

# ACOUSTIC PHONETIC PROPERTIES OF MID VOWELS IN NEW CALEDONIAN FRENCH

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## ABSTRACT

This paper investigates production of the mid vowels /e, ε, ø, œ, o, ɔ/ by four speakers of New Caledonian French (NCF). Formant and durational properties of these vowels are examined with respect to the type of syllable in which they occur. Results point to general adherence to the *loi de position* in NCF, such that the close-mid vowels occur in open syllables and the open-mid vowels occur in closed ones. There is, however, interspeaker variation concerning the realization of open syllable /ε/. There is also some evidence of /ɔ/-centralization in NCF, and of phonetically higher productions of /e/ and /o/ relative to other varieties.

**Keywords:** French, phonetics, mid vowels, New Caledonia, variation

## 1. INTRODUCTION

New Caledonian French (NCF) is a distinct regional dialect shaped by the complex social history of the collectivity [9]. The phonetics and phonology of NCF have been very infrequently addressed, however. One area of interest highlighted in the few descriptions of NCF sound systems is the realization of mid vowels, e.g. [9, 13].

### 1.1. French mid vowels & the *loi de position*

‘Standard French’ is generally said to contain two series of phonemic mid-vowels, close-mid /e, ø, o/ and open-mid /ε, œ, ɔ/ [5, 6].

Realization of these vowels is complicated by the so-called *loi de position* (LdP), a rule of complimentary distribution specifying that the open-mid vowels occur in closed syllables and the close-mid vowels occur in open ones [4, 6]. This is a tendency rather than a strict rule in most metropolitan varieties of French, and exceptions do occur in the form of minimal pairs containing /ø/-/œ/ and /o/-/ɔ/ oppositions in closed syllables (e.g. *jeûne* /ʒø̃n/ vs. *jeune* /ʒœ̃n/, *saute* /sot/ vs. *sotte* /sɔt/), and /e/-/ε/ opposition in open syllables (e.g. *des* /de/ vs. *dais* /dε/). In other varieties, notably those spoken in the south of France, the LdP is followed more

strictly, precluding such minimal pairs (i.e. *saute* & *sotte* both realized [sɔt], *des* & *dais* both [de]) [3].

There is some evidence that the mid vowels are undergoing change in metropolitan varieties such as Parisian French, in the direction of an eventual loss of close-mid/open-mid phonemic oppositions [7, 12]. This trend is found to be strongest for the /e/-/ε/ contrast, while /o/-/ɔ/ is the opposition least affected. A substantial increase in the frequency of phonetically intermediate mid vowel productions has also been documented [7].

Another phenomenon affecting the French mid vowels is centralization of the back vowel /ɔ/ (such that it is realized [ɔ̃] or near /œ/), a long-attested feature of working-class Parisian French that has since become more widespread and perhaps even prestigious in metropolitan Frenches [1].

### 1.2. Mid vowels in NCF

Hollyman [9] suggests that NCF contains just one series of phonemic mid vowels, /e, œ, o/, and that these may be realized as intermediate or ‘positional’ variants [10] (which may refer to allophonic variation according to the LdP). This claim remains to be tested experimentally.

Pauleau [14] does not discuss the phonemic status of the NCF mid vowels, but does note that their degrees of aperture often differ from those of e.g. Parisian French, specifying a closing of /ε/ towards /e/ (including in closed syllables like *quel* [kel], which would violate the LdP), an opening of /ø/, and loss of the /o/-/ɔ/ distinction or even inversion of their heights. She also finds that /e/ is phonetically higher in NCF than in other varieties (approaching [i]), that /o/ is higher and more retracted (occurring in the vicinity of [u]), and that lip unrounding or spreading can sometimes affect /ø/, causing a production closer to [e] [13].

## 2. AIMS

Given the hypotheses outlined in previous work on NCF, and the behaviour of mid vowels in French more generally, the current study aims to investigate the realization of NCF mid vowels, specifically:

- How closely do speakers of NCF follow the LdP in their production of mid vowels?

