

A cross-cultural study of the rhythm in English and Japanese popular music

*Makiko Sadakata¹, Peter Desian¹, Henkjan Honing²,
Aniruddh D. Patel³, John R. Iversen³*

¹Nijmegen Institute for Cognition, University of Nijmegen, The Netherlands

²Institute for Logic, Language & Computation, Music Department, University of Amsterdam, The Netherlands

³The Neurosciences Institute, San Diego, California, United States

m.sadakata@nici.kun.nl

Abstract

The aim of this study is to investigate the linguistic impact on rhythm in music. It has been shown that the composer's native language exerts an influence on the music composed [10] using the normalized Pairwise Variability Index [5]. Our project aims at finding more evidence for the linguistic impact on musical rhythms in various kinds of music and language. In this study we apply the same index to analyze popular music with English and Japanese lyrics composed by Japanese composers to investigate an influence of the language of the lyrics on musical rhythm. Results showed a slight but significant tendency which supports the prediction that musical rhythm reflects certain aspects of the characteristics of the language of the lyrics.

1. Introduction

1.1. Cultural impact on music

Cultural impact on music has drawn the attention of musicologists for a long time. More specifically, many efforts have been made to associate different aspects of musical behavior with language because they share their fundamental features; language and music consist of structured acoustics and require a complex cognitive process to be understood. For example, composer R. Lerdahl and linguist F. Jackendoff indicated the similarity between language and music syntactic structures in their influential work [7]. There are more approaches found which point out similarities between music and language [2, 8].

Rhythm (temporal aspect) is one of the most prominent components for both of music and language. Several studies have already shown the evidence of closer relations between music and language regarding their rhythm. Wenk [15] revealed that French composers tend to

reflect prosodic characteristics of the French language on musical rhythm. Furthermore, Patel & Daniele [10] found a more general and systematic tendency that the rhythm of a composer's native language is reflected in the rhythm in music written by French and English composers from a certain era by applying measures developed to describe rhythmic features of language.

1.2. Rhythm in language

Traditionally it has been proposed that some languages are so-called stress-timed, while others are syllable-timed based on the isochrony of their stress or syllable intervals [11, 1]. Although it is widely known that there is little phonetic evidence for supporting this typology, it might capture some fundamental fact about rhythmic patterns across languages, otherwise this distinction would fall into oblivion [3]. Among many recent studies searching for empirical evidence for linguistic typologies, one interesting approach is to direct an attention to the proportion of durations of vocalic and intervocalic intervals and their variability [13, 5]. In fact this approach has successfully shown an empirical difference between the so-called stress-timed and syllable-timed languages. Similarly, this approach [13] revealed distinct rhythmic features of Japanese, which belongs to third group of the so-called mora-timed languages.

The normalized Pairwise Variability Index (nPVI) is devised by Grabe and Low [5] as a new empirical tool for analyzing speech rhythm in the field of phonetics. It shows contrastiveness of successive vocal durations in speech utterances. It is an extension of the raw Pairwise Variability Index (rPVI), which was employed to analyze variability of intervocalic durations [13, 12]. Both of them show the contrastiveness of successive durations in speech utterances; higher value shows larger difference of successive durations. The raw Pairwise Variability Index (rPVI) is defined as:

$$rPVI = \frac{100}{m-1} \sum_{k=1}^{m-1} |d_k - d_{k+1}| \quad (1)$$

, where m is the number of intervals and d_k is the duration of the k th interval [13, 12]. The nPVI is defined as:

$$nPVI = \frac{100}{m-1} \sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{\frac{d_k + d_{k+1}}{2}} \right| \quad (2)$$

, where m is the number of intervals and d_k is the duration of the k th interval [5]. The average duration of two successive intervals normalizes the difference of these two durations.

Table 1 summarizes the basic characteristics of each language class regarding relative values of vocalic nPVI and intervocalic rPVI represented as in figure 2 in the study by Ramus [12]. Japanese is not only showing low nPVI similar to French (syllable-timed) but also showing low rPVI. Thus Japanese was distinguished by showing less contrastiveness of both successive vocal and intervocalic durations than the other two language classes (stress-timed and syllable-timed).

