Rhythmic Variability and Swedish-Estonian Language Contact

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Abstract
Pairwise Variability Index (PVI) gives a measure of the amount of variation between adjacent speech units, making it possible to arrange languages in a continuum of relative variability. In the present study, the PVI of Estonian speakers living in Sweden for over 60 years was compared to the PVI of Swedish and of Estonian spoken in Estonia. The results show that (1) PVI is significantly higher in Swedish for vowels and syllables, but not for consonants and feet; (2) the PVI of Estonian speakers in Sweden does not differ from the PVI of Estonian speakers in Estonia; (3) the PVI of Swedish spoken by Estonians in Sweden is closer to the Swedish than to the Estonian VPI but does not reach the level of native Swedish speakers.

Introduction
Pairwise Variability Index (PVI) is a metric for quantifying rhythm in languages. The attempts to find isochrony of syllables or interstress intervals(feet), and dividing languages into syllable-timed and stress-timed have not given satisfactory results (Eriksson, 1991; Kohler, 2009). Some languages do not fit to either category, while others may fit both. Estonian, for example, has been described as syllable-timed by Eek and Help (1987), while Ross and Lehiste (2001) have characterized it by foot-isochrone.

PVI serves a complement to the categorization of languages as syllable-timed or stress-timed by making it possible to arrange languages in a continuum of relative variability of speech units (Low et al, 2000; Grabe and Low, 2002). Like standard deviation, VPI shows the relative variability of units, but unlike standard deviation, VPI shows the difference between adjacent units, taking into account local variation. The mean value of absolute differences between pairs of units is calculated. In order to avoid that changes in speech tempo could influence the degree of variation in the duration of units, Low (1998) introduced nPVI, the normalized PVI:

$$nPVI = 100 \times \left( \frac{1}{(n-1)} \sum_{k=2}^{n} \frac{|v_k - v_{k-1}|}{(v_k + v_{k-1})/2} \right)$$

In nPVI the difference between each pair of adjacent units is divided by the mean value of the pair. The result is multiplied by 100 to give whole numbers.

Purpose of this study
The purpose of the present study was to use PVI to find out if and to what degree the rhythm of one language can be influenced by the rhythm of another language if there is a long time contact between the languages. Estonians who have lived in Sweden for more than 60 years are a good example of such a long time language contact. The PVI of Estonian speakers in Estonia has been studied by Asu and Nolan (2005) and can serve as a base for comparison. Swedish PVI has not yet been measured – it was not among the 18 languages in the study of Grabe and Low (2002). Therefore Swedish PVI as well the PVI of Estonians living in Sweden had to be calculated.

Procedures
The material consisted of an Estonian and a Swedish text of about 120 syllables each. Both texts were read in normal tempo by five female speakers who had Estonian as their native language but who had lived in Sweden since the 1940ies. Their ages at the arrival to Sweden varied between 6 and 17
years. The five native Swedish speakers read only the Swedish text. The speakers were all female for better comparison with the study of Asu & Nolan (2005). However, there was perforce a large difference in age – Asu and Nolan’s speakers were between 22 and 28 years of age.

The material was recorded in an anechoic chamber at the Department of Linguistics, Stockholm University. The measurements were made on spectrograms and speech waves (Swell Editor, version 4.0), in some cases with the help of careful listening, e.g. when different vowels appeared at word boundaries. For comparison, the units measured were the same as in Asu & Nolan (2005): a. nVPVI – from the start of a vowel to the beginning of the following consonant (vowels); b. nCPVI – the intervocalic consonant(s); (3) nSVPI–the linguistic syllable; (4) nPSVPI – the ‘pseudo-syllable’ i.e. the intervocalic interval plus the following vowel(s). Asu and Nolan (2005) explain the inclusion of the pseudo syllable with its “heritage into the research of speech production”; (5) nFPVI – interstress interval or phonological foot.

