# Quantification of speech rhythm in Canadian French in a minority setting

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This article focuses on French spoken in a minority context in Ontario, Canada,and examines variations in rhythm measurements between the sexes and in two age groups of speakers. Based on the hypothesis that male and younger participants will demonstrate a more stress-timed (English-like) pattern, leading to a convergence toward English, while females and older speakers will demonstrate a more syllable-timed (French-like) pattern, the following methods of rhythmic analysis are applied: nPVI-V, ΔV, ΔC, %V, VarcoV,VarcoC, and CCIs. The results reveal contradictory tendencies according to different metrics, with the CCI method presenting the most adequate picture. CCI also highlights certain trends between the social groups under examination. The results are better understood when rate and some of the aspects of general and regional French phonologies are taken into consideration*.

## *1. Introduction: French in Ontario*

The French presence in the predominantly Anglophone province of Ontario, Canada, was established when immigrants from the neighbouring province of Quebec settled in Fort Pontchartrain near Detroit at the beginning of the $18^{th}$ century. Since then, Ontario has witnessed a more or less continuous influx of French speakers from Quebec. These immigrants primarily settled in the province's Northern, Central and Southwestern regions, where the population density of francophones varies. In certain areas, such as Hawkesbury and Hearst, up to 85% of the population is francophone. In Sudbury, up to 30% of the inhabitants speak French. In Toronto and Windsor, however, only 2-3% of the population speaks French. This variation in the distribution of French speakers has consequences for the "ethnolinguistic vitality of Francophones" (Mougeon 2004: 155), and it creates differences between the French spoken in minority settings and that spoken in majority settings. In addition, it affects the degree of influence the English language exerts on French grammar and usage.

Genetically descending from Quebec French, Ontario French shares its phonological grammar while demonstrating some specific features due to geographical distance from the parent variety and contact with English (Thomas 1986, 1989, Poiré 2009). The degree of such contact, or a majority/minority situation, has effects on the

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grammar of French and its usage, so while French spoken in majority settings does not differ from Quebec French (Tennant 2012), minority varieties show divergence from it. Thus, the effects of language contact on Ontario French spoken in a minority context have been previously examined in morphophonological studies (Mougeon & Beniak 1991, Tennant 1995, among others), and in phonetic analyses, which report specifics on the realisation of glides (Poiré et al. 2007), nasal vowels (Poiré et al. 2006), and schwa and liaison (Poiré et al. 2010).

On the prosodic level, Ontario French has usually been described as similar (if not identical) to the Québécois variety, which, unlike the 'standard' French of France, exhibits a more salient penultimate syllable (Vinay 1955) and has an irregular rhythmic pattern (Robinson 1968). In their overview of Ontario French prosody in a minority setting, Kaminskaïa and Poiré (2012) note that the nature of stress, the stress pattern, and the intonational grammar do not differ here from standard French or other dialects not in a contact situation. At the same time, we also report a series of divergences specific to this variety. Among them is a considerably later alignment of the final peaks of stress groups than in European and Quebec dialects. This allows for a complex low-high tone realized over the same vowel, leading to a more sign-song intonation. Younger speakers and women were found to align the peak even later than men and older participants.

Some similarities between Ontario French and English intonation have been noted by Cichocki and Lepetit (1986): both languages exhibit similar patterns of fundamental frequency declination. Additionally, in my comparison of intonation patterns between older and younger female speakers, I observed a higher proportion of falling contours occurring utterance medially in the latter group (Kaminskaïa 2013). Given that in French we normally find rising rather than falling contours in this context, and that the younger population uses more English than French in their everyday life, this feature is believed to originate from the dominant language, which uses a lot of falling contours (Kenning 1983).

Recent analyses of prosodic rhythm in Ontario French are still preliminary and report inconclusive findings: for example, Tennant (2011) observed a possible effect of English in adolescent French speakers in minority settings; Kaminskaïa et al. (2013) find no firm evidence supporting the hypothesis of English influence, even though some tendencies suggesting such influence appeared during the analysis (see below).

In this paper, I propose a more comprehensive analysis of prosodic rhythm in Ontario French spoken in a minority setting by applying a series of methods and investigating the effects of speaker sex and age on the patterns observed. Based on our preliminary findings in Kaminskaïa et al. (2013), older participants in general and women in particular are expected to demonstrate a typical French rhythmicity, better resisting the trend towards English rhythm. Younger participants and males are, for their part, expected to exhibit more English-like patterns. Overall, the dataset is expected to demonstrate a trend towards English rhythm. The analysis is conducted on speech samples collected in the Windsor region (database of the international project *Phonologie du français contemporain*, PFC, Durand et al. (2002, 2009)) [1].

The following section reviews previous studies on prosodic rhythm and introduces the paper's analytical approach.

## *2. Rhythm studies*

Pike proposed a rhythm pattern classification system based on the rhythm patterns observed in various languages (1945).This system was subsequently developed further by Abercrombie (1967). These authors differentiated languages that display regular intervals of syllable duration, such as French and Spanish, from those that exhibit regular intervals of stress, such as German and English. The rhythm of the first category of languages was defined as 'syllable-timed', whereas the language rhythm of the second category was termed 'stress-timed'. In addition to these two major rhythmic classes, the category of mora-timed languages (e.g., Japanese and Tamil) was introduced (Hoequist 1983), and then a mixed category of rhythm (Nespor 1990), which includes Polish and Catalan, was also added. A substantial number of the rhythm analyses that followed have focused on classifying languages into one of the major rhythmic types based on the regularity of the duration of various units.

However, the practice of categorising languages by isochronically spaced syllables or stresses is not universally accepted, because empirical analyses have failed to provide evidence supporting the existence of equally timed intervals in natural languages. A very detailed review of the research has been provided by Bertinetto (1989), and more recently by Kohler (2009). As for the French language, characterised by the lengthening of the stressed (group final) syllable, its classification as a syllable-timed language was questioned by Dauer (1983), Wenk and Wioland (1982) and Astésano (2001), among others. Therefore, to reflect the status of the stressed syllable in (standard) French, Wenk and Wioland (1982) proposed the term 'trailer timed'. In addition, the traditional view of the rhythm of standard French omits the initial group stress (Di Cristo 1999, 2000) and variation in regional rhythmic patterns (e.g., rhythm in Southern French (Léon 1992)). It also ignores the increased duration of the penultimate syllable in Ontario French (Robinson 1968) and in Acadian French in Nova Scotia (Cichocki 1997) and Prince Edward Island (Tennant & King 2007).

## *3. Rhythm metrics*

Lately, researchers have adopted methods such as acoustic rhythm measurements (rhythm metrics), which are believed to reflect phonological properties of stress- vs. syllable-timed languages, including the syllabic typology, reduction of vowel quality and duration, gemination, vowel harmony, and the presence of tones (Dauer 1983). Because these properties can be independent and cumulative, Dauer (1987) proposed a model of rhythm along a continuum, with typical stress-timed and syllable-timed languages at either end.

After perceptual studies (Mehler et al. 1996) found that infants can discriminate between languages of different rhythm types but not between two languages belonging to the same rhythmic category (e.g., English vs. Japanese but not English vs. Dutch), Ramus et al. (1999) hypothesised that rhythm perception in infants is driven by the simple segmentation of speech into vocalic and non-vocalic intervals, rather than by the phonological properties of individual languages. This hypothesis enabled the authors to "arrive at language-specific auditory patterns reminiscent of the syllable- vs. stress-timed distinction that forms the basis of infants' successful discrimination between various languages" (Fagyal 2011: 97). More specifically, syllable-timed languages, whose characteristics include similar vowel durations, the absence of vowel reduction, and predominately CV syllable types, exhibit a larger proportion of vocalic intervals (%V, or the ratio of total duration of vocalic intervals to total sentence duration) and a smaller standard deviation of vocalic and consonantal intervals ($\Delta V$ and $\Delta C$, respectively). The %V and $\Delta C$ rhythm measurements (metrics) proved successful in Ramus et al.'s (1999) analysis of eight languages (English, Polish, Dutch, French, Spanish, Italian, Catalan, and Japanese) for grouping them into three rhythmic types.

These methods, originally applied to a rate-controlled corpus, were later extended to natural speech by Dellwo (2006). He developed the rate-controlled metric VarcoC (or 'Variation Coefficient for consonantal intervals': ΔC divided by the mean duration of consonantal intervals and multiplied by 100), which the author found to be more successful than ΔC in differentiating between stress-timed (German and English) and syllable-timed (French) languages. Subsequently, White and Mattys (2007a, 2007b) added the VarcoV metric (ΔV/AveVx100).

In addition to these interval measures, another metric widely used in rhythm research is the pairwise variability index (PVI).

> [It] captures the degree of durational variability in a set of acoustic data, measured sequentially, and [...] allows us to express numerically a tendency towards stress- or syllable-timing in one language or variety relative to another. (Low et al. 2000: 378)

Raw PVI calculations can be made for consonants and vowels (rPVI; Low et al. 2000); PVI can also be normalised for rate variations (nPVI; Grabe & Low 2002, Low 1998).

nPVI quotients calculated from the vocalic intervals (nPVI-V) of various languages enabled Grabe and Low (2002) to arrange these languages on a continuum from the most syllable-timed (Mandarin, with an nPVI-V value of 27.0) to the most stress-timed (Thai, with an nPVI-V value of 65.8). On this continuum, standard French, which has an nPVI-V quotient of 43.5, tends toward the syllable-timed languages. British English,which has a quotient of 57.2, tends toward the stress-timed languages.

Finally, a modification of rPVI, called the 'Control and Compensation Index' (CCI) was elaborated by Bertinetto and Bertini (2008). The CCI

> takes into due account the degree of phonotactic complexity as reflected by the number of segments composing each interval (both V and C ones), a feature that is ultimately at the core of the contrast Controlling [or syllable-timed] vs. Compensating [or stress-timed] languages (p. 428).

In a controlling language, segments are articulated with similar articulatory effort and tend to have similar durations (Bertinetto & Bertini 2010). Thus, "the durational fluctuations of Cs and Vs should [...] be of the same magnitude" for the first type of language, which translates into comparable CCI-V and CCI-C values (Bertinetto & Bertini 2008: 428). In compensating languages, on the other hand, co-articulations between segments are regularly observed, lead-

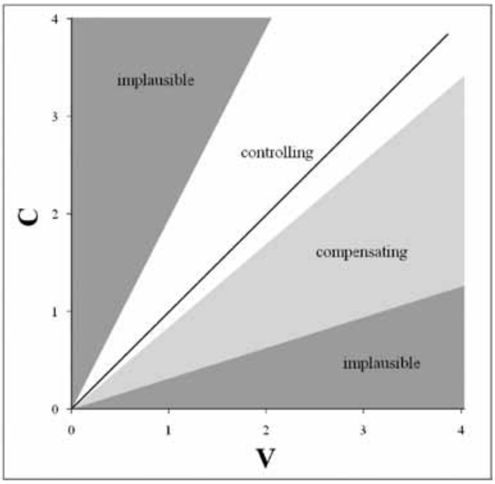


**Fig. 1** Schematic representation of the major rhythmic types according to the CC hypothesis (adopted from Bertinetto et al. 2012).

ing to different articulatory effort put into the production of adjacent vowels and consonants. Typically, it is a vowel in an unstressed syllable that is 'sacrificed' most in terms of articulatory effort. In other words, compensatory languages are characterised by vowel reduction, or fluctuations in vowel durations, and they have higher CCI-V values compared to CCI-C ones. The CCI model thus proposes a definition of language rhythm and makes a clear prediction that in a controlling (syllable-timed) language, CCI values will fall close to the bisector within the white zone when plotted on a graph (Figure 1). In a compensating (stress-timed) language, values "should fluctuate more in the V than in the C portions, thus falling in the bottom grey area." (Bertinetto & Bertini 2008: 428). In this way, the rhythmic behaviour of languages is reformulated in terms of control and compensation, which are tied to the language phonotactics and, more specifically, to the relationship between the articulatory efforts put into the production of vocalic and consonantal intervals.

