The Dhaka University Journal of Linguistics : Vol. 12, No. 23-24, Published by the Registrar, University of Dhaka, ISSN 2075-3098

Exploring the Transformation of Speech Stress into Melody in a Song

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Abstract: In order to show the intertwining relationship between language and music the current study investigates a Bangla song to explore how one domain interacts with another. A theoretical framework based on metrical phonology as well as Generative Theory of Tonal Music (GTTM) has been used to reveal how a lyric achieves musical virtue through transforming its built-in stress pattern or speech stress of language. In particular, the data analyzing parameters have been taken from linguistic and musical aspects. In case of linguistic aspect, the lyric of the selected song have been tested through the prosodic hierarchical structure, feet structure inventory and parameters of metrical constituents. In addition, acoustic phonetic evidences of stress transformation have been shown from the linguistic aspect. Whereas, grouping structure, metrical structure, time-span reduction and prolongational structure of GTTM have been selected as parameters from the musical aspect. However, both domains have been considered as autonomous hierarchical systems. Although Bangla is a trochaic feet structured, quantity-sensitive language the prime stress always falls on the initial syllable, significant changes other than this rule are observed due to melodic insertion in this study.

Keywords: Metrical phonology, Generative theory of tonal music, stress, Prosody, Hierarchical structure, Iambic, Trochaic

Introduction

The relationship between music and language have been systematically discussed by biologists, anthropologists, musicologists, cognitivists and linguists (Brown, 200; Fogany, 1983; Bernstein, 1976; Patel, 2012; Lerdahl and Jackendoff, 1983) from their own point of views using different methodologies. According to William Bright (1963) "language and music are the two most important ways in which man use sound" (p. 26). The most significant point of connection between language and

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music is that they both rely on the analysis of complex sound. This paper is an interdisciplinary study of language and music regarding processing of complex sound as well as hierarchical structures as shared features of both communicative medium. Although systematic investigation of exploring the relationship between those domains are rarely found, scholars (Bernstein, 1976; Bright, 1963; Brown, 2001; Livingstone, 1983) from various academic arena from musicology to linguistics discuss those domains from basically comparative and analogical interest. The prime concern of this study is to show how the stress pattern of language transforms into melody through transforming the rhythm patterns in a song. In other words, the tunes of songs achieve musical virtue through transforming the natural or regular stress pattern of language in particular lyrics. In order to show this transformational phenomenon a Bangla song has been analyzed in this paper.

In fact, the relationship of stress has been built by generative perspective as well as metrical phonology of language and music. The tendency of showing direct analogy between language and music of both systems was very attractive in the late 70s. Bernstein (1976) is the first musicologist, who strongly proposes that linguistic theories and methodologies might be applied to describe musical structures. In his Norton lectures entitled phonology, syntax and semantics, he postulates some notions such as, 'universal musical grammar' or 'subject, verb, object in a musical passage' following generative aspects of linguistics (Benstein, 1976). Nevertheless, this kind of analogical postulation did not last by ruthless criticism of systematic research of cognitive as well as generative studies (Patel, 2012; Lerdahl and Jackendoff, 1983). Basically, the structural dissociations are as prominent as they express themselves as individual systems. Inspired by Chomskian Revolution[1] in linguistics as well as in the intellectual landscape in the early 1970, Ray Jackendoff and Fred Lerdahl postulate that music might be studied in similar fashion. Instead of showing the similarities between music and language, they developed a common framework by taking theoretical apparatus from linguistics (in particular generative phonology) which is known as Generative Theory of Tonal Music (GTTM).

[1] After proposing the transformational generative enterprise by Noam Chomsky the way of describing human languages was entirely changed.

Significance of the Study

Since any research work regarding the intertwining relationship of the fundamental structures of Bangla language and music is not found, this work will play a vital role in describing the phonological structure of Bangla language and music. Almost all the scholars (Karunamaya, 2007; Tagore, 1978) who are interested in Bangla musicology wrote a lot on history and evolution of Bangla songs, but music has not been considered as a communicative system from interdisciplinary aspect. Consequently music-language interface has not been discussed theoretically from any academic interest. This study is the beginning of describing their connection in respect of structural investigation through Bangla songs.

Method

Since this research is a first attempt to understand the connection between language and music regarding Bangla song by taking prosodic structure as interface, grounded approach of qualitative research is prevailed in this study. Consequently, this study has been conducted inductively in contrast to the hypothetical deductive approach and a quasi-experimental model have been developed as well in this study.

Data Collection Design

The data of this research may be classified into two types, a) Lyrics of the selected songs; b) Melodies of the selected songs.

A song of Rabindranath Tagore from *puja parjay* has been selected for this study. This song is known as *Anondoloke mongolaloke.* Although there is a variety of genres in Bangla music, this song has been chosen due to the popularity and simple musical structure. Since this study is proceeded through quasi-experimental method, simplicity would be more convenient for our analysis.

In the section of previous experiment on stress relationship of language and music the analysis of Lerdahl (2013) on Beatles' song "Yesterday" has been discussed.

Second type of data is the recorded song. The selected song has been sung and recorded by the researcher. In case of recording song the sound recorder of Asus cell phone has been used. The prime inventory

of this study is to show how the stress pattern of lyrics with tune differ from the lyrics without melodies. Thus it is necessary to examine the physical representation like, acoustic phonetic representation of lyrics with melody in this study. For this reason linguistic software Praat has been used to investigate the acoustic presentations of stresses. In this research the version 6.0.43 of Praat has been used.

