



## Speech intonation and music: A look at their dynamics within the song format

Valentyna Marchenko <sup>a 1</sup> 

<sup>a</sup> National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

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### Abstract

In the present research we look into the mechanisms which facilitate integrated functioning of speech and music components within a song. To understand the underlying mechanisms of such interaction we investigate poems set to music, analyzing the components of both speech and music intonation. The study is performed within the scope of Speech Energetic Theory and employs its idea of the emotional-and-pragmatic potential, which is believed to precisely convey the idea of a poem and therefore further facilitate successful speech-music interaction within a song. During the experiment the levels of emotional-and-pragmatic potential in poems and songs were firstly determined perceptively by the informants and afterwards verified instrumentally by using specifically developed formula for the evaluation of emotional-and-pragmatic potential. The values of the intonation components were obtained with the help of PRAAT software. Overall, the results demonstrated that that speech and music profoundly correlate on the prosodic level, possessing some common auditive and acoustic features.

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*Keywords:* speech intonation; music; phonetics; prosody; emotional-and-pragmatic potential

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## 1. Introduction

Speech and music relations have long been in the spotlight of research in linguistics (Bolinger, 1986; Jacobson, 1985), musicology (Adorno, 1956; Bernstein, 1976), psychology (Frick, 1985), neurology (Koelsch, 2011; Sloboda, 2010), neurolinguistics (Cook, 2002; Patel, 2010), cognitive linguistics (Jackendoff, 2009; Lerdahl & Jackendoff, 1996).

Outstanding scholars indicated a deep connection between speech and music giving a particular emphasis to their commonalities in regards to their generation (Langleben, 2000), perception (Asafiev, 1965; Leontiev, 1981; Nazaikinsky, 1972), ability to convey emotions (Cook, 2002; Frick, 1985; Juslin, 2011; Krumhansl, 2002), syntactic and stylistic properties (Kostruykova, 2007; McMullen & Saffran, 2004), neurological basis (Clynes & Nettheim, 1982; Zbikowski, 2002).

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<sup>1</sup> Corresponding author. Tel.: +380-97-931-9448  
E-mail address: [v.marchenko@kpi.ua](mailto:v.marchenko@kpi.ua)

The alliance of all the above-mentioned speech and music properties is perfectly manifested in songs, which we define as specific complex means of communication created through speech and music synthesis (Marchenko, 2014). Among various types of songs, the most challenging seems to be the one formed by setting an existing poem to music.

The reason is that a poem is already a coherent unity created by an intricate combination of such elements as plot, syntax, rhythm, various intonational contours, etc. (Langleben, 2000), so the question is what exactly helps a composer to correctly perceive and afterwards convey the main idea of a poem choosing the relevant music accompaniment. Such complex integration is believed to be only possible due to the so-called motive bases, i.e. verbal sources of musical motives that become the ground for the prosodic contour of a song (Langleben, 2000), and the role of these motive bases is believed to be played by intonation and its components. This idea and also the fact that in many ways different speech and music definitely coincide in one point, which is intonation (Bolinger, 1986; Jackendoff, 2009), inspired an experimental phonetic research during which we compared components of speech and music intonation and their integrated functioning within a song.

Similarly, to any other interdisciplinary research, most problematic was the choice of relevant theoretical background intended to cover all the aspects of speech-music synthesis. After analyzing the existing theoretical approaches towards the study of speech-music relations, we chose Speech Energetic Theory as the ground for further research. Therefore, the goal of our paper is to reveal the specifics of speech and music relations by exploring their integrated functioning in songs within the framework of Speech Energetic Theory.

### *1.1. Theoretical background of the research: Speech Energetic Theory*

Introduced by the Ukrainian phonetician Prof. A. A. Kalyta in 2007, Speech Energetic Theory encompasses the idea that all the utterances (verbal, musical or verbal-musical) we produce are generated by the energy which in its turn is forced by emotions and intentions of a speaker. The energy enables a speaker to select the most appropriate language means in order to express their feelings as accurately as possible.

