Original Article

Speech Rhythm in Goan Konkani Speakers

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Abstract

Introduction: Languages of the world vary in their rhythm. Rhythm is hierarchical in nature in language, as it is in music. All spoken languages exhibit isochronous units of speech, and all languages can be classified based on rhythm. The present study aimed to investigate the rhythm in Goan Konkani speakers. **Materials and Methods:** Ten females in the age group of 18–22 years were participated in the study. All of them were screened for speech-, language-, and hearing-related problems. A speech sample of each participant was elicited using pictures depicting a story, and these samples were audiorecorded. The speech samples were transferred into PRAAT software, and the vocalic (V) and intervocalic (IV) durations were found out. The duration difference between successive vocalic and IV segments was calculated and averaged to get the normalized pairwise variability index (nPVI) and raw pairwise variability index (rPVI), respectively. **Results:** The mean nPVI and rPVI values obtained were 50.64 and 60.87, respectively. The results of paired sample *t*-test revealed a significant difference between the nPVI and rPVI values. **Conclusions:** The trend of low nPVI value and high rPVI value is a basic characteristic of syllable-timed language. Similar trend was identified in the present study, suggesting Konkani as a syllable-timed language.

Keywords: Intervocalic duration, pairwise variability index, speech rhythm, vocalic duration

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Introduction

Languages differ in rhythmic structure. Rhythm is one of the aspects of prosody, and it can be referred to as an event which is occurring repeatedly over a period of time. All spoken languages exhibit isochronous units of speech and that languages are either stress timed or syllable timed.[1,2] In stress-timed languages, intervals between stresses or rhythmic feet are said to be near equal, whereas in syllable-timed languages, successive syllables are said to be of near-equal length. Moratiming is the third type of rhythm.[3-5] In Mora-timed language, the durational difference between the simplest and the most complicated syllable is not wide. It has very simple syllabic structure.

The development of concept on rhythm measurement was initiated with the concept of isochrony. The first attempt[6] to test rhythm class hypothesis using the average syllable duration was not found to be effective in classifying rhythm types. Later, pairwise variability index (PVI) was developed[7] for rhythmic analysis. It is a quantitative measure of acoustic correlates of speech rhythm, and it calculates the patterning of successive vocalic and intervocalic (IV) intervals. After a decade, for measuring vocalic and IV durations, normalized PVI (nPVI) and raw PVI (rPVI) were developed.[8] They measured the durations of vowels and the duration of intervals between vowels (excluding pauses) in a passage of speech. Then, they computed a PVI for each type of measurement. The index expresses the level of variability in successive measurements. The rPVI is given in equation (1).

$$\text{rPVI} = \frac{100}{\text{m}-1} \times \left[\sum_{\text{k}=1}^{\text{m}-1} \left| \frac{d_{\text{k}} - d_{\text{k}+1}}{(d_{\text{k}} + d_{\text{k}+1})/2} \right| / (\text{m}-1) \right] \qquad \text{Equation 1}$$

Where "m" is number of intervals, vocalic, or IV, in the text and "*d*" is the duration of the kth interval. Here, the rPVI is not normalized for speech rate. Low *et al*.[8] used a normalized version of the PVI in their measurements on vowel durations. Normalization involves expressing each difference as a proportion of the average of the two units involved (e.g., their average duration). The equation for this version, the nPVI, is

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$$rPVI = \frac{100}{m-1} \times \left[\sum_{k=1}^{m-1} d_k + d_{k+1} / (m-1) \right] \quad \text{Equation 2}$$

Where "m" is number of items in an utterance and "d" is the duration of the kth item. Equation (2) shows that the nPVI is compiled by calculating the difference in duration between each pair of successive measurements, taking the absolute value of the difference and dividing it by the mean duration of the pair. Equation (1) for the rPVI differs only in omitting the third step. The differences are then summed and divided by the number of differences. The output is multiplied by 100 because the normalization produces fractional values.

According to this, languages are classified as stress timed, syllable timed, and mora timed based on pattern of nPVI and rPVI, i.e., high nPVI and rPVI for stressed-time language, low nPVI and rPVI for mora-timed language, and low nPVI and high rPVI for syllable-timed language.