Graphical representation of melodies are the third types of data in this research. In case of analyzing data with applying GTTM tools it is necessary to show the staff notation of the melody. The notation has been written by the researcher. In order to write the staff notation musescore 2 software has been used.

Theoretical Guideline

Since this is a twofold study which contains the aspects of showing the linguistic stress assignment of lyrics and melodic stress pattern, the theoretical basement has to be constructed by taking a common field. In this regard considering metrical phonology as theoretical guideline, prime data analyzing tools have been designed from GTTM whose core foundation has been built inspired by not only generative theories of linguistics but also metrical phonology. Moreover, it is noteworthy that the melodic stress pattern develops by modifying the natural stress pattern of language (e.g. lyric) in a song and this research is an endeavor to show how this change is occurred. The connection between the theoretical guideline and the analyzing tools of this study can be shown by a diagram:

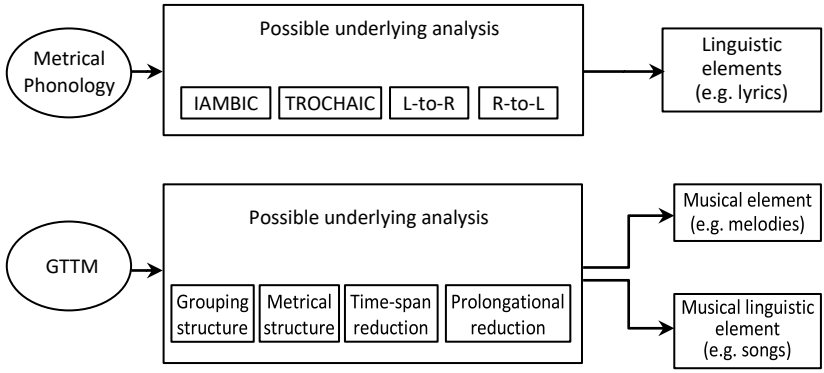


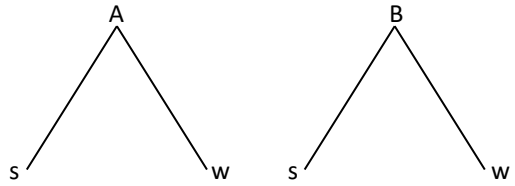
Figure 1: Model of the Connection between theoretical guidelines and tools

The figure: 1 depicts that the possible underlying analyzing tools of GTTM have been integrated by direct influence of metrical phonology, though the forms of both methodologies are quite different. The linguistic elements like, lyrics without melodies require metrical parameters whereas, musical and musical linguistic elements such as, melodies and songs need analyzing tools of GTTM. The possible underlying analysis of metrical phonology and GTTM have been discussed briefly below.

Metrical Phonology: The Core Foundation of the Study

Though basically the theories of metrical phonology was developed as a theory of stress, the domain of this theory was extended to other phenomena which has not been focused here. Fudge (1969) argues that there are two types of hierarchical organizations imposed on each linguistic expression and both take segments or the elements of the segmental skeleton as their starting points. One is the morpho-syntactic hierarchy in which segments are organized into morphemes, morphemes into words, words into phrases and so forth. The other is the phonological hierarchy in which segments are grouped together into syllables, syllables into feet, and feet into phonological words and so on. Metrical phonology is a theory about the nature of this phonological hierarchy which contains internal organization as well as plays role in the application of phonological rules. The theory was originally proposed by Mark Liberman (1975) and elaborated by Liberman and Prince (1977), halle and Vergnaud (1978), Selkirk (1980) and Hayes (1981).

In the metrical approach of phonology the SPE (Sound pattern of English) (Chomsky and Halle, 1968) rules are not completely abandoned rather, the rules have been modified such as, the string of segments are now fed into an algorithm that parsed it into a constituent structure. In metrical theory of stress pattern of a word is represented in terms of a binary branching constituent structure where sister nodes are labelled as ‘S’ means ‘stronger than’ or dominant and ‘W’ means ‘weaker than’ or dependent. The basic building block are look like:



Hulst (1995) comments that "from Vergnaud & Halle's work on metrical phonology it is quite clear that the word stress rules of a great variety of languages could be unraveled and represents in terms of settings of metrical parameters (p. 3)". They provided some basic metrical parameters such as, foot form: left-strong/right-strong, foot type: quantity-sensitive/ quantity-insensitive, foot direction: Left-to-right/ right-to-left and so on (Hulst, 1995). Since the linguistic metrical analysis of lyric is one part of our study, we need not only to sort out simplified foot inventory but also make metrical parameters economically. Here a set of parameters for analyzing metrical constituent has been given below:

(a) IAMBIC: The rightmost syllable in a foot is the head syllable

(b) TROCHAIC: The leftmost syllable in a foot is the head syllable

(c) R-to-L: Align the right edge of the foot

(d) L-to-R: Align the left edge of the foot

We have assumed a simplified foot inventory, where feet are disyllabic and are either trochaic [2](σ́ σ) or iambic (σ σ́). Here we consider the first two parameters IAMBIC and TROCHAIC are responsible for the placement of the stressed syllable within a foot on the other hand, the rest of the two constraints R-to-L and L-to-R are responsible for the placement of the foot within the word. It has been seen in the previous studies that languages have tend to have either IAMBIC or TROCHAIC feet rather than a mix of them (McCarthy and Prince, 1986; Kager, 1996; Van and Vijer, 1998). From the previous observations it is also seen that R-to-L and L-to-R stems tend to have feet that are either close to the beginning or to the end of a word, or tend to assign feet relatively starting either near the beginning or near the end of the

