

# MEASURING RHYTHM IN DIALECTS OF NEW BRUNSWICK FRENCH: IS THERE A ROLE FOR INTENSITY?

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## 1 Introduction

While dialect differences are often associated with lexical items and with the pronunciations of certain vowels and consonants, rhythmic features can also characterize regional varieties of a language. In recent years, researchers have developed metrics that describe rhythmic structure by measuring the variability in the durations of vocalic and consonantal intervals. These rhythm metrics have been used to classify languages into syllable-timed and stress-timed groups, to study rhythm in second language phonology and to classify speakers with dysarthrias. They have also been used to distinguish among the dialects of one language.

However, researchers have noted that these measures have a number of shortcomings. One limitation is the fact that they are based only on duration, to the exclusion of other cues of prominence such as intensity, fundamental frequency and vowel quality. This criticism, made by [1] among others, suggests that an adequate account of rhythm may require a more complex or multidimensional approach that takes into account several prosodic features.

Only a few studies of rhythm have included intensity. Among these, two have examined differences among regional and postcolonial dialects of British English [2,3]. Another study has shown that intensity-based metrics can distinguish between English and Mandarin [4]. Although each study presents different ways of measuring intensity and different formulations of intensity-based rhythm metrics, these studies show that intensity adds significant information towards distinguishing between varieties, going beyond what is captured with duration.

The goal of the present study is to consider the contribution of intensity to the description of cross-dialect rhythmic differences. Specifically we examine how well certain duration-based and intensity-based rhythm metrics can distinguish among dialects of French spoken in New Brunswick (Canada). This is a followup to our preliminary work [5] that shows that regional varieties are a significant source of variation in duration-based metrics.

## 2 New Brunswick French

New Brunswick is Canada's only officially bilingual province. Francophones, who represent about one-third of

the total population of 750,000, live mainly in the northern and eastern regions of the province. Acadian French is the main variety of French spoken. There are three regional dialects: NorthWest, NorthEast and SouthEast, which includes the urban area of Moncton-Dieppe.

Among the features noted in a phonetic study of the SouthEast dialect is the "uneven" (*haché, heurté*) character of the rhythm [6]. Qualitative observations suggest that this impression is due to variable vowel durations and to a strong articulatory force on consonants that occur in the onsets of certain stressed syllables.

## 3 Methodology

### 3.1 Speech materials

Speech materials are from the RACAD (*Reconnaissance automatique du français acadien*) Speech Corpus, used for research on the automatic speech recognition of regional varieties of French spoken in New Brunswick [7]. The corpus consists of recordings by 140 native speakers of French from the three regional dialects.

The speakers are stratified by age and gender. There are two age groups: younger adults (average age: 21.1 years) and older adults (average age: 48.3 years). Although the number of speakers in the three dialect groups is uneven, each dialect has a fairly large representation in the corpus: NorthWest (N=26), NorthEast (N=65), SouthEast (N=49). For the present study, we analyzed two sentences that were read by all 140 speakers. Together, the sentences contain about 115 segments.

### 3.2 Procedure and measurements

Sentences were segmented manually into vocalic and consonantal intervals using *Praat* and following generally accepted segmentation criteria. Almost 14,000 intervals (6,670 vocalic and 7,100 consonantal) were identified.

Durations (measured in msec) were extracted from the segmentation using a script. A *Praat* script was also used to measure the intensity of each vocalic and consonantal interval. We chose the "dB method" which measures (in dB) the mean of the intensity curve of the interval. Because we are not conducting a study of the perceptual basis of the prominence that is rhythm, we limit our focus to this acoustic measure.

We calculated four "local" rhythm metrics, as developed by Grabe and colleagues [8]. These measures are sensitive to sequential contrasts in the speech chain. They focus on differences between immediately consecutive intervals and

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average those differences over a longer unit such as the utterance. The pairwise variability index (PVI) is calculated as the mean of the durational differences between successive vocalic or consonantal intervals. For vowels the index is normalized for speech tempo, (nPVI-Vdur); for consonants the raw (non-normalized) index (rPVI-Vdur) is used.

To calculate rhythm indices for intensity, we used the same formulas as for duration. Thus, the two intensity-based metrics studied are nPVI-Vint, for vocalic interval intensities, and rPVI-Cint, for consonantal interval intensities.

## 4 Results

Descriptive statistics for duration and intensity measures are given in Table 1. The average nPVI-Vdur in New Brunswick French (48.4) is similar to values reported by [9] for other varieties of French spoken in Canada: Hearst ON (43.9), Québec City QC (44.5), Windsor ON (45.5). As a further point of comparison, we note a value of 43.5 for European French, given by [8].

	NorthWest	NorthEast	SouthEast	Dialect
nPVI-Vdur	49.12 (5.3)	47.60 (5.4)	48.90 (5.8)	ns
rPVI-Cdur	61.9 (10.9)	54.48 (8.6)	54.85 (10)	sign
nPVI-Vint	7.65 (3.1)	7.37 (3.0)	5.95 (2.4)	sign
rPVI-Cint	36.30 (4.6)	32.8 (5.0)	34.9 (4.6)	sign

**Table 1:** Means and standard deviations for four duration- and intensity-based rhythm metrics for the three regional dialects. Statistical significance for dialect is shown in the final column.

Statistical ANOVA tests on rhythmic measures, with dialect as the independent variable, yield differences on one of the duration-based measures: rPVI-Cdur. Post hoc tests show that consonantal duration variability is significantly higher in the NorthWest than in the other two dialects.

ANOVAs show dialect differences for both intensity-based measures. Post hoc tests identify two patterns: NorthWest vs. SouthEast (for nPVI-Vint), and NorthWest vs. NorthEast (for rPVI-Cint).

To observe the performance of these metrics in discriminating among the three dialects, we carried out three linear discriminant analyses. Classifications were done with the duration-based metrics, with the intensity-based metrics and with both types of measures. Results (in Table 2) show that these metrics achieve a modest degree of success in classifying speakers from the three dialects. While intensity-based metrics perform slightly better than duration metrics, the best results are obtained with a combination of both types of metrics.

Type of metrics used	Metrics selected	% correct classification
Duration	rPVI-Cdur	41.4%
Intensity	nPVI-Vint, rPVI-Cint	45.7%
Both duration and intensity	rPVI-Cdur, nPVI-Vint, rPVI-Cint	47.1%

**Table 2:** Correct classification of 140 speakers from three regional dialects, based on linear discriminant analyses.

## 5 Discussion and Conclusion

Overall the results show that both duration- and intensity-based rhythm metrics play a role in distinguishing among the three dialects of New Brunswick French. In the three discriminant analyses, the classification results were clearly better than chance. The result that intensity measures achieve a higher rate of classification than duration measures parallels earlier findings in research on the classification of regional dialects of British English [2].

This significant role played by intensity suggests that intensity is an acoustic cue of prominence in New Brunswick dialects of French. While descriptions of European varieties of French note that duration and fundamental frequency are the main correlates of stress, no experimental work (to our knowledge) has studied the acoustic correlates of stress in Canadian varieties. The results of the analyses presented here point to both vocalic and consonantal intensities as likely components of stress.

The broader implication of this study is that it lends support to a multidimensional view whereby different prosodic features contribute to a model of speech rhythm.

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