- Are close-mid/open-mid contrasts maintained in minimal pairs, in either quality or duration?
- What are the phonetic qualities of the mid vowels produced by NCF speakers?

### 3. METHOD

#### 3.1. Speakers

Four students from the Université de la Nouvelle-Calédonie (UNC) were recorded for this experiment, two male (both aged 19 years) and two female (aged 18 & 19 years). All four were born and completed all schooling in New Caledonia, and all spoke French as their first language.

#### 3.2. Corpus & recording procedure

Recording sessions took place in a meeting room at the UNC, and were captured using an H4N Zoom portable recording device (sampling rate 44.1kHz/16-bit) and an AudioTechnica AT892c ear-mounted microphone. Elicitation materials were presented to speakers as a slideshow on a laptop screen (1 item per slide).

Speakers produced real or nonsense-words of the form /pVp/ (or /pV/ for certain vowels) and real words, containing all French vowels. These included at least two minimal pairs for each close-mid/open-mid pair of phonemes (e.g. *des/dais*, *jeûne/jeune*, *saute/sotte*). Words were elicited in the following carrier phrases, produced x4 per word, in random order (i.e. 8 tokens per word, N=288 per speaker):

*Je dis X encore.* X. – /pVp/, /CVC/ & /CVCC/ words  
*Je dis X parfois.* X. – /pV/ & /CV/ words

#### 3.3. Analysis

Acoustic waveforms and spectrograms were generated in Praat [2] and consonants and vowels manually segmented, identifying relevant acoustic landmarks. Files were then converted for use with the Emu Speech Database System [8] and analysis using the Emu/R package in R [11]. Vowel targets were extracted at the midpoint of identified formant steady states, and plotted (F1~F2) by underlying Standard French phoneme.

Euclidean distances and ERatio comparisons were then calculated (following the procedure outlined in [8]) to quantify the relative acoustic distance between vowels /ø, o/ produced in closed syllables and the centroids of the same vowels as produced in open syllables, versus the centroids of open-mid vowels /œ, ɔ/ in closed syllables (i.e. to determine whether the contrasts were maintained, or whether the LdP was followed). The same procedure was followed to assess whether open syllable /ɛ/ was

realized closer in the acoustic space to the centroids of closed syllable /ɛ/ or open syllable /e/.

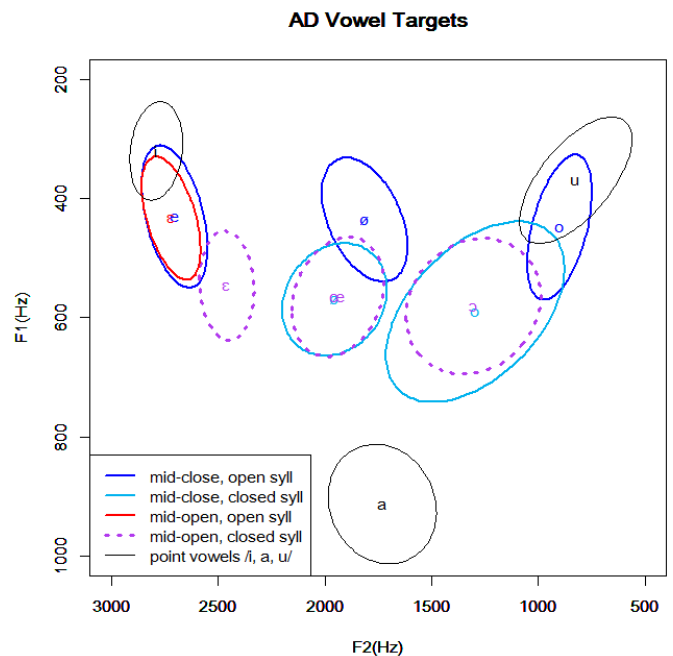
Finally, to ascertain whether the phonemes were kept distinct using length, the durations of mid vowels occurring in minimal pairs were statistically compared using either a paired Wilcoxon rank signed test or paired t-test (depending on the results of a Shapiro-Wilk test for normality of distribution).

