The /ɛ/-/ɜ/ contrast in Quebec French

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ABSTRACT

The historical length distinctions have disappeared from the vowel system of Standard French, but they remain in several regional varieties. We focus on the /ɛ/-/ɛ:/ contrast in Quebec French, for which Santerre [2, 3] proposed a reanalysis based on vowel quality /ɛ/ vs. /ɜ/. We build on Santerre's proposal by providing a large scale acoustic analysis of 1718 realizations of /ɛ/ and /ɜ/ in final and non-final syllables, taken from the word lists of the PFC-Quebec corpus [6, 7]. Acoustical results for duration, position in the F1/F2 space, and distance between the starting and end points of the vowels confirm that /ɛ/ and /ɜ/ are distinct in both duration and quality. A regional difference in the realization of /ɜ/ is also observed. A lexical decision task performed by 44 listeners suggests that vowel duration is not a relevant perceptual cue in the perception of the /ɛ/-/ɜ/ contrast.

Keywords: Laurentian French, vowel contrasts, diphthongization, perception, acoustics, Quebec

1. INTRODUCTION

Whereas historical length distinctions have been lost in the Standard French vowel system (e.g. [1]), they remain productive in other varieties, in particular that between /ɛ/ and /ɛ:/, as exemplified by the minimal pair *faites* /fɛt/ 'do.2PL' vs. *fête* /fɛ:t/ 'party'; other minimal pairs include *mettre* /mɛtʁ/ 'put.INF' vs. *maître* /mɛ:tʁ/ 'master' and *belle* /bɛl/ 'beautiful.FEM' vs. *bêle* /bɛ:l/ 'bleat'. Laurentian French, the main variety spoken in Quebec and Canada, is one such variety, but Santerre [2, 3] has proposed that the /ɛ/-/ɛ:/ distinction has been reinterpreted as mainly based on vowel quality and he adopts the symbol /ɜ:/ for the long vowel, a more open and less anterior vowel than /ɛ/. Santerre's vowel measurements for the pair *faites-fête* are summarized in Table 1.

As a result, the Laurentian vowel system includes pairs of long and short vowels, which are all distinguished by both duration and quality [4], as shown in Figure 1 for oral vowels. In this variety, however, long vowels are diphthongized in closed final syllables toward the corresponding high vowel, as in *fête* [fɜ͡it].

Table 1: Average durations (cs), average values of F1 and F2 at the beginning (F1_A, F2_A) and end (F1_B, F2_B) of the vowel (Hz). Based on [2].

	Av. Dur (cs)	Av. F1_A (Hz)	Av. F1_B (Hz)	Av. F2_A (Hz)	Av. F2_B (Hz)
faites	12.071	560	600	1914	1845
fête	21.643	645	533	1717	1990

Figure 1: Oral vowel system of Quebec French. Based on [4].
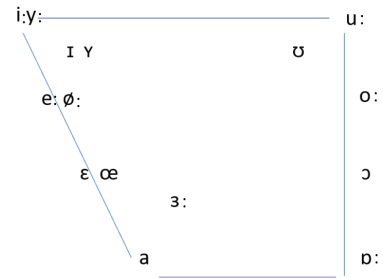
Santerre's findings were based on a small date set: seven speakers uttered each word twice and there are missing values for F1 or F2 for most tokens (mainly due to the material difficulty to examine formants in the 1970s-1980s). In addition, since the long vowel was measured only in a context that favors diphthongization, we cannot exclude the hypothesis that the observed difference in quality between the short and long vowels is only due to diphthongization and not to an underlying contrast in quality between them. It is also unclear to what extent speakers rely on quality or duration to distinguish between /ɛ/ and /ɜ:/.

We offer a large scale replication of Santerre's acoustic findings, including /ɜ:/ in non-final syllables to prevent diphthongization, and using new spectral measurements, such as the distance between the initial and final positions of each vowel in an F1/F2 space [5]. The results also point to regional variation in Quebec in the diphthongization of /ɜ:/. In addition, we complement the production data with the results of a lexical decision task addressing the role of vowel duration in the perception of /ɛ/ vs. /ɜ:/.

2. PRODUCTION

2.1. Speakers

The data considered in this study were taken from the Canadian portion [6] of the Phonologie du Français Contemporain (PFC) project [7].