## *4. Rhythm metrics and variation*

These and other methods have been applied in various combinations to compare languages, dialects, and first- and second-language rhythms. ΔC and %V proved successful in Ramus et al.'s (1999) study of languages with different rhythmic types. They also proved successful in Dellwo and Wagner's (2003) comparison of English, French and German, as well as in the analysis of these three languages plus Italian by Mairano and Romano (2007). Moreover, these authors considered two dialects of English and French, which showed similar behaviour within each language.

Asu and Nolan (2005) studied Estonian exclusively through the PVI perspective. On the other hand, all of the conventional (i.e., all but CCI) methods were adopted and evaluated in analyses by Ferragne and Pellegrino (2004), who examined British English dialects; by Ghazali et al. (2002), who studied Arabic dialects; and by White and Mattys (2007a), who compared the rhythms of participants' first and second languages (Dutch vs. English and Spanish vs. English).

The success of these methods in discriminating rhythmic types varies. However, overall, "vocalic measurements, namely, %V, ΔV, VarcoV, and nPVI-V, provide us with a more robust index of rhythmic classes than consonantal measures" (Prieto et al. 2012: 692).

Thus, nPVI-V, VarcoV and %V offered the most distinctive analysis in one of White and Mattys's studies (2007a), but in their perceptual study (White &Mattys 2007b), the strongest predictor of the presence of a foreign accent was VarcoV. After testing all of the above methods on an American English dialect and determining raw and normalised PVIs for consonantal intervals in this dialect, Yoon (2010) concluded that normalised PVIs are "more reliable measures that can capture rhythmic similarity shared by the same dialect and that can discriminate dialectal or language differences". In contrast, in their analysis of francophone English language learners, Tortel and Hirst (2010) found that ΔC and VarcoC "appear to be the most discriminating combination in predicting the tendencies of the production."

In addition to language variation and language learning, rhythm metrics can be successfully applied to languages spoken in contact environments. In a diachronic investigation of the rhythm of African-American English, Thomas and Carter (2006) observed that the syllable-timed rhythm of an earlier variety of African-American English appears to have undergone convergence towards a stress-timed rhythm through contact with Euro-American English. In contrast, in an analysis of Singapore English, Low et al. (2000) found that this dialect was converging toward a more syllable-timed rhythm, which the authors attributed to effects of the Chinese language, which was also spoken by the study participants.

The analysis of Spanish-English bilinguals and Spanish monolinguals conducted by Carter (2005) and based on PVI values did not lead to an easily discernable difference between the groups. However, a trend for bilinguals to have slightly higher indices was noticed. Another study that looked at contact of English and Spanish in children and adult bilingual and monolingual speakers (Bunta & Ingram 2007) found, among other things, that normalized vocalic PVI scores were helpful in discriminating the rhythmicities of the two languages, and that the syllable timing of Spanish was mastered by the children earlier than the stress timing of the English language: "a more equally timed pattern [is] linguistically less marked from an acquisition standpoint because it appears to be the default […] setting for the early stages of speech rhythm acquisition" (p. 1001). Finally, bilingual children still separated "the speech rhythm of Spanish and English at 4-4.5 years of age" (p. 1006).

Thus, recent studies suggest that the traditional method of classifying languages according to the major types of rhythmicity may not reflect the actual variation observed. Therefore, the tendency to regard speech rhythm as a continuum has persisted. Whether the continuum model adequately reflects the perceptual categorisation of rhythm types remains an open question.

## *5. Studies of French rhythm*

The rhythm of French has recently seen renewed interest. A model for predicting rhythmic variation was proposed by Cichocki and Flikeid (1997), who concluded that in spontaneous speech, "syllable timing is constrained by factors which reflect the organization of the syllable, the prosodic hierarchy and articulation rate" (p. 165). In an analysis of text readings by high school students from Paris suburbs, Fagyal (2011) examined the influence of heritage stress-timed languages on speakers' French rhythmic patterns. She observed higher ΔV and larger ΔC values, but no significant effect of heritage language on the variability of vocalic intervals and syllable structure. In Fagyal's analysis, the major predictors of rhythmic variation appeared to be social-demographic and performance-related factors.

In their analysis of rhythm metrics of 21 languages, Mairano and Romano (2011) included standard and Canadian varieties of French, which showed that nPVI-V and CCI values characterise both dialects as syllable-timed.

Avanzi et al. (2012) looked at standard and regional varieties of French in France, Switzerland and Belgium with the goal of comparing their rhythmic and accentual properties: articulation and speaking rates, accentuation rate, the number of syllables in a stress group, %V and ΔC, for the former, and stressed syllable lengthening and F0 rise for the latter. The authors found that ΔC and articulation rate most accurately described variation, confirming that informants from regional varieties 'tend to speak more slowly than speakers of 'standard varieties' […] due to […] articulation rate and ΔC (the latter indicating that standard varieties have a more regular syllable structure than other varieties).' (p. 4, retrieved from http://www.speechprosody2012.org/uploadfiles/file/sp2012_submission_77.pdf) At the same time, %V proved not to be a reliable tool for capturing regional variation in their analysis.

Obin et al. (2012) also considered regional varieties of French, including the ones spoken in contact with German in Switzerland and with local languages in Central African Republic and Senegal. Their study demonstrated that the varieties in contact have higher ΔC and PVIs but slower speaking and articulation rates compared to European regional varieties, and especially to standard French.

Cumming's (2011) study on standard French and Swiss varieties of French and German found no significant differences between the two French varieties. More importantly, this analysis offered a new approach to rhythm quantification by "combin[ing] duration and F0 in a PVI, and weight[ing] each cue's contribution according to its significance for perceived rhythm (p. 259)". Cumming concluded that this method best accounted for the interaction of acoustic cues and linguistic factors that contribute to rhythm perception. In addition, this approach demonstrated that German and French were more similar than suggested by the durational method, leading Cumming to conclude that "rhythm may be even less cross-linguistically divergent than durational metrics suggest" (p. 275).

Cumming's research attempted to reconcile the popularity of rhythm metrics with the view that rhythm metrics seem to be "problematic as measures of rhythm" (Arvaniti & Ross 2010: 1, retrieved from http://speechprosody2010.illinois.edu/papers/100887.pdf) because "their variability is opaque" (ibid.) and because they "cannot rhythmically classify languages or provide insight into the nature of linguistic rhythm" (ibid.). In addition, Cumming sought to address the evidence that 1) languages use different cues, or parameters, to mark prominent syllables, 2) "the same parameter may be allocated different degrees of importance in different languages" (Arvaniti 2009: 60), and 3) prominence perception is language-dependent and should be incorporated into rhythm studies.

As for analyses of Ontario French, in preliminary work on the rhythm of French spoken by adolescents in majority and minority settings (semi-directed interviews) and by French L2 speakers (text readings), Tennant (2011) found that the nPVI-V values in both datasets exhibited no effects of English. A preliminary analysis by Kaminskaïa et al. (2013) examined spontaneous French in a contact environment. Comparison of the rhythmic patterns of Ontario French varieties in minority and majority settings using nPVI-V, %V and ΔC showed a (non-significant) tendency of minority speakers to use a less syllable-timed pattern. The tendency of younger informants and males toward a stress-timed pattern also suggested that the speakers' social characteristics may affect their rhythmic patterns.

## *6. Issues with metrics*

From the numerous analyses that have used rhythm metrics, the following problems can be discerned. First, rhythm metrics are affected by the elicitation method. They exhibit no consistency across metrics when results are pooled from different elicitations, and occasionally they yield contradictory results for the same dataset. Additionally, they are sensitive to the composition of sentences (i.e., phonotactics and syllable structure).

Prieto et al. (2012) tested a series of rhythm metrics using data from several languages of different syllable types with the goal of observing metric robustness vis-à-vis the changes in phonotactics. The authors observed that ΔC and VarcoC were the least robust and concluded that these variables were purely dependent on syllable structure; nPVI-V and VarcoV, on the other hand, turned out to be the most resistant to changes in phonotactics and were found to be dependent only on phrasal prosodic factors, thus reflecting rhythmic differences. Finally, %V and ΔV were found to be sensitive to syllable structure as well as phrasal prosodic factors and contributed to a greater understanding of both syllable structure and rhythm (p. 695).

## *7. Questions and hypotheses*

Here, I propose a study of the "durational characteristics of events" (Arvaniti 2009: 59) in a dialect of French spoken in the Windsor region, which is an environment of intense linguistic contact, while a discussion of the "pattern of periodicities that is extracted from these durations" (ibid.) remains beyond the scope of this article.

First, I will compare the current results with the results from previously conducted analyses on French and English in order to determine if the new values approach those of English. Their closeness will be indicative of the effect of the linguistic contact and the possible transfer from the majority language. Secondly, among the participants in the current study, there are older ones who grew up speaking French and younger ones who learned both languages simultaneously; thus, age may have an impact on the speakers' rhythmic patterns and will be considered in the analysis. Finally, to complete the picture, the effect of sex will also be taken into consideration.

The following popular metrics will be considered: ΔV, ΔC, %V, nPVI-V, VarcoV, VarcoC, as well as the phonologically driven CCI-V and CCI-C variables; the latter are designed for distributing languages along the controlling-compensating continuum (corresponding to the continuum between syllable- and stress-timed languages).

Thus, I would like to determine whether Ontario French [2] data overall exhibit nPVI-V and VarcoV values that are more similar to English timing than to French timing. Next, I plan to establish whether higher ΔC and VarcoC values will in fact be found here and how these values can be contextualised and interpreted, given that the participants all read the same text (see below).The contribution of %V and ΔV to the results will also be discussed. Finally, the distribution of CCI-V and CCI-C values will contribute to the interpretation of the individual and overall results as showing either a controlling (syllable-timed) or compensating (stress-timed) type of language/variety.

I hypothesise that, under the influence of stress-timed English rhythm, speakers in a minority setting will converge overall toward English and exhibit rhythm metrics that tend toward the stress-timed end of the continuum. This pattern is expected to be illustrated by higher nPVI-V, ΔC, ΔV, VarcoC and VarcoV values and lower %V values than the reference values provided in Table 2, and by clustering of CCI values near the x-axis in the Cartesian plane. Based on previous observations (Kaminskaïa et al. 2013), I predict that younger participants and males will lead the convergence and exhibit measurement values that approach the English reference values more closely. As such, older females are expected to demonstrate the most syllable-timed pattern. Finally, I expect that rhythm metrics will show some consistency and complement each other.