[2] The symbol (σ) stands for syllable.

word. We will now consider an underlying form of with three syllables represents as |ɕ ɕ ɕ|. If we assume that stress is assigned purely by the grammar, at least four different types of syllable arrangement can be found like:

Table 1: Parameters of metrical constituents

Underlying: |ɕ ɕ ɕ|	IAMBIC	TROCHAIC	L-to R	R-to-L
/(ɕ́ ɕ) ɕ/	×			×
⇒/(ɕ ɕ́) ɕ/		×		×
/ɕ (ɕ́ ɕ)/	×		×	
/ɕ (ɕ ɕ́)/		×	×	

Now suppose that in a specific language, the most frequent or important parameter is IAMBIC and the most infrequent parameter is L-to-R. In this case, the 2nd column of the table is the assumed foot structure for this language. Here, The cross symbol (×) in the table depicts which arrangement violet which parameters. This table may look like the tableau of constraints in the experiment of optimality theory (OT). Even though our set and the table of parameters have been influenced a bit by OT, this theory is not our theoretical concern at all.

Basic Component of GTTM Model

In both language and music there are four abstract aspects of hierarchy like, a) a string of objects, b) Nested grouping of these objects, c) a prominence grid assigned to the objects and d) Headed hierarchy of the grouped object.

Regarding these notions GTTM theorists proposed four components for their model such as:

1. Strings and grouping structure: expresses the hierarchical segmentation of the piece into motives, phrases and sections.
2. Metrical structure: expresses the intuition that the event of the pieces are related to a regular alternation of strong and weak beats at a number of hierarchical levels.
3. Time-span reduction: assigns to the pitches of the pieces or melodies a hierarchy of ‘structural importance’ with respect to their position in grouping and metrical structure.

4. Prolongational structure: assigns to the pitches of hierarchy that expresses harmonic and melodic tension and relaxation, continuity and progression. (Lerdahl and Jackendoff, 1983, p. 8-9)

The GTTM theorists state that generative music theory, unlike generative linguistic theory, must not only assign structural descriptions to a piece, but must also differentiate them along a scale of coherence, measure them as more or less preferred interpretations. Thus the rules of their theory are divided into two distinct types:

a) Well-formedness rules: which specify the possible structural description.

b) Preference rules: which designate out of the possible structural descriptions those that correspond to the listeners. (Lerdahl and Jackendoff, 1983, p 8-9)

It is noteworthy that those rules have been formed inspired by prosodic segmentation rules, prosodic well formedness rules and prosodic rules of prominence. These linguistic phonological rules are established by Liberman and prince (1977). Each of the above mentioned component produces possible representations whose properties are characterized by a set of well-formedness rules. Among the class of well-formed representations for a particular piece within each component, only a subset are normally preferred by a listener. The preference rules of each component make reference to the properties of the other components.

Previous Experiment on Stress Relationship of Language and Music

Using GTTM's analyzing tools discussed above, Lerdahl explored how linguistic stress pattern changed into musical stress (Lerdahl, 2013). By analyzing Beatles' song 'yesterday' to some extent, moving from lyrics to music and beginning with phonology he revealed how prominence and hierarchy of stress differ between language and music. First of all, prosodic information of each word of the first line of lyrics employing a tree notation with strong (S) and weak (W) node have been analyzed. Then same information using a combination of prosodic grouping and stress grid have been shown. Next, linguistic prosodic tree structures have been translated into musical time-span reduction tree notation in which domination is represented by the branching length. The next

level was a prosodic analysis of the entire first line of the lyrics showing a stress grid, an inverted metrical grid and prosodic grouping. Finally, the prolongational structure translated from the prosodic analysis of first line was shown. Each stage of the experiment is given here:

(a)

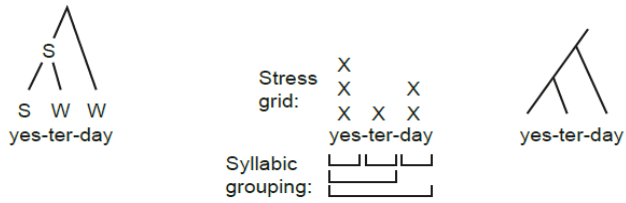


Figure 2: Prosodic analysis of the word 'yesterday' with mostly equivalent notation *(Lerdahl, 2013, p 263)*

In figure 2, from the prosodic tree structure it is evident that '-yes' is the most strong syllable in the word 'yesterday' and similar interpretation has been found in stress grid. It is clearly seen that '-yes' is the only stressed syllable in this word. Thus the translated time-span tree notation of prosodic tree also indicates the elaboration of left node of the tree, thus the elaboration of '-yes'.