1.3. Rhythm in music

Patel & Daniele [10] applied referred nPVI to musical scores. The method relates contrastiveness of vocalic durations in speech to that of duration of intervals in music. They found that rhythm in English and French musical themes is significantly different in their contrastiveness of successive durations in the same manner as those of spoken language. This study extends the past study to popular music for finding more evidence of linguistic impact on musical rhythm. Different from Patel & Daniele [10], we analyze music with lyrics, and written by composers who have Japanese as their native language. In this study we expect to find an influence of the language of the lyrics on musical rhythm; English (stress-timed) and Japanese (mora-timed). As Japanese and French (syllable-timed) have virtually identical lower nPVI values for speech than that of stress-timed languages [12], less contrastiveness of successive duration in Japanese music than English music would be expected. Further interest includes the component of rhythms (musical notes) that appear in the music in order to obtain more detailed information about rhythmic structure.

2. Method and Material

nPVI was employed to analyze the melody part from midi files of popular music from the RWC Music Database (Popular Music, [4]). One bar was divided into 48 time units and the ratio of note duration in one bar was represented using these time units; e.g. the sixteenth note in time signature of 4/4 is represented as 3, 3/4 and 6/8 is represented as 4. These ratios of note duration were substituted in the place of vocalic durations in formula (2); d_k is the note duration of the k th interval in musical phrases. The database contains 80 Japanese and 20 English popular music with lyrics. Both English and Japanese music in this database were written by Japanese composers. Careful processing of musical data has been done in order to provide a proper sample for nPVI calculation. Durations longer than one bar are omitted from the target, and rhythmic phrase including less than 12 successive notes are removed from the target. POCO [6] was used for the segmentation of musical materials. Sample size comprised 157 musical phrases (7,129 subsequent durations) for English and 494 (27,341 subsequent durations) phrases for Japanese music, respectively. Furthermore, frequency of occurrence of each musical note was counted up from each data set.

3. Result

3.1. nPVI Analysis

nPVI values were calculated from music phrases and compared between English and Japanese data set. There was a slight but significant difference between the language groups regarding nPVI value (computed using a Mann-Whitney U test) in the same direction as the difference between British English & Japanese speeches. Figure 1 shows that calculated nPVI value for each language group (English: median nPVI = 53.44, Japanese: median nPVI = 49.26). It suggests that there seems to be an influence of the language of the lyrics on their musical rhythms.

Although we expected a large difference in their nPVI because the difference between British English and Japanese in speech shown by Ramus [12] was quite large (approximately 20 nPVI points), the size of the difference in referred English vs. Japanese popular music was rather small (about 3 nPVI points). This 3 nPVI points is also smaller than that of English vs. French music which Patel & Daniele [10] obtained (about 6 nPVI points).

Table 1. Summary of characteristics of different language classes regarding contrastiveness of successive intervocalic / vocalic durations, presented as Figure 2 in Ramus [12]. For definitions of rPVI and nPVI, see formula (1) and (2).

Language class	Languages	Intervocalic rPVI	Vocalic nPVI
Stress-timed	English, German	High	High
Syllable-timed	Catalan, French, Italian, Polish, Spanish, Catalan	High	Low
Mora-timed	Japanese	Low	Low

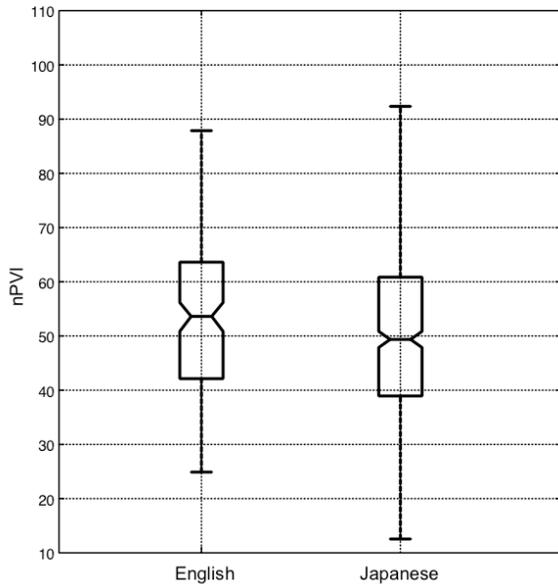


Figure 1 Musical nPVI values for popular music in English and Japanese. The ends of the box are the 25th and 75th quantiles, the line across the middle of the box identifies the median (English=53.4, Japanese=49.3). Lines that extend from the ends of the box indicate the outermost data point that falls within the distances computed.

