

## **Acoustic Study of Persian Rhythmic Structure : Poetry Vs. Prose**

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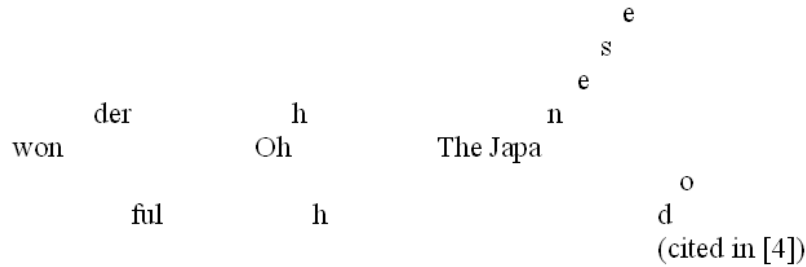
### **Abstract**

This work presents experimental findings of the Persian Rhythmic verse. In this study, the four acoustic constituents are used- duration, amplitude, and intensity for measuring the acoustic values of the Persian verse. One Persian verse is taken in a normal environment along with one Persian prose by one native speaker of Persian. The aim of this experimental study is to test for the presence of acoustic properties in verse system of Persian poetry and indeed the present study provides the instrumental evidence of the acoustical difference in the prose and the poetry of Persian language.

### **Introduction**

The study of poetic language and the rhythmic pattern has a long history. In the Indian literary work, the study of the Rig Vedic poetic language was first sketched back in 1850s by Adalbert Kuhn ([1], p.1). Elizarenkova [1] says "... compared Ancient Greek and Rig Vedic data, succeeded in reconstructing not an isolated word, but a whole phrase, in which he (Kuhn) recognized a Proto-Indo-European (PIE) poetic formula...". In 20<sup>th</sup> century Bolinger [2], Vanderslice & Ladefoged [3] argued the rhythmic system in a language. Both identified the rhythmic cues of the accent analysis. According to Ladd [4] : "Both Bolinger and Vanderslice & Ladefoged recognize the existence of scoop". Ladd [4] states: "The best illustration is provided by scooped contours..." for example (1):

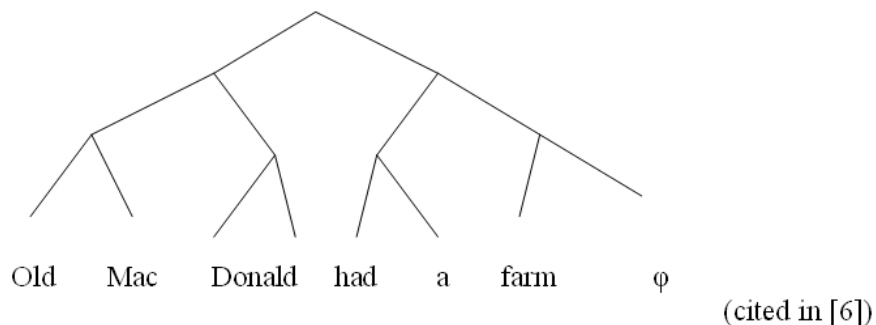
1.



This example can be seen as fine case of rhythm in defining the rhythmic pattern. Bolinger [5] also discussed the phenomenon of rhythmic stress shift in his article “Pitch Accent and Sentence Rhythm”.

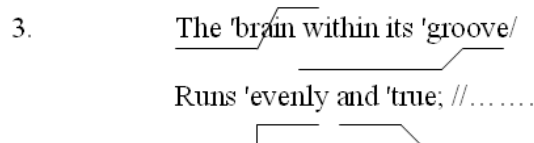
Martin (1972) represents rhythmic patterns as tree structures with [1 0] pattern (cited in [6]). These patterns define accent level on their terminal elements by the principle [(Martin 1972: 490) cited in [6]]. Kreidler [6] further states: “Martin gives two rules for establishing the accent pattern of a given rhythmic hierarchy (in 2): the “accent rule”, which assigns the pattern [1 0] to all nodes of the tree, and the “terminal rule”, which “applies to non repeating or terminal sequences like musical cadences, as well as to a variety of speech units” (1972:492)” (cited in [6]).