## 4. RESULTS

#### 4.1. Vowel targets

Figures 1 to 4 plot ellipses (95% confidence intervals) of the vowel targets (F1~F2) produced by the four NCF speakers for the mid vowels, and point vowels /i, a, u/.

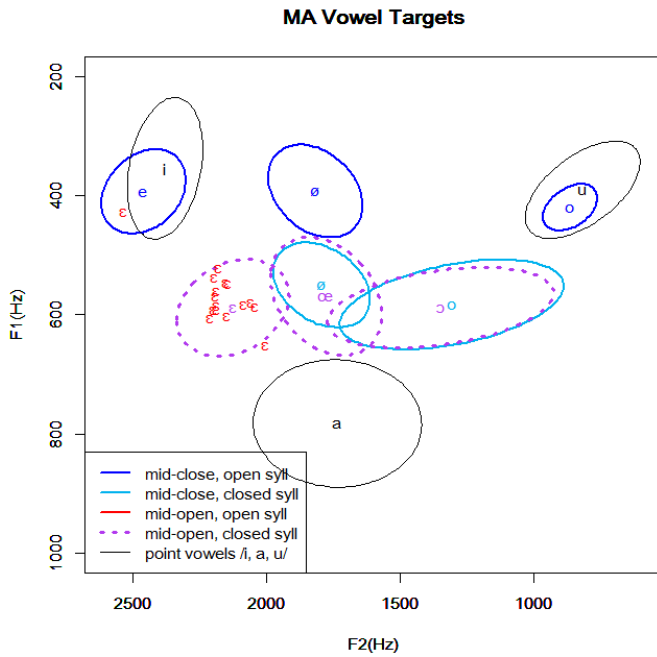
In all plots, the ellipses of closed syllable /ø/ and /o/ (light blue solid ellipses) and closed syllable /œ/ and /ɔ/ (purple dashed ellipses) show near-complete overlap. This indicates that the LdP is followed categorically for these vowels: close-mid /ø/ and /o/ are consistently realized [œ] and [ɔ] when they occur in closed syllables (e.g. *saute* & *sotte* are both realized [sɔt]). For three of the four NCF speakers (female AD and males YT & EK, Figures 1, 3 & 4), the ellipses of open syllable /e/ (dark blue) and /ɛ/ (red) also occur in exactly the same part of the plot, indicating that open-mid /ɛ/ is pronounced the same way as /e/ in open syllables (*tais* & *tes* both [te]).



**Figure 1:** Vowel targets (F1~F2) produced by female speaker AD

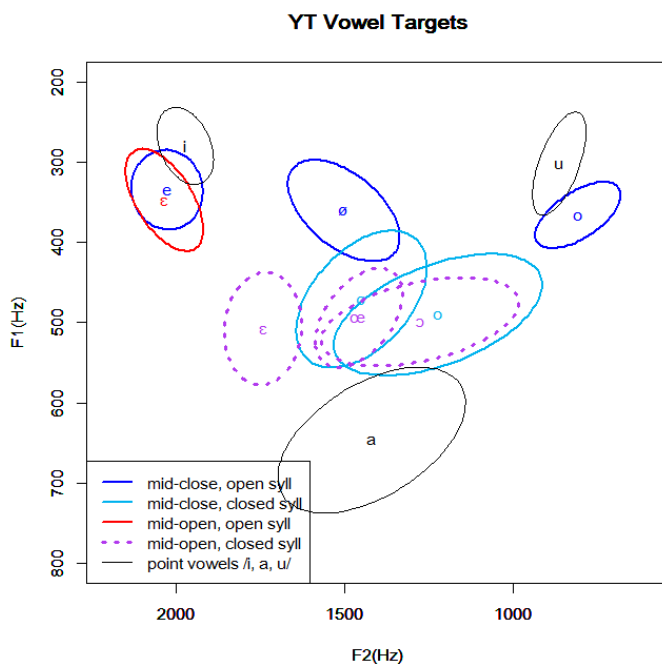
For the remaining speaker (female MA, Figure 2), however, all but one token of open syllable /ɛ/ (tokens plotted individually in red) occur lower in the plot, in the same space as closed syllable /ɛ/

(purple dashed ellipse). This demonstrates that for this speaker /ɛ/ typically remains phonetically open-mid, even in open syllables (i.e. *tais* [tɛ] & *tes* [tɛ]).

