VOWEL LAXING IN LAURENTIAN FRENCH: LOWERING, CENTRALIZATION, AND INDIVIDUAL VARIATION*

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Laurentian French, which encompasses the varieties spoken in Ontario and Quebec, is well-known for a process of allophonic laxing that targets the high vowel phonemes /i/, /y/, and /u/. We are interested in resolving two areas of disagreement in the literature on this phenomenon, those being (a) whether laxing occurs before voiced fricative and rhotic codas and (b) whether laxing involves both tongue centralization and lowering or simply tongue body lowering. Our paper is structured as follows. First, in section 1, we review previous work on Laurentian French laxing, highlighting the disagreements we wish to address. Next, in section 2 we describe our experimental setup. Following that, section 3 presents our findings that laxing occurs before rhotics but not before voiced fricatives, and that laxing involves centralization for some but not all speakers. Finally, section 4 concludes and offers directions for future research, including a planned ultrasound study on harmonic spreading.

1. Background

Laurentian French (henceforth LF) includes the varieties of Canadian French spoken in Ontario and Quebec, but excludes other varieties like Acadian French, which is spoken in the maritime provinces. Aside from the process of vowel laxing which is the focus of our study, LF is also distinguished phonologically by a phonemic distinction between /a/ and /ɑ/, as well as a process of affrication affecting alveolar stops before high front vowels. Examples of these characteristics are given in (1).

(1) Phonological characteristics of LF
   a. Phonemic distinction between /a/ and /ɑ/
      - [pat] *patte*‘paw’
      - [pɑt] *pâte* ‘pasta’

   b. Affrication of /t, d/ before /i, y/
      - /pəti/ → [pətˢi] *petit* ‘small (masc.)’
      - /pitu/ → [pitu] *pitou* ‘doggy/puppy’

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c. Laxing of /i, y, u/
   - /pəti/ → [pətˢi] *petit* 'small (masc.)'
   - /pətit/ → [pətˢɪt] *petite* 'small (fem.)'

Laxing occurs when high vowels appear before certain coda consonants in closed syllables (Poliquin, 2006). The process is optional in non-final syllables (Poliquin, 2006), although we focus on final syllables where the process is obligatory (Poliquin, 2006). It is widely agreed that laxing occurs when the coda consonant is not one of /ʁ/, /v/, /z/, or /ʒ/, that is when it is neither a rhotic nor a voiced fricative. As for the four consonants just mentioned, which are often labelled together as *lengthening* consonants in the literature on LF, there is little agreement with regards to their relationship to vowel laxing. Some authors (MacKenzie and Sankoff, 2010; Paradis, 1985) claim that laxing occurs before all of the lengthening consonants. Other authors (Gauthier, 2013; Gendron, 1966; Hall, 2016; Walker, 1984) claim that laxing does not occur before any of the lengthening consonants. One author (Boulanger, 1986) claims that laxing occurs before the voiced fricatives but not before the rhotic. The reverse claim that laxing occurs before the rhotic but not before the voiced fricatives is made by Côté (2012) and Lamontagne (2021). Finally, still more authors (Côté, 2010; Dumas, 1974; Leblanc, 2012; MacLaughlin, 1986; Ostiguy and Tousignant, 1993; Sigouin and Arnaud, 2014, 2015) claim that high vowels are diphthongized before the lengthening consonants, starting with a lax quality but ending with a tense quality. All the varying claims are summarized in Table 1

Table 1. Summary of claims regarding lengthening codas.
Laxing = L, diphthongization = D, and neither = N

/ʁ/ coda	/v/ coda	/z/ coda	/ʒ/ coda	Sources
L	L	L	L	MacKenzie and Sankoff (2010), Paradis (1985)
N	L	L	L	Boulanger (1986)
L	N	N	N	Côté (2012), Lamontagne (2021)
N	N	N	N	Gendron (1966), Walker (1984) Hall (2016), Gauthier (2013)
D	D	D	D	Dumas (1974), MacLaughlin (1986), Côté (2010), Leblanc (2012), Ostiguy and Tousignant (1993), Sigouin and Arnaud (2014, 2015)