2.



Martin system of describing ‘rhythmic pattern’ was a very simple system of limited empirical value.

Pike [7] tried to compare three readings (by a graduate student, by a poet, and by a literary critic) of a poem by Emily Dickson. He investigated that the rhythmic pattern of a graduate student is mechanical and evenly spaced stress groups ([7], p. 6):



The reading of a poet was very different from the graduate student. The whole reading was soft, low, quiet, with narrow pitch spread ([7], p. 7):

4.            The 'brain within its 'groove/  
                  Runs 'evenly and 'true; //.....

The reading of a literary critic shows the deliberate and dramatic effects with a very large pitch range ([7], p. 8):

5.            The 'brain within its "groove /  
                  Runs / "evenly and 'true; //.....

It is shown in the above examples (3, 4, 5) of Pike [7] that he gave evidences how different readers utilize the different systems of rhythmic patterns for exploiting the poem, directly.

The first person who discussed the prosodic features in Persian was Chodzko (1852: 182-184) (cited in [8], p. 145). Windfuhr states: "Chodzko identified as the basic rule of Persian that stress is word-final in simple, derived, and compound nouns and adjectives, nominal verb forms (except for the infinitive...), and that in addition, there is final stress on the comparative and superlative as well as on the plural suffixes." The first Iranian who discussed about prosodic features in Persian was Fo'âdi (1933: 961-68) (cited in [8], p. 144). Windfuhr further states: "who...distinguished word stress (*lafzi*), sentence stress (*manteqi*) and intonation (musical accent), .....intensity is the primary feature of Persian stress...." ([8], p. 145). Towhidi (1974) investigated the prosodic system in Persian and the phonetic-phonological cues used were: tone, pitch-range, pause, loudness, tempo and rhythmicity. ([8], p. 148).

In Persian poetry, the traditional Persian metrics and rhyme schemes were changed to the new poetic pattern in mid twentieth century. 'New Poetry' (/<e re nou/) was founded by the poet Nimayushi (1895-1960)" ([9], p. 3004).

In this work, the correlates of Persian poetic rhythm will be highlighted in the context of the comparison of the duration, amplitude, and intensity obtained from a sample of Persian poetry and Persian prose from the same native speaker.

The sample for analysis consists of the following experimental lines: - 6.

1. The Poetic form:

na bii ni yaz man ra hii be joz xed mat  
 na daa ra maz to ta ma    be joz dii daar

2. The Prose form:

az man ra hii be joz xed mat na bii nii

az to ta ma    be joz dii daar na daa ram

This sample is taken from the text “al-mojam” as recited by Ali Rabi a native speaker of Persian. In this line Phrase structure has been focalized at the line initial position. This deviance marks the poem is poetic affective, in the process the rhythmic pattern of recitation. The native speaker agreed that of the Phrase structure is brought back to its original position than it becomes a line of ordinary prose and cannot be recited in the poetic way. Hence correlates of duration, amplitude, and intensity of the two lines i.e. poetic and the prose lines, are studied and compared.

The comparisons in the contexts of duration, amplitude, and intensity were undertaken in the framework provided by the software Praat (4.0.5). Praat is a system for doing phonetics by computers. The computer program Praat is a research, publication, and productivity tool for phoneticians. With it we can analyze, synthesize and manipulate speech and create high quality pictures for the articles and theses. The Persian speech was recorded in the Digital-Lab of the Department of Linguistics, University of Delhi and it is digitized in the Praat recording system itself, at the sample rate of 22050 Hz. For each experimental line visual acoustic cues were used to make a series of acoustic constituents – duration, amplitude, and intensity.

The acoustic constituents used in the current study are:

**Duration:** Duration is a time period during which a (process or) speech sound is produced. Some processes or intonation patterns are longer than other and this can be easily identified by the experimental analysis. The duration is expressed in seconds.