To compensate for possible effects of the methodological shortcomings mentioned above, I limit my analysis not only to one language but also to one language variety. Furthermore, I use text readings based on the PFC protocol, which was designed for phonological analysis, but not necessarily for rhythmic analysis. The text used is phonotactically representative because it includes a full sound inventory and all of the

**Table 1.** Participants, identified by pseudonyms, organised into groups by age and by sex.

| Under 45 | | 45 and over | |
|---|---|---|---|
| Females | Males | Females | Males |
| Rémie (17) | Mathis (21) | Éliane (65) | Chris (46) |
| Claire (42) | Patrice (33) | Lucie (74) | Roland (66) |
| Debbie (43) | William (41) | Vanessa (84) | Raymond (74) |

**Table 2.** Reference values for the measurements taken.[4]

| French | | English | |
|---|---|---|---|
| nPVI-V (Grabe & Low 2002; Mairano 2011; White & Mattys 2007a) | 43.5-50 | nPVI-V (Grabe & Low 2002; Mairano 2011; Prieto et al. 2012; White & Mattys 2007a) | 55-73 |
| ΔV (Fagyal 2011; Mairano 2011; Ramus et al. 1999; White & Mattys 2007a) | .038-.044 | ΔV (Ramus et al. 1999; Mairano 2011; White & Mattys 2007a) | .043-.049 |
| ΔC (Avanzi et al. 2012; Fagyal 2011; Mairano 2011; Ramus et al. 1999; White & Mattys 2007a) | .041-.051 | ΔC (Ramus et al. 1999; Mairano 2011; White & Mattys 2007a) | .054-.059 |
| %V (Avanzi et al. 2012; Fagyal 2011; Mairano 2011; Ramus et al. 1999, White & Mattys 2007) | 43.6-51 | %V (Mairano 2011; Ramus et al. 1999; Prieto et al. 2012; Tortel & Hirst 2010; White & Mattys 2007a) | 38-42.2 |
| VarcoV (Mairano 2011; White & Mattys 2007a) | 45.5-50 | VarcoV (Mairano 2011; Tortel & Hirst 2010; White & Mattys 2007a) | 53-64 |
| VarcoC (Mairano 2011; White & Mattys 2007a) | 43-44 | VarcoC (Mairano 2011; Prieto et al. 2012; Tortel & Hirst 2010; White & Mattys 2007) | 47-52 |
| CCI-V (Mairano 2011; Mairano & Romano 2011) | 41 | CCI-V (Mairano 2011; Mairano & Romano 2011) | 42 |
| CCI-C (Mairano 2011; Mairano & Romano 2011) | 39 | CCI-C (Mairano 2011; Mairano & Romano 2011) | 36 |

typical phonological phenomena of the French language. [3] I chose this elicitation method for comparability, because previously reported work on French has focused primarily on reading tasks. I do not include spontaneous data in the analysis for two reasons. First, phonostylistic variation may considerably affect syllabification in Canadian French because of the realisation or omission of schwa and liaison, the simplification of consonant clusters, vowel fusion and diphthongisation. Second, rhythm metrics vary between speaking styles (see, among others, Payne et al. 2009). Because variation between speech registers is outside the scope of this paper, text readings appear to be the most appropriate type of data for my purposes.

## *8. Method*

### *8.1. Data and participants*

The data used in this analysis were collected under the PFC project protocol (Durand et al. 2009) in the region of Windsor, Ontario, Canada. All of the participants were native francophones (6 males and 6 females) ranging in age from 17 to 84 (Table 1). The number of speakers under and over 45 years of age was equal. Therefore, this threshold was chosen to divide the speakers into younger and older groups. This distribution of speakers into age groups is not without problems, because the age of the participants in the younger range varies considerably. However, I use this distribution because of the consistency of patterns observed within each group during previous research with these data (Kaminskaïa 2013).

The participants had the opportunity to practice reading the text until they felt comfortable reading it for the recording. They were instructed to read as fluently as possible but not to feel pressured to repeat sentences if they paused or hesitated. Certain sentences were long and syntactically complex, containing lists, appositions and reported speech. Thus, it was sometimes unnatural, and difficult not to pause. In terms of audibility, the participants exhibited a relatively similar level of comfort while performing the reading task.

### *8.2. Analyses and measurements*

The analysis was performed using Praat (Boersma & Weenink 2005). Readings of the first 10 sentences of the text (out of 21 total) were semi-automatically segmented using *EasyAlign* (Goldman 2011). Next, the segmentation was manually reviewed and corrected according to the segmentation criteria developed by Peterson and Lehiste (1960) and through auditory verification. This verification was necessary because the recordings were made at the homes of the participants, and the acoustic signal contained background noise (e.g., air conditioning and children outdoors) that affected the sound-wave fluctuation at the zero crossing and often created formants in silent passages. However, the quality of the recordings was otherwise excellent, and these imperfections did not affect the analysis.

Analysing only the first half of the recordings (Appendix) provided the necessary minimum of 200 nPVI-V quotients per speaker (White & Mattys 2007a), which on average corresponded to 329 vocalic and 341 consonantal intervals per participant, for a total of 3944 and 4095 intervals respectively. This allowed the second part of the text to be excluded, which was in fact preferable, because in this section speakers occasionally sounded tired, made mistakes, or, in anticipation of the end, read faster. The segmentation was followed by segment labelling and identification of vocalic and consonantal intervals (sequences of two or more consonants or vowels that form one respective interval). All pauses (breaks in production that resembled a pause; these were typically greater than 38 ms), code switches and hesitation phenomena, such as filled pauses and false starts, were excluded from the analysis. Devoiced vowels were considered vocalic intervals when they were accompanied by a formant pattern, which provided the cue to vowel duration. Aspiration and bursts associated with stops were included in the consonantal intervals in accordance with White and Mattys (2007a).

Additionally, glides were considered consonantal intervals, which is consistent with some previous studies based on French data (Cumming 2011), but not others. For example, Mairano and Romano (2011) distinguished between on-glides and off-glides, treating the latter as vocalic intervals. This uniform approach was necessary for a comparative analysis of 21 languages. However, I treat all phonological glides as intervocalic intervals based on the following: In French, the only glide that can appear at the end of a syllable is [j] ([travaj] *travail* 'work', [fij] *fille* 'girl'), and it can be resyllabified from Coda into Onset position ([tra-va-jɑ̃] *travaillant* 'working', [tra-va-ja-vɛk] *travaille avec* '(I) work with', [fi-jɛt] *fillette* 'little girl', [fi-jo-zjø-blø] *fille aux yeux bleus* 'little girl with blue eyes'), which proves its phonological status as a non-vocalic element. That being said, off-glides that were a part of a diphthong originating from a long vowel (e. g. [tɛʲt] *tête* 'head') were considered part of a vocalic interval.

The boundaries of glides were determined by combining acoustic and auditory evaluations, including examination of the waveform amplitude, spectrogram intensity and formant structure, and the author's auditory perception. Initial stops were not excluded from the analysis because the acoustic signal facilitated their identification, and the absence of ambient noise indicated the beginning of a voiceless segment. In addition, this approach allowed the many consonants that appeared after pauses in the middle of sentences to be included in the analysis.

Glottal stops, which usually occurred to avoid hiatus (instead of liaison or *enchaînement*, for example) or after a pause, were treated as non-vocalic intervals. All allophones of /R/ were treated as consonants.

For each speaker, the tier containing all the intervals and their durations was automatically extracted using one of Praat's functions, and the following variables were calculated in Excel:

- %V: the proportion of vocalic intervals
- ΔV: the standard deviation of all vocalic intervals
- ΔC: the standard deviation ofallconsonantal intervals
- VarcoV: ΔV divided by the mean duration of the vocalic intervals and multiplied by 100
- VarcoC: ΔC divided by the mean duration of the consonantal intervals and multiplied by 100
- nPVI-V: calculated for between-pause sequences according to the following formula:

(1)
$$\sum_{n=1}^{m-1} \left( \left| \frac{d_n - d_{n+1}}{(d_n + d_{n+1})/2} \right| / (m-1) \right) x\ 100$$

where $d$ is the length of the n^th^ vocalic interval and $m$ is the number of intervals in a between-pause sequence.

In other words, for every two consecutive vocalic intervals, I calculated the difference in their respective lengths and then divided the absolute value of the result by the average length of the intervals. The results of all such calculations were added, and the sum was divided by the number of differences and multiplied by 100. Again, lower indices indicate a syllable-timed pattern, and higher indices indicate a stress-timed pattern.

The overall mean and median values of the nPVI-V scores were also obtained. The mean values were calculated and compared with previously reported results and with the median values. In calculating the median values, I followed Thomas and Carter (2006), who suggested that this method is more appropriate for utterances of varied lengths interrupted by breaks, like in our dataset and in spontaneous speech.

The CCI index is calculated following the formula below:

(2) $$\sum_{n=1}^{m-1} \left( \left| \frac{d_n}{N_n} - \frac{d_{n+1}}{N_{n+1}} \right| / (m-1) \right) x\ 100$$

where $d$ is the length of the n$^{th}$ vocalic interval and $m$ is the number of intervals, and $N$ is the number of segments in an interval.

This is the same formula that computes a raw PVI, with the only difference being that the duration of each interval is divided by the number of segments that compose it. Then, the absolute value of the difference between the values for two neighbouring intervals is found. The results are added, divided by the number of intervals and multiplied by 100. To calculate CCIs, I used the *Correlatore* software created by Paolo Mairano (2011) and available at http://www.lfsag.unito.it/correlatore/index_en.html.

The results of the current study were compared with the reference values for readings in standard French and in English compiled from previously reported findings (Table 2). In Table 2, the range of numbers provides evidence of the problems with rhythm metrics reported by Arvaniti (2009, 2012) and Arvaniti and Ross (2010). However, the values for the standard varieties of the two languages overlap only for %V and ΔV.

To better understand the results, the speaking and articulation rates were also calculated. Because false starts and truncations were excluded from the analysis, for the rate calculations, I distinguished not only between total and net durations, but also between total and net number of syllables. This approach allowed me to calculate speaking rate as a function of total number of syllables and total duration, and articulation rate as a function of net number of syllables and net duration (Table 3). Fagyal (2011) calculated rate as intervals/sec, while Bertinetto and Bertini (2010) looked at number of segments uttered per second. These approaches may be more reliable when comparing rhythm between rate classes (Bertinetto & Bertini 2010), but since such comparison is not pursued here, and for comparability with previous studies, rate is measured here in syllables/second.

