tis. They were also perceived faster and easier as evidenced by the latency values. This indicates that the Tishra and Chatushra ta:las are easier ta:las to be perceived by individuals who have not undergone any formal training in music. This may be because these ta:las are more regular, the accents being produced after regular intervals and thus can be easily extracted and perceived from an ongoing melody. According to Ghosh (1968), the Chatushra Ja:ti ta:las, eg., the 'teental' is most popular of the ta:las. He explained this popularity being caused by an increased concentration of table, players on this ta:la. He also mentioned that the intricate ta:las have gone out of practice. This may be due to the inability of the non-musicians to perceive and appreciate difficult and complex ta:las. As per Geoffrey's (1982), reflection on Indian classical music, though the thirteenth century treatise Sangeeta Rathnakara describes 120 ta.las, contemporary musicians claim only 20 ta:las in common use. The Khanda Ja:ti tala used in this study being a relativeJ|Complex ta:la was perceived only by three individuals.

No significant differences were found between the performances of the two ears during the mono aural presentations. This may indicate some amount of cross hemispheric activity and equal ability of each ear in handling rhythm perception when the melodies are presented in absence of any competition. No significant differences in the perception of on beat and off beat modes of rhythmic structures indicates mat the 'missed beat' in the offbeat mode of the ta:la is aptly cued in the melody which helps in its perception. The perception of this cue in the ongoing melody may require more time which might explain the slightly, though not so significantly, longer latencies in its perception.

In experiment II, significantly greater number of subjects perceived the rhythm structures presented to the left ear in the dichotic paradigm suggesting a left ear-right hemisphere superiority in the perception of the rhythm. This superiority was found irrespective of the inherent difficulty in the rhythm. This result is in agreement with the studies on melodic perception stating right hemisphere superiority in perception of music by the non -musicians (Bryden et al., 1976; Johnson, 1977; Johnson et al., 1977; Gates et al., 1977; Gaede et al., 1978; Wagner et al.,1981; Bever, 1983; Barod and Goodglass, 1989; Bever and Chiarello, 1994).

However the results of this study are not in consonance with the results attained by Gordon (1978) whose study involved a similar paradigm. He found a right ear - left hemisphere advantage for both musicians and non- musicians in perceiving rhythm cues. The differences in the results may be accounted for by the differences in the duration of melodies presented, nature of task and mode of response used in both the studies. The duration for which the melodies were given dichotically in Gordon's study was four seconds after which the subjects had to indicate both the rhythms on a special answer sheet. The present study used a 'tapping' task as the mode of response to be performed along with the melody in accordance with the rhythmic structure the subject found easiest to perceive. This eliminates the short term memory variable during response but incorporates a motor task.

Hence the present study suggests that the nature of overall rhythm perception by non- musicians is more gestalt or processed in a wholistic fashion than in an analytical and sequential way which may be evidenced in individuals trained in music.

A knowledge of rhythm and basic rhythmic structure has immense implication in music therapy as well. According to Silverman (1995) some Afro-Cuban drumming styles affect psychological processes like heart rate and peristaltic movements. Faulty biological rhythms may be corrected by entraining the systems to follow appropriate rhythmic cycles (Manning, 1977). A passive knowledge of metrical structure enhances learning memory and recall (Essens & Povel, 1985). AlsO/the differential psychological and cognitive effects of rhythm can be used to facilitate teaching of communication skills.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The role of hemispheric processing in the perception and production of various prosodic features has been studied in normals as well as in brain damaged population. In the area of music a left ear superiority has been reported for perception of melodies in non-musicians as opposed to better recognition of melodies presented to the right ear in trained musicians. In terms of rhythm perception, a right ear- left hemisphere superiority has been reported by Gordon (1978) in musicians as well as in non-musicians.

All the studies conducted in this area pertain to the Western music. Hence, the present study intended to address the issue of perception of Indian musical rhythms. The study aimed at investigating the following:

- Perception of rhythm in music in normal individuals
- The role of hemispheres in perception of rhythm in music.

Thirty two normal right handed musicians in the age range of 18-25 years served as subjects for experiment I and II. In Experiment I, each of the subject was presented with melodies hummed in each of Chatushra, Tishra, Mishra and Khaṇḍa Jarthi ta:las both in on beat and off beat modes monoaurally. Experiment II incorporated a dichotic paradigm, in which three ta:las of Chatushra, Mishra and Tishra ja:ti were used to prepare four rhythm pairs. Both the rhythms in each pair were sung in the same melody and were recorded dichotically. The response task for both the experiments was to tap in accordance with the rhythm perceived at their earliest along with the ongoing melodies.

In Experiment I, the Tishra and Chatushra Ja:ti ta:las were found to be perceived correctly and relatively quickly by most subjects followed by Mishra ja:ti ta:las. This indicates that the former ta:las are relatively easier and less complex for the non-musicians to perceive. The difference in the average latencies between the on and off beat modes of each ta:la and between the right and left ear were not significant.