Prior to elaborating on the applicability of Speech Energetic Theory to the study of speech-music relations, let us mention that in our research we view a song as a multimodal text. The study of songs definitely falls within the field of multimodality (Walker, 2018), since it involves the complex interweaving of word, image, gesture and movement, and sound, including speech, combined in different ways and presented through a range of media (Bearne & Wolstencroft, 2007). Moreover, the act of listening to a speech-and-music work is considered a deep, rich multimodal experience (Way & McKerrell, 2017).

Considering a song to be a multimodal text we chose to analyze the processes of its generation and perception by analogy with communication, since its actualization is one of the real acts of communication. This idea encouraged us to study speech-music relations within Speech Energetic Theory, which was originally developed for understanding the processes involved in generation of a verbal utterance. Speech Energetic Theory has proved its relevance to the study of songs actualization mainly because (a) singing is commonly acknowledged as communicative process, just the way speaking is (Garipova, 2010), (b) energy is believed both by linguists (Kalyta, 2007) and musicians (Kurt, 1993) to be the driving force of speech and music generation respectively, (c) energy in its turn is generated by emotions, whose creative and inspirational capacity for both speech and music is beyond dispute.

According to Speech Energetic Theory, the generation of any utterance as well as a song is a cognitive process which involves all the spheres of a speaker's supersubstantial being.

The model of psycho-energetic process of song generation and actualization (Fig. 1) enables us to follow the process of song generation in the speaker's mind which emerges as entirely emotional (in the existential sphere), passes to emo-rational (in the mental sphere), eventually transforms into rational (in the transcendental sphere), and finally is drawn up by consciousness into logical.

