QUEBEC FRENCH CLOSE VOWELS IN LENGTHENING CONTEXTS: TENSE, LAX OR DIPHTHONGISED? AN ACOUSTIC STUDY

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ABSTRACT

Quebec French close vowels /iyu/ are regularly lengthened in syllables closed by the consonants /ʁvzʒ/. The quality of these variants is subject to debate: they are variously described as tense, slightly unstable or diphthongised. It has also been suggested that they would be tense before /vzʒ/, but lax before /ʁ/, with a concomitant diphthongisation. The present study aims to provide an acoustic account of the question. 360 tokens of lengthened close vowels produced by 30 speakers from three cities were analysed and compared to short (tense and lax) variants. The duration was calculated and F_0, F_1, F_2 and F_3 were estimated at 25, 50 and 75% of the duration. Our results suggest that the F_1 of lengthened variants is intermediate between tense and lax values, and that it decreases during emission. Furthermore, the acoustic characteristics of lengthened vowels vary according to the following consonant and the speaker's geographical origin.

Keywords: high vowels, Quebec French, diphthongs, regional dialects, spectral change.

1. INTRODUCTION AND GOALS

Quebec French (QF) close vowels /iyu/ are affected by various contextual phenomena. They can be shortened (if not dropped), devoiced, laxed, lengthened and diphthongised (e.g. [5, 9, 10, 15, 19, 22, 26]). As [15] pointed out, in unstressed syllables, these phenomena are not systematically observed and some might co-occur. However, in final stressed syllables, close vowels are traditionally described as categorically a) tense in open syllables (V#), b) lax in syllables closed by any consonant except /ʁvzʒ/ (VK), and c) lengthened (and eventually diphthongised) in syllables closed by the so-called *lengthening* consonants /ʁvzʒ/ (VR). The only exceptions to this complementary distribution are found in some contractions or loans [6] and in the speech of some speakers from eastern Quebec who may produce lax vowels in syllables closed by /vzʒ/ [4]. Close vowel laxing and diphthongisation do not seem to be subject to negative social evaluation [10, 21]. The quality of lengthened variants of QF close vowels is subject to debate. For example, [11, 18, 26] describe them as tense. According to [5, 9], they are rather diphthongised. For their part, [22] state that they "do not present diphthongized variants but only a variation in quality, as in *rire* /ʁiʁ/ → [ʁɪ^{i}ʁ]" (p. 174). As for [13, 20, 27], they detected in their respective corpora a certain proportion of diphthongised lengthened close vowels. Finally, [6, 19] suggest that QF close vowels in VR would be tense when preceding /vzʒ/, but lax when preceding /ʁ/. In both cases, diphthongisation would also apply. The lack of consensus about the quality of QF lengthened close vowels can be explained by various factors, two of which are especially worth noting. The first factor is that most studies cited above were founded on auditory (and thus necessarily subjective) evaluations. The second potential factor resides in the speakers' geographical origin, which differs from one study to another. Indeed, diphthongisation of long and lengthened vowels in general has been noted to be less frequent and/or noticeable in eastern Quebec than it is in western Quebec [8, 10].

The present study aims a) to provide a detailed acoustic description of QF lengthened close vowels that takes into account spectral change and allows a comparison with tense and lax short variants, and b) to determine if lengthened close vowels exhibit a different pattern depending on the lengthening consonant and the geographical origin of the speakers.

2. EXPERIMENTAL FRAMEWORK: ASSESSING SPECTRAL CHANGE

Except for diphthongs, vowel formant frequencies are traditionally estimated at a single point, where formant configuration reaches a steady state. However, like [1] mention, "in coarticulated vowels, formants often do not reach the steady-state values of their isolated counterparts, and frequently do not contain any region which can be described as 'steady state'" (p. 390). More recent studies (e.g. [17]) noticed that even some English

monophthongs produced in isolation show significant formant trajectories, which seem to maintain in different consonantal contexts. These observations led [17] to postulate a *vowel-inherent spectral change* (VISC), a formant movement characteristic of a particular vowel (whether the vowel be diphthong or monophthong, coarticulated or isolated). It is also noteworthy that spectral changes facilitate the acoustic distinction between tense and lax vowels in English [12], but also in QF [2]. Various parameterisations of VISC have been proposed (see [16] for a review). We opted for the robust *dual target hypothesis*, which consists of having two measurement points per vowel. Just like [13], we chose our two time points so they would be "sufficiently extreme to include a substantial portion of observed formant frequency changes, while at the same time avoiding certain irregularities in source characteristics associated with absolute endpoints of the stimuli" (p. 1298). A measurement point at the centre of the vowel was included in order to capture nonlinear trajectories.