(b)

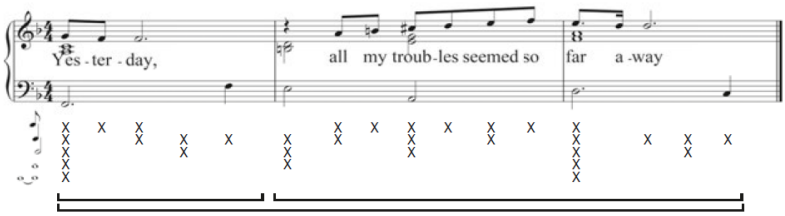


Figure 3: First phrase of the yesterday with notation, metrical grid and grouping (Lerdahl, 2013, p 264)

Figure 3 shows the Beatles' musical settings, accompanied by a musical grouping analysis and metrical grid. The stress metrical pattern of 'yesterday' essentially repeats in 'far way' in which 'far' receives the major metrical stress whereas, without melody the stress falls on the final syllable in case of this word in regular speech. This is the transformation of stress from speech to music. Furthermore, a complete prolongational notation of the first line have been provided in this experiment like:

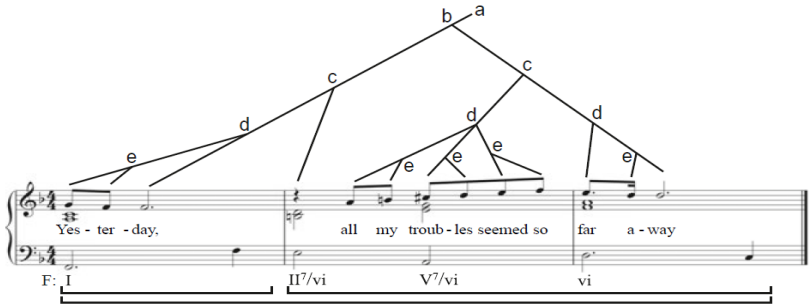


Figure 4: Prolongational structure of the first phrase of 'yesterday' (Lerdahl, 2013, p 265)

In this figure the complete elaboration of strong stress has been shown such as, in case of left node the node of '-yes' has been elaborated the most as well the nodes of '-troub' and '-far' are the utmost elaborated right node. This experiment of translation of prosodic tree into time-span reduction and prolongational tree reveals the truth that melody created different expression of sound by transforming the stress pattern of speech which is one of the significant assumption of this study.

Now a phrase of a Bangla song *Anondoloke mongolaloke* of Rabindranath Tagore has been analyzed through the parameters and tools of metrical phonology and GTTM mentioned above.

Analyzing the Stress Transformation of a Bangla Song

The complete analysis of the songs can be divided into two parts: a) linguistic analysis of the lyrics without melodies and b) musical analysis of both lyrics and melodies. In case of linguistic analysis metrical representation of lyrics have been shown such as, the feet structures, stress distribution and so on. First of all showing the stress assignment of the first phrase in terms of the regular speech of Bangla, the prosodic tree diagram of each word with syllabic feet structures are depicted following by a list of feet structures inventory. After that, the list of feet structures are reanalyzed by using the parameters of metrical constituents.

Secondly, after inserting the melody the lyric is investigated by using the analyzing tools of GTTM. In this case starting with grouping

structures, complete prolongational structures are drawn. To elaborate, at the beginning of this experiment the grouping well formedness rules are implemented in order to show the structural prominence of the constituents. Next, the metrical representation of the song are shown. In addition, acoustic phonetic information (e.g. pitch, intensity) are presented as the evidence of metrical changes of stress patterns. Again, the metrical representation of transformed stress grid of lyrics with musical setting are provided. However, this types of representations do not show the hierarchical explanation of the stress transformation. The hierarchical relationship of the constituents have been revealed by drawing the time span reduction tree diagram. In the next step, the prosodic structures of lyrics are translated into the time span reduction diagram in order to show hierarchical arrangement of the transformation. Finally, complete prolongational structures are constructed to show the ultimate transformation of stresses in the song.

Linguistic Analysis of the Lyric

It is accepted among the Bangla linguists (Chatterji 1921; Goswami 1944; Ferguson & Chowdhury 1960) that Bangla is a stress-accent language and there is not any contrastive features of stress assignment on words such as, two words cannot be differentiated solely on the basis of stress. Furthermore, it is also stated in almost all studies that stress is consistently assigned on the initial syllable of words. On the contrary, it is also found that stress is assigned to the second syllable unless the first one is heavy. Thus the first syllable has to be heavy if it is stressed. Concerning these above tendencies of stress of Bangla language the stress distribution of the first phrase of the song has been given below,

á.non. ḍo.ló.ke	móŋ.go.la.ló.ke	bí.ra.ɟo	ʃo.ṯṯó	ʃun.ḍó.ro
joyful	blissful halo	present	true	beautiful

‘You are honorably present with the halo at the blissful world’

It is evident from the lyric with stress notation provided above that stresses have been distributed in the most of the case according to the norm of Bangla phonology. In this lyrics most of the primary stresses have been fallen on the initial syllable. Nevertheless, two words

contain different word stresses in which primal stresses are not assigned on the initial syllable like, [ʃo.tt̪ó] and [ʃun.d̪ó.ro]. On the other hand, in case of compound word like, [á.non. d̪o.ló.ke], [móŋ.go.la.ló.ke] stresses have been fallen on the every initial syllable. Thus, we get two kinds of foot structures in a single word, though most of the word follow one foot type, either standard foot structure or deviated from standard foot structure of Bangla. In this regard it can be said that the trochaic formation of foot is very prominent in this lyric whereas, iambic formation as well as the manipulation of both formation are also found in this lyric.