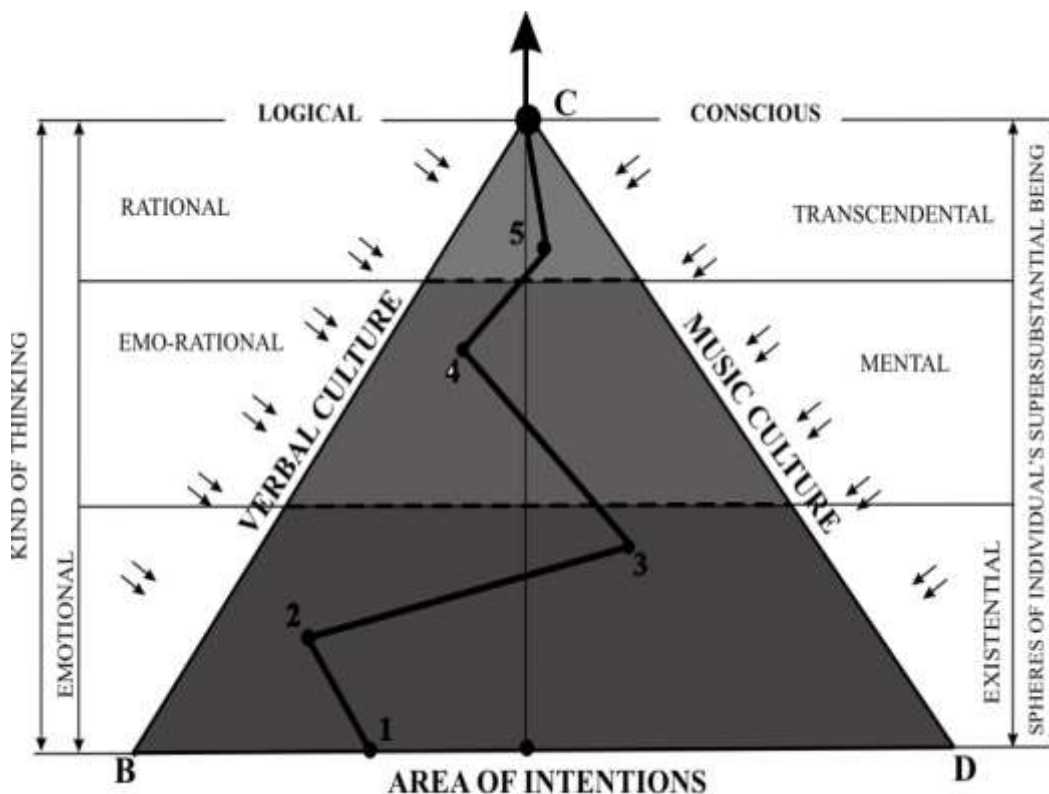


Figure 1. Model of psycho-energetic process of song generation and actualization

The stochastic interaction between these forms of thinking results into the self-development of inherently synergetic mechanism of song generation and actualization which on the model appears in the form of the attractor structure (1-C). As well as any other synergetic mechanism song's generation is completely controlled by order parameters, in the model presented by the author's verbal and music culture. In fact, the predominance of either verbal or music culture or their harmonious interaction within a song is the underlying factor determining the model of speech-music communication, which could be characterized by (a) balanced interaction of speech and music components comprising a song, e.g. all-time greatest *Memory* from *Cats* the musical or *Show Must Go On* by Queen, (b) prevalence of speech components, e.g. Bob Dylan's *Knocking on Heaven's Door* or different versions of *Auld Lang Syne*, (c) prevalence of music components, e.g. My Bloody Valentine's *Sometimes*.

### 1.2. The idea of emotional-and-pragmatic potential

Speech Energetic Theory offers a profound ground for experimental research. The basic concept of the Theory is the phenomenon of **emotional-and-pragmatic potential** which could be explained as follows:

The generative process of any utterance is realized in quite a wide range of an individual's emotional states varying from simply the interest to the stress. Emotions arising in the sphere of individual's

existential being (see Figure 1) generate chaos. At the initial stage of the chaos the energy of the pragmatic intention together with the emotional energy create fairly precise emotional-and-pragmatic potential of the utterance or the text. The above-stated potential remains intact during the actualization of either the utterance or the text due to stochastic redistribution of energy between the means of all language levels involved in its realization.

Now, if the energy, which excites the composer's emotions and defines the melodic pattern of a future song, is concentrated in the emotional-and-pragmatic potential of a poetic text, then according to the principle of emotional-and-pragmatic potential preservation (Kalyta, 2007), we may hypothesize that the emotional-and-pragmatic potential of poetic work also remains unaffected after the addition of a musical component, which results in the creation of basically a new entity.

The study of speech and music interaction through emotional-and-pragmatic potential looks fairly promising, since the dimensionless criterion (1) was developed for its quantitative evaluation (Kalyta & Taranenko, 2012).

$$(1) \quad K = \frac{F_0 \times t \times I_0}{1000 \times I_3}$$

where: K – criterion of the level of the emotional-and-pragmatic potential actualization;  $f_0$  – fundamental frequency (Hz); t – syllable duration (ms.);  $I_0$  – amplitude of  $F_0$  (dB);  $I_3$  – amplitude of  $F_3$  (dB); 1000 – milliseconds to seconds conversion factor.

The presented formula enabled us to precisely determine the level (low <30, medium 30-105, high >105) of emotional-and-pragmatic potential in a poetic text and compare it to emotional-and-pragmatic potential of its song variant.

## 2. Method

### 2.1. Research material

The research material comprised the poems by T.S. Eliot, R. Burns, E. Dickinson, e.e. cummings, W. Blake, S. Plath, D. Thomas which were set to music and were performed by more than one singer. The number of analyzed poems totals to 36; the number of songs, based on the poems, totals to 92.

Throughout the research the focus was on the songs created by setting a poem to music. The basic motivation for this choice was the presumption that within a song its verbal and melodic elements either correlate and complete each other, or, on the contrary, disaccord and contradict, thus, we believe, revealing both common and specific features of language and music.

Also, we believe that by comparing emotional-and-pragmatic potential of as many vocal renditions of a certain poem as possible is the only way to get objective results concerning commonalities and discrepancies between speech and music.