3. METHODOLOGY

The speech material used in this study comes from a larger QF database which consists of the recordings of 40 university students and alumni, 20 to 31 years of age. All are native speakers of QF. The speakers came from, and were living in, one of the two following cities at the time they were recorded: Saguenay (SG) and Quebec City (QC). From this sample, 20 speakers, 10 from each city, 5 men and 5 women, were selected. In order to increase the geographic coverage, a complementary sample of 10 speakers from Rouyn-Noranda (RN) was established using the same criteria. Linguists traditionally divide the province of Quebec into two dialectal areas: one in the west (centred on Montreal) and one in the east (centred on Quebec City). SG and QC are located in the eastern area, though it is considered that SG is part of a region with its own dialect [9]. RN is located in a region more recently settled (starting in the early 1900s) by people from both the eastern and the western areas. Participants were recorded in an anechoic room (in SG and QC) with a Shure SM10A headset microphone amplified by a XENYX 802 Behringer mixer connected to a Tascam HD-P2 recorder (44 kHz, 16 bits). They were instructed to read, out loud, over 500 meaningful sentences ending in a target word. After each sentence, the interviewer asked the participant to repeat the last word as if it had not been understood, and only the isolated repetitions were analysed. The same experimental protocol was applied for RN speakers, except that these participants were recorded at home. The subcorpus used for this study consists of 42 monosyllabic words from the French lexicon containing a close vowel (see Table 1). Each of the three vowels /iyu/ was presented in five different words for the V# and VK contexts and in four different words for the VR context (one per lengthening consonant).This corpus of 1260 tokens allows a comparison between lengthened, tense and lax vowels. The 360 tokens of lengthened variants were used to detect potential differences amongst lengthened vowels depending on the following consonant.

Table 1: Corpus.

	/i/	**/y/**	**/u/**
V#	*chie* 'shit'	*but* 'goal'	*boue* 'mud'
	gui 'mistletoe'	*cul* 'ass'	*cou* 'neck'
	pie 'magpie'	*fût* 'barrel'	*fou* 'crazy'
	qui 'who'	*pus* 'pus'	*goût* 'taste'
	vies 'lives'	*vue* 'sight'	*poux* 'lice'
VK	*Bic* (city)	*bûches* 'logs'	*bouc* 'goat'
	bite 'dick'	*butte* 'mound'	*boude* 'sulk'
	guide 'guide'	*cubes* 'blocks'	*coude* 'elbow'
	kit 'kit'	*pub* 'ad'	*coupe* 'goblet'
	pic 'peak'	*puces* 'fleas'	*gouttes* 'drops'
VR	*pire* 'worst'	*pur* 'pure'	*cours* 'courses'
	vive 'bright'	*cuve* 'tank'	*couve* 'hatch'
	bise 'kiss'	*buses* 'hawk'	*cousent* 'sew'
	pige 'draw'	*luge* 'sledge'	*bouge* 'move'

Target vowels were segmented and analysed manually using Praat [3]. First, vowel duration was calculated. Next, the fundamental frequency and the central frequency of the first three formants (hereafter F_0, F_1, F_2 and F_3) were estimated at 25, 50 and 75% of the duration. Seven tokens (of which one was a lengthened vowel) were rejected. Six of them were non-analysable and one, produced with hesitation, did not perceptively correspond to the variant expected in the context.

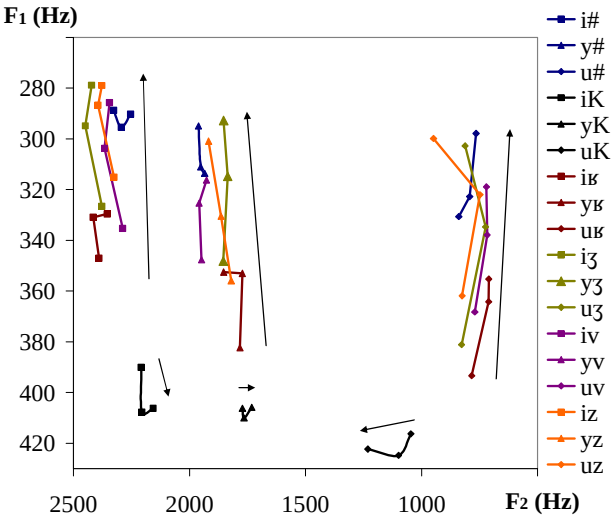
4. RESULTS

4.1. Overview of vowel trajectories

We first wanted to take a broad look at the position and trajectory of lengthened close vowels in the vocalic space compared to those of tense and lax short variants. The mean trajectory for each tense (i#, y#, u#), lax (iK, yK, uK), and lengthened (iʁ, yʁ, uʁ, iv, yv, uv, iz, yz, uz, iʒ, yʒ, uʒ) vowel category was calculated. A visual inspection of these trajectories plotted in an F_1/F_2 plane (see Fig. 1) reveals some general trends (a more detailed analysis may be found in [23]). Firstly, lax vowels have the highest F_1 values, whereas the