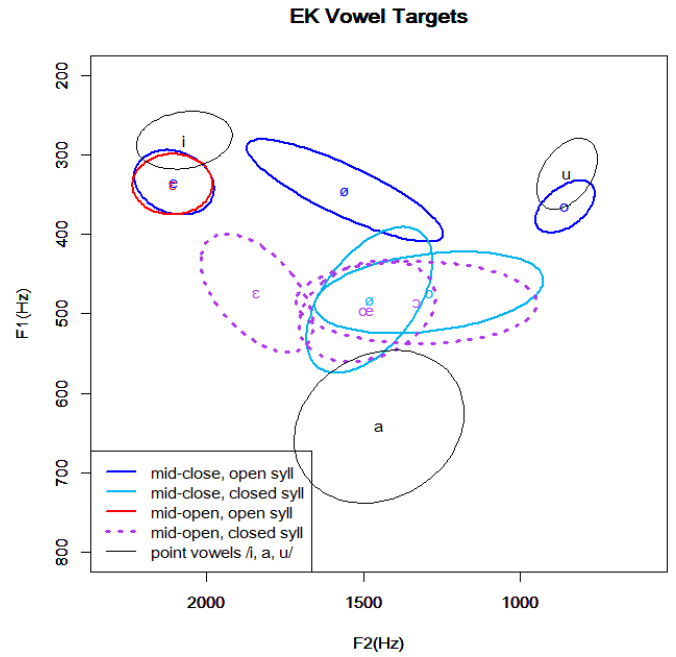


**Figure 2:** Vowel targets (F1~F2) produced by female speaker MA

The vowels /e/ and /o/ both occur relatively high in the vowel space for all speakers, sitting closely below (or even overlapping with) /i/ and /u/ respectively. Closed syllable /ɛ/ is also phonetically quite high for speaker AD (Figure 1), but for all other speakers there is substantial separation between /e/ and /ɛ/. No unrounding of /ø/ (which would result in a raised F2) is observed in the data.



**Figure 3:** Vowel targets (F1~F2) produced by male speaker YT



**Figure 4:** Vowel targets (F1~F2) produced by male speaker EK

Also prominent in the vowel plots is considerable intraspeaker variation in the production of closed syllable /o/ and /ɔ/, particularly in the dimension of F2, with some tokens being produced as far forward as the ellipses of /œ/ for speakers MA, YT and EK.

#### 4.2. Euclidean distance ERatios

The mid vowel realization patterns observed in the F1~F2 plots are further supported by the Euclidean distance ERatios presented in Table 2.

/ɛ/ open syllable	Mean ERatio	S.D.
AD	-1.49	0.31
MA	1.5	0.94
YT	-2.22	0.78
EK	-2.12	0.63
/ø/ closed syllable	Mean ERatio	S.D.
AD	-0.86	0.56
MA	-1.1	0.71
YT	-0.79	0.74
EK	-0.86	0.56
/o/ closed syllable	Mean ERatio	S.D.
AD	-1.02	0.86
MA	-1.42	1.17
YT	-1.57	1.17
EK	-1.13	0.67

**Table 1:** Mean Euclidean distance ERatio values for open syllable /ɛ/ & closed syllable /ø, o/

Mean ERatio values are consistently negative, signifying that tokens of closed syllable /ø, o/ are generally closer in the acoustic space to the centroid of closed syllable /œ, ɔ/ than that of open syllable /ø, o/, and open syllable /ɛ/ productions are consistently closer to the centroid of open syllable /ɛ/ than that of closed syllable /ɛ/. For speaker MA, the mean ERatio for open syllable /ɛ/ is positive, reflecting the fact that, unlike the other NCF speakers, her productions are usually closer to the centroid of closed syllable /ɛ/ than that of open syllable /ɛ/.