### 2.2. Methods and procedure

The experimental phonetic research comprised the following steps:

1. A group of informants was offered to listen to the poems and their musical interpretations and to perceptively determine the level of emotional-and-pragmatic potential (high, mid or low) for their separate fragments. The values were entered into the specially designed chart.

2. Using computer programs such as PRAAT, SpectraLab, Cool Edit Pro, the values of fundamental frequency F0, syllable duration – t, amplitude of F0 – I0 (dB) and amplitude of F3 – I0 were registered and entered into the calculation chart. Afterwards the registered figures of prosodic characteristics were inserted into the formula (1) and thus we obtained the value of emotional-and-pragmatic potential for each fragment. The obtained values were entered into the evaluation matrix (Table 1) and afterwards compared with the results of perceptive analysis conducted by the informants.

3. The third step supposed the comparison of emotional-and-pragmatic potential values of poetic segments with the corresponding song segments. The examples of some fragments which were contrasted are presented in Table 1.

**Table 1.** Matrix representing the emotional-and-pragmatic potential correlation of experimental fragments from a poetic work and corresponding fragments from songs

No	EXPERIMENTAL FRAGMENT	VALUE OF EPP* CRITERION FOR			
		POETIC FRAGMENT	FRAGMENTS FROM SONGS		
			song A	song B	song C
1	<i>Should auld acquaintance be forgot, and never brought to mind?</i>	57	83	121	108
2	<i>Should auld acquaintance be forgot, and days of auld lang syne?</i>	50	87	106	114
3	<b><i>For auld lang syne, my dear, for auld lang syne,</i></b>	<b>211</b>	<b>184</b>	<b>219</b>	<b>136</b>
4	<b><i>We'll take a cup o' kindness yet, for auld lang syne.</i></b>	<b>117</b>	<b>127</b>	<b>107</b>	<b>106</b>
5	<i>O my Luve's like a red, red rose That's newly sprung in June;</i>	52	54	59	102
6	<i>O my Luve's like the melodie That's sweetly play'd in tune.</i>	108	113	105	110
7	<i>And I will luv thee still, my dear, Till a' the seas gang dry:</i>	100	112	95	94
8	<b><i>And I will come again, my Luve, Tho' it were ten thousand mile.</i></b>	<b>67</b>	<b>157</b>	<b>107</b>	<b>119</b>
9	<i>Because I could not stop for Death – He kindly stopped for me –</i>	198	180	175	164
10	<i>The Carriage held but just Ourselves And Immortality.</i>	170	162	171	172
11	<b><i>I went to heaven,-- 'T was a small town,</i></b>	<b>125</b>	<b>65</b>	<b>50</b>	<b>72</b>
12	<i>Lit with a ruby, Lathed with down.</i>	120	70	85	81

### 3. Results and discussion

The correspondence between levels of emotional-and-pragmatic potential in poetry and music can be illustrated by fragment 3 from Table 1: *For 'auld 'lang syne, my 'dear, | for 'auld 'lang syne* (K = 211) and the intonogram of its poetic variant as well as the music-sheet fragments for its sung versions (Fig. 2).

According to the results of both perceptual and acoustic analysis, this fragment was classified as the one possessing high emotional-and-pragmatic potential. The same evaluation was given to its song variant, which, in our opinion, is due to the irreciprocal interaction of intonation and lexical composition of the analyzed fragment.