For all measurements, the significance of the differences between social groups was evaluated using 2x2 ANOVAs. [5] To better understand the relationships between the measurements, Pearson correla-

**Table 3.** Individual measurements of the speaking and articulation rates.

| | Total duration | Total #syll | Speaking rate (syll/sec) | Net duration | Net #syll | Articulation rate (syll/sec) |
|---|---|---|---|---|---|---|
| Raymond | 151.93 | 334 | 2.20 | 80.67 | 313 | 3.88 |
| Roland | 112.87 | 303 | 2.68 | 73.24 | 301 | 4.11 |
| Chris | 167.81 | 330 | 1.97 | 88.53 | 306 | 3.46 |
| William | 130.09 | 337 | 2.59 | 82.08 | 324 | 3.94 |
| Patrice | 132.52 | 339 | 2.56 | 78.51 | 334 | 4.25 |
| Mathis | 84.56 | 343 | 4.06 | 53.72 | 320 | 5.96 |
| Vanessa | 130.30 | 329 | 2.52 | 75.66 | 312 | 4.12 |
| Lucie | 122.65 | 334 | 2.72 | 75.65 | 307 | 4.06 |
| Eliane | 111.02 | 325 | 2.93 | 72.20 | 311 | 4.31 |
| Claire | 94.93 | 333 | 3.51 | 67.41 | 320 | 4.75 |
| Debbie | 93.31 | 329 | 3.53 | 65.60 | 323 | 4.92 |
| Rémie | 102.00 | 318 | 3.12 | 67.43 | 309 | 4.58 |
| **Ave** | **119.50** | **329.50** | **2.87** | **73.39** | **315.00** | **4.36** |
| **std** | **23.68** | **10.15** | **.57** | **8.73** | **8.95** | **.61** |

tion tests were performed to find the strength and significance of the interaction effects overall and within social groups. [6]

## *9. Results* [7]

### *9.1. Speaking and articulation rates*

A shown in Table 3, the total duration of the analysed recordings varied between 84.56 sec (Mathis) and 167.81 sec (Chris). Those same speakers exhibited the shortest and longest net durations: 53.72 sec and 88.53 sec, respectively. The total number of syllables produced varied from 303 (Roland) to 343 (Mathis), and the net number of syllables varied from 301 to 334 (Roland and Patrice, respectively). Additionally, the youngest male participant, Mathis, exhibited the fastest speaking (4.06 syll/sec) and articulation (5.96 syll/sec) rates. The slowest rates were observed for Chris: 1.97 syll/sec for speaking and 3.46 syll/sec for articulation.

In White and Mattys's (2007a) analysis, French speakers uttered sentences at an average rate of 5.6 syllables/sec. This rate was calculated based on the number of syllables uttered and the duration of the sentences, excluding all pauses. Therefore, White and Mattys's rate corresponds to the articulation rate in this study. Our analysis obtained a considerably lower rate (4.36 syll/sec, Table 3), which could be the result of the difference between reading separate sentences and reading a text. On the other hand, a slower rate appears to regularly characterise regional varieties of French compared to the standard variety. Thus, after examining text readings of the same PFC text by speakers of standard and regional French, Swiss and Belgian dialects, Avanzi et al. (2012) found that each standard variety exhibited a faster articulation rate compared to the regional one (6.1 – 6.2 syll/sec, 5.6 – 5.3 syll/sec, and 5.5 – 5.3 syll/sec, respectively for the aforementioned dialects), with both French varieties showing the fastest rates. Additionally, in their study of Swiss varieties, Schwab and Racine (2013: 290) report articulation rates between 4.85 and 5.24 syll/sec. In comparison with these numbers, rates obtained for our participants appear very slow, in line with Avanzi et al.'s (2012) observation.

The slow rate observed here could also relate to the minority status of the language and its reduced usage by the speakers. Indeed, for varieties of French in contact, Obin et al. (2012) report articulation rates varying from 4.45 to 5.2 syll/sec and speaking rates from 3.7 to 4 syll/sec. These values are lower than the ones obtained for standard French and regional European French varieties (Avanzi et al. 2012, Obin et al. 2012) and just slightly higher than ours. This rate difference between our speakers and those of previous analyses may have resulted in higher values of the rhythm metrics sensitive to rate ($\Delta V$ and $\Delta C$). We will return to this issue in the next section.

As shown in Table 3, the women demonstrated shorter signal durations and faster rates overall. Consequently, on average, the women spoke and articulated faster than the men (women: 3.05 syll/sec and 4.46 syll/sec; men: 2.68 syll/sec and 4.27 syll/sec; see Figure 1, left panel). However, these differences were not significant ($F (1, 8) \leq 1.785$, $p \geq .218$). In addition, the women exhibited less inter-speaker variation, judging by the values in Table 3 and error bars in Figure 2. It is interesting to note that in Schwab and Racine's (2013) analysis of the same PFC text read by Swiss speakers, the rate tendencies between males and females were the opposite of those observed here.

Participants under the age of 45 displayed faster rates but more intra-group variation than older speakers (speaking rate: 3.23 syll/sec versus2.5 syll/sec; articulation rate: 4.73 syll/sec versus3.99 syll/sec) (Figure 1, right panel). The differences in speaking and articulation rates between the age groups in our study were significant ($F (1, 8) \geq 5.560$, $p \leq 0.046$). No interaction of the age and sex variables was

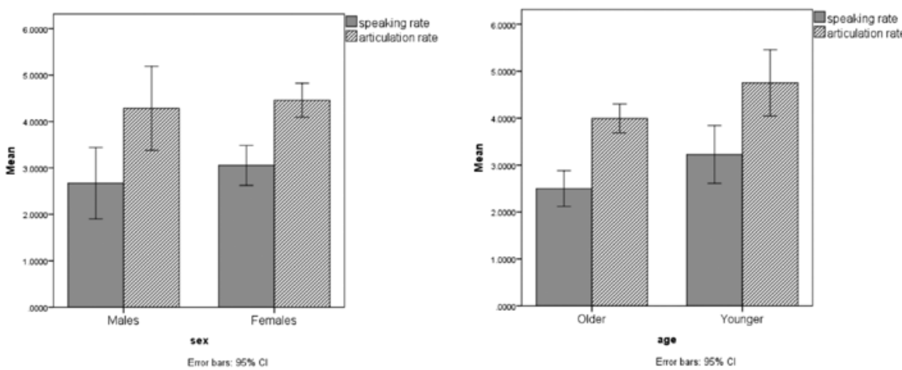


**Fig. 2** Sex (left panel) and age (right panel) groups' rate averages and error bars.

revealed for speaking and articulation rates. A similar trend between age groups was reported in Schwab and Racine (2013).

*9.2. Metrics*

The results for the interval measurements are reported in Table 4. Table 5 presents the outcomes for the pairwise variability indexes and CCIs. In this section, I first discuss ΔC and VarcoC, then VarcoV and nPVI-Vs, then %V and ΔV,with the goal of evaluating their different abilities to reflect the complexity of phonotactics and prosodic rhythm, following Prieto et al. (2012). Finally, CCIs will be discussed.

In Table 4, the individual values of ΔC fluctuate between .0368 (Mathis) and .0641 (Claire), or from a typical French value to a value higher than a typical English one (cf. Table 2). It should be noted that most of the values in Table 3 are very high. VarcoC values vary between 45.15 (Roland) and 58.81 (Raymond), with all of the values higher than the reference ones for French in Table 2. The averages for these two metrics (ΔC: .0547; VarcoC: 50.74) classify our data as characteristically English. In other words, the values of these two metrics suggest that syllable structures produced by our speakers may be more complex than those typically found in French, which could be due to the composition of the text itself. However, the analysis of the same text read by speakers of European varieties of French, including the standard variety (Avanzi et al. 2012, Table 2) showed considerably lower ΔC values (.041-.053) compared to ours. Additionally, for French in contact, Obin et al. (2012) report ΔC values between .054 and

**Table 4.** Individual interval measurement values.

| | ΔC | ΔV | %V | VarcoV | VarcoC |
|---|---|---|---|---|---|
| Raymond | .0641 | .0679 | 54.77 | 48.33 | 58.81 |
| Roland | .0479 | .0616 | 55.27 | 45.78 | 45.15 |
| Chris | .0614 | .0797 | 55.96 | 49.25 | 51.49 |
| William | .0550 | .0641 | 50.43 | 50.28 | 45.94 |
| Patrice | .0547 | .0551 | 49.63 | 47.24 | 47.75 |
| Mathis | .0386 | .0417 | 51.74 | 48.05 | 48.72 |
| Vanessa | .0576 | .0578 | 50.10 | 47.61 | 48.63 |
| Lucie | .0528 | .0476 | 51.55 | 37.45 | 45.98 |
| Eliane | .0557 | .0562 | 53.86 | 44.94 | 53.82 |
| Claire | .0641 | .0679 | 45.63 | 48.33 | 58.81 |
| Debbie | .0520 | .0538 | 50.19 | 51.83 | 51.70 |
| Rémie | .0524 | .0560 | 52.08 | 49.30 | 52.09 |
| **Ave** | **.0547** | **.0591** | **51.77** | **47.37** | **50.74** |

**Table 5.** Individual values of nPVI-V scores.

| | # nPVI-V quotients | Mean nPVI-V | Median nPVI-V | CCI-V | CCI-C |
|---|---|---|---|---|---|
| Raymond | 226 | 49.43 | 44.24 | 75.92 | 35.72 |
| Roland | 242 | 44.83 | 40.90 | 62.33 | 32.65 |
| Chris | 202 | 50.22 | 43.70 | 86.76 | 41.36 |
| William | 213 | 48.94 | 44.44 | 71.78 | 40.26 |
| Patrice | 255 | 47.41 | 40.55 | 58.22 | 43.40 |
| Mathis | 257 | 42.52 | 37.59 | 44.85 | 26.75 |
| Vanessa | 236 | 44.52 | 39.56 | 60.73 | 42.77 |
| Lucie | 221 | 40.27 | 34.45 | 52.81 | 37.01 |
| Eliane | 236 | 43.76 | 36.01 | 55.12 | 33.11 |
| Claire | 263 | 40.51 | 32.82 | 40.48 | 40.54 |
| Debbie | 244 | 47.60 | 38.17 | 59.34 | 36.61 |
| Rémie | 245 | 46.43 | 39.20 | 53.68 | 37.50 |
| **Ave** | **236.7** | **45.54** | **39.30** | **60.17** | **37.31** |

.061, which are comparable to ours. The differences and similarities between the current results and previous ones correspond to differences observed for articulation rates.

When examining the VarcoV and nPVI-V values, we notice that they lean towards typically French ones (cf. Table 2). Indeed, the VarcoV values vary from 37.45 (Lucie) to 51.83 (Debbie), with an overall average of 47.37 (Table 4). The mean nPVI-V values range from 40.27 (Lucie) to 50.22 (Chris), with an overall average of 45.54 (Table 5). So, these results suggest a characteristically French pattern for our overall data.

The median nPVI-V values (average: 39.30; see Table 5) are even more distinctly French. Indeed, not only the minimum (Claire: 32.82) but also the maximum (William: 44.44) of these values indicate a very syllabic rhythmicity. However, because the median nPVI-V values are typically lower than the mean value (Thomas & Carter 2006), this difference is expected. Nevertheless, the syllabic rhythmicity of our data is also suggested by the average nPVI-V values: ranging from 40.51 (Claire) to 50.22 (Chris) and averaging 45.54, they fall within typically French range, staying well below the English values in Table 2.

The ΔV and %V values also exhibited opposite tendencies, as did the two reported pairs of metrics ΔC and VarcoC compared to VarcoV and nPVI-Vs. All but one of the ΔV values (Mathis: .0417) are in the English zone (Table 2) and reflect the pattern of a stress-timed language. However, %V aligns the data with languages that have syllabic rhythmicity; all but one of the values of this metric in Table 4 are higher than previously reported for English (Table 2) and than the values obtained for European French dialects by Avanzi et al. (2012, Table 2), who conducted their analysis based on the readings of the same text.

As for the CCI-V and CCI-C values, the variation for consonantal intervals ranges from 26.75 (Mathis) to 43.40 (Patrice), and for vocalic intervals, from 40.48 (Claire) to 86.76 (Chris). Most of the CCI-C values and all except one of the CCI-V values are higher than the reference values observed for both French and English in Table 2. The relationship between the two types of CCIs demonstrates whether a language is controlling or compensating, depending on how close the CCI-V values are to the CCI-C ones. Similarity between these values is observed only for Claire (40.48 and 40.54 respectively), whereas the other speakers demonstrate a larger distance between the values, with larger variation observed in vocalic intervals. Because the variation in consonantal intervals is less, the CCI values are clustered below the bisector in Figure 3. Thus, values observed for Claire, Lucie, Vanessa, Patrice and William appear closer to the controlling zone, while the rest of the values are found in the upper part of the compensating zone. Thus, the speakers in our dataset exhibit a rhythmicity that ranges from intermediate to stress-timed.