Prosodic Tree Diagram and Syllabic Feet of the Lyric

The prosodic tree diagram of the first phrase of the lyric of the song on the basis of the stress assignment has been given below

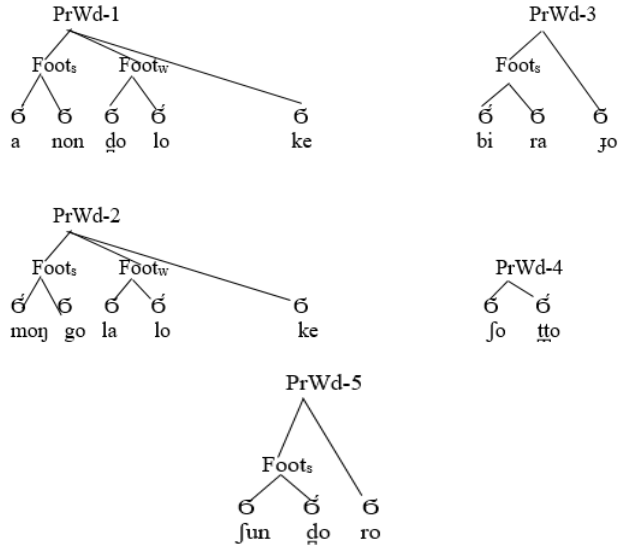


Figure 5: prosodic tree diagram of the first phrase

The syllables of the words have been shown regarding binary branching relationship of stress in the figure 5. Thus if the left nodes of the trees are strong, the right nodes are automatically weak and vice versa. Any asymmetrical arrangement other than this algorithm has not been found in this figure. Now the feet types of the words of the phrase has been given:

Table 2: Formation of feet structure of the phrase of *Anandoloke*

Words	Feet structure	Feet inventory
á.non. d̪o.ló.ke	(ɓ ɓ) (ɓɓ) (ɓ)	Trochaic+ Iambic
móŋ.go.la.ló.ke	(ɓ ɓ) (ɓɓ) (ɓ)	Trochaic+ Iambic
bí.ra.ɟo	(ɓ ɓ) (ɓ)	Trochaic
sho.ʈ̪ʈ̪ó	(ɓ ɓ)	Iambic
ʃun.d̪ó.ro	(ɓ ɓ) (ɓ)	Iambic

From this table it is observed that most of the feet structure of the words of the lyric of Bangla song-1 strictly follow the general stress tendency of Bangla word. On the contrary, it has been also found some incongruity of stress assignment which do not obey the stress rules of Bangla like, the Iambic distribution of syllables. It is significant from the previous studies of Bangla stress (Chatterji 1921; Goswami 1944; Ferguson & Chowdhury 1960) that initial word stress requires an initial heavy syllable in word otherwise, stress is generally assigned on penultimate or non-initial syllables. As a matter of fact, the Iambic structures of feet have been formed for this reason in the lyric such as, [ʃo.ʈ̪ʈ̪ó] and [ʃun.d̪ó.ro]. It is also evident that single word contains both feet structures such as, [á.non. d̪o.ló.ke]. In this regard we are now going to reanalyze the feet structures through the parameters of metrical constituents like, along with TROCHAIC, IAMBIC two parameters such as, Align the Right Edge of the Foot (R-to-L) and Align the Left Edge of the Foot (L-to-R). Using this four parameters of metrical constituents of the lyric has been provided here.

Testing the Metrical Parameters

Table 3: metrical parameter testing

Words	Feet structure	IAMBIC	TROCHAIC	L-to-R	R-to-L
á.non.d̪o.ló.ke	(ɓ ɓ) (ɓ ɓ) (ɓ)				
móŋ.go.la.ló.ke	(ɓ ɓ) (ɓ ɓ) (ɓ)				
bí.ra.ɟo	(ɓ ɓ) (ɓ)	×			×
sho.ʈ̪ʈ̪ó	(ɓ ɓ)		×	×	×
ʃun.d̪ó.ro	(ɓ ɓ) (ɓ)	×			×

From this test of table some facts have been revealed which were not seen in the previous table. Here, the cross (×) sign expresses the violation of the parameters, thus if any parameter is not relevant to any particular syllabic structure, this sign has been used. First of all, generally one word contains maximum two metrical parameters except the words [á.non.d̪o.ló.ke] and [móŋ.go.la.ló.ke]. Since both L-to-R and R-to-L parameters are function in those words, it is easily assumed that both IAMBIC and TROCHAIC features are active in their syllabic structures. Stressing on the left edge syllable is a primary requirement of trochaic parameters, thus it is beyond any doubt that L-to-R parameter helps to construct trochaic stress pattern of syllable. On the other hand R-to-L feature tries to build iambic stressed syllabic types as it concerns on the right edge stressed syllable.

The discussion of the next sections have been proceeded to reveal whether the stress pattern of the song, which has been found from the above discussion are transformed while melody is added; Since the previous study of Lerdhal proved that the stress pattern of lyric is changed dramatically by adding tune.

Analyzing the First Phrase of the Bangla Song using GTTM Theories

String and Grouping Structure

It has been already mentioned that both language and music are the hierarchal organization of strings of discrete objects or of features belonging to the objects. In GTTM assigning a set of well-formedness rules objects are constructed in a variety of groups. Grouping Well Formedness Rules 1 (GWFR1), which is relevant for analyzing the song for this study has been given below,