tense vowels have the lowest ones. Lengthened variants, globally, have an intermediate F_1. However, the F_1 of lengthened vowels preceding /vzʒ/ ends up at similar F_1 values as the tense variants at some point during emission, which is not the case when they precede /ʁ/. Secondly, lax variants tend to centralise over the course of their duration, while lengthened and tense variants exhibit a closing trajectory. Lastly, the trajectories of lengthened variants appear to be the longest.

Figure 1: Mean trajectories of vocalic classes in an F_1/F_2 plane. Symbols represent measurement points. Arrows indicate the direction of the trajectories.



In the next subsections, only the selected 360 tokens of lengthened vowels are analysed. Statistical analyses were executed with PAWS Statistics 18. Taking into consideration the size of our sample, we opted for the very conservative significance level of 0.1%.

4.2. Lengthened vowel duration and F_0

Lengthened vowel duration and F_0 do not meet assumptions required for performing mixed models. Therefore, our analysis of these variables is limited to a qualitative description of their distribution amongst vowel categories. We observe that the duration of vowels in front of /v/ tend to be slightly shorter than vowels preceding another consonant. The duration does not seem to vary according to either the vowel or to the speaker's city and sex. As to F_0, it is higher for women then for men, as expected [24]. It also decreases during emission in all cases, which is not surprising as a descending intonation is predicted at the end of declarative sentences in French [7]. No clear trends appear with regard to the vowel, the following consonant, or the speaker's city.

4.3. Lengthened vowel formants

In order to identify the sources of variation in the formant frequency of lengthened vowels (the dependent variable), nine mixed models (CS matrix, REML, SSType III) were carried out (one per vowel per formant). Independent variables were the measurement point, the following consonant, and the speaker's sex and city. The speaker was included as the repeated-measure factor of the measurement point and of the following consonant. Assumptions regarding distribution of missing cases, linearity of the relationship between the residuals, and the formant frequency, as well as the normality and the homoscedasticity of the residuals were verified.

Our results reveal some recurrent trends for every vowel and formant. Indeed, the speaker's sex was found to have a significant effect in all cases ($p = 0.000$), which is consistent with the fact that the proportions of the vocal tract differ between men and women [24]. The mean formant values also show significant differences between 25, 50 and 75% of vowel duration ($p = 0.000$), with the exception of the F_2 of /y/ and the F_3 of /u/. More precisely, the mean F_1 values decrease continuously over the course of every vowel. F_2 displays a more complex pattern. Between 25 and 50%, F_2 increases for /i/, stays stable for /y/ and decreases for /u/. While F_2 remains stable for /y/, its movement is reversed after 50% for /i/ and /u/, so that F_2 does not differ significantly between 25 and 75%. These trajectories can be seen in Fig. 1 above. As for F_3, it increases and then decreases for /i/ whereas it does the opposite for /y/ and stays stable for /u/.

4.3.1. Region and consonant effects on F_1

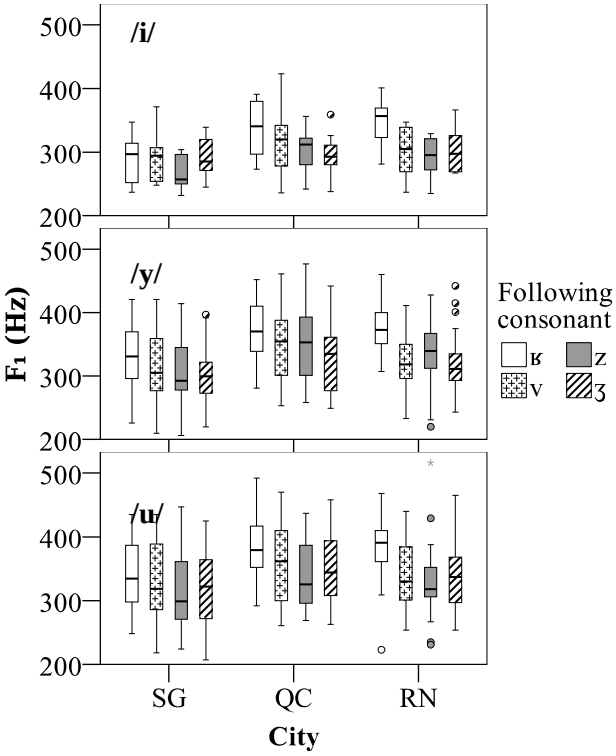
A significant effect of the following consonant in interaction with the speaker's city was found for lengthened /i/ ($p = 0.000$). For /y/ and /u/, a significant effect of the following consonant alone was found ($p = 0.000$). In almost every pairwise comparison, F_1 appears to be higher for vowels in front of /ʁ/ than for vowels in front of /vzʒ/. In SG however, the F_1 of /i/ is lower when preceding /z/ than when preceding /ʁvʒ/ (see Fig. 2).