Another aspect of LF laxing, namely its acoustic and articulatory correlates, is equally rife with differing findings. While every acoustic study of LF laxing finds that laxed vowels have a significantly higher first formant (F1) than their regular tense counterparts, the results pertaining to second formant (F2) differences are inconsistent. Most find that

laxed front vowels have significantly lower F2 and that laxed back vowels have significantly higher F2 (Arnaud et al., 2011; Dolbec et al., 1993; Gendron, 1966; MacKenzie and Sankoff, 2010; Martin, 2002; Paradis, 1985), but a minority of studies find no such differences (Dalton, 2011; Sigouin and Arnaud, 2014, 2015). Based on these formant differences, we expect a lower tongue position (since F1 is negatively correlated with vowel height) and a more central tongue position (since F2 is negatively correlated with backness), although the single existing articulatory study by Dalton (2011) reported only tongue lowering.

With this background in mind, our research questions are as in (2). To answer these questions, we conducted an online acoustic study, the design of which is described in the next section.

(2) Current research questions:
   a. Do high vowels in laxing environments centralize and lower, or just lower?
   b. Does laxing and/or diphthongization occur:
      i. before /v, z, ʒ/, that is before voiced fricatives?
      ii. before the rhotic /ʁ/?
   c. What is the extent of individual variation in the realization of vowel laxing?

2. Methods

Nine native speakers of LF (8 female) were recruited through the University of Ottawa Integrated System for Participation in Research. The study was conducted online, since in-person experiments were not permitted at the time due to COVID-related concerns. Participants read a word list aloud while audio was being recorded locally on their computer using Audacity, a freely downloadable software (Audacity Team, 2021). Following the experiment, participants completed a basic demographic questionnaire.

The word list consisted of 42 French words in total: 24 disyllabic critical words, 12 monosyllabic words for another experiment, and 6 disyllabic filler words. The 24 critical words were split evenly, with 8 for each of the 3 high vowel phonemes /i/, /y/, and /u/. Each group of 8 was again split evenly, with 2 for each of the 4 types of final syllable: open, voiced fricative coda, rhotic coda, or other coda. The list was repeated 6 times, with a different randomization for each repetition. This randomization was the same across all participants.

We extracted F1, F2, and F3 values from vowels in final syllables. These formant values were taken at 25%, 50% and 75% of the vowel's duration using Praat (Boersma and Weenink, 2022). We then normalized formant values on a speaker-by-speaker basis using the Nearey 2 method (see Adank et al., 2004 for details).

3. Results

To analyze the normalized formant values, we ran mixed effects models in R (R Core Team, 2022) using the lme4 package (Bates et al., 2015). Estmated p-values were obtained with the lmerTest package (Kuznetsova et al., 2017). In total there were six models, with two models for each of the three high vowels, one predicting normalized F1 and the other predicting normalized F2. With the higher number of models, we set a conservative threshold of $p < 0.0083$ (i.e., $0.05 \div 6$) for significance.

Each model included a fixed effect of syllable type, with open syllables acting as the baseline. Models also included a fixed effect of time ($-1 = 25\%$ duration, $0 = 50\%$ duration, $1 = 75\%$ duration) to test for diphthongization, and included all syllable-by-time interaction terms as well. For random effects, we used the maximal structure, as recommended by Barr et al. (2013). This consisted of by-word intercepts, by-word slopes for time, by-participant intercepts, and by-participant slopes for syllable type, time, and their interactions.

In all models, the effect of time and its interactions with syllable type were never significant, so the remainder of this section discusses only the measurements taken at vowel midpoint. Vowels before coda consonants other than voiced fricatives (VFs) had significantly higher F1 than vowels in an open syllable and vowels before a voiced fricative ($p < 0.001$ in all cases). This effect was consistent across all vowels and all speakers, and Figure 1 offers a visual summary of the differences. Since F1 is negatively correlated with vowel height, these acoustic results suggest that vowels before rhotics and other non-VF codas are articulated with a lower tongue position. Our results parallel those of Sigouin and Arnaud (2014, 2015) who also find that rhotics pattern with other non-VF codas, although we see full laxing where they saw partial laxing.

