Perception of Musical Rhythm in Persons with Stuttering

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Abstract

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. 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 persons with stuttering. Two groups of subjects participated in the experiment. Group I consisted of 10 persons with stuttering (PWS) 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 subjects were presented with the ta:las in monaural condition and in dichotic condition. The results indicated no significant ear or group differences under monotic presentation. However in PWS, left ear preference was observed and in normals right ear preference was observed. Misra ta:la was the most difficult and Tisra and Khanda ta:las were the easiest to identify. Under dichotic presentation varying responses were observed. In general, it was observed that compared to normals PWS were poorer in identifying rhythm. In normals a wide difference was observed between the identification scores of ears, while in PWS it was not so. This probably indicates mixed laterality in PWS. Tisra ta:la was not preferred except when it was presented in right ear along with Misra ta:la in left ear. Also, whenever Khanda and Misra ta:las were presented dichotically, there was a confusion and no ta:la was identified. The results indicated that the identification of rhythm was different in PWS compared to normals and that there was a right hemisphere dominance or mixed laterality in PWS.

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. Intonation refers to the movement of fundamental frequency, stress refers to the increased effort and rhythm refers to the regular movement. Rhythm in speech is not regular. However, when it is poetry or music one finds a regular rhythm. Several investigations Gates & Bradshaw (1977), Gorden (1978), Gaede, Parsons & Bertera, 1978, Johnson (1977), Zatorre (1978) have been conducted on the biologic substrates of music perception. The results of these investigations reveal that musicians are more strongly right hemisphered for unitary musical tasks. Odekar (2001) studied rhythm perception in 32

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normal non musician adults. Results showed no significant difference between the performances of the two ears during monaural presentations. In the dichotic presentation, significantly greater number of subjects perceived the rhythm structure presented to the left ear suggesting left ear-right hemisphere superiority in the perception of rhythm.

Stuttering is considered to be a disorder of rhythm. Orton & Travis (1929) putforth the Cerebral Dominance theory, according to which, 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 speech and language processing. In persons who stutter 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 half sphere which is adequate for processing language or the pathways for speech start in the left half sphere and jog through the right half sphere rather than staying on the left half sphere of the brain. This suggests that PWS use inefficient pathway of talking. If there is left ear advantage in rhythm processing and stuttering is a result of reverse cerebral dominance, then it could be hypothesized that PWS should have right ear advantage in a rhythm processing task. It would be interesting to examine if PWS have difficulty in perceiving musical rhythm. In this context the present study investigated the perception of musical rhythm and ear preferences in PWS.

Method

Experiment I: Monaural presentation

Material: The rhythm structures selected were four ta:las from Catusra, Misra, Tisra and Khanda. The details of these ta:las are presented in table 1. These melodies were hummed (sung as la la) in the raga 'Maya:ma:lavagaula' by a trained singer for 15 seconds duration, each of which was 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). The beats are marked bold in the table.

Table1: Material for experiment I.

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

Subjects: Two groups of subjects participated in the study. Group I consisted of ten normal right handed non musicians. Group II consisted of ten individuals with stuttering. All of them were right handed non musicians and in 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. They 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 in 50% of the subjects and to the left ear in the remaining subjects.

Analysis: The percent time 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 dichotically presented using the two tracks of Cool Edit Pro Syntrillium Software.

Table 2: Material for experiment II

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

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

Procedure: Subjects were presented with the dichotic stimuli through earphones at a comfortable loudness. 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 were administered to find out the significant difference between groups and ears.

Results

Experiment I: Monotic presentation

The results indicated that in general, PWS (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 and PWS identified rhythms presented to left ear better than those presented to right ear. 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. 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. Walsh test showed significant difference between groups and ears.

Table 3: Average percent correct responses in normals and stutterers

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

Experiment II: Dichotic presentation

Under dichotic presentation, normals performed better compared to PWS. Further, both the groups identified rhythms presented to right ear better than those presented to left ear. Table 4 shows the average percent correct response to dichotic stimuli. Walsh test showed no significant difference between ears in both groups except for a few ta:las. Also no significant difference between groups except for two of the ta:las was noticed.

Table 4: Responses for dichotic stimuli (C-Catusra, K- Khanda, M- Misra, T- Tisra, N- not identified)

Stimulus		Response			
LE	RE	Normals		PWS	
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 % response		L	R	L	R
		8.33	58.33	33.33	16.66
	N	33.33		50	

Discussion

The results indicated several points of interest. First of all, under monotic presentation no significant ear or group differences were found. However, in PWS 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. Fourth, it was observed that compared to normals PWS 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 PWS and a right ear advantage in normals were observed indicating a right hemisphere dominance in PWS 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. 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 PWS it was not so (33.33-16.66 = 16.66). This probably indicates mixed laterality in stutterers. Curry & 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 & 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 PWS. 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 modes) 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 probably because of the structure of the two ta:las. 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 PWS compared to normals and that there was a right hemisphere dominance or mixed laterality in PWS. 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 two hypotheses on prosodic processing. Van Lancker (1980) theorized that linguistic prosody is processed by left hemisphere and emotional prosody is controlled by the right hemisphere. Van Lancker & Sidtis (1992) hypothesized 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 PWS have a left ear advantage or mixed laterality. These results indicate that PWS have problem in rhythm processing at least momentarily. Further, it would be interesting to study processing of dichotic speech signals in PWS and normals.

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