We analyzed words containing /ɛ/ and /ɜː/ phonemes, read by 360 speakers (166♂ and 194♀) recorded between 2009 and 2017 in 25 localities in Quebec and one in Ontario (Canada). The speakers belonged to three different age groups: 108 born in 1953 or before, 141 born between 1954 and 1984, and 111 born in 1985 or after. They were all native speakers of Laurentian French. Speakers of Acadian French, the other variety spoken in Canada, whose vocalic system functions differently [8], were not included.

2.2. Material

Among other tasks, each speaker read two word lists, which included the words *faites* 'do.2PL', with the short /ɛ/, and the words *fête* 'party', *fêtard* 'reveler', *fêter* 'celebrate-INF' and *fêteriez* 'celebrate-COND.2PL', with the long counterpart /ɜː/, in final and non-final syllables. The last three words are morphologically derived from *fête*. Unfortunately, the word lists did not include derived forms with the short /ɛ/ (e.g. *pèter* /pɛte/ 'pop.INF' derived from *pète*). The first vowel of each token was automatically segmented [9] in Praat [10], and manually checked and corrected. A total number of 347 /ɛ/ and 1371 /ɜː/ was included in the analysis; see Table 2 for details.

Table 2: Number of tokens for each word.

faites	*fêtard*	*fête*	*fêter*	*fêteriez*	**Total**
347	333	332	352	354	1718

2.3. Metrics

A Praat script automatically extracted the duration (s) of each vowel and the values of its 1st and 2nd formants (Hz) at the 1/5, 2/5, 3/5, 4/5 and 5/5 of the duration of the vowel. We did not convert the formant values in Bark for the sake of comparison with [2] in Table 1.

We computed the Euclidian distance from the initial position (F1 and F2 at 1/5) to the final position (F1 and F2 at 5/5) for each vowel in a F1/F2 space (see equation 1). This measure is used as an approximation of the degree of diphthongization.

$$(1) \quad d = \sqrt{(F1pt1 - F1pt5)^2 + (F2pt1 - F2pt5)^2}$$

2.4. Statistical analysis

To analyze these data we used a linear mixed model (lmer package of R). Word, age, gender, and locality were set as fix effects, and speaker as a random effect. Duration and the Euclidian distance were set as dependent variables. We also computed R^2 values [11], representing the explained variance. The values obtained indicate to what extent the independent variables included in the linear mixed model influence our metrics. Here R^2 values will be used to qualify the weight of certain effects on the variation.

Posthoc tests (Tukey HSD) then allowed us to observe how our five words differed from one another in terms of diphthongization (=distance between the initial and final positions in the vowel in a F1/F2 space), position in a F1/F2 space, and duration.

A clustering model (Ward method, data = mean F1 and F2 for each speaker) was also used to further explore the link between regional origin, age, and vowel realization.

2.5. Results

First, our data showed durations, mean F1, and mean F2 values similar to those found by [2] (see Table 3 for our results vs. Table 1 for [2]'s results).

Table 3: Average durations (s), average values of F1 and F2 at the beginning (F1_A, F2_A) and end (F1_B, F2_B) of the vowel in Hz.

Word	Av. Dur (s)	Av. F1_A (Hz)	Av. F1_B (Hz)	Av. F2_A (Hz)	Av. F2_B (Hz)
faites	0.138	528	553	1845	1777
fête	0.23	693	477	1541	1881

2.5.1. Durations

The posthoc test showed significant differences in duration between the vowels of each word. Nevertheless Figure 2 allows us to observe that the vowel [ɜː] in *fête* (at the extreme right) is much longer than the others (*μ*=220ms, σ=57ms). The shorter duration of the vowels in *fêter*, *fêteriez* and *fêtard* is arguably related to their non-final and unstressed position in the word.

However, vowel duration in *faites* (*μ*=112ms, σ=39ms) is half that in *fête*, clearly indicating that [ɛ] and [ɜː] contrast in length. The word was the variable which had the higher effect on the variation in duration (R^2=0.48).