To summarise, the results obtained through the application of different methodologies show contradictory tendencies: ΔV, ΔC and VarcoC values describe our data overall as patterning with stress-timed languages, whereas %V, VarcoV, and nPVI-V values suggest a very syllable-timed pattern. Finally, the CCI values, in turn, demonstrate a borderline behaviour suggesting a trend towards stress-timed rhythmicity.

As noted in many previous analyses, articulation rate is liable to affect the metrics and thus explain some of our results. Correlations between the metrics and the rates are considered in section 4.4. The next section presents the results by social group.

*9.3. Effect of social factors on rhythm metrics*

The differences between social groups (i.e. older vs. younger, male vs. female) were evaluated using 2x2 ANOVAs in which sex and age were the two-level independent variables and the metric measurements were the continuous dependent variables. The groups' averages and the results of the ANOVA tests appear in Table 6. No significant interactions were found between the age and sex variables for any of the measurements. The tendencies identified between men and women and between older and younger participants are discussed below.

Based on ΔC (men: .0536; women: .0558; Figure 4, left panel) and VarcoC values (men: 49.64; women: 51.84; Figure 4, right panel), males tend to exhibit less variability in consonantal intervals than women, but the variation within their group is greater (cf. error bars). Higher ΔC values have typically been related to slower articulation rates. However, in our data, women exhibited (insignificantly) faster rates.

In contrast, the VarcoV (men: 48.15; women: 46.58) and the mean nPVI-Vvalues (men: 47.23; women: 43.85), shown in Figure 4 (right panel), indicate that there was less variability in vocalic intervals for females than for males, and therefore that females had a tendency toward more syllabic rhythmicity. The median nPVI-V values confirm this tendency (men: 41.90; women: 36.70). Moreover, this difference between sex groups is significant ($F(1, 8) = 9.661$, $p=.014$).

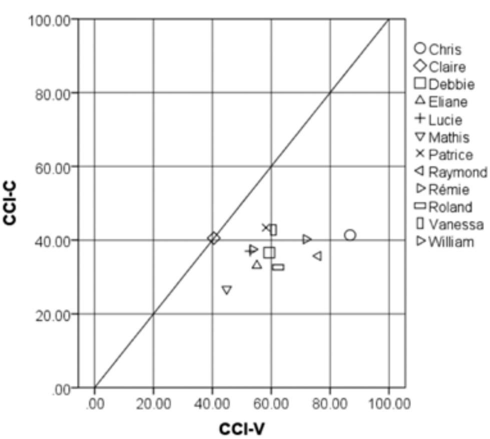


**Fig. 3** Results for the CCIs.

With respect to ΔV (Figure 4, left panel) and %V (Figure 4, right panel) values, the higher values for males (men: .0617;women: .0566 and men: 52.97%;women: 50.57%) appear to sug-

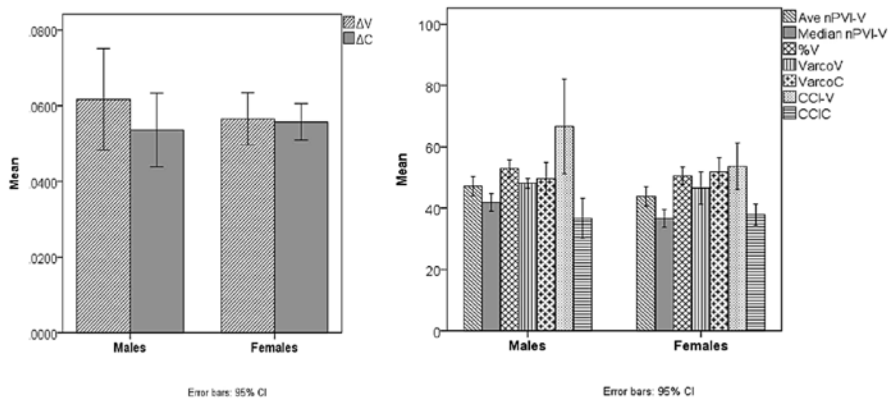


**Fig. 4** Interval metrics and nPVI-Vs for the sex factor.

gest contradictory trends. Their higher ΔV values suggest a less syllabic rhythmicity, and their higher %V values suggest a more syllabic rhythmicity.

Finally, the higher CCI-V average in men (66.64) than in women (53.69) is also accompanied by a higher variability in the former group (Table 9, Figure 4, right panel). Higher variation in men is also found for CCI-C values, but with a lower average (36.69) than in women (37.92). Neither of these differences was significant (Table 6). When looking at the plot of the CCIs in Figure 5 (left panel), we note that the males' values cluster lower than the women's values, which suggests a more stress-timed rhythm in the former group.

The results by age group show that contradictory tendencies appear in the ΔC (Figure 6, left panel) and VarcoC (Figure 6, right panel) pairs. The standard deviation value suggests a greater variability in consonantal intervals for older participants (older: .0566; younger: .0528); however, according to the normalised metric, the same group of participants exhibited less variability for the same intervals (older: 50.65; younger: 50.84). For both metrics, the differences are minimal and not significant (Table 6).

nPVI-V and VarcoV values were expected to be greater in younger participants because this population has greater contact with English. However, we found little difference in mean nPVI-V values between age groups: 45.57 (younger speakers) versus 45.51 (older speakers). The difference between age groups was more noticeable for VarcoV values - younger: 49.17, older: 45.56. However, the median nPVI-V values contradict the results for both metrics reported above,

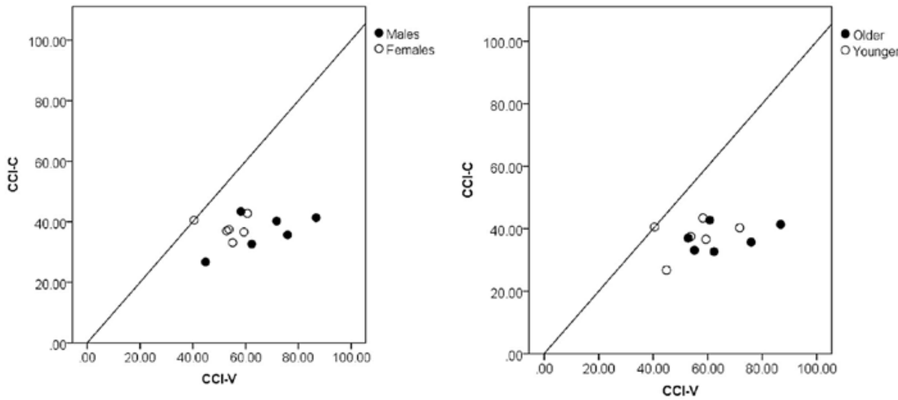


**Fig. 5** Distribution of CCIs across groups of sex (left panel) and age (right panel).

since the value in the younger group is lower (38.80) than in the older one (39.81). There was no significant effect of age identified for either mean or median nPVI-V, or for VarcoV.

ΔV displayed more variability in the older group (older: .0618; younger: .0565; Figure 6, left panel), suggesting that participants older than 45 tend towards stress timing. However, the larger proportion of vocalic intervals observed in the same group (older: 53.59%; younger: 49.95%) suggests the opposite. Moreover, the latter difference appears significant, ($F(1, 8) = 9.837$, $p = .014$).

Age groups show more differences with respect to CCI-V than CCI-C values (Figure 6, right panel). Indeed, the values in Table 6 indicate that the older participants have an average CCI-V of 65.61, and the younger ones of 54.73. The CCI-C values are, on the other hand, very similar: 37.10 and 37.51 respectively. The right panel of Figure 5 shows that the CCI values of four out of six older participants are well in the compensating zone, suggesting a stress-timed rhythmicity in this group. However, these differences between age groups were not significant (Table 6), despite a significant difference in speaking and articulation rates ($F(1, 8) \geq 5.5560$, $p \leq .046$)

### *9.4. Correlations*

Table 7 demonstrates correlations for all of our data. There, we find that ΔV and ΔC were negatively correlated with both speaking and articulation rates[11]: the lower the rate, the higher the variation between interval durations ($r \leq -.585$, $p \leq .046$). In addition, ΔV and ΔC

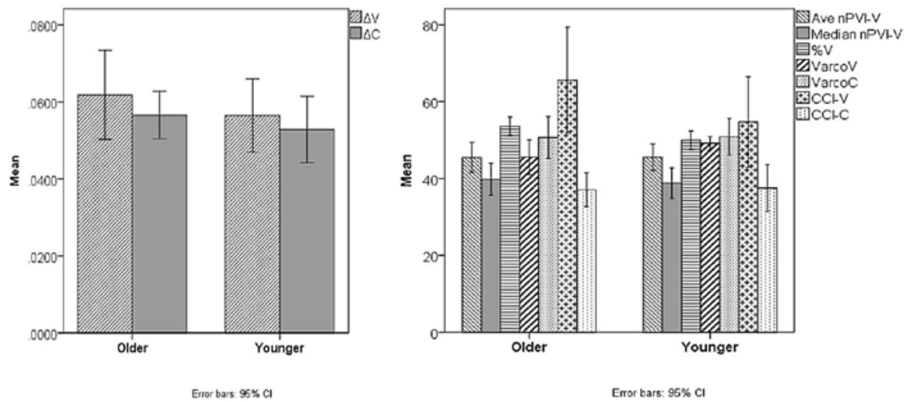


**Fig. 6** Interval metrics and nPVI-Vs for the age factor.

were correlated with one another (r = .771, p = .003), and ΔC was correlated with VarcoC (r = .623, p = .030) (Table 7). The dependency of ΔV and ΔC values on rate suggests that when these metrics are compared with results from previous studies, such a comparison should include rate as well (see also Dellwo (2009)). In fact, as was stated above in the section on rates, participants in our study exhibited very slow rates, which is likely the source of the differences and contradictions observed.

Surprisingly, median nPVI-V values showed a correlation with speaking rate, despite being normalized (r = -.644, p = .024). It is interesting to note that even with the rate as slow as was observed above and with the dependency of nPVI-V on the rate, syllable timing is still strongly suggested by this metric. Average nPVI-V did not correlate with rates (Table 7). In Dellwo (2009) this metric also showed no correlation with rate and was considered as a robust tool for analysis of rhythm.

Other normalised values did not show this dependency on speaking and articulation rates, nor a significant correlation with one another: VarcoV was not correlated with mean or median nPVI-V values (r ≤ -.333, p ≥ .050). No significant correlations were found for %V or VarcoV (r = .183, p = .568). The only correlations found for VarcoC were those mentioned above (Table 6).

