A preliminary analysis of speech rhythm in three varieties of Irish (Gaelic)

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Abstract

This paper gives a preliminary account of speech rhythm characteristics for the three main dialects of Irish (Donegal, Connemara and Kerry Irish). The analysis is based on a short read passage. The segmental level Pairwise Variability Index metrics (rCPVI, nVPVI) indicate that Irish groups with stress-timed languages. At the level of the syllable and the foot, results suggest that Irish has irregular syllable structure, but more regular foot size. Only minor differences emerged among the dialects.

Index Terms: rhythm, intonation, Irish (Gaelic)

1. Introduction

The aim of this paper is to provide a preliminary description of rhythm characteristics for each of the three main Irish dialects (see Figure 1). It is prompted by the common perception that the Northern dialect of Irish (Donegal) is rhythmically somewhat different from the Southern dialects, exemplified by the well known expression "*bheadh na preátaí nite, bruite agus ite ag na hUltaigh san am a thógfadh sé ar na Connachtaigh fataí a rá"* ('*The Ulster Folk would have the potatoes washed, boiled and eaten in the time it would take the Connaught folk to say the word potato.'*). We wondered whether this perceived difference might have to do with rhythm, rather than simply speech tempo. All three dialects of Irish would be regarded as stress-timed. Note, however, that quantitative studies on rhythm have suggested that the stress vs syllable timing distinction may involve a continuum along which languages may differ, rather than presenting them as two discrete categories [1]. Studies using rhythm-related measurements such as PVI lead us to believe that languages can fall somewhere on such a continuum: some languages exhibiting clear features of stress-timing; others show features we would associate with syllable-timing; for some languages, however, the situation is not clear-cut, and they fall into a 'mixed' category.

Our hypothesis therefore was that the Donegal dialect might differ from the Southern dialects in being less clearly (or less extremely) stress-timed, veering more towards the 'mixed' category in exhibiting some features that would be associated with syllable-timing. Specifically we hypothesized that Donegal Irish might exhibit (relative to the other dialects) a lesser degree of variation in the duration of vowels. This would show up as lower nVPVI scores. As a corollary, one would also predict that there might be less variation in syllable durations, and (perhaps) a greater degree of variation in foot duration.

The classification of languages according to their rhythmic properties has received continuous attention in speech research, as it is somewhat problematic in nature. The traditional way of grouping languages into syllable-timed (e.g. Spanish, French), stress-timed (i.e. British English, German) or mora-timed (Japanese) [2,3] assumed a certain regularity of rhythm as a result of equally distributed units of speech. Later, however, syllable structure and vowel reduction have been argued as the basis for classification [1,4]: stress-timed languages are said to have a more complex syllable type inventory, longer vowels in stressed and shorter ones in unstressed syllables. Yet it has been debated if rhythm is a property of phonological structures alone that influence timing, or if it results from acoustic-phonetic properties.

During recent years, research has mostly focused on calculating different metrics to measure this variation in the production as well as in the perception of speech rhythm. Different types of Pairwise Variability Indices (PVI) [5,6], which are concerned with the temporal succession of vocalic (nVPVI) and inter-vocalic (rCPVI) intervals and their variability have been applied to numerous languages and have also been calculated for larger units such as the syllable and the foot [7]. The metrics proposed in [8] classify languages according to the time devoted to vowels (%V) as well as by the standard deviation of consonant and vowel units (ΔC, ΔV). Yet others argue for measuring alternations between voiced and unvoiced stretches of speech (VarcoV, VarcoC) [9], or calculating CCIs (Control and Compensation Index), a normalisation of PVIs by the number of segments they are composed of [10]. It has been pointed out, however, that most metrics, despite normalisation procedures, are strongly affected by speech rate [9, 11].

As regards the perceived rhythm, the interdependence between f_0 and rhythm has been highlighted in [12]. Stimuli with dynamic f_0 in stressed syllables were generally judged longer than with level f_0, but rises were perceived as longer in duration less often than falls or complex pitch contours. This is particularly interesting since here we are dealing with varieties of the same language with contrasting tonal patterns and differences in perceived rhythm.