Figure 2: Boxplot of the distribution of vowel duration (s) for each word
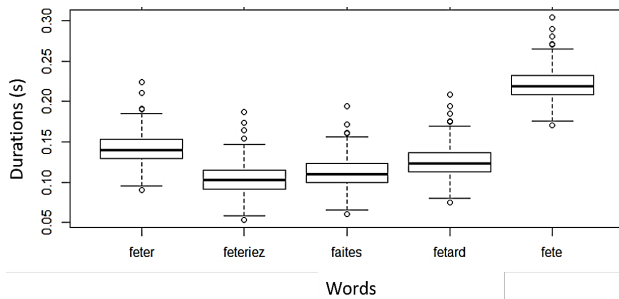
2.5.2. Spectral measures

Posthoc tests showed a significant difference in the distance in F1 and F2 between the 1st and 5th points of measure for *fête*, as opposed to the other four words, *fête* displaying a greater formant shift (see Figure 3). Once again, the word was the IV which had the higher effect on the DV (R²=0.23).

We can also qualitatively observe that formant trajectories go in opposite directions for *faites* vs. the other four words: backward and downward for the short vowel, but forward and upward for the long vowels, in both final and non-final position.

Figure 3: Formant trajectories of the vowels in our 5 words in a F1/F2 space (Hz)
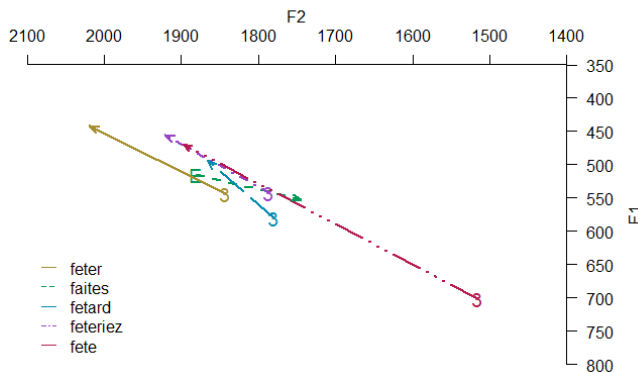
Our clustering model for the vowel of *fête* generated two main clusters which essentially differ in their F2 value: the mean F1 and F2 in Cluster1 were 595Hz (σ=80.29) and 1610Hz (σ=142.56), as opposed to 606Hz (σ=79.42) and 1950Hz (σ=97.18) in Cluster2. These formant values suggest that speakers in Cluster2 realize diphthongs that are more anterior than speakers in Cluster1.

This difference appears to indicate regional variation in the realization of the diphthong, as well as an interaction between age and location. To further address this issue, the 26 localities were divided between East and West, with a border situated halfway between Montreal and Quebec City. This corresponds to the traditional dialectal division

proposed for Quebec (e.g. [12]). As shown in Figure 4, Cluster2 includes more speakers from the eastern part of Quebec in each age group and this difference is more marked for older speakers, the old group from the East being the only one with a majority of diphthongs in Cluster2. The effect of the East-West division on the quality of the diphthongs is confirmed by an analysis of variance for mean F1 (F(1,351)=12.46, p<0.001) and mean F2 (F(1,351)=5.67, p<0.05). We also observe a significant effect of age groups on mean F1 (F(2,350)=5.06, p<0.01) and mean F2 (F(2,350)=6.73, p<0.01).

Figure 4: % of speakers from each age group and locality belonging to the 2 clusters.
Y=young, M=middle age, O=old; E=East, W=West. E.g. Y_E = young people from the East.
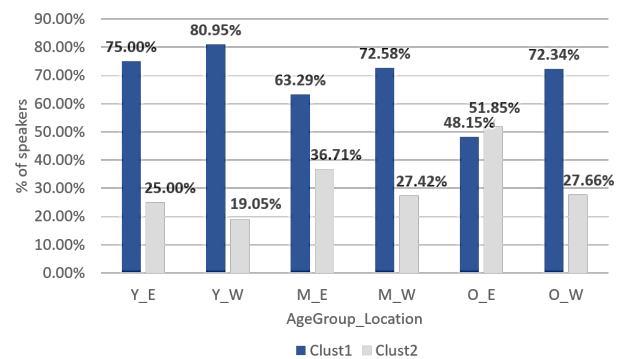
3. PERCEPTION

We designed a perception test in order to assess to what extent vowel duration affects the perception of contrast between *faites* and *fête*.

3.1. Material

We extracted 32 tokens of *fête* and *faites* from our corpus, as detailed in Table 4. Four groups of tokens were defined, in which male and female speakers were equally represented.