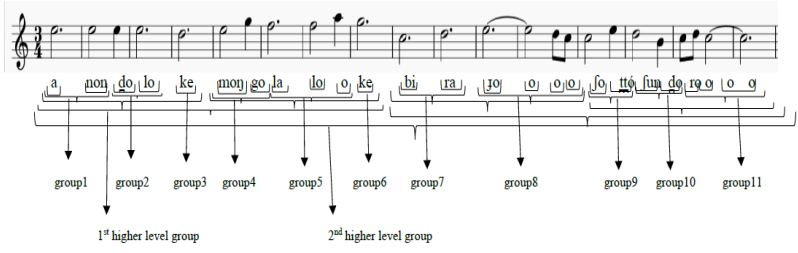


Figure 6: Grouping of first line of Bangla song

GWFR1: Any contiguous sequence of pitch events can constitute a group and only contiguous sequences can constitute groups. To make this rule clear Lerdahl explained Mozart's G minor symphony by using this rule (Ledahl and Jackendoff, 1983, p.37). Here we are going to implemented this rule on our Bangla song such as:

The figure 6 shows the grouping construction of the first line is that same note as well as notes belongs to C[3] major scale make a contiguous sequence such as, E E E E D G F F A G (third, second, fifth fourth, sixth and fifth of c major scale from the perspective of musical interval) and along with linguistic syllables these notes create groups. For example,'-a', '-non' and two 3rd of C major construct group1. Similarly, '-d̪o', '-lo' and 3rd, 3rd again make group2, whereas '-ke' and 2nd belong to one single group3. On the other hand, móŋ+go and 3rd, 5th create group4; la+lo and 4th, 4th, 6th construct group5. Then group5 consists of one syllable '–ke' with single 5th similar to group6. In the same way, rest of the words of this phrase construct groups and these groups can be marked as, G_1 G_2 G_3 G_4 G_5 G_6 G_7 G_8 G_9 G_{10} and G_{11}.

Secondly, there is an equal distribution of notes on each syallble approximately other than the syllables '-lo', '-jo', and '-ro' which cotain 2, 4 and 2 notes respectively. Each of these mentioned groups act as sub groups and step by step they build higher level group. The GWFR1 rule prevent from being group like, [E E E E D G F F A G]. Rather, it permits these sub groups to be incorporated in higher level groups G_1 ,G_2 and G_3 thus, [E E E] construct 1st higher level group within 5th bar. In this way the grouping of the first word of the song has been occurred as well as in the same process the group structure of the rest of the words have been accomplished but may be in defferent grouping style. Like group7 and group8 belong to the word [biraɟo] as well as G_7 G_8 G_9 G_{10} ,G_{11} make another 1st higher level group. Next, all the groups of 1st phrase create the final higher level group.

Metrical Structure of the Phrase Regarding Regular Speech Stress

Metrical grid or stress grid can be drawn on the basis of stress assignment. A stressed grid in linguistic phonology represents relative

[3] C major scale contains 7 notes: C (Tonic), D (2nd), E (3rd), F (4th), G (5th), A (6th), B (7th), C (octave)

syllabic stress and on the other hand in music it depends on the strong beats. Now, firstly the stress grid of the first phrase of Bangla song has been shown and after that the metrical grid of lyric with melody has been drawn in order to compare between the stress pattern of lyric with melody and without melody.

Here the metrical representation of first phrase on the basis of syllabic structure of regular Bangla Speech has been given,

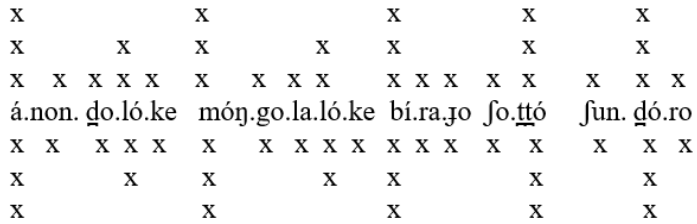


Figure 7: Metrical structure of the first phrase of the song

In fact this diagram is another kind of representation of syllabic stress of lyric which has already been discussed. By assigning metrical well formedness rules, actual stress distribution of any syntagmatic system can be analyzed by this metrical grid system and here we can describe this lyric through the rules like, Metrical Well Formedness Rules 3 (MWFR 3) (Lerdahl and Jackendoff, 1983, p.69).

MWFR3: At each metrical level strong beats are spaced either two or three beats apart

It is clearly seen that the MWFR3 is applicable for the first phrase of the lyric as well as it is assumed that those rules have also been applicable for the rest of the lyric. At this stage of our discussion the acoustic phonological information of lyric with melody have been provided in order to show the stress transformation.

Acoustic Phonetic Evidence of Stress Transformation

Discussing Beatles song 'yesterday' Lerdhal shows that after putting melody the stress pattern of the word 'away' is changed. Thus, it is seemed that there is a shift of pitch and time duration from speech to melody. Due to melodic stress the stress assignment of each and every syllables are not changed. Now we are going to discuss the acoustic properties of our selected Bangla song briefly in order to show the

stress shift. Here pitch and intensity of each syllable and note of first phrase of the song have been given. In this study the acoustic feature analyzing software Praat (version 6.0.43) has been used.