Both CCI-V and CCI-C were correlated with articulation rate: r ≤ -.580, p ≤ .0.48. CCI-C was also correlated with ΔC (r = .688, p = .013), whereas CCI-V showed correlations with aseries of variables: mean and median nPVI-V, ΔV and %V (r ≥ .643, p ≤ .024), and speaking rate (r = -.820, p = .001). This result is not surprising since, as Bertinetto

**Table 6.** Results of 2x2 ANOVAs testing the effects of social factors (*df* = 1, 8).

| Group of | Men | Women | ANOVA for Sex variable | Older speakers | Younger speakers | ANOVA for Age variable | ANOVA for Interaction Age X Sex |
|---|---|---|---|---|---|---|---|
| **Speaking Rate** | 2.68 | 3.05 | $F$ = 1.785, $p$ = .218 | 2.5 | 3.23 | $F$ = 6.557, $p$ = .034 | $F$ = .047, $p$ = .833 |
| **Art Rate** | 4.27 | 4.46 | $F$ = .649, $p$ = .444 | 3.99 | 4.73 | $F$ = 5.560, $p$ = .046 | $F$ = .222, $p$ = .650 |
| **Mean nPVI-V** | 47.23 | 43.85 | $F$ = 3.481, $p$ = .099 | 45.51 | 45.57 | $F$ = 001, $p$ = .973 | $F$ = 1.141, $p$ = .317 |
| **Median nPVI-V** | 41.9 | 36.7 | $F$ = 9.661, $p$ = .014 | 39.81 | 38.8 | $F$ = .368, $p$ = .561 | $F$ = .410, $p$ = .540 |
| **ΔV** | .0617 | .0566 | $F$ = 1.056, $p$ = .334 | .0618 | .0565 | $F$ = 1.142, $p$ = .316 | $F$ = 4.603, $p$ = .064 |
| **ΔC** | .0536 | .0558 | $F$ = .254, $p$ = .628 | .0566 | .0528 | $F$ = 768, $p$ = .401 | $F$ = 1.154, $p$ = .314 |
| **%V** | 52.97 | 50.57 | $F$ = 4.282, $p$ = .072 | 53.59 | 49.95 | $F$ = 9.837, $p$ = .014 | $F$ = .898, $p$ = .371 |
| **VarcoC** | 49.64 | 51.84 | $F$ = .717, $p$ = .422 | 50.65 | 50.84 | $F$ = .005, $p$ = .944 | $F$ = 3.058, $p$ = .118 |
| **VarcoV** | 49.64 | 51.84 | $F$ = .018, $p$ = .896 | 50.65 | 50.84 | $F$ = 4.742, $p$ = .061 | $F$ = 2.709, $p$ = .138 |
| **CCI-V** | 66.64 | 53.69 | *$F$ = 4.559 $p$ = .065* | 65.61 | 54.73 | *$F$ = 3.222 $p$ = .110* | *$F$ = .925 $p$ = .364* |
| **CCI-C** | 36.69 | 37.92 | *$F$ = .145 $p$ = .713* | 37.10 | 37.51 | *$F$ = .016 $p$ = .903* | *$F$ = .003 $p$ = .957* |

and Bertini (2010) remark, CCIs are among the metrics most sensitive to rate changes.

The correlations based on the sex variable displayed slightly different results for males and females (Table 8). For men, ΔV and ΔC exhibited negative correlations with speaking and articulation rates (r ≤ -.872, p ≤ .023), but positive correlations with both types of nPVI-V (r ≥ .860, p ≤ .028) and with each other (r = .847, p = .033). VarcoV and VarcoC exhibited no significant correlations with other measurements. In addition to the previously mentioned correlations with the standard deviations, the two types of nPVI-V were also correlated negatively with the rates (r ≤ -0.853, p ≤ .031) and positively with one another (r = .924, p = .009). CCI-C in males showed no correlations, whereas CCI-V was negatively correlated with both types of rates (r ≤ -.898, p ≤ .015) and with the PVIs and deltas (r ≥ .883, p ≤ .020).

According to Table 8, the following correlations were established for women: ΔC was only correlated with ΔV (r = .884, p = .019); however, ΔV was also correlated with VarcoC (r = .871, p = .024). %V did not display any correlations, while VarcoV was correlated with articulation rate (r = -.846, p = .034), and both rate types and both types of nPVI-V were corre-

**Table 7.** Pearson correlation results for the total of the data (N = 12, two-tailed).

| | | Speaking Rate | Transf ArtRate | Mean nPVI-V | Median nPVI-V | ΔV | ΔC | %V | VarcoC | Transf VarcoV | CCI-V | CCI-C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Speaking Rate** | **r** | 1 | .967** | -.561 | -.644* | -.641* | -.585* | -.502 | .086 | -.224 | -.820 | .0549 |
| | **p** | | .000 | .058 | .024 | .025 | .046 | .096 | .791 | .484 | .001 | .065 |
| **Transf ArtRate** | **r** | .967** | 1 | -.491 | -.543 | -.711** | -.647* | -.443 | .063 | -.197 | -.790 | -.580 |
| | **p** | .000 | | .105 | .068 | .009 | .023 | .149 | .846 | .539 | .002 | .048 |
| **Mean nPVI-V** | **r** | -.561 | -.491 | 1 | .902** | .541 | .278 | .442 | .043 | -.575 | .847 | .310 |
| | **p** | .058 | .105 | | .000 | .069 | .381 | .150 | .895 | .050 | .001 | .326 |
| **Median nPVI-V** | **r** | -.644* | -.543 | .902** | 1 | .490 | .148 | .540 | -.166 | -.333 | .867 | .200 |
| | **p** | .024 | .068 | .000 | | .105 | .647 | .070 | .606 | .290 | .001 | .533 |
| **ΔV** | **r** | -.641* | -.711** | .541 | .490 | 1 | .771** | .236 | .400 | -.215 | .682 | .511 |
| | **p** | .025 | .009 | .069 | .105 | | .003 | .459 | .197 | .502 | .015 | .090 |
| **ΔC** | **r** | -.585* | -.647* | .278 | .148 | .771** | 1 | -.106 | .623* | -.046 | .401 | .688 |
| | **p** | .046 | .023 | .381 | .647 | .003 | | .743 | .030 | .886 | .197 | .013 |
| **%V** | **r** | -.502 | -.443 | .442 | .540 | .236 | -.106 | 1 | -.128 | .183 | .643 | -.371 |
| | **p** | .096 | .149 | .150 | .070 | .459 | .743 | | .692 | .568 | .024 | .235 |
| **VarcoC** | **r** | .086 | .063 | .043 | -.166 | .400 | .623* | -.128 | 1 | -.205 | -.052 | .032 |
| | **p** | .791 | .846 | .895 | .606 | .197 | .030 | .692 | | .522 | .873 | .922 |
| **Transf VarcoV** | **r** | -.224 | -.197 | -.575 | -.333 | -.215 | -.046 | .183 | -.205 | 1 | .-234 | .-140 |
| | **p** | .484 | .539 | .050 | .290 | .502 | .886 | .568 | .522 | | .465 | .664 |
| **CCI-V** | **r** | -.820** | -.790** | .847** | .867** | .682* | .401 | .643* | -.052 | -.234 | 1 | .318 |
| | **p** | .001 | .002 | .001 | .000 | .015 | .197 | .024 | .873 | .465 | | .313 |
| **CCI-C** | **r** | -.549 | -.580* | .310 | .310 | .511 | .688* | -.371 | .032 | -.140 | .318 | 1 |
| | **p** | .065 | 0.48 | .326 | .326 | .090 | .013 | .235 | .922 | .664 | .313 | |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

lated with one another (r ≥ .853, p ≤ .031).The only correlation found for CCI-V was with the median nPVI-V values (r = .822, p = .045).

Within the subset of older speakers (Table 9), ΔV was positively correlated with both nPVI-Vs (r ≥ .888, p ≤ .018), and negatively correlated with VarcoV (r = -.895, p = .016) and with the speaking and articulation rates (r ≤ -.834, p ≤ .039). ΔC was correlated with VarcoC(r ≥ .832, p ≥ .040). Both rate types were correlated with each other (r = .937, p = .006). The mean and median nPVI-Vs were also correlated with each other (r = .943, p = .005). %V did not exhibit any significant correlations. Both nPVI-Vs were correlated with speaking rate (r ≤ -.847, p ≤ .033) but not with articulation rate. Finally, CCI-V in older speakers correlated negatively with the rates and VarcoV (r ≤ -.848, p ≤ .033) and positively with both types of PVIs and with ΔV (r ≥ .896, p ≤ .016).

Within the subset of younger speakers (Table 9), the following positive correlations were found: between ΔV and ΔC, between the

**Table 8.** Pearson correlation results for sex groups (N = 6, two-tailed).

| | | | Speaking Rate | Transf Articulation Rate | Mean nPVI-V | Median nPVI-V | ΔV | ΔC | %V | VarcoC | Transf VarcoV | CCI-V | CCI-C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Males | Speaking Rate | r | 1 | .983** | -.904* | -.853* | -.920** | -.930** | -.411 | -.351 | .208 | -.900* | -.775 |
| | | p | | .000 | .013 | .031 | .009 | .007 | .418 | .495 | .692 | .015 | .070 |
| | Transf Art Rate | r | .983** | 1 | -.877* | -.874* | -.926** | -.872* | -.396 | -.212 | .257 | -.898* | -.765 |
| | | p | .000 | | .022 | .023 | .008 | .023 | .437 | .686 | .623 | .015 | .076 |
| | Mean nPVI-V | r | -.904* | -.877* | 1 | .924** | .866* | .960** | .204 | .455 | -.562 | .914* | .809 |
| | | p | .013 | .022 | | .009 | .026 | .002 | .698 | .364 | .246 | .011 | .051 |
| | Median nPVI-V | r | -.853* | -.874* | .924** | 1 | .860* | .883* | .292 | .389 | -.596 | .908* | .627 |
| | | p | .031 | .023 | .009 | | .028 | .020 | .575 | .446 | .212 | .012 | .183 |
| | ΔV | r | -.920** | -.926** | .866* | .860* | 1 | .847* | .611 | .351 | -.363 | .986** | .607 |
| | | p | .009 | .008 | .026 | .028 | | .033 | .198 | .495 | .480 | .000 | .202 |
| | ΔC | r | -.930** | -.872* | .960** | .883* | .847* | 1 | .319 | .612 | -.353 | .883* | .727 |
| | | p | .007 | .023 | .002 | .020 | .033 | | .537 | .197 | .492 | .020 | .102 |
| | %V | r | -.411 | -.396 | .204 | .292 | .611 | .319 | 1 | .421 | .208 | .548 | -.192 |
| | | p | .418 | .437 | .698 | .575 | .198 | .537 | | .405 | .693 | .261 | .715 |
| | VarcoC | r | -.351 | -.212 | .455 | .389 | .351 | .612 | .421 | 1 | -.091 | .430 | .007 |
| | | p | .495 | .686 | .364 | .446 | .495 | .197 | .405 | | .865 | .395 | .990 |
| | Transf VarcoV | r | .208 | .257 | -.562 | -.596 | -.363 | -.353 | .208 | -.091 | 1 | -.483 | -.365 |
| | | p | .692 | .623 | .246 | .212 | .480 | .492 | .693 | .865 | | .332 | .477 |
| | CCI-V | r | -.900* | -.898* | .914* | .908* | .986** | .883* | .548 | .430 | -.483 | 1 | .610 |
| | | p | .015 | .015 | .011 | .012 | .000 | .020 | .261 | .395 | .332 | | .198 |
| | CCI-C | r | -.775 | -.765 | .809 | .627 | .607 | .727 | -.192 | .007 | -.365 | .610 | 1 |
| | | p | .070 | .076 | .051 | .183 | .202 | .102 | .715 | .990 | .477 | .198 | |
| Females | Speaking Rate | r | 1 | .963** | .207 | -.284 | .454 | .188 | -.490 | .720 | -.686 | -.470 | -.166 |
| | | p | | .002 | .694 | .586 | .366 | .721 | .324 | .106 | .132 | .347 | .754 |
| | Transf Art Rate | r | .963** | 1 | .436 | -.025 | .450 | .104 | -.442 | .666 | -.846* | -.278 | -.078 |
| | | p | .002 | | .388 | .963 | .371 | .844 | .380 | .148 | .034 | .594 | .883 |
| | Ave nPVI-V | r | .207 | .436 | 1 | .853* | -.164 | -.561 | .355 | -.068 | -.774 | .676 | -.155 |
| | | p | .694 | .388 | | .031 | .757 | .247 | .490 | .898 | .071 | .141 | .769 |
| | Median nPVI-V | r | -.284 | -.025 | .853* | 1 | -.278 | -.546 | .436 | -.399 | -.446 | .822* | .133 |
| | | p | .586 | .963 | .031 | | .594 | .262 | .387 | .433 | .376 | .045 | .801 |
| | ΔV | r | .454 | .450 | -.164 | -.278 | 1 | .884* | -.720 | .871* | -.227 | -.624 | .448 |
| | | p | .366 | .371 | .757 | .594 | | .019 | .107 | .024 | .665 | .185 | .373 |
| | ΔC | r | .188 | .104 | -.561 | -.546 | .884* | 1 | -.757 | .677 | .149 | -.699 | .516 |
| | | p | .721 | .844 | .247 | .262 | .019 | | .082 | .139 | .779 | .122 | .294 |
| | %V | r | -.490 | -.442 | .355 | .436 | -.720 | -.757 | 1 | -.516 | .251 | .635 | -.687 |
| | | p | .324 | .380 | .490 | .387 | .107 | .082 | | .295 | .632 | .176 | .132 |
| | VarcoC | r | .720 | .666 | -.068 | -.399 | .871* | .677 | -.516 | 1 | -.319 | -.678 | -.019 |
| | | p | .106 | .148 | .898 | .433 | .024 | .139 | .295 | | .538 | .139 | .971 |
| | Transf VarcoV | r | -.686 | -.846* | -.774 | -.446 | -.227 | .149 | .251 | -.319 | 1 | -.235 | -.067 |
| | | p | .132 | .034 | .071 | .376 | .665 | .779 | .632 | .538 | | .653 | .899 |
| | CCI-V | r | -.470 | -.278 | .676 | .822* | -.624 | -.699 | .635 | -.678 | -.235 | 1 | -.116 |
| | | p | .347 | .594 | .141 | .045 | .185 | .122 | .176 | .139 | .653 | | .827 |
| | CCI-C | r | -.166 | -.078 | -.155 | .133 | .448 | .516 | -.687 | -.019 | -.067 | -.116 | 1 |
| | | p | .754 | .883 | .769 | .801 | .373 | .294 | .132 | .971 | .899 | .827 | |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