As Asu and Nolan (2005) have remarked, there are hardly any problems with finding syllable and foot boundaries in Estonian: long or overlong vowels form a syllable, consonant clusters are split so that the last consonant starts a new syllable. Long consonants and identical vowels at word boundaries were divided at their midpoint. A phonological foot in Estonian consists of a stressed syllable followed by at most two unstressed syllables. Words of three syllables can constitute a foot if there is no secondary stress on the second or third syllable (Ross and Lehiste, 2001). A syllable carrying secondary stress thus counted as stressed. All decisions on the location of syllable and foot boundaries followed the example of Asu and Nolan (2005)

In Swedish, a syllable consists of a vocalic nucleus that can be preceded or followed by one or more consonants. Determining syllable boundaries did not pose serious problems. The difficulty lies in determining whether a syllable was stressed or not. As Eriksson (1991) remarks, this may in some cases be impossible, especially in spontaneous speech. In the present material, careful listening was necessary in a few cases. The foot boundaries were determined following the example in Eriksson (1991, p. 76). In contrast to Estonian, secondary stressed syllables thus did not count as stressed. In both languages, phrase initial unstressed syllables were not included in the analysis, pauses and hesitations were also left out.

The definition of foot differs between Estonian and Swedish. There is an even greater difference between e.g. English and Spanish. Nolan and Asu (2009) note that it might be objected that languages can therefore not be compared. In defense, they presented an analogy with the syllable: “The constituency of a syllable clearly differs between languages, but that does not debar generalizations such as describing languages as having stress on a penultimate syllable of the word.”

Results

A comparison between Estonian and Swedish nPVI (E-E and S-S in Table 1) showed that the values for consonants and

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<tr>
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<th>V</th>
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<tr>
<td>E-E</td>
<td>44.6</td>
<td>57.5</td>
<td>45.7</td>
<td>35.3</td>
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<tr>
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<td>55.8</td>
<td>42.4</td>
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<tr>
<td>E-S</td>
<td>46.4</td>
<td>58.1</td>
<td>53.1</td>
<td>36.5</td>
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<tr>
<td>S-S</td>
<td>52.1</td>
<td>57.2</td>
<td>58.6</td>
<td>36.7</td>
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Table 1. nPVI in vowels (V), consonants (C), syllables (S) and feet (F) in an Estonian text read by Estonians in Estonia (E-E) (Asu and Nolan 2005); by Estonians living in Sweden (S-E); Swedish text read by Estonian speakers in Sweden (E-S); the same text read by native Swedish speakers (S-S)
feet were nearly identical, while there was a relatively large difference for vowels (V) and syllables (S). According to a t-test, the difference in nPVI was significant for vowels (p < 0.05) and syllables (p < 0.001). In both languages, the nPVI of pseudo-syllables was regularly lower than for linguistic syllables (p < 0.001). The difference between languages was also significant (p < 0.05).

Comparing the Estonian spoken in Sweden with the Estonian spoken in Estonia clearly showed that there was no Swedish influence: the differences were small and not statistically significant. Moreover, the existing small differences were in a direction away from the Swedish nPVI values (Table 1. E-E and E-S, and Fig 1).

On the other hand, the nPVI of Estonian speakers reading Swedish showed a probable Estonian influence: the nPVI for vowels (Fig. 2) and syllables (Fig. 3) had moved toward Swedish values, although without quite reaching them. The difference was statistically significant for both vowels (p < 0.05) and syllables (p < 0.001). No influence could be expected for the consonants and feet as their nPVI had about the same value in both languages. Pseudo syllables had only a small non-significant difference.

It may be of interest to note that one of the Estonian speakers who came to Sweden at the age of 6 had no noticeable accent in Swedish. In spite of that, her Swedish nPVI was about the same as that of the other speakers who had a slight Estonian accent in Swedish.

Conclusion

It was mentioned in Introduction that Estonian has been described both as syllable-timed and stress-timed. According to the PVI analysis, both characterizations could be justified. Estonian is as much stress-timed as English with a foot nPVI of 33.9 for both Estonian and English (Nolan and Asu, 2009). At the same time there is an overlap of syllabic nPVI with Castilian Spanish – a language usually characterized as typically syllable-timed.
A large difference between Estonian and Swedish was found in the nPVI for syllables, and a relatively large difference for vowels. In spite of these differences, the nPVI of Estonian speakers who have lived in Sweden for over 60 years has not been influenced by the Swedish variability values. On the other hand, the nPVI of these speakers when reading the Swedish text seems to have retained some of its lower, Estonian variability for both syllables and vowels. This was true also for the speaker who had no noticeable accent in Swedish. The question arises: how much of the PVI depends on the structure of a language and how much can vary with speakers? Is PVI something acquired in early childhood?

Future research is planned for two additional groups of subjects: native Swedish speakers learning Estonian, and Estonian speakers learning Swedish. How much is the influence of the native language PVI dependent on the degree of proficiency the speaker has reached in the new language?

References