Table 4: Acoustic phonetic information of the first phrase of Bangla Song

Syllables	Notes	Time	Pitch (Hz)	Intensity (DB)
a	E	3.26	153.3	70
non	E	4.7	151.3	65.39
d̪o	E	4.92	151.6	65.2
lo	E	5.8	151.4	65.39
ke	D	6.9	75	63.16
moŋ	E	8.8	132.2	69.6
go	G	9.78	154.3	71.23
la	F	10.20	177.2	71.2
lo	FA	12.83	180.8	71.13
ke	G	13.4	183.5	70.98
bi	C	14.96	112.8	64.64
ra	D	16.48	131.6	63.63
ɟo	EEC	19.68	153.3	67.67
ʃo	C	21.5	118.7	64.39
t̪t̪o	E	22.28	153.2	68.16
ʃun	D	22.89	133.7	65.38
d̪ɔ	E	23.68	117.4	65.43
ro	DCC	24.49	121	75

First of all, the table illustrates the fluctuation rate of similar note is not so high. For example, same notes have different syntagmatic position such as, in the first word [á.non. d̪o.ló.ke], the first four syllables take E note and again E is seen in the first syllable '-moŋ' of second word. In the most of the case, the pitch frequencies of E fluctuate between 151Hz to 154Hz and intensities are 63Db to 65Db. Moreover, it is significant that in the first line the pitch frequency starts with 153.3 Hz following a dramatic fall of 75Hz on syllable '-ke' which contains D note and then the frequency rises at 183.5Hz surprisingly in G note of the same '-ke' syllable. Finally the first line ends up with three notes which belongs to one single syllable '-ro' that gets 121Hz of pitch. However, following the pitch frequency the degrees of intensity are also changed. However, it is clearly seen that due to the melodic insertion, the pitch frequency of speech has been changed which is a significant precursor

of stress transformation. As a matter of fact the syllable '-lo' get the second highest frequency of pitch 180.8Hz and becomes the most stressed syllable or 'headed stress' of the first line.

Time Span Reduction or Headed Hierarchical Explanation of the Song

It is assumed from the above discussion is that grouping structure and metrical grids do not show the hierarchical relationship of musical and linguistic objects. In this regard time span reduction theory has been implemented in order to describe musical hierarchical objects. It has been mentioned in the section of theoretical guidelines that Time-span reduction assigns to the pitches of the pieces a hierarchy of 'structural importance' with respect to their position in grouping and metrical structure.

Translation of the Prosodic tree Diagrams into Time Span Reduction Diagrams

The dominant (5^{th}), sub-dominant (4^{th}) or headed strong features of music are shown through drawing time span reduction as well as prolongational tree diagrams. In addition, it has been also mentioned that this tree structure is formed by the direct influence of linguistic prosodic tree diagram and syntactic tree diagram. Now firstly the prosodic tree structures of the words of the song have been translated into time span reduction tree diagrams and after that the phrasal prolongational structure with notation have been provided. Here the structural translation of the words of first line is given:

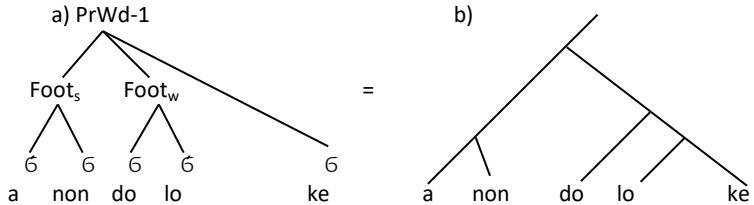


Figure 8: translation of the time span reduction tree diagram of the word anandoloke

In the above tree diagram of the prosodic structure of the word *anandoloke* has been translated into time span reduction tree structure. The prime stress has been assigned on the initial syllable in this word. It is noteworthy that in case of the prosodic tree the

opposition is strong versus weak node on the contrary, in time span reduction the opposition is head versus elaboration. In figure a) shows the prosodic structure of the word which is a representation of relationship of strong and weak nodes. In addition, the structure has been formed according to the syllabic structure of the word. On the other hand the time span reduction structure b) does not show any binary relationship like strong vs weak as a) do rather it shows the elaboration of the head of the structure. For example, the node of the initial syllable which contains the major stress of the word has been prolonged and this the only concern of this structure. Moreover, it is also significant that this structure does not follow the linguistic syllabic structure such as, unlike prosodic structure the syllable '-do' does not merge with the syllable '-lo' rather it merge with the higher level node of the '-lo' and '-ke' jointly. Next, these three syllables form a single node and this node connect with the headed node and finally the headed node has been elaborated. In the same way we can translate other words of the first line of the song like:

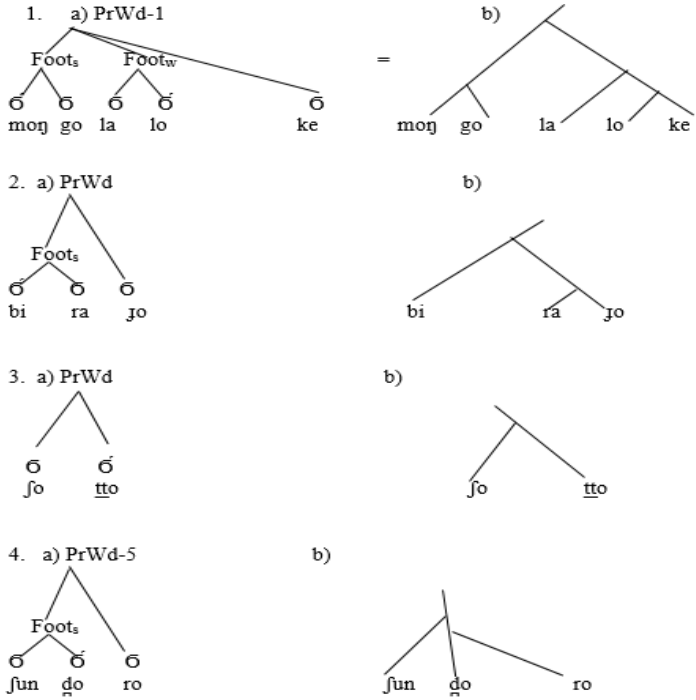


Figure 9: Translation of the time span reduction of the first phrase of the song

This figure demonstrate three types of stress elaborations such as, initial, penultimate and final. In 1 and 2 examples as the words contain initial stress syllables, the left nodes are elaborated. On the other hand, since the final and penultimate syllables are stressed in case of 3 and 4 examples, the right nodes of the tree have been prolonged. Now prolongational representation of the transformed stress pattern of first line of the song has been explored.