4.3.2. Region and consonant effects on F_2

For /i/, a significant effect of the following consonant was found ($p = 0.000$). Indeed, the F_2 of /i/ tends to be higher before /ʁz/ than before /v/, and still higher before /ʒ/. For /y/, a significant effect of the following consonant in interaction with the speaker's city was found ($p = 0.000$). In

QC and RN, the F_2 of /y/ tends to be highest before /v/ and lowest before /ʁ/. However, in SG, the F_2 of /y/ is as high before /ʁ/ as it is before /zʒ/. For /u/, a significant effect of the following consonant in interaction with the measurement point was found (p = 0.000). In fact, the F_2 of /u/ differs depending on the following consonant only at 75% of vowel duration, where it is higher in front of /ʒ/ than in front of /ʁv/, and still higher in front of /z/.

Figure 2: F_1 of /iyu/ from all measurement points in function of the city and the following consonant.



4.3.3. Region and consonant effects on F_3

For every vowel, a significant effect of the following consonant in interaction with the speaker's city was found (p = 0.000). In SG, the F_3 of /i/ does not vary according to the following consonant. However, in QC and RN, it is lower before /ʁ/ than before /vzʒ/. In addition, in QC, it is higher in front of /ʒ/ than in front of the other consonants. The F_3 of /y/ does not differ in SG. In QC, it is higher before /z/ than before /ʁʒ/ (the F_3 of /y/ preceding /v/ being not significantly different from the F_3 of /y/ preceding the other consonants). In RN, it is higher preceding /vz/ than preceding /ʁʒ/. The F_3 of /u/ is equivalent in front of any lengthening consonant in RN. In QC, it is higher in front of /ʁ/ than elsewhere. Finally, in SG, F_3 is higher preceding /ʁʒ/ than preceding /vz/.

5. DISCUSSION AND CONCLUSION

First and foremost, it should be emphasized that our sample includes only 30 speakers from three cities and that the corpus of lengthened vowels is composed of 12 lexical units in which the first consonant was not controlled. Geographical, lexical and consonantal conditionings still require, therefore, additional study. A possible effect of gender, as opposed to biological sex, could also be investigated. Our results concerning F_1 are particularly informative. On average, lengthened variants follow a trajectory starting with an F_1 value intermediate to those of tense and lax variants. However, in the course of their duration, vowels preceding /vzʒ/ reach the F_1 values of the tense variants. Vowels preceding /ʁ/ also tend toward tense values, even though they do not attain them. This might explain why QF lengthened close vowels have been claimed to be tense by [11, 18, 26]. Nonetheless, lengthened close vowels exhibit an important closing trajectory, as do the well-known diphthongised vowels in QF [14]. This noticeable formant movement could be what has led many researchers (like [5, 9, 13]) to perceive lengthened close vowels (or at least some of them) as diphthongised. The F_1 of lengthened vowels preceding /ʁ/ is almost always significantly higher then the F_1 of those preceding /vzʒ/, yet they display significant closing trajectories. Taken together, these observations seem to be coherent with the impressionistic label "lax and diphthongised" given by [6, 19] to lengthened vowels preceding /ʁ/. In conclusion, the acoustic patterns that we have brought to light can be consistent with diverse auditive impressions which have been discussed in the literature. Nevertheless, the majority of the studies cited above did not assess in depth the perception of lengthened close vowel quality, relying instead mainly on the authors' subjective evaluation. To our knowledge, no perception experiments or interjudge agreements were conducted in QF (except in [13]). Subsequent studies are therefore essential in order to explore the links between production and perception of QF lengthened close vowels.

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