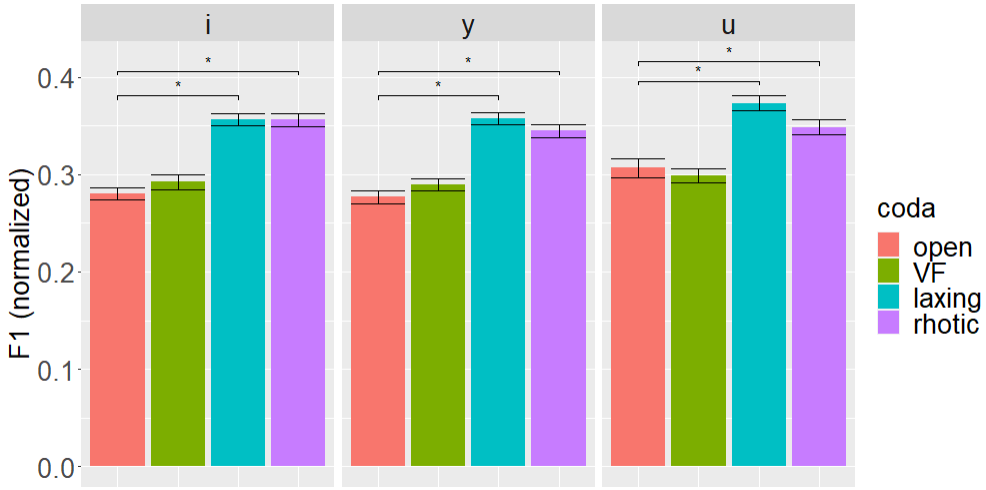

Figure 1. Normalized F1 by vowel and syllable type

As for F2 differences, the vowel /i/ had lower F2 before non-VF and non-rhotic codas ($p = 0.0011$), which would suggest a more central articulation since F2 is negatively cor-

related with backness. Closer inspection, however, revealed a split between speakers with strong centralization (of which there were 6) and those with no centralization (of which there were 3). Figure 2 depicts the normalized F2 for /i/ from a representative speaker of each type, with speaker 02 exhibiting no centralization and speaker 06 exhibiting strong centralization.

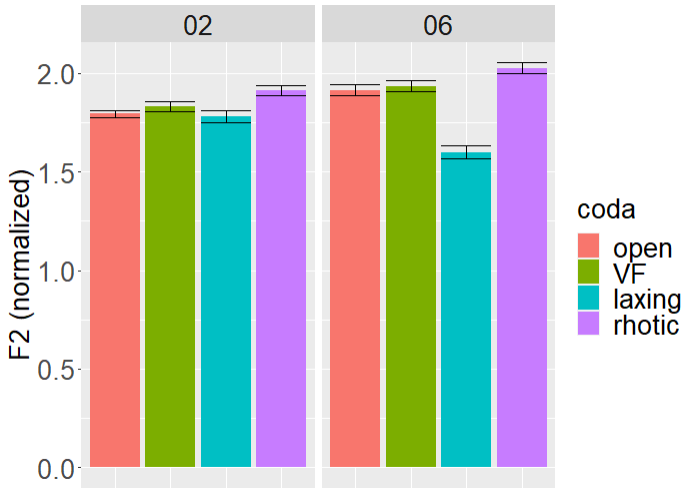

Figure 2. Normalized F2 for /i/ from two representative speakers

The vowel /y/ also had lower F2 ($p = 0.0026$), but this occurred specifically before rhotic codas, and the effect was consistent across all speakers. One possibility for this F2 difference is centralization, like we saw above for /i/ before non-rhotic and non-VF codas, although another possibility is that /y/ is susceptible to r-colouring. We think the latter interpretation is more likely since Mielke (2015) finds that the other front rounded vowel phonemes in LF (/ø/, /œ/, and /œ̃/) can be rhoticized. Figure 3 illustrates the observed F2 difference for /y/.