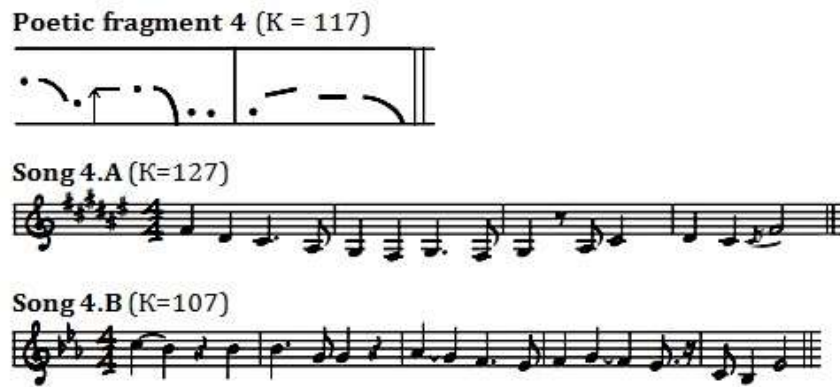
**Figure 2.** Intonogram of the poetic fragment 3 *For auld lang syne, my dear, for auld lang syne* and musical notations of the corresponding fragments in Song 3.A and Song 3.B

The intonogram shows that the gradually descending stepping scale with the low fall in the first syntagm and the mid fall in the second syntagm together with regular rhythm, slow tempo, variations in loudness convey the speaker's melancholic mood, sadness and nostalgia for the past. Such a mood is intensified in the second syntagm by repeating *for auld lang syne* with slowed tempo and decreased loudness, which informants also perceived as melancholic but at the same time friendly and somewhat gullible.

The comparison of the described fragment with its musical variants indicates certain common features in their rhythmic and melodious structure, which, in our opinion, explains their high level of emotional-and-pragmatic potential. The music-sheet fragments show that the presented fragment is written in major key and are realized in one octave, however, they are characterized by different melodious contours and are actualized at different pitch levels.

Thus, the rising-falling melodic contour of Song A is realized in F-sharp major, while Song B is characterized by falling-rising melodic contour and is realized in E-flat major, which sounds a bit lower, though remaining within one octave and one range. The difference in tonality is explained by the fact that Song 3.A is performed by a woman with alto voice range (low female voice), and Song 3.B – by a male tenor voice (high male voice), and, as it is known, alto and tenor sound in approximately the same range. Therefore, they were perceived by the informants as possessing equally high emotional-and-pragmatic potential.

Another example of emotional-and-pragmatic correlation is fragment 4 from Table 1: *We'll 'take a 'cup of 'kindness yet, | for 'auld 'lang 'syne* (Fig. 3):



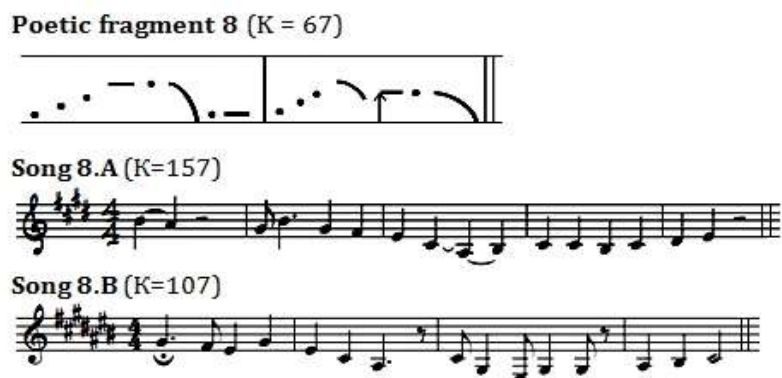
**Figure 3.** Intonogram of the poetic fragment 4 *We'll take a cup of kindness yet, for auld lang syne* and musical notations of the corresponding fragments in Song 4.A and Song 4.B

As we can see, among the prosodic features that provide the high level of emotional-and-pragmatic potential and coincide in both poems and songs are falling-rising-falling melodic contour, the high pitch zone of fragment's beginning, wide pitch range, decelerated tempo, moderate loudness, light, sad and nostalgic timbre, lyrics with positive connotation (e.g. *kindness, auld lang syne*) correlates with major key.