Figure 1: *Map showing the three main Irish dialect areas (shaded in grey).*

It is worth noting that the three varieties investigated here are considerably different in their basic linguistic typology [13] and also in terms of their prosodic features. Donegal Irish (DI) has characteristically rising tonal patterns in neutral declaratives (L*+H L*+H L*+H %), whereas those of

Connemara Irish (CI) and Kerry Irish (KI) are generally falling (H*+L H*+L H*+L %) [14]. Broadly speaking, in Irish, lexical stress is predictable and falls on the initial syllable of the word. Kerry Irish (KI) stands out in this respect: it has undergone stress shift [15], so that in certain contexts lexical stress is moved to the right edge of the prosodic word, whereas in Donegal and Connemara Irish, the stress remains on the left edge for the same word (e.g. bealach, '*way*': DI /ʲbˠʲalˠah/, CI /ʲbˠʲalˠax/, KI /bˠʲəlˠax/). Syllabic sequences can be complex and syllabification is often ambiguous, as different rules for syllable division have been proposed [13]. Besides, consonant clusters can be broken up by the insertion of an epenthetic vowel, and this has also consequences for syllable division.

Since this is a pilot experiment with very limited data, we provide only a tentative set of results, along with a comparison of our results to those of previous studies of other languages, which were carried out on larger data sets. The main goal was to offer a preliminary description of Donegal, Connemara and Kerry Irish with PVI metrics, in order to explore possible cross-dialect differences in their rhythmic properties. In addition, we are also interested in locating Irish in the context of other languages which have been traditionally classified as stress-timed.

Here we calculated the normalised PVI (nVPVI) for vowel clusters and the raw PVI (rCPVI) for inter-vocalic intervals, as well as normalised PVIs for syllables (nSPVI) and the prosodic foot (nFPVI) for each of the three dialects.

2. Methods and Materials

2.1. Materials

For this experiment three female speakers were recorded, one for each of the dialects: (Donegal (Gaoth Dobhair), Connemara (Cois Fharraige) and Kerry (Corca Dhuibhne)). Each informant read a rendition of a translation of the *North Wind and the Sun*, a well-known text in phonetic studies. Since the three dialects differ in their lexical properties, the basic Irish version of the text [16] was adapted to suit the syntactic structures and the vocabulary typical of each dialect. The analysis is based on 5 sentences from the passage, whose structure and lexical composition was identical in the three dialects to allow for direct comparison. All recordings were carried out in the semi-anechoic recording booth in Trinity College.

2.2. Measurements

All data was labelled and segmented using the Praat [17] software. As a first step in the analysis, sentences were transcribed orthographically and stressed syllables marked. Then, vocalic and inter-vocalic intervals were labelled manually, as were stressed and unstressed/weak syllables. Vocalic intervals correspond to single vowels as well as vowel sequences irrespective of syllable or word boundaries. Inter-vocalic intervals correspond to single consonants or consonant clusters across syllable or word boundaries (see Figure 2).

Additionally, on-glides were included in inter-vocalic intervals (e.g. *bhain* [wan] (CI, DI), *ghrian* [jɾʲian]), as were hold-phases of stops if there was no perceptual pause after the segment. Glottal stops marking word boundaries in vowel sequences were included in the vocalic measurements. Hesitations and pauses between phrases were excluded from the measurements.

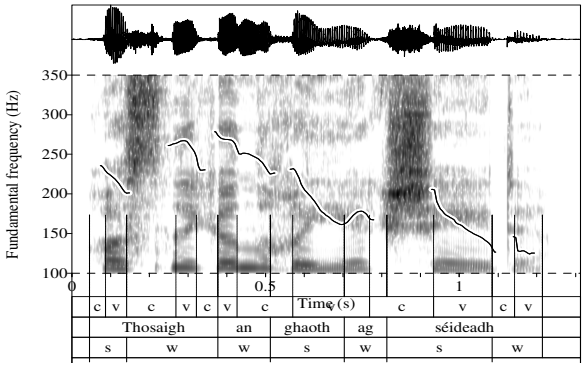

Figure 2: *Example of annotation for the phrase 'Thosaigh an ghaoth ag séideadh' /ʰhɔsnɪg an ˈɣi əg ˈʃeidə/, The wind was blowing strongly, from the Kerry Irish data: segmentation of vocalic (v) and inter-vocalic (c) intervals, orthographic transcription and segmentation of stressed (s) and unstressed/weak syllables (w).*

Our data also showed some problematic cases with regard to two segment types in inter-vocalic or post-vocalic position: alveolar approximants [ɹ] and glottal and palatal fricatives [h], [ç]. In a number of cases for alveolar approximants [ɹ] no clear-cut formant transition could be identified, therefore these were included in vocalic intervals. The same also applied to a sequence of [ɹ] followed by an epenthetic vowel.