3.2. Analysis of rhythmic component

High correlation was obtained between the English and Japanese data sets regarding frequency of occurrence of musical notes (0.85 on logarithmic scale) suggesting that the rhythmic component (musical notes) in both data set was quite similar. Figure 2 shows the proportion of frequency of occurrence for each kind of musical notes in logarithmic scale. It clearly shows that musical notes that were frequently used were systematically concentrated on the multiple of eighth notes in the time signature of 4/4 (e.g., 6=eighth note, 12=crotchet, etc.).

4. Discussion

It has been shown that the way the simple rhythm is performed differs among musicians who have different cultural backgrounds [9, 14]. However, these studies did not specify the possible causes of such difference. Our aim is to specify what contributes to such differences, more specifically, to broaden the application of nPVI to compare speech and music with the purpose of investigating an influence of the prosody of language on musical rhythm. When a musical material has lyrics, both the language of the composer and the language of the lyrics can potentially affect the musical rhythm. In this paper, we showed effect of the language of the lyrics on musical rhythm as a significant difference in lower nPVI in music with Japanese lyrics than that with English lyrics, which is in accordance with the tendency of spoken language. Although this difference of nPVI points between groups was smaller than expected, the result still seems to suggest a closer relation between rhythm in language and music.

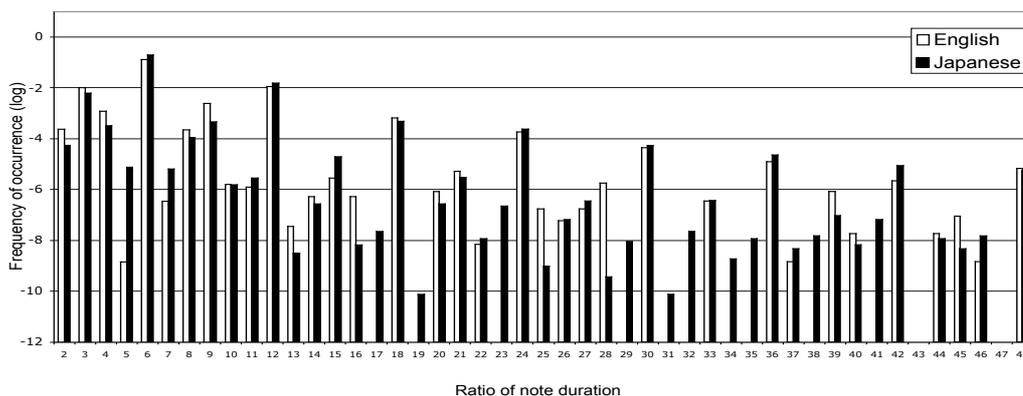


Figure 2 Proportion of frequency of occurrence of musical notes in popular music with English and Japanese lyrics on logarithmic scale. The horizontal axis shows ratio of note duration in one bar (48 division a bar).

There are various music styles, and languages exist in the world, and consequently rhythm is thought to contribute to make such diversifications. In this study we examined two different levels of rhythmic structure, frequency of occurrence of musical notes (component) and contrastiveness of successive durations (order of these component, nPVI). High correlation of frequency of occurrence between different data suggested the data sets in this study are based on similar materials that consist their rhythm. The materials seem to reflect the rhythmic restriction of western tonal music since 99 % were with time signature of 4/4 and the frequently occurring musical notes were the ones which easily fit the metrical unit of 4/4 (eighth note, crotchet, etc). When different nPVIs are obtained from data sets which consisted from similar rhythmic material, there might be an effect of the order of these components. In fact, there were often the cases in music phrases with Japanese lyrics which aligned many short notes with same durations next to each other so that one mora (Japanese syllable) can fit well to one note.

However, it is important to note that this type of study largely depends on the property of the musical material. Although the RWC popular music database is convenient because it is well formatted, well classified and is especially aimed at research use, it is still questionable whether we can draw general conclusions regarding popular music from it because of possible constraints such as the number of samples and non exposure to the public. Nevertheless, the direction of the results in the current paper is encouraging since they are in line with those of previous studies. Also, it is necessary to expand this method to other musical sources, especially to further investigation to be carried out using English popular music written by English speaking composers.

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