Speech rhythm of various languages has been investigated. Based on the compilation of nPVI and rPVI values[9] of 19 languages they found that British English, German, Dutch, and Thai as stress-timed language; Tamil, Spanish, French and Singapore English as syllable-timed language; in Japanese as mora-timed and mixed rhythm in Catalan and Polish.[10] Figure 1 is the illustration of stressed and syllable-timed languages published by Grabe *et al*.[10]

A study on rhythm in Kannada-speaking adults[11] showed Kannada as a mora-timed language (low rPVI and nPVI). Rhythm in normally developing 8–9-year-old Kannada-speaking children was investigated.[12] The rPVI values for these children ranged between 44.97 and 78.17 with a mean of 65.90, and the nPVI values ranged between 80.10 and 122.75 with a mean of 96.06. The results indicated high nPVI and low rPVI values, and hence, the rhythmic pattern remains unclassified. Speech rhythm of Kannada language in children aged between 11 and 12 was found out.[13] The results revealed higher nPVI when compared to rPVI and suggested Kannada as stress-timed language. As a part of project, the speech rhythm of children aged between 3 and 4 years was found.[14] The results showed a mean nPVI of 59.38 and mean rPVI of 85.22. As the mean value of nPVI is lesser that rPVI, the speech rhythm of children in this age group was considered as syllable timed. Speech rhythm in normally developing Kannada-speaking children was investigated. It was reported that 3–4-year-old children had syllable-timed rhythm pattern. Rhythm type in 8–9-year-old and 11–12-year-old children was mora timed. The findings of the study indicated a need to develop data on rhythm to understand the developmental pattern.[15]

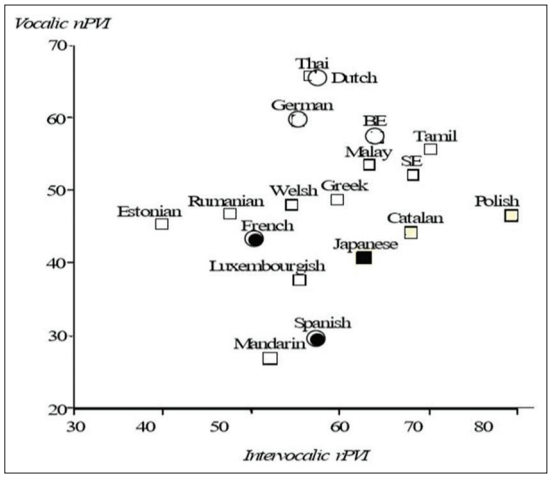

Figure 1: Pairwise variability index profiles for data from 18 languages

Literature review indicated most of the studies of speech rhythm in the Indian languages focused on Dravidian language family.[11-15] Only a few studies have been carried out in Indo-Aryan languages. Konkani is an Indo-Aryan language which is spoken widely in the areas along the Arabian sea coast of western India. It has two main dialect groups which include Canara Konkani and Goan Konkani. It is also associated particularly with places in south western Karnataka and also along the west coast of Maharashtra state.

Languages differing in characteristic rhythm have long served as an inspiration in phonetic research.[9,16] Many researchers have identified the rhythm of various Indian languages.[11-14] However, no such studies have been done to identify the rhythm of Konkani language. Understanding the rhythm of language has therapeutic advantage, i.e., rhythm can be taught to individuals having deficits in prosody of language provided the speech language pathologist knows the type of rhythm in a language. It also helps the speech language pathologist to identify the individuals who lack the rhythmic properties of speech and also would shed some light for the synthesis of speech. In this context, the present study aimed to identify the rhythm of Goan Konkani.

Methods

Participants

The study comprised of ten female participants in the age range of 18–22 years. All the participants were native speakers of Goan Konkani. Informal speech and language screening evaluation was carried out for all the participants. None of the participants were identified to have any speech-, language-, and hearing-related problems. The study was adhering to the ethical guidelines of the institute. A written consent was obtained from every participants of the study.

Materials used

Pictures depicting thirsty crow story.

Procedure

Participants were seated comfortably in a less noisy and distraction-free room. They were instructed to describe the pictures depicting the story of thirsty crow, which was kept infront of them. Speech sample of each participant was recorded using Sony digital voice recorder.

Analysis

The speech samples were transferred into PRAAT software (Paul Boersma and David Weenink, Institute of Phonetic