We also frequently noted partial de-voicing of vowels and consonants before phrase breaks. In these cases, the cessation of the speech waveform served as the segment end point.

Duration measurements for all vocalic and inter-vocalic intervals were extracted automatically by a Praat script from which PVI metrics were then calculated.

2.3. Calculations

The calculation method of PVI values followed those suggested in [5]. The vocalic nVPVI and inter-vocalic rCPVI metrics were calculated with formulae (1) and (2) respectively. In both calculations m indicates the number of intervals and d_k indicates the duration of the kth interval.

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

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

As suggested in [7], the vocalic and inter-vocalic metrics alone may not fully capture the rhythmic properties of a language. The syllable and foot based metrics may provide a better insight into the rhythmic properties of stress-timing.

Consequently we calculated the normalised syllable PVI (nSPVI) and normalised foot PVI (nFPVI). The calculation method follows [7,18]. By foot we mean the interval consisting of a stressed syllable plus any number of following unstressed syllables until the next stressed syllable. For nFPVI the duration unit (*d*) understood as the rhythmic foot was derived by adding the duration of a stressed syllable and any number of following unstressed syllables.

3. Results

Results of all calculations referred to in section 2.3 are presented below for the three dialects. Overall our hypothesis was not supported.

Figure 3.1 shows nVPVI and rCPVI results for the three dialects, DI, CI and KI. These are plotted in a table adapted from Grabe & Low's study [5] along with PVI values obtained for other languages. Results show that each of the dialects is characterised by relatively high nVPVI values (DI 65.5, CI 65.1, KI 68.4) and also high rCPVI values (DI 62.4, CI 66.9, KI 66.7). We observed minor differences between the dialects. In terms of the variability of vocalic intervals, KI had a slightly higher rate than DI and CI. Regarding the variability of inter-vocalic intervals, on the other hand, the two southern dialects, CI and KI, grouped together, having slightly more variability than DI. Given the limited amounts of data involved here, we do not attach too much importance to these small differences.

It is interesting to note that the three Irish dialects are rather extreme in their vocalic variability relative to other stress-timed languages (Figure 3.1): they are located at the higher end of the nVPVI scale closer to Dutch than to British English or German.

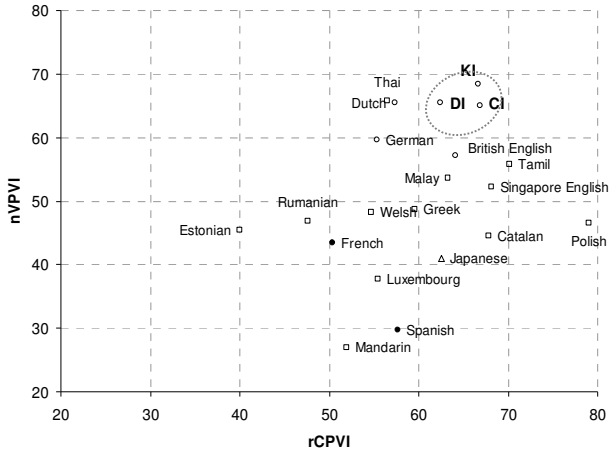

Figure 3.1: *Average vocalic nVPVI (y-axis) and inter-vocalic rCPVI (x-axis) results for DI, CI and KI plotted against PVI metrics for other languages reproduced from [5]. Data point symbols indicate rhythmic classification (squares = mixed or unclassified, circles = stress-timed, black dots = syllable-timed, triangles = mora-timed).*

Figure 3.2 presents the results of nSPVI and nFPVI for the three Irish dialects. These are plotted along with the values for English reported in [7]. Results show that each of the dialects is again characterised by relatively high nSPVI values (DI 64.4, CI 67.4, KI 66.9), but lower nFPVI values (DI 38.0, CI 40.9 KI 40.6). Here too, we observed minor cross-dialect differences. The syllabic PVI is lower for DI than for the two Southern dialects, and the same can be observed for the foot PVI.