Time Span Reduction Trees with the Transformed Stress Pattern of the First Line of the Song

It is revealed in the previous section that after inserting melody the stress pattern of lyric is being changed significantly. Now the time span reduction tree diagrams of each words of the first line of the song with transformed stress assignment have been drawn first. After that, the overall prolongational tree diagram has been illustrated. The prolongational tree structure of each words of the first line with transformed stress pattern have been given below:

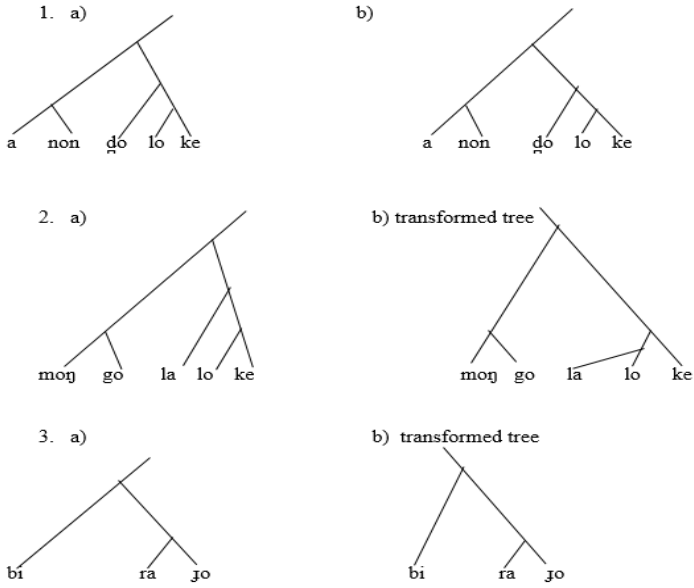


Figure 10: Time span reduction trees with the transformed stress pattern

The above tree diagrams illustrate the transformed stress patterns of words due to the insertion of melody of first line. It is observed from

the figure that stress pattern of all the words do not changed rather some words show stress transformation. For example, in case of the word [anond̪oloke] the initial syllable receives extra stress yet, the stress do not shift into other syllable. Similarly any stress shift or change do not occur in the word [ʃo.t̪t̪ó]. On the other hand, the syllabic stress uttrely transposes from the initial to penultimate and final in the word [móŋ.go.la.ló.ke]. In this regard the final syllable '-ke' receives the major stress. In the same way stresses tranpose from intial to final in the words [bí.ra.ɟo] and [ʃun.d̪ó.ro]. Now a complete prolongational notation of the first line of song has been given below:

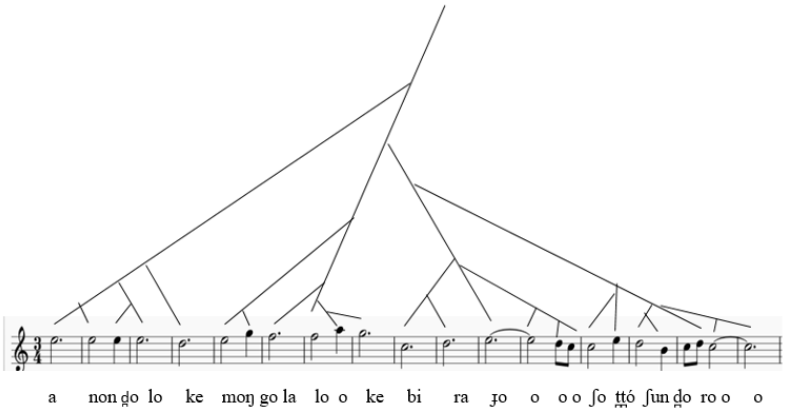


Figure 11: Complete prolongational tree diagram of the first line of the song

It is observed from the figure that the left node of the tree has been prolonged thus, it is beyond doubt that after melodic insertion the most stressed syllable belongs to the left node of the diagram. To elaborate in case of the first word the initial syllable '-a' receives the major stress of the entire phrase and the syllable '-non' merge directly with the '-a' whereas, '-do', '-lo' joint together first and after that their elabotaed node links to the node of '-a'. Again similar to '-non' the extrametrical '–ke' merge with the most prolonged node separately.

Secondly, the major stressed syllable of the [móŋ.go.la.ló.ke] is indicated as also left node of the diagram and the elaborated node of the anondoloke has been merged with this node. In the same way the syllables '-moŋ', '-go', '-la' and '–ke' join the most elaborated node of the word '-lo'. Since the node of the '-lo' is not only the most elaborated node of the word but also the most prolonged node of the

phrase, the elaborated node of the word anandoloke merge as a sub left node with it. Consequently, the elaborated right nodes of the words birajo, shotto and shundoro merge with the most stressed syllables node.

At the end of the analysis it can be utterly stated that the selected Tagore's song shows specific structural pattern regarding stress assignment. From the above analysis of this song it is quite evident that significant tranformation of stress has been occurred due to melodic insertion in lyric which makes the melody unique.

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