**Amplitude:** Clark and Yallop ([10], p. 197) say “Amplitude is the term normally used to refer to the magnitude of displacement in a sound vibration”. If the vocal fold vibration is increased the amplitude of the resultant sound wave is increased and if the vocal fold vibration is decreased the amplitude of the resultant sound wave is decreased. Clark and Yallop ([10], p. 197) further state “Most commonly it is air pressure that is varied by this displacement. Pressure is defined as force per unit area and is measured in Pascals (Pa).”

**Intensity:** Intensity and amplitude are interrelated acoustic elements. Clark and Yallop ([10], p. 199) say “We can derive from amplitude a property called INTENSITY. Intensity is power per unit area, or the way power is distributed in a space.” Intensity is measured in decibel (dB).

The above mentioned parameters are associated with the data analysis of Persian prose and the verse in the following way:

- duration may reflect a visible genuine difference associated with the experimental prose and poetic lines.
- quantitative results of amplitude may provide the contrast found in the minimum, maximum, and mean of experimental lines.
- difference in intensity can figure out the way power is distributed in Persian experimental lines.

### Analysis of Persian Speech

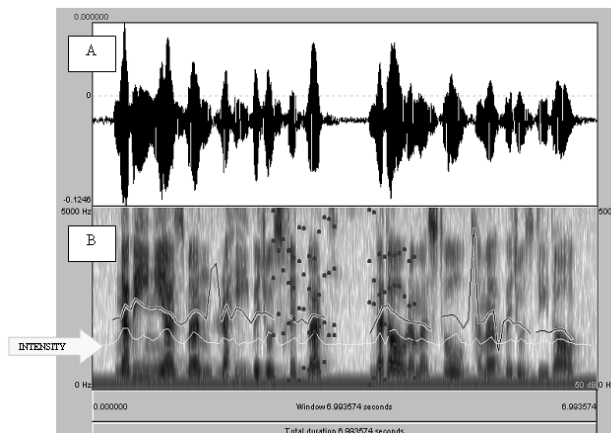
The most significant part of this study is to develop the phonetic characterization of the poetic and prose forms of Persian language by using the acoustic parameters (duration, amplitude, and intensity). Given both the forms (poem & prose) of Persian speech to be analyzed, it is desirable to use measurement procedures which involve the measured mathematical values of acoustic parameters. The analysis of Persian speech is represented by two instrumental techniques (as shown in Figures 1 & 2) - (1) Waveforms on part A and (2) Spectrograms on part B. The very idea of trying these techniques is to provide information-rich visual investigation of the physical pattern of the variation (of speech) in air pressure, as well as, to demonstrate the formants along with the measurements of the acoustic parameters in Persian speech.

### The Poetic Form Analysis

In this work, the Praat picture (shown in Figure 1) is used to analyze the following experimental poetic lines:

7.                na bii ni yaz man ra hii be joz xed mat  
                      na daa ra maz to ta ma    be joz dii daar

The above example (7) can be demonstrated as follows (as in Figure 1):



**Figure 1: Poetic Form**

The Figure (1) displays, for poetic form, the two dimensions: the upper half, i.e. A of the figure shows the waveform of the Persian verse and lower half i.e. B, shows the spectrogram (containing intensity and the formants of the poetic form). The upper half demonstrates that the rate of vibration in the beginning of stanzas is increased and it is dropped in the following words of each stanza. The situation is complicated in the case of first stanza i.e. *na bii.....mat* as *mat* shows a greater flow of air (Figure 1 part B). Part B presents the acoustic analysis by providing the measurement of the

following acoustic parameters.

### Measurements of the Acoustic Parameters:

Total duration: 6.9935742 seconds.