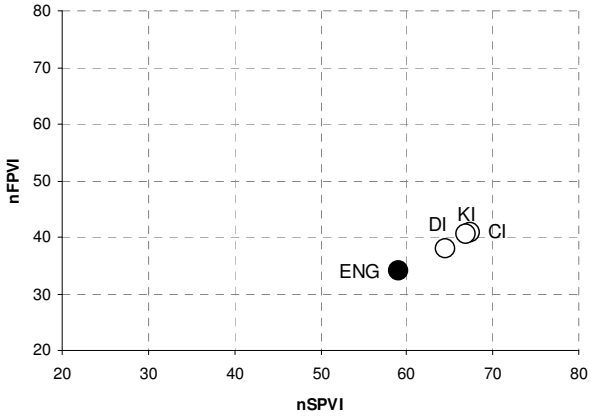

Figure 3.2: *nSPVI (x-axis) and nFPVI (y-axis) results for DI, CI and KI.*

Note that Irish is again located at the higher end of the scale with regard to the syllabic PVI, but at the lower end for the foot PVI. If we take English as a reference, we observe similarity between these two stress-timed languages at both these levels (Figure 3.2).

4. Discussion

Earlier studies have suggested that in terms of PVI measurements, typical stress-timed languages such as British English are described by high nVPVI values which indicate bigger differences in vowel durations, due to reduction phenomena in unstressed syllables as well as differences in vowel qualities [5]. Our nVPVI results suggest that this is also the case for Irish.

High vocalic nVPVI values suggest that Irish clearly shows features typical of stress-timed languages. This is not surprising since Irish has phonologically long and short as well as reduced vowels. Apart from that, certain grammatical structures such as verbs in progressive tense and personal pronouns in combination with words ending in a vowel can result in sequences of two, three or four vowels (e.g.: Agus b'éigean don ghaoth adu*aidh é a a*dmháil).

High rCPVI results quantify the syllable complexity in Irish. In other words, high rCPVI values point to Irish having a high number of syllable structure options, which is indeed the case.

The metrics at the segmental level showed that Kerry Irish had slightly higher vocalic variability, while Donegal exhibited the lowest inter-vocalic variability. At this particular moment we are not sure what segmental aspects these minor differences can be attributed to. Although we are dealing with a limited amount of material in this study, we suspect that with a larger data set and more speakers the results will occupy a similar place in the segment-level PVI space.

As regards nSPVI results, we observe a similar pattern: all dialects have yet again relatively high values for this metric. DI, CI and KI each have high variability in terms of syllable duration, and few differences between one another.

Notably, the syllabic level PVI groups Irish together with English, which also has relatively high variability for this metric. The normalised syllabic PVI is boosted as a result of unstressed vowel reduction, and also due to the occurrence of simple and complex syllable structures.

As regards the foot level, each of the three dialects show less variation in nFPVI and again differences between the dialects are minor. With respect to this metric, Irish is also relatively similar to English which tends to strive towards foot-isochrony. This also seems to be the case for Irish.

Overall, the rhythmic findings suggest that Irish exhibits the features characteristic of a stress-timed language. When compared to English, it appears quite similar on the segmental and syllabic levels. With regard to the foot, Irish also shows similar trends to English which "squashes its unstressed syllables to achieve approximate foot-isochrony" [7].

On the basis of previous accounts of intonation we already know that Donegal Irish is very different from the Southern varieties, Connemara and Kerry Irish [14,19]. It is also known that DI and CI generally have word-initial stress, whereas Kerry Irish exhibits a more complex stress system with the stress position on the second or the final syllable in a word. Since the rhythmic foot was defined as a left-headed unit for all three dialects, the present nFPVI results for Kerry Irish do not account for the stress pattern difference found in this dialect. We suspect that this perceived difference may be attributed to the position of the stressed syllable in the phrase.

5. Conclusions

This paper has provided a preliminary description of rhythm characteristics for three varieties of Irish. Our initial hypothesis that Donegal Irish PVI measures might place it somewhat more towards the syllable-timed end of the continuum (relative to the other dialects) was not borne out. The traditional PVI measures as well as the syllable and foot PVI suggest very similar rhythmic structures in all three dialects and indicate that Irish groups with stress-timed languages. Since this is a pilot experiment with very limited data, we suggest that the results should be treated with caution until they are supported with analysis from a larger data set.

There is little in our results that would explain the layman's observation concerning the rhythmic cross-dialect differences. In the future we intend to investigate if the differences in tonal patterns between the dialects add to the perceived differences across the Irish varieties. There is also the possibility that the dialects are more similar in read speech, and that differences may be more apparent when conversational speech is examined. But for now we have to conclude that we still haven't found what we're looking for.

6. Acknowledgements

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