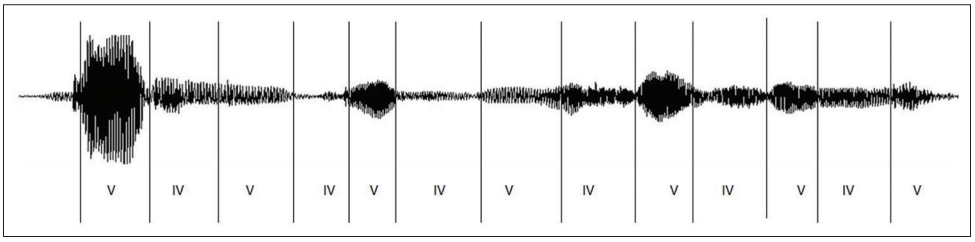

Figure 2: Measurement of vocalic and intervocalic duration of the sentence

Sciences, University of Amsterdam, GNU GPL. Praat Version 5.3.10). The pauses were carefully removed from the displayed waveform using the software. This was done to get an appropriate measure of the vocalic and intervocalic intervals for the analysis. Figure 2 shows the measurement of vocalic and intervocalic duration of a sample sentence. Vocalic interval refers to the duration of vowel/semivowel/diphthong from the onset of voicing to the offset of voicing for that vowel/semivowel/diphthong. IV measure refers to the duration between two vocalic segments. The duration difference between successive vocalic and IV segments was calculated and averaged to get the nPVI and rPVI, respectively.

PVI developed by Low *et al*.[8] was used as a measure of rhythm. The rPVI and nPVI were measured using the following formulae:

$$rPVI = \frac{100}{m-1} \times \left[\sum_{K=1}^{M-1} \left| \frac{|d_k - d_{k+1}|}{(|d_k - d_{k+1}|)/2} \right| /(m-1) \right]$$

$$rPVI = \frac{100}{m-1} \times \left[\sum_{K-1}^{M-1} |d_k - d_{k+1}| /(m-1) \right]$$

Where "m" is the number of intervals and "dk" is the duration of the k^{th} interval.

Microsoft Visual Basic 6 was used to implement the equation to compute nPVI and rPVI.

Results and Discussion

The nPVI and rPVI were found out and the values were subjected to statistical analysis using licensed version of SPSS 18.0 software (SPSS Inc., IBM, Armonk, New York, USA). The nPVI ranged from 41.70 to 60.84 with the mean value and standard deviation being 50.64 and 6, respectively. The rPVI ranged from 52.12 to 72.69 with the mean value of 60.87 with standard deviation being 9.1.

To determine any significant difference between the nPVI and rPVI mean values, paired sample *t*-test was carried out. The result revealed a significant difference between the nPVI and rPVI values ($t = 4.3[2.3, 9]$ $P < 0.01$). The trend of low nPVI value and high rPVI value is a basic characteristics of syllable-timed language.[9] Similar trend was identified in the present study, suggesting Konkani as a syllable-timed language.

Comparing the data of nPVI and rPVI of different languages, it can be seen that the nPVI and rPVI obtained in the present study are similar to the language Tamil which was classified as a syllable-timed language.[17,18] Various studies have been carried out to investigate the type of rhythm in different languages. The nPVI and rPVI values of 19 languages were compiled[9] and reported British English, German, Dutch, and Thai as stress-timed language with high IV rPVI and high vocalic nPVI values; Tamil, Spanish, French, and Singapore English as syllable-timed language exhibiting low vocalic nPVI and low IV rPVI values; Japanese as mora timed with relatively simple syllable structure and mixed rhythm in Catalan and Polish. Catalan was said to be mixed because it resembles syllable-timed language in syllable structure but does not have vowel reduction.[10] According to reports based on an investigation of rhythm in 12 Indian languages including Hindi, Kashmiri, Assamese, Marathi, Bengali, Telugu, Oriya, Punjabi, Tamil, Malayalam, Kannada, and Gujarati, only Hindi was classified as syllable-timed language whereas remaining all the languages were grouped under mora-timed language.[19]

Different languages have different types of rhythm. The characteristic feature of syllable-timed language is syllables tend to be equal in length, and interstress intervals are unevenly spaced.[6] The results of the present study indicated Konkani language as a syllable-timed language because of low nPVI and high rPVI pattern. Which indicated that the occurrence of syllables are tend to be equal in duration irrespective of the stress placed on them in language Konkani.

Conclusions

From the results of the study, it can be concluded that the language Konkani can be classified under syllable-timed language. Understanding the rhythm of language has clinical implication for the speech language pathologists. First, knowing the rhythm of language helps the speech language pathologist to identify the individuals with aprosodia. Second, it helps speech language pathologist to train the rhythmic aspect of speech for individuals who lack in suprasegmental properties of speech. Third, it helps in synthesizing the speech. However, there are a few limitations for the present study. The results of the study cannot be generalized to other gender, age groups, and speech tasks as well. The present study consisted of only female participants. In future, research can be carried out including more number of individuals with greater number of narration samples for the validation of the current findings.

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Conflicts of interest

There are no conflicts of interest.

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