In this poetic fragment, mid pre-head, broken descending stepping scale (special rise on  $\uparrow$ cup) with mid high low fall in the first syntagm together with a moderate tempo indicates a high degree of emotionality and conveys the idea of benignity, cordiality and discreet solemnity. The melancholic mood of the fragment is enhanced in the second syntagm by the phrase *for auld lang syne*, which is pronounced with decreased loudness and at slow tempo by increasing the duration of the word *auld* (521 ms) and the pause (457 ms) between the words *auld* and *lang*.


As in the previous fragment, the song variants of *We'll take a cup of kindness yet, for auld lang syne* are performed in F-sharp major (Song 4.A) and in E-flat major (Song 4.B), with Song 4.B being rendered in a wider range, within two octaves. Interestingly, unlike the poem, all the analyzed songs are characterized by a falling-rising melodic contour, despite the fact that, as the last stanza of the chorus, this fragment is performed at the end of the song. Usually, affirmative sentences are uttered with a falling tone at the end, and the rising tone is known to convey incompleteness setting the listener up to the continuation of a message. Such discrepancy between poetic and song versions can be explained by the fact that in songs, the role of the finisher of the main thought is not played by the word, but by music, which generalizes any theme or plot.

As for the revealed differences, let us consider fragment 8 from Table 1 *And I will come again, my Love, though it were ten thousand mile* and its corresponding song variants 8.A and 8.B (Fig. 4). The poetic fragment was evaluated as the one possessing mid level of emotional-and-pragmatic potential (K = 67) while fragments from the sung versions definitely have high level of emotional-and-pragmatic potential (Song 8.A: K = 157; Song 8.B: K = 107).

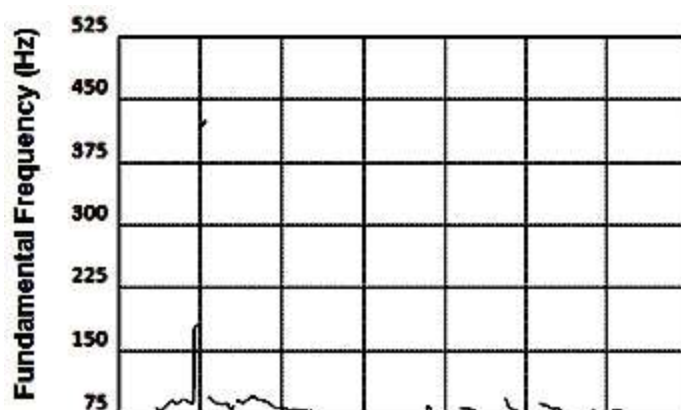


**Figure 4.** Intonogram of the poetic fragment 8 *And I will come again, my Love, though it were ten thousand mile* and musical notations of the corresponding fragments in Song 8.A and Song 8.B

From the illustration above we can see the difference in melodic contour – a rising-falling contour in a poetic fragment and a falling-rising one in songs. This fragment in songs is final and the falling-rising contour can be explained by the increase of intensity at the end of the song which is quite typical of dramatic love songs.

High level of emotional-and-pragmatic potential in song 8.B may occur due to prolonged high-pitch singing of a conjunction *And*, at note picture indicated by a fermata .

This difference is observed on the acoustic level as well. Let us consider graphic interpretations of the fundamental frequency localization in both poetic fragment (Fig. 5) and a corresponding sung one (Fig. 6).



**Figure 5.** Graphic interpretation of the fundamental frequency of the poetic fragment 8 *And I will come again, my Love, though it were ten thousand mile* (generated by the PRAAT computer program)



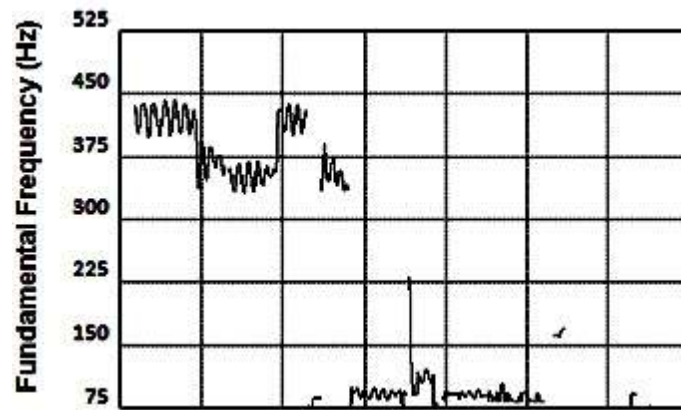


Figure 6. Graphic interpretation of the fundamental frequency of the song fragment 8.B