**Table 9.** Pearson correlation results for age groups (N = 6, two-tailed).

| | | | Speaking Rate | Articulation Rate | Mean nPVI-V | Median nPVIV | ΔV | ΔC | %V | VarcoC | Transf VarcoV | CCI-V | CCI-C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Older | Speaking Rate | **r** | 1 | .937** | -.860* | -.847* | -.863* | -.724 | -.419 | -.389 | .773 | -.952** | -.570 |
| | | **p** | | .006 | .028 | .033 | .027 | .104 | .409 | .446 | .072 | .003 | .237 |
| | Transf ArtRate | **r** | .937** | 1 | -.742 | -.691 | -.834* | -.564 | -.504 | -.207 | .608 | -.914* | -.517 |
| | | **p** | .006 | | .091 | .128 | .039 | .244 | .308 | .693 | .200 | .011 | .293 |
| | Mean nPVI-V | **r** | -.860* | -.742 | 1 | .943** | .957** | .717 | .663 | .629 | -.932** | .950** | .250 |
| | | **p** | .028 | .091 | | .005 | .003 | .108 | .151 | .181 | .007 | .004 | .633 |
| | Median nPVI-V | **r** | -.847* | -.691 | .943** | 1 | .888* | .565 | .593 | .456 | -.894* | .896* | .238 |
| | | **p** | .033 | .128 | .005 | | .018 | .243 | .214 | .363 | .016 | .016 | .650 |
| | ΔV | **r** | -.863* | -.834* | .957** | .888* | 1 | .584 | .717 | .430 | -.895* | .971** | .304 |
| | | **p** | .027 | .039 | .003 | .018 | | .223 | .109 | .395 | .016 | .001 | .558 |
| | ΔC | **r** | -.724 | -.564 | .717 | .565 | .584 | 1 | .144 | .832* | -.662 | .678 | .476 |
| | | **p** | .104 | .244 | .108 | .243 | .223 | | .785 | .040 | .152 | .139 | .339 |
| | %V | **r** | -.419 | -.504 | .663 | .593 | .717 | .144 | 1 | .335 | -.449 | .646 | -.410 |
| | | **p** | .409 | .308 | .151 | .214 | .109 | .785 | | .516 | .372 | .166 | .420 |
| | VarcoC | **r** | -.389 | -.207 | .629 | .456 | .430 | .832* | .335 | 1 | -.520 | .460 | -.064 |
| | | **p** | .446 | .693 | .181 | .363 | .395 | .040 | .516 | | .290 | .358 | .904 |
| | Transf VarcoV | **r** | .773 | .608 | -.932** | -.894* | -.895* | -.662 | -.449 | -.520 | 1 | -.848* | -.416 |
| | | **p** | .072 | .200 | .007 | .016 | .016 | .152 | .372 | .290 | | .033 | .412 |
| | CCI-V | **r** | -.952** | -.914* | .950** | .896* | .971** | .678 | .646 | .460 | -.848* | 1 | .384 |
| | | **p** | .003 | .011 | .004 | .016 | .001 | .139 | .166 | .358 | .033 | | .452 |
| | CCI-C | **r** | -.570 | -.517 | .250 | .238 | .304 | .476 | -.410 | -.064 | -.416 | .384 | 1 |
| | | **p** | .237 | .293 | .633 | .650 | .558 | .339 | .420 | .904 | .412 | .452 | |
| Younger | Speaking Rate | **r** | 1 | .941** | -.703 | -.687 | -.515 | -.478 | .003 | .433 | -.087 | -.728 | -.825* |
| | | **p** | | .005 | .119 | .132 | .296 | .338 | .996 | .391 | .871 | .101 | .043 |
| | Transf Art Rate | **r** | .941** | 1 | -.621 | -.533 | -.748 | -.699 | .200 | .182 | .079 | -.681 | -.908* |
| | | **p** | .005 | | .188 | .276 | .087 | .123 | .704 | .730 | .881 | .136 | .012 |
| | Mean nPVI-V | **r** | -.703 | -.621 | 1 | .878* | .032 | -.035 | .517 | -.708 | -.475 | .945** | .374 |
| | | **p** | .119 | .188 | | .021 | .952 | .947 | .293 | .116 | .341 | .004 | .466 |
| | Median nPVI-V | **r** | -.687 | -.533 | .878* | 1 | -.046 | -.217 | .601 | -.900* | -.170 | .920** | .193 |
| | | **p** | .132 | .276 | .021 | | .931 | .680 | .207 | .014 | .748 | .009 | .715 |
| | ΔV | **r** | -.515 | -.748 | .032 | -.046 | 1 | .946** | -.693 | .414 | -.051 | .191 | .790 |
| | | **p** | .296 | .087 | .952 | .931 | | .004 | .127 | .415 | .923 | .717 | .062 |
| | ΔC | **r** | -.478 | -.699 | -.035 | -.217 | .946** | 1 | -.784 | .544 | -.013 | .045 | .861* |
| | | **p** | .338 | .123 | .947 | .680 | .004 | | .065 | .265 | .981 | .933 | .028 |
| | %V | **r** | .003 | .200 | .517 | .601 | -.693 | -.784 | 1 | -.696 | -.152 | .385 | -.494 |
| | | **p** | .996 | .704 | .293 | .207 | .127 | .065 | | .124 | .773 | .451 | .320 |
| | VarcoC | **r** | .433 | .182 | -.708 | -.900* | .414 | .544 | -.696 | 1 | .026 | -.723 | .110 |
| | | **p** | .391 | .730 | .116 | .014 | .415 | .265 | .124 | | .961 | .104 | .836 |
| | Transf VarcoV | **r** | -.087 | .079 | -.475 | -.170 | -.051 | -.013 | -.152 | .026 | 1 | -.457 | .024 |
| | | **p** | .871 | .881 | .341 | .748 | .923 | .981 | .773 | .961 | | .362 | .965 |
| | CCI-V | **r** | -.728 | -.681 | .945** | .920** | .191 | .045 | .385 | -.723 | -.457 | 1 | .390 |
| | | **p** | .101 | .136 | .004 | .009 | .717 | .933 | .451 | .104 | .362 | | .445 |
| | CCI-C | **r** | -.825* | -.908* | .374 | .193 | .790 | .861* | -.494 | .110 | .024 | .390 | 1 |
| | | **p** | .043 | .012 | .466 | .715 | .062 | .028 | .320 | .836 | .965 | .445 | |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

two nPVI-Vs, between the speaking and articulation rates, between CCI-V and the PVIs, and between CCI-C and ΔC ($r \geq .861$, $p \leq .028$). Negative correlations were found between VarcoC and the median nPVI-V, and between CCI-C and the rates ($r \leq -.825$, $p \leq .043$).

There were more correlations for males and older speakers than for females and younger speakers. However, in all groups, %V did not correlate with any other factor, and VarcoV (transformed) displayed correlations (with the PVIs, ΔV and CCI-V) only for the older participants. Finally, it is surprising that the normalised metrics VarcoV and nPVI-Vs correlated with the rates (more often with the speaking rate).

## *10. Discussion and Conclusions*

The purpose of this paper was to examine rhythmic variation in a French dialect spoken in a minority setting in Ontario (Canada), with the goal of finding out whether this variety adheres to a more stress-timed than syllable-timed rhythmicity, and whether men vs. women and younger vs. older speakers display different trends in their adoption of a syllable-timed rhythmic pattern. With the hypothesis that the participants overall, and especially men and younger participants, have a less syllable-timed pattern under the influence of the English language, while women and older speakers maintain a more typical French rhythmicity, I applied a series of methods of rhythmic analysis to text readings. The results revealed several inconsistencies and contradictions, and they cannot be fully understood without reference to vernacular features of Ontario French (e.g. diphthongation, vowel lengthening, consonant cluster simplification, high vowel laxing) and to general French phonological phenomena (e.g. liaison, *enchaînement*, and schwa omission) that may affect phonotactics, which in turn affect rhythm metrics. This will be discussed below.