### 4.3. Duration

No significant differences in duration occur between any mid vowel pair that is produced in the same F1~F2 acoustic space in the minimal pairs. For open syllable /e/ and /ɛ/, speaker MA was excluded from the comparisons, and her vowels compared separately, on the basis that she keeps the pair distinct in vowel quality. These vowels are also significantly different in duration for this speaker ( $p < 0.01$ , mean durations of 134 ms for /e/ & 153 ms for /ɛ/).

## 5. DISCUSSION & CONCLUSIONS

The results presented in this paper indicate general adherence to the LdP (i.e. the close-mid variants occurring in open syllables, and the open-mid variants in closed syllables) for three of the four NCF speakers (AD, YT & EK), and adherence for the pairs /ø/-/œ/ and /o/-/ɔ/ for the fourth speaker (MA). This is evident in the formant characteristics of the underlyingly close-mid and open-mid vowels, which do not differ when the phonemes are realized within the same type of syllable. It also does not appear that the contrasts are preserved (within the same type of syllable) by means of duration. No significant duration differences are observed between any of the close-mid/open-mid phoneme pairs found to be alike in formant structure when produced in minimal pairs.

Interestingly, production of open syllable /ɛ/ is where we do see violation of the LdP for one NCF speaker (MA). /e/-/ɛ/ is actually the mid vowel opposition found to be most affected by loss of contrast in Parisian French [7, 12]. The pair /o/-/ɔ/, however, which is consistently merged in closed syllables in this study, is in Parisian French said to be a more robust mid vowel contrast [7, 12]. Perhaps tellingly, speaker MA did realize open syllable /ɛ/ as [e] once, within the carrier phrase, before reverting to [ɛ] when the word (*tais*) was repeated at the end of the phrase. It may be the case that this speaker is conscious of the variation possible in the production of open syllable /ɛ/, and her use of the variant [ɛ]

may therefore be confined to the careful speaking style elicited in this experiment.

As previously documented for NCF [13], participants in the current study produce tokens of /e/ that are unusually low in F1, clustering closely with their /i/ productions, and tokens of /o/ that are also quite close, occurring just below /u/ in the F1~F2 space. The raising of /ɛ/ in closed syllables also found by Pauleau [13, 14], however, is only somewhat apparent for speaker AD, whose tokens of /i/, /e/ and /ɛ/ are all very closely clustered in the F1~F2 plot (her tokens of /ɛ/ do not reach the phonetic height of /e/, however). Raised F2 for /ø/ as a result of lip unrounding or spreading (another feature of NCF mid vowel realization identified in [13]) is not observed in these speakers' productions.

Variation in closed syllable /o/ and /ɔ/ realization is substantial in the presented data; some tokens of [ɔ] in *saute/sotte* and *côte/cotte* are produced with a remarkably high F2, within the ellipses of /œ/, for three of the four speakers (MA, YT & EK). /ɔ/-centralization is well-attested in metropolitan Frenches, and has been found to occur more frequently in coarticulatorily favourable environments, such as preceding a 'front' lingual (but not labial) consonant [1]. In this study, too, we see centralized /ɔ/ occurring preceding one such consonant, [t], but not when the same vowel precedes the labial consonant [p].

The presented results provide some support for Hollyman's [9] claim that there is just one series of phonemic mid vowels in NCF, and that these may be realized as 'positional' variants [10], according to syllable type (although there does seem to be some level of interspeaker variation in this regard). The direction of phonetic adjustment according to syllable type also fits with Pauleau's [14] observations that /ø/ and /o/ are lowered in words like *jeûne* and *paume* (i.e. closed syllables) in NCF, and that /ɛ/ is often raised (at least in open syllables).

Future analysis of data from additional NCF speakers, and of less controlled speech styles, will help to accurately determine the prevalence within NCF of the mid vowel trends seen in this study (particularly those concerning realization of closed syllable /ɛ/, which here is subject to interspeaker variation). Future work will also consider the dynamics of formants across the length of the mid vowels in this variety.

## 6. ACKNOWLEDGEMENTS

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