The 'canon' group includes realizations with a canonical vowel duration for each word (i.e. about 120ms for the vowel of *faites* and 210ms for the vowel of *fête*). The other three groups were designed by dividing in three the duration span shared by the vowels in *faites* and *fête*. The G1 group includes the shortest vowels (75ms to 103 ms), G2 corresponds to an intermediate duration (103ms to 131ms), and G3 consists of tokens with longer vowels (131ms to 160ms). The tokens in G1, G2 and G3 contain vowels that are all relatively short for *fête*, which suggests that they could be perceived as *faites* if vowel duration is an important factor in the distinction.

Table 4: Number of tokens for each word per duration group and speaker gender.

Duration / Gender	Canon		G1		G2		G3		Total
	F	M	F	M	F	M	F	M	
faites	2	2	2	2	2	2	2	2	16
fête	2	2	1	3	2	2	2	2	16
Total	**4**	**4**	**3**	**5**	**4**	**4**	**4**	**4**	**32**

For all 32 stimuli, we added a 70ms silence at the beginning of the word and normalized their intensity at 70dB. The stimuli were used in an online audio recognition test on the LimeSurvey platform. For each stimulus, listeners had to indicate whether they heard the word *faites* or the word *fête*. Stimuli were displayed in a random order (different for each participant).

A total of 44 native speakers of Laurentian French participated in the experiment (15♂ and 29♀, average age of 39 – σ=15.9). The test lasted around five minutes.

3.2. Analysis and results

We computed the percentage of good vs. bad identifications for each stimulus and for each listener, as well as kappa scores (Fleiss Kappa computed with R Package irr) to measure interjudge agreement.

The recognition test showed very little confusion between *fête* and *faites*. As shown in Figure 5, the error rates for *faites* and *fête* were respectively about 7% (46 errors) and 4% (30 errors). In each duration group, the error rates were as follows: for *faites*, 1% in G1 (with the shortest vowels), 11% in G2, 8% in G3, and 4% in the canonical group; for *fête*, 2% in G1, 1% in G2, 13% in G3, and 0.5% in the canonical group.

Fleiss' Kappa score for interjudge agreement was k=0.73 (73% of agreement between listeners' answers to the test, p<0.001). This level of agreement is considered quite good [13].

Figure 5: Number of *faites* and *fête* answers for both types of stimuli.
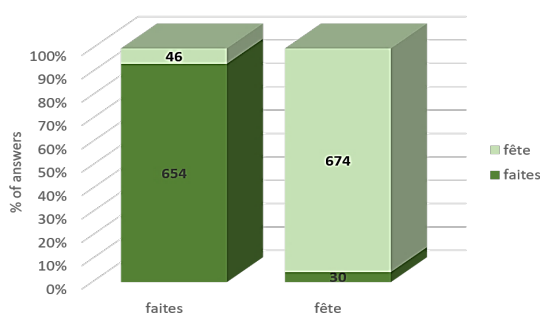
These results allow us to conclude that there is no effect of vowel duration on the perception of the distinction between *fête* (with a phonologically long vowel) and *faites* (with a phonologically short vowel). In particular, the tokens of *fête* with the shortest vowels were not perceived as *faites*.

4. DISCUSSION

In this study we pursued the work done by Santerre [2, 3] on the distinction between the long vowel /ɜ:/ of *fête* and the short vowel /ɛ/ of *faites*. We used a large corpus (360 speakers, 1718 tokens), computed new acoustic measures, and designed a lexical decision test to assess the influence of vowel duration on the perception of the /ɜ:/-/ɛ/ contrast.

In addition to the duration, mean F1 and mean F2 for each token of /ɜ:/ and /ɛ/, we computed the Euclidian distance from the starting point (at 1/5 of the vowel duration) to the end point (at 5/5 of the vowel duration) in a F1/F2 space.

These measures confirm the longer duration and diphthongized quality of the vowel of *fête* as opposed to that of *faites*, but also to those of *fêter*, *fêtard* and *fêteriez*, which are morphologically derived from *fête*. However, formant trajectories suggest that the two vowels remain distinct in all positions: going backward and downward in *faites*, but forward and upward in all words of the *fête* family. We conclude that even if the mean formant values for /ɜ:/ in non-final syllables are close to those of /ɛ/ in *faites*, there is no neutralization between the two vowels' quality. These results must be confirmed with additional minimal pairs, as well as derived forms with /ɛ/.