For our overall data, stress timing is suggested by the ΔV, ΔC and VarcoC values (Table 10). However, based on the %V, VarcoV and nPVI-V values, our dataset exhibits a very French-like pattern, while also demonstrating considerably slower rates compared to speakers in previous studies of standard and regional French varieties. This conflict between the metrics appears to be resolved by the CCI model, which classifies our dataset as having between syllable- and stress-timed rhythmicity. This is especially interesting not only because it intuitively appears most adequate, but also because the CCI value is “autonomously derived: it stems from behavioural measures mirroring relevant structural properties.” (Bertinetto & Bertini 2010: 19) In other words,

**Table 10.** Recapitulation of the current results and of the previous results on French and English (from Table 2).

| | French | English | Windsor French | | | | |
|---|---|---|---|---|---|---|---|
| | | | Males | Females | Older | Younger | Total |
| ΔC | .041-.051 | .054-.059 | .0536 | .0558 | .0566 | .0528 | .0547 |
| VarcoC | 43-44 | 47-52 | 49.64 | 51.84 | 50.65 | 50.84 | 50.74 |
| VarcoV | 45.5-50 | 53-64 | 48.15 | 46.58 | 45.56 | 49.17 | 47.37 |
| Mean nPVI-V | 43.5-50 | 55-73 | 47.23 | 43.85 | 45.51 | 45.57 | 45.54 |
| ΔV | .038-.044 | .043-.049 | .0617 | .0566 | .0618 | .0565 | .0591 |
| %V | 43.6-51 | 38-42.2 | 52.97 | 50.57 | 53.59 | 49.95 | 51.77 |
| CCI-V | 41 | 42 | 66.64 | 53.69 | 65.61 | 54.73 | 60.17 |
| CCI-C | 39 | 36 | 36.69 | 37.92 | 37.10 | 37.51 | 37.31 |

this model predicts patterns of behaviour for different rhythm types and yields results independently of the investigator's expectations.

When looking at the results for social groups, contradictory trends are again suggested by the traditional metrics. Thus, ΔV, VarcoV and both nPVI-Vs demonstrate smaller values in females than in males suggesting a more syllable-timed rhythmicity in the first group. At the same time, this tendency is contradicted by higher ΔC and VarcoC values and lower %V in women. So, the stability and reliability of these methods are called into question once again.

The CCI model, on the other hand, successfully solves this problem in the context of social groups as well, by considering both vocalic and consonantal intervals simultaneously. The pattern that emerged between the two groups in Figure 5 (left panel) shows that women's CCI values clustered closer to the bisector which suggests that the hypothesis about a more syllable-timed rhythmic pattern in this social group is viable. This pattern is a result of the relationship between vocalic and consonantal CCIs: the closer they are, the more controlling type of data (and syllable-timed rhythm) we have, while a larger variability of vocalic intervals points towards a compensating type of data (and stress-timed rhythm). Indeed, the individual values (Table 5) and the average group values (Table 10) indicate that CCI-V and CCI-C values in women are closer to each other than in men. I calculated the difference between vocalic and consonantal CCIs for each speaker and applied a t-test to establish whether values for men and women differ significantly. The obtained p-value ($p = .038$) statistically confirmed the observed trend in women to have a more controlling production and therefore a more syllable-timed rhythmicity.

The smaller difference between vocalic and consonantal CCIs in women is mostly due to their regularly lower CCI-Vs, and to the occasional higher CCI-Cs in comparison with men (Table 5). This difference between the two types of intervals in males and females in our dataset may originate from phonotactic processes in the vocalic and consonantal systems of Canadian French. For instance, the larger variation of consonantal intervals in females and the smaller variation in males could be related to their different treatments of consonant clusters and differences in the realisation of schwa and liaison by these two groups of speakers. The examples below illustrate how *enchaînement*, the realisation of schwa and liaison, and simplification of consonant clusters can affect interval counts and their variability.

In (3a), the omission of [ə] and the *enchaînement consonantique* between [r] and [a] produce an interval sequence in which the first consonantal interval consists of three segments ([str]) and the first vocalic interval has two vowels ([aɑ̃]). In (3b), the simplification of the cluster in *ministre* 'Ministre' does not affect the number or the order of the intervals. However, their content is different; the first interval has only one consonant instead of three. Consequently, the variation of the consonantal intervals in (3a) is larger than in (3b).

(3) *ministre a en effet décidé* 'the Ministre has indeed decided':
/…s t r ə a ɑ̃ (n) ε…/, where (n) is the liaison consonant
a) […s t r a ɑ̃ n ε…] = Intervals CONS-VOW-CONS-VOW with CCCVVCV segmental sequence
b) [… s a ɑ̃ n ε…] = Intervals CONS-VOW-CONS-VOW with CVVCV segmental sequence

In (4), the variation between the consonantal intervals in the underlined portion of the text depends on the realisation of the optional liaison in *pâtes italiennes* 'Italian pasta'. (4a) exhibits two segments in the first consonantal interval because of the liaison. In (4b), however, the liaison's absence results in one pronounced consonant. Again, this liaison is a feature of a formal pronunciation. Based on the fact that women are typically more oriented towards standard pronunciation, and on the analysis of liaison in these text readings by Poiré et al. (2010), which concluded that the women in this dataset realised liaison more regularly than men, the higher values of consonantal intervals in women in the current analysis could be related to liaison and thus to women's more normative readings.

(4) *pâtes italiennes* 'Italian pasta':
/…t ə (z) i t…/
a) [… t z i t …] = Intervals CONS-VOW-CONS with CCVC segmental sequence
b) [… t i t…] = Intervals CONS-VOW-CONS with CVC segmental sequence

The lower values of vocalic intervals found for the women could also originate from a more standardised pronunciation with less regional vocalism. This fact would explain the presence of more isochronous vocalic intervals, indicating a more syllable-timed rhythmicity among women.

The conventional metrics lead to contradictory results for age groups as well. Thus, according to ΔC, older informants exhibited more variation in consonantal intervals. However, according to VarcoC, more variation was found in the younger group. According to the ΔV values, the vocalic intervals of the older group were less stable, which can be explained by this group's slower articulation rate and their use of local vernacular phonology. However, nPVI-Vand VarcoV values suggested that more variation exists in the group of younger speakers, but the same explanation as above does not work for these higher values found in this group. Nonetheless, the lower %V and the (negligibly) higher VarcoC in this group are consistent with a less syllable-timed pattern, as suggested by the nPVI-V and VarcoV results. The traditional metric values remain well within the French zone (Table 10) suggesting syllable-timed rhythm for our dataset and not supporting our initial hypothesis about a trend towards stress-timed rhythm in younger participants. The plot of the CCI values in Figure 5 does not confirm our initial hypothesis either. Instead, it suggests the opposite trend: the values of four out of six older speakers cluster below and further from the bisector, suggesting that this group tends towards a stress-timed rhythmicity. However, a t-test evaluated the differences between vocalic and consonantal CCIs for older vs. younger speakers as non-significant ($p = .114$).

The patterns revealed by the CCI method (the slight trend towards a syllable-timed rhythmic pattern in females and younger participants) are consistent with: 1) the previous observations in sociolinguistic studies that women adopt linguistic forms and production characterizing the standard variety more easily than men, 2) the fact that for younger generations of Franco-Ontarians the possibility of using French outside the home is limited to the school context, where vernacular forms and pronunciation tend to be replaced by their more standard equivalents, and 3) the relationship between rate and rhythmicity observed in previous analyses i.e. faster speech production leads towards lesser variation between the intervals and therefore a more syllable-timed rhythm.

Analysis based on a larger dataset with a sociolinguistic approach focusing on the informants' practice of speaking French (or language restriction, Mougeon & Beniak 1991) would help to establish how language restriction affects their prosody. Such analysis should include not only the phonotactic level but also other levels, because languages may have opposite tendencies at different levels (e.g. phonotactic vs. sentential levels (Bertinetto & Bertini 2010) and syllable vs. foot (Nolan & Asu 2009)). A comparison with other Canadian varieties spoken in majority settings would contextualise the current findings. Finally, an investigation of spontaneous production of English rhythm in monolingual and bilingual Anglophones should be part of such a comprehensive analysis.

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*Appendix*
*The analysed part of the recorded text*

"Le Premier Ministre, ira-t-il à Beaulieu?"

Le village de Beaulieu est en grand émoi. Le Premier Ministre a en effet décidé de faire étape dans cette commune au cours de sa tournée de la région en fin d'année. Jusqu'ici les seuls titres de gloire de Beaulieu étaient son vin blanc sec, ses chemises en soie, un champion local de course à pied (Louis Garret), quatrième aux jeux olympiques de Berlin en 1936, et plus récemment, son usine de pâtes italiennes. Qu'est-ce qui a donc valu à Beaulieu ce grand honneur? Le hasard, tout bêtement, car le Premier Ministre, lassé des circuits habituels qui tournaient toujours autour des mêmes villes, veut découvrir ce qu'il appelle «la campagne profonde».

Le maire de Beaulieu - Marc Blanc - est en revanche très inquiet. La cote du Premier Ministre ne cesse de baisser depuis les élections. Comment, en plus, éviter les manifestations qui ont eu tendance à se multiplier lors des visites officielles? La côte escarpée du Mont Saint-Pierre qui mène au village connaît des barrages chaque fois que les opposants de tous les bords manifestent leur colère. D'un autre côté, à chaque voyage du Premier Ministre, le gouvernement prend contact avec la préfecture la plus proche et s'assure que tout est fait pour le protéger.

## Notes

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1 The PFC project gathers data from the entire French-speaking world. Each speaker recorded two sociolinguistic interviews and readings of a list of words and a text. For the current study I use text readings performed by all 12 speakers of the Windsor corpus, which was gathered in 2003 by François Poiré and Stephanie Kelly from The University of Western Ontario (section 3.1).

2 In this paper, 'Ontario French' is a short form for 'Ontario French in a minority environment'.

3 "Lors de la fabrication du texte, nous avons tenté d'inclure non seulement la majorité des segments vocaliques et consonantiques du français, mais aussi tout un ensemble de phénomènes phonologiques typiques du français. Le texte soumis permet de dresser l'inventaire des phonèmes du locuteur, il reprend certains mots et paires minimales repris dans la liste. Le texte permet de tester deux phénomènes en détail: la prononciation du schwa et la liaison (y compris les phénomènes connexes de nasalisation et de 'h' aspiré). D'autres phénomènes sont néanmoins présents: par exemple, la palatalisation, les glissantes et diverses assimilations" (Durand et al. 2002: 43-44).

4 Because the results in the original texts are often presented in plots and graphs without actual values, some of the values are approximate (at worst).

5 The distribution of the residuals of the dependent variables was normal for all but VarcoV and articulation rate. VarcoV showed negative skew, and articulation rate displayed positive skew. Values of these variables were therefore log transformed following Tabachnick and Fidell's (2001) recommendations (cited in Larson-Hall 2010: 92). This transformation improved the distribution of the values and allowed for the application of ANOVA for these variables as well. Statistical results reported here for VarcoV and articulation rate are based on their log values. However, when presenting the results, I use the original values, since the log ones do not correspond to the type of measurements they report, and are therefore difficult to comprehend.
A log transformation of ΔC values was applied in Dellwo (2009). This not only improved the distribution of values but also proved to be a "suitable rate normalization procedure" (p. 23).

6 Given that the sample size was limited, I resampled the data by applying bootstrapping. This procedure randomly generates data using the original sample as a 'surrogate'. The bootstrapped results confirmed the ones obtained with the original sample, so I chose to report statistics based on the original sample here.

7 I acknowledge the limitations of this analysis due to sample size. However, it is worth noting that, since the ANOVA tests did not reveal interactions between sex and age variables (see below), the results are based on comparisons of groups of six, which improves the representativeness of the results.

8 I would like to remind the reader that for articulation rate and for VarcoV, statistics were performed on and are reported based on transformed data (see note 5 above).

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