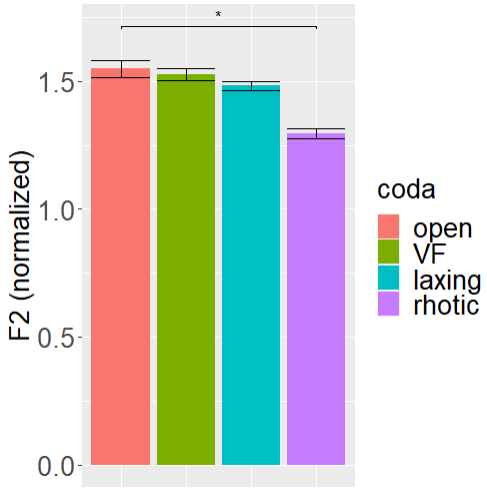

Figure 3. Normalized F2 for /y/ from all speakers

Table 2 summarizes all the results just discussed, with open syllables acting as the baseline for comparison. We remind readers that no other effects were found to be significant in the statistical models. The lack of significant time effects and time-by-syllable interactions implies a categorical lack of diphthongization in the data we collected.

Table 2. Summary of significant effects from the statistical models

Vowel	Coda	Formant	Direction	Significance
/i/ /y/ /u/	Laxing	F1	Higher	$p < 0.001$
/i/ /y/ /u/	Rhotic	F1	Higher	$p < 0.001$
/i/	Laxing	F2	Lower	$p = 0.0011$
/y/	Rhotic	F2	Lower	$p = 0.0026$

4. Discussion and Conclusion

An unexpected finding in the data we collected is that there was no evidence of laxing before voiced fricative (VF) codas, despite there being three studies (Boulanger, 1986; MacKenzie and Sankoff, 2010; Paradis, 1985) claiming that laxing can occur in this environment. Equally unexpected was that we observed no statistical evidence for diphthongization before VFs or rhotics, despite there being seven studies (Côté, 2010; Dumas, 1974; Leblanc, 2012; MacLaughlin, 1986; Ostiguy and Tousignant, 1993; Sigouin and Arnaud, 2014, 2015) that report diphthongization in these environments. Inspecting the responses to the demographic questionnaire, we saw that our participants were all from Montréal or further west, whereas the participants of the just-mentioned studies are generally from Montréal and further east. It is possible, then, that these discrepancies are due to finer grained dialectal differences within Ontario and Quebec, although further experimentation is necessary before we can make this claim with certainty.

Another result of ours that merits discussion is the fact that only /i/ displayed any centralization before non-VF and non-rhotic codas. This could be because backing /y/ or fronting /u/ would create confusion between these two phonemes. The vowel /y/ is distinguished from /u/ only in terms of backness, whereas /i/ differs from /u/ in terms of backness and rounding, and thus may have greater freedom to shift within the vowel space. The Laurentian French vowel inventory (excluding schwa) is given in Table 3 for reference. As an interesting aside, we note that the proportion of our speakers who displayed centralization (six out of nine) mirrors the proportion of past studies that report centralization (six out of nine).

Table 3. Laurentian French vowel inventory (excluding schwa)

	Front Unround	Front Round	Back
High	i	y	u
Close-mid	e	ø	o
Open-mid	ɛ ɛ̃	œ œ̃	ɔ ɔ̃
Low	a		ɑ ɑ̃

Based on our acoustic findings, we conclude that (a) LF vowel laxing involves a lower tongue articulation, (b) LF laxing also involves tongue backing for /i/ in some speakers, and (c) laxing occurs when the final syllable's coda is not a voiced fricative. In the future we plan to corroborate these findings with articulatory data collected via ultrasound. We also plan to investigate an additional process of laxing harmony that has been reported for the language (Cuerrier and Reiss, 2020; Dalton, 2012; Dumas, 1974; Gauthier, 2013; Hall, 2016; Poliquin, 2006). In this optional process, the laxing of a final closed syllable can cause preceding high vowels in open syllables to become lax (e.g., /filip/ → [fi.lɪp] or [fɪ.lɪp] 'Phillip'), even though open syllables are supposed to be tense by default.

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