In addition, the statistical analysis uncovers a regional distinction in the diphthong in *fête*, as well as an interaction between age and location. Speakers from the eastern part of Quebec display diphthongs that are more anterior (which is known to be one of the distinguishing features of the East-West dialectal division of the Laurentian domain [14]). Moreover, this difference in the quality of the diphthongs appears to be subject to levelling across age in the direction of the western variant. This type of levelling has been observed for other sound variables [15], but the quality of diphthongs requires further investigation.

Finally, our perceptual experiment on the minimal pair *faites* vs. *fête* showed that word recognition was essentially driven by vowel quality rather than vowel duration. Our 44 native listeners correctly identified words at a rate of more than 90%, independently from vowel duration. Listeners relied on vowel quality, which further confirms Santerre's earlier proposal that the historical /ɛ/-/ɛ:/ contrast has been reanalyzed in terms of vowel quality in Laurentian French.

5. ACKNOWLEGDEMENTS

6. REFERENCES

[1] Lyche, C. 2010. Le français de référence: éléments de synthèse. In: Detey, S. et al. (eds), *Les variétés du français parlé dans l'espace francophone. Ressources pour l'enseignemen.* Paris: Ophrys, 143–165.

[2] Santerre, L. 1974. Deux E et deux A phonologiques en français québécois: étude phonologique, articulatoire et acoustique des oppositions de timbre et de durée. *Cahier de linguistique* 4, 117–145.

[3] Santerre, L. 1981. Stabilité et variation des oppositions ɛ/ɜ et a/ɑ en français de Montréal. In: Geckeler, H. et al. (eds), *Logos Semantikos: Studia Linguistica in Honorem Eugenio Coseriu 1921-1981.* Madrid/Berlin/ New York: Gredos/Walter De Gruyter, vol 4, 376–384.

[4] Côté, M.-H. 2012. Laurentian French (Québec): extra vowels, missing schwas and surprising liaison consonants. In: Gess, R., Lyche, C., Meisenburg, T. (eds), *Phonological Variation in French: Illustrations from Three Continents.* Amsterdam: John Benjamins, 235–274.

[5] Leblanc, G. 2012. *Une étude acoustique des voyelles orales susceptibles d'être diphtonguées en français québécois.* MA thesis, Université Laval.

[6] Côté, M.-H. 2014. Le projet PFC et la géophonologie du français laurentien. In: Durand, J., Kristoffersen, G., Laks, B. (eds), *La phonologie du français: normes, périphéries, modélisation.* Nanterre: Presses Universitaires de Paris Ouest, 175–198.

[7] Durand, J., Laks, B., Lyche, C. 2002. La phonologie du français contemporain: usages, variétés et structure. In: Pusch, C., Raible, W. (eds), *Romanistische Korpuslinguistik – Korpora und gesprochene Sprache.* Tübingen: Gunter Narr Verlag, 93–106.

[8] Cichocki, W. 2012. An overview of the phonetics and phonology of Acadian French spoken in northeastern New Brunswick (Canada). In: Gess, R., Lyche, C., Meisenburg, T. (eds), *Phonological Variation in French: Illustrations from Three Continents.* Amsterdam: John Benjamins, 211–233.

[9] Milne, P. 2014. *The Variable Pronunciations of Word-Final Consonant Clusters in a Force Aligned Corpus of Spoken French.* PhD thesis, University of Ottawa.

[10] Boersma, P. 2002. Praat, a system for doing phonetics by computer. *Glot International* 5.

[11] Nakagawa, S., Schielzeth, H. 2013. A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution* 4(2), 133–142.

[12] Verreault, C., Lavoie, T. 2004. Les parlers de l'Est et de l'Ouest québécois. Essai de caractérisation linguistique. In: Mercier, L., Cajolet-Laganière, H. (eds), *Français de Canada - Français de France VI.* Tübingen: Max Niemeyer, 71–121.

[13] Landis, J. R., Koch, G. G. 1977. The measurement of observer agreement for categorical data. *Biometrics,* 159–174.

[14] Dolbec, J., Ouellon, C. 1999. Peut-on distinguer des variétés phonétiques en français québécois ? *Dialangue* 10, 17–28.

[15] Friesner, M. 2010. Une prononciation 'tsipéquement' québécoise ? La diffusion de deux aspects stéréotypés du français canadien. *Canadian Journal of Linguistics* 55, 27–53.