In Experiment II, a significantly greater number of subjects perceived the rhythms presented to the left ear, suggesting a left ear- right hemisphere advantage. This may be indicative of a gestalt/ holistic processing of the rhythm cue by non-musicians.

To conclude, it is evident that some Indian musical rhythms are relatively easier to perceive than other rhythms by non-musicians. Also,, the nature of processing of rhythmic cues in Indian music in these individuals as suggested by a left ear advantage may differ from the analytical nature of processing proposed in musicians.

Research in rhythm perception has implications in many areas owing to differential cognitive, psychological and physiological effect in individuals. These areas include music therapy and facilitation of communication skills in speech and languagetpopulation. Studies could be carried out in disordered population as well, eg. in individuals with stuttering and learning disabilities. Further research is warranted in studying the hemispheric role in perception of rhythm and in devising better methodological paradigms in studying the nature of processing of rhythm.

REFERENCES

Balasubramaniam,T. (1980). Timing in Tamil. Journal of Phonetics, 8. 449-467.

BenguereL A.P., & D'ArcyJ. (1986). Time-Warping and the perception of rhythm in speech. Journal of Phonetics, 14, 231-246.

Bever, T.G. (1983). Cerebral lateralization, Cognitive asymmetry and human consciousness, In Perecmen, E. (Ed.), Cognitive Processing in the Right Hemisphere. Academic Press, New York.

Bever, T.G., & Chiarello, R.J. (1974). Cerebral dominance in musicians and non-musicians. Science, 185, 537-539.

Blumstein, S., & Cooper, W.E. (1974). Hemispheric processing of intonation contours. Cortex, 2, 146-158.

Borod, T.C., & Goodglass, H. (1980). Lateralization of linguistic and melodic processing with age. Neuropsychologia, 18, 79-83.

Boyden, C. (1956). Cited in Deri,O. (1968). Exploring twentieth century music, Holt, Rinehard and Winston Inc., U.S.A.

Bruner, P. (1973). Cited in Ray, J. (1993). A synthetic test of Rhythm. An unpublished Masters Dissertation, University of Mysore, Mysore.

Bryden, M.P., Ley, R.G., & Sugarman, J.H. (1982). A left ear advantage for identifying the emotional quality of tonal sequences, Neuropsychologia, 20, 83-88.

Chaitanyadeva, B. (1967). Perception of rhythm. The Journal of the Music Academy, 38, 132-135.

Cutler, A., & Butterfield, S. (1992). Rhythmic cues to speech segmentation : Evidence from juncture misperception. Journal of Memory & language, 3, 218-236.

Dauer, R.M. (1983). Stress timing & Syllable timing, re-analysed. Journal of Phonetics, 11,51-62.

Deri, 0. (1968). Exploring twentieth century music. Holt, Rinehard and Winston Inc., U.S.A.

Dowling, W.J., Lung, K.M., & Herrbold, S. (1987). Aiming attention in pitch and time in the perception of interleaved melodies. Perception and Psychophysics, 41 (6), 642-656.

Encyclopedia Britannica. (1965). Cited in Savithri, S.R. (1995). On Speech rhythms in Kannada. Journal of Phonetics, 23(3), 273-290.

Essens, P.J., & Povel, D.J. (1985). Metrical and non-metrical representation of temporal patterns. Perception and Psychophysics, 18, 1-8.

Fant, G., Kruckenburg, A., & Nord, L. (1989). Stress patterns, pauses & timing in prose- reading. STL-QPSR, 1,7-12.

Farnetani, E. (1990). Rhythmic structures in Italian noun phrases: A study on vowel duration, Phonetica, 47, 50-65.

Gaede, S.E., Parsons, D.A., & Bertera, T.H. (1978). Hemispheric differences in music perception : Aptitude Vs. experience. Neuropsychologia, 3, 369-373.

Garding, E., & Erikson, L. (1989). Cited in Ray, T. (1993). A Synthetic test of Rhythm. An unpublished Masters Dissertation, University of Mysore, Mysore.

Gates, A., & Bradshaw, T.L. (1977). The role of the cerebral hemisphere in music. Brain and language, 4, 403-431.

Geoffrey, H. (1982). Larousse Encyclopedia of Music, Gris Impressores, Portugal.

Ghosh, W. (1968). Fundamentals of Raga and Tala with a new system of notation. Usha Printers : National House, Bombay.

Gordon, H. (1978), Left hemisphere dominance for rhythmic elements dichotically-presented melodies. Cortex, 14(1), 58-70.