(Sampling frequency: 22050 Hertz)

### Amplitude:

Minimum: -0.12463379 Pa

Maximum: 0.084106445 Pa

Mean: -0.02656589 Pa

### Intensity: 63.69 dB

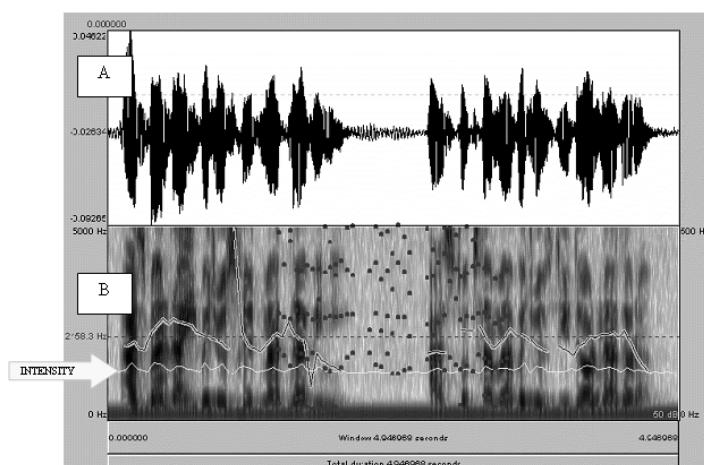
The above measurements indicate that the difference between the Maximum Amplitude and the Minimum Amplitude is 0.0405 Pa with Intensity 63.69 dB.

### The Prose Form Analysis

In this section, i.e. 2.2 the similar lines (as in example 7) are used in the form of the prose (but the construction of the similar lines is changed a little bit as the places of the clauses are changed. When asked about such change, no satisfactory reply is obtained. After discussing with the native speakers, we assume that, in prose the clauses change their places in Persian language). The experimental prose lines are:

8.                    az man ra hii be joz xed mat na bii nii  
                          az to ta ma    be joz dii daar na daa ram

Example (8) can also be shown as follows (in Figure 2):



**Figure 2: Prose Form**

Figure 2 shows that the rate of vibration in the beginning of the first stanza (*az*) is much greater than the rest of the words of the first and the second stanzas (part A of

Figure 2). Part B (Figure 2) provides the following measurements:

**Measurements of the Acoustic Parameters:**

Total duration: 4.946968 seconds.  
 (Sampling frequency: 22050 Hertz)

**Amplitude:**

Minimum: -0.092651367 Pa  
 Maximum: 0.046218872 Pa  
 Mean: -0.026619566 Pa

Intensity: 63.2 dB

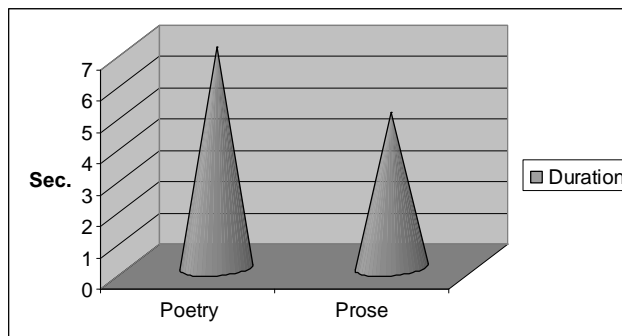
The above measurements indicate that the difference between Maximum Amplitude and Minimum Amplitude is – 0.0464 Pa with Intensity 63.2 dB.

**Generalizations**

With all its technical limitations, this study has produced some surprising generalizations. The observations made with regards to all used acoustic parameters can be systematically compared with the help of following tables (Table 1 and Table 2), cone diagrams and a line diagram in Figures 3, 4 and 5.