*And I will come again, my Love, though it were ten thousand mile*

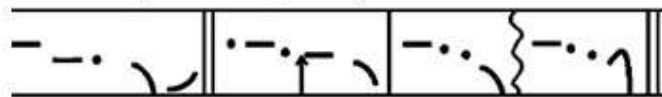
(generated by the PRAAT computer program)

Graphic interpretations show that tonal maximum in the poem is realized on the head (*come*) while in the song it is localized on the pre-head (*And*) which might as well be explained by a high vocal potential of phoneme [æ]. Thus, it may be concluded that the differences in emotional-and-pragmatic potential were mostly caused by the increased loudness, prolonged singing of certain vowels and elaborate use of musical instruments in songs.

However, as seen from the Table 1, there are cases when emotional-and-pragmatic potential in poems is higher than in songs despite of the facts mentioned above, such as prolonged singing or the use of musical instruments. The examples of the problematic adaptation of one semiotic system to another can include the incongruity of prosodic pattern of the verse phrase and the rhythmic and intonational organization of the musical one.

A good example in this matter is songs created by setting Emily Dickinson's poems to music. It is well known that the rhythm of most of her poems is mostly mixed due to the slant rhyme, which greatly complicates the choice of music component. Let us consider poetic fragment 11 from Table 1: *I<sup>l</sup>went to <sup>h</sup>heaven, – || 'T<sup>l</sup>was a <sup>↑</sup>small <sup>\</sup>town, /<sup>l</sup>Lit with a <sup>∨</sup>ruby, ⇒ /<sup>l</sup>Lathed with <sup>\</sup>down* (Fig. 7).

Poetic fragment 11 (K=125)



Song 11.A (K=65)



Figure 7. Intonogram of the poetic fragment 11 *I went to heaven, – 'T was a small town, Lit with a ruby, Lathed with down* and musical notations of the corresponding fragments in Song 11.A

Here we see that mixed rhythm of a given fragment correlates with a gradually descending stepping scale, a broken descending stepping scale and long or medium boundary pauses which causes a specific intonation contour, characterized by sharp differences in pitch level. Such an intonation pattern complicates the process of setting such a poem to music. The figures in Table 1 prove that setting of this poem to music was not very successful since the song fragments were evaluated by informants as those with a mid level of emotional-and-pragmatic potential. In this case we can assume that the identical melodic contour (up, down, down, down) in the poetic fragment 11 and a corresponding song fragment 11.A does not necessarily imply successful textsetting. However, it might be viewed as another confirmation to the idea that music reflects the prosody of the national language (Patel, Ivesen, & Rosenberg, 2006).

Thus, it may be concluded that the high level of emotional-and-pragmatic potential of songs is predetermined by the equal participation of language means and music in conveying the meaning and emotions. For instance, the phonosemantic properties of vowel and consonant phonemes or their clusters may be enhanced by varying of the tone range, volume, tempo, rhythm, etc., as well as by the selection of musical instruments whose timbre pattern corresponds to the emotional and semantic nature of the work (e.g., the wind instruments amplify solemnity and significance of the described event; the strings help convey melancholia, sadness or alternatively playfulness, joy).