Haggard, M.P. (1975). Cited in Freeman, F.J. (1982). Prosody in perception, production & pathologies. In N.J. Lass, L.V. McReynolds, T.L. Northern, & D.E.Yoder, (Eds.), Speech, Language & Hearing, W.B. Saunders Company, Philadelphia.

Ivry, R.B. (1996). The representation of temporal information in perception and motor control. Current opinion in Neurobiology, 6, 851-857.

Ivry, R.B., & Hazeltine, R.E. (1985). Perception and production of temporal intervals across a range of durations. Evidence for a common timing mechanism. Journal of Experimental Psychology : Human perception and performance, 21, 3-18.

Johnson, P.R. (1977). DichoticaUy-stimulated ear differences in musicians and nonmusicians. Cortex, 13, 385-389.

Johnson, P.R., Bowers, J.K., Gamble, M.K., Lyons. F.W., Presbrey, T.W., & Vetter, R.R. (1977). Ability to transcribe music and ear superiority for tone sequences, Cortex, 13, 295-299.

Kimura, D. (1964). Cited in Helm- Estabrooks, N. (1983). Exploiting the right hemisphere for language rehabilitation : Melodic Intonation therapy. In E. Perecman (Ed.), Cognitive processing in the right hemisphere. Academic Press, NY.

Large, E.W., & Kolen, J.F. (1996). Resonance and the Perception of musical meter. Connection Science, 6(1), 177-208.

Leeuwen, T.V. (1999). Speech, Music & Sound. Macmillan Press Ltd., Hong Kong.

Lehiste, I. (1977). Isochrony reconsidered. Journal of Phonetics. 5. 253-263.

Lehiste, I. (1979). The perception of duration with sequences of four intervals. Journal of Phonetics, 7(4), 313-316.

Lehiste, I. (1985). Rhythm of Poetry, Rhythm of Prose. In V.A. Fromkin (Ed.), Phonetic Linguistics. Academic Press, Inc, Florida.

Lerdahl, F., & Jackendoff, R. (1983). A Generative theory of tonal music. MIT Press, Cambridge.

Mangels, A.J. (1998). Dissociable contributions of the prefrontal and neocerebellar cortex to time perception. Cognitive Brain Research, 7, 15-39.

Manning, P. (1977). Cited in Large, E.W., & Kolen, J.F. (1996). Resonance and the perception of musical meter. Connection Science, 6(1), 177-208.

Martin, J.G. (1979). Rhythmic & Segmental perception are not independent. Journal of^Acoustical Society of America, 65, 5, 1286-1297.

Meyer, L. B. (1956). Cited in Leeuwen, T.V. (1999). Speech, music & Sound, Macmillan Press Ltd, Hong Kong.

Miller, M. (1984). On the perception of rhythm. Journal of Phonetics, 12, 75-83.

Nakatani, L. H., Connor, K.D., & Carletta, K.A. (1981). Prosodic aspects of American English speech rhythm. Phonetica, 38, 84-106.

Narmour, E (1990). Cited in Large, E.W., & Kolen, J.F. (1996). Resonance and the perception of musical meter. Connection Science, 6(1), 177-208.

Nichelli, P. (1996). Perceptual timing in cerebellar degeneration. Neuropsychologja, 34, 863-871.

Pike, K.L. (1945). Cited in Lehiste, I. (1977). Isochrony reconsidered. Journal of Phonetics, 5, 253-263.

Pointon, G.E. (1980). Is Spanish really syllable timed. Journal of Phonetics, 8, 193-394.

Povel, D.J., & Essens, P. (1985). Peception of temporal patterns, Music Perception, 2, 411-440.

Roy, CM. (1981). Stress timing in Brazilian Portugese. Journal of Phonetics, % 343-351.

Savithri, S.R. (1995). On Speech Rhythms in Kannada. Journal of Phonetics, 23(3), 273-290.

Silverman, C. (1995), Cited in Ivry, R.B. (1996). The representation of temporal information in perception and motor control. Current opinion in Neurobiology. 6,851-857.

Simon,J.. & Summer, E. (1968), Cited in Povel, D.J., & Essens, P. (1985). Perception of temporal patterns. Music Perception, 2, 411-440.

Srinivasa. R. (1967). The place of rhythm in art. The Journal of the Music Academy, 38, 130-131.

Wagner, M.T., & Harmon. R., (1981). Hemispheric asymmetries in faculty and student musicians and non-musicians during melody recognition tasks. Brain and Language, 13. 379-388.

Wioland, E. & Wenk, BJ. (1982). Is French really syllable timed ? Journal of Phonetics, 10. 193-216.

Woodrow, H. (1951). Time perception, In S.S. Stevens (Ed.), Handbook of Experimental Psychology, Wiley Pub., New York.

Zlatoustava, L.V. (1975). Cited in Ray, J. (1993). A Synthetic test of rhythm. An unpublished Masters dissertation, University of Mysore, Mysore.