**Table 1: Duration**

Parameter	Duration (sec.)
Lines Read	
as Poetry	6.9936
as Prose	4.9469



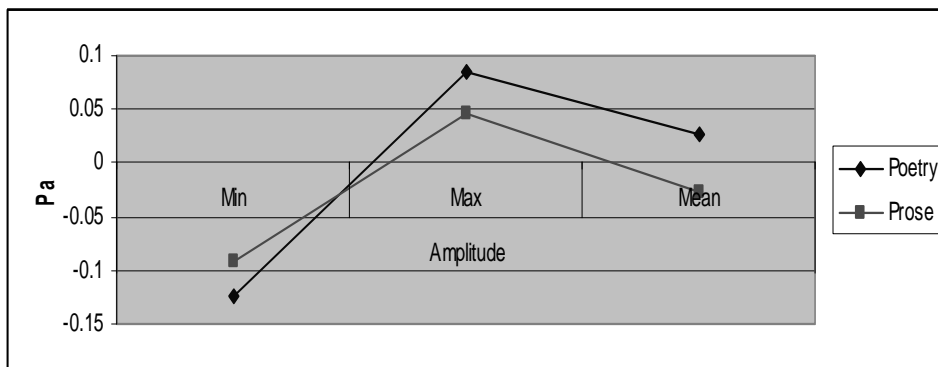
**Figure 3: Cone diagram of Duration**

Table 1 consists of duration (sec.) and standard deviations of the poetry and prose lines read by the Persian speaker. The duration of poetry line is greater, i.e. 6.9936 sec., than the prose line, i.e. 4.9469 sec. The reading of lines as poetry shows a larger standard deviation (0.0151) than the reading of lines as prose (0.0112). The measurement of duration shows the significant difference in poetry and prose which can be seen in Figure 3.

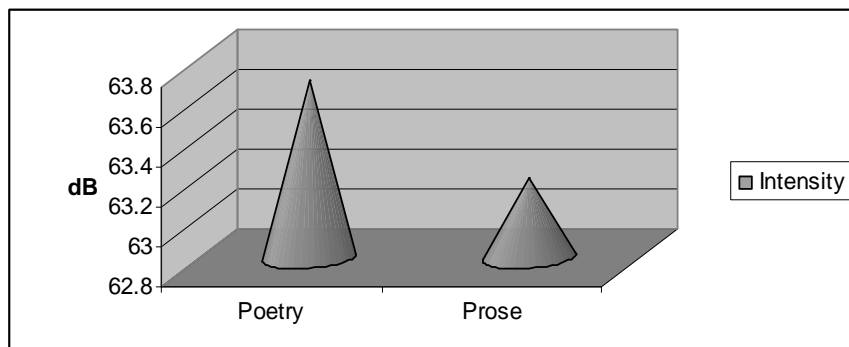
Table 2 shows that the value of amplitude (Max) is greater in the lines read as poetry (Max- 0.0841 Pa) than in the lines read as prose (Max- 0.0462 Pa). Unlike maximum amplitude, the minimum amplitude in poetry is -0.1246 Pa which is lesser as compared to the prose i.e. -0.0927 Pa.

**Table 2:** Amplitude (Minimum, Maximum and Mean), Intensity

Parameter	Amplitude (Pa)			Intensity (dB)
	Min	Max	Mean	
Lines Read				
as Poetry	-0.1246	0.0841	0.0266	63.69
as Prose	-0.0927	0.0462	-0.0266	63.20



**Figure 4:** Line diagram of Amplitude (Minimum, Maximum and Mean)



**Figure 5:** Cone diagram of Intensity



Table 2 and Figures 4 & 5 also show the interesting results that the mean (amplitude) value of the lines read as poetry i.e. is 0.0266 Pa is much greater than prose i.e. -0.0266 Pa. The difference (i.e. the difference of 0.49 dB) in measurements of Intensities of lines read as poetry is higher i.e. 63.69 dB than the lines read as prose i.e. 63.20 dB.

## **Conclusion**

The study shows that the lines read as poetry are longer than the same lines read as prose in Persian language. This study also shows that the standard deviations are larger in the case of poetry. It means, poetry has more metric variation as compared to the prose (of the same lines), as it is a natural phenomena of poetry meters. The measurements depict that in the case of poetic lines the vocal fold vibration is increased (the amplitude of the lines read as poetry is increased) so as the intensity of the sound waves.

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