While analyzing similarities and differences between speech and music intonation we also detected certain prosodic clusters functioning through different poems and their song variants. Among such prosodic patterns, the most frequent are those of admiration, anger, confusion, despair, nostalgia, regret, romance, sadness, and triumph, all of them possessing a profile of specific intonation means. For instance, *sadness* tends to be expressed by low or mid-low pre-head, low tonal level of syntagm beginning and low or extra-low level of syntagm ending, gradual descending stepping scale, narrow or mid range, low fall or level low fall, slow tempo, regular legato-like rhythm, moderate or decreased loudness, high recurrence of long pauses between syntagms, decreased intensity and its narrow range. *Joy* tends to be characterized by increased tempo, wave-form melodic contour, intervals, moderate loudness, checked scales, division of the syntagm into short rhythmic groups.

Interestingly, some of them strongly correspond to the recently discovered 27 categories of emotions (Cowen, Keltner, 2017), which could be the subject matter of the deeper exploration.

Comparison of these characteristics with the relevant musical parameters in song fragments showed the highest level of congruity. This gives reason to argue that speech and music components, closely integrating in songs, generate a complex speech-music concept capable of preserving its functional and structural characteristics in different types of speech-music communication. This statement could be the object of the future research on speech-music relations.

#### 4. Conclusions

The research based on the principles of Speech Energetic Theory showed that speech and music profoundly correlate in prosody, possessing some common auditive and acoustic features, such as melody, rhythm, tempo, pauses, timbre, which together with appropriately chosen lexical means provide high emotional-and-pragmatic potential for both poetry and music.

The high level of emotional-and-pragmatic potential of a poem, ensured by primarily intonation components, helps the composer to decode the author's main message and therefore successfully set the poem to music without losing the main idea. The prolonged singing of certain vowels, increased loudness and intensity enhanced by musical instruments further increase the level emotional-and-

pragmatic potential of songs. The rhythmic structure of the poem, however, can be the reason for unsuccessful textsetting.

## 5. Ethics Committee Approval

The author(s) confirms that all the procedures performed in the studies involving informants were in accordance with the ethical standards of institutional research committee and with the 1964 Helsinki Declaration and its later amendments for comparable ethical standards. Informed consent was obtained from all individual informants involved in the study. (Date of Confirmation: 10.03.2020)

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## Konuşma tonlaması ve müzik: Bunların şarkı biçimindeki dinamiklerine bir bakış

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### Öz

Bu araştırmada, bir şarkı içindeki söz ve müzik bileşenlerinin entegre işleyişini kolaylaştıran mekanizmaları incelemekteyiz. Bu etkileşimin altında yatan mekanizmaları anlamak için, hem söz hem de müzik tonlamasının bileşenlerini analiz ederek müziğe uyarlanmış şiirleri araştırmaktayız. Çalışma, Konuşma Enerjisi Teorisi kapsamında gerçekleştirilmiş olup bu teorinin duygusal ve pragmatik potansiyel fikrini benimsemiştir ki bu potansiyelin potansiyelin şiir fikrini tam olarak aktardığına ve bu nedenle bir şarkı içinde başarılı söz-müzik etkileşimini daha da kolaylaştırdığına inanılmaktadır. Deney sırasında şiirler ve şarkılardaki duygusal ve pragmatik potansiyel seviyeler ilk olarak kaynaklar tarafından algılanmış ve daha sonra duygusal ve pragmatik potansiyelin değerlendirilmesi için özel olarak geliştirilmiş formül kullanılarak araçsal olarak doğrulanmıştır. Tonlama bileşenlerinin değerleri PRAAT yazılımı yardımıyla elde edilmiştir. Genel olarak, sonuçlar, söz ve müziğin, bazı ortak işitsel ve akustik özelliklere sahip olmakla birlikte prosodik düzeyde derinden ilintili olduğunu ortaya koymuştur.

*Anahtar Kelimeler:* konuşma tonlaması; müzik; fonetik; aruz; duygusal ve pragmatik potansiyel

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### AUTHOR BIODATA

Valentyna Marchenko is an Associate Professor at the Faculty of Linguistics, National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”. She got her Master’s Degree on English Philology at Kyiv National Linguistic University in 2007. She received her PhD Degree at National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” in 2016. Her professional interest areas are phonology, intonation, language-music relations, multimodality, multimodal texts, language teaching.