# The role of vowel type, preceding consonant and lexical frequency on final vowel devoicing in Continental French

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## ABSTRACT

Final vowel devoicing is a feature of Continental French in which utterance-final vowels lose their voicing and produce fricative-like whistles. Previous studies have examined the phenomenon's phonological and pragmatic tendencies, revealing its preference for high vowels in open syllables at the ends of statements. Here, we re-examine and expand upon previous work by investigating the role of vowel type, preceding consonant and lexical frequency. Results reveal that high rounded vowels devoice more frequently than high unrounded ones, and that stops precede devoiced vowels at significantly higher rates than fricatives or sonorants. No significant effect was found for voicing in the preceding segment. A slight effect for lexical frequency was also found, such that words that were more frequent were more likely to be realized with a devoiced vowel. This suggests that although final devoicing is heavily predictable via phonological constraints, it also exists on the lexical level.

**Keywords**: phrase-final, vowel devoicing, French, phonetics, phonology

## 1. INTRODUCTION

Phrase-final vowel devoicing (PFVD) is a readily observed phenomenon in Continental French (CF) in which utterance-final vowels lose their voicing and produce intense fricative-like whistles [3], as in (1).

(1)      Mais oui_hhh.          Je t'ai vu_hhh.

To date, the scholarly attention on PFVD has focused on its phonological and pragmatic conditioning. Several studies have examined read and free speech data from native CF speakers and determined that high vowels /i,y,u/ in open syllables and statement-final position (where intonation canonically falls in CF) exhibit the highest degree of devoicing [2, 4, 5, 6]. Among these high vowels, Fagyal & Moisset [2] report the highest rates of devoicing in /i/ (80% of the time) from a sample of 10 speakers and 6 different target words (60 total vowels), while Martin [4] reports the highest rates

for /u/ (78.3% of the time) from a larger sample of 55 speakers and 60 target words (3,300 vowels).

Only one study has investigated the role of the phonological properties of the consonant immediately preceding the devoiced vowel [4], with the finding that stops overwhelmingly favor devoicing over fricatives. However, because the environments in this study were limited to preceding voiceless obstruents (/p,t,k,f,s,ʃ/), none has yet to examine the role of other manner types, such as liquids or nasals, or the role of voicing.

Similarly, given the phonological nature of early studies, previous work has also not yet examined the relationship between word frequency and PFVD. The lexicalization of this phenomenon was first suggested by Smith [7], who reported four instances of it in the high-frequency item *oui*, even when it occurred outside of the usual phrase-final domain.

The goals of this study are thus threefold: (1) to revisit the conflicting findings from Fagyal & Moisset [2] and Martin [4] by examining the set of high vowels more closely, to see if PFVD is a blanket phonological process applied to all members at similar rates or one that favors certain combinations of features with [+high], (2) to further examine the conditioning role of the previous consonant by testing voicing and a wider array of manner types, and (3) to formally investigate the role of word frequency.

## 2. METHODS

### 2.1. Materials

71 native CF speakers were recorded reading and roleplaying two separate tasks. 37 of the speakers were recorded in France (7 in Lyon, 8 in Strasbourg, 22 in Paris), and 34 were recorded in the United States (23 in Portland, OR, 11 in Austin, TX). Each task was performed twice and targeted 18 phrase-final tokens of /i/, /y/ and /u/, in open syllables and environments with preceding consonants that were both voiced and voiceless and distributed among the different manners of articulation: stops, fricatives, nasals and liquids (72 vowels per participant: 5,112 total). The target words, shown in Table 1, were embedded in meaningful texts and not marked with

any special characters during presentation (reading task adapted from [2]).

**Table 1**: Target words

| Vowel | Target Words | Task |
|-------|--------------|------|
| /i/ | *ennemi, energie, vie, souci, perfidie, redit* | Reading, Roleplay |
| /y/ | *vu, lu, connu, entendu, devenu, vaincu* | |
| /u/ | *bout, beaucoup, gourou, goût, atouts, flou* | |

Target words were also selected for their distribution across the frequency spectrum, some relatively common, others more obscure, as shown in Table 2. This was done in order to test if the application of PFVD is purely phonological, or more frequent in higher frequency items. Words were selected by their frequency score from a 6,000,000-word online corpus of French [9]. In order to avoid placing the scores in arbitrarily defined low-medium-high categories during statistical analyses, they were rescaled (i.e. divided by 150,000) and treated as continuous variables.

**Table 2**: Frequency of target words

| Frequency Score | Target Word |
|-----------------|-------------|
| Low (377-11,489) | *perfidie, energie, redis, goût, gourou, flou* |
| Medium (12,298-98,840) | *vaincu, ennemi, atouts, souci, lu, entendu* |
| High (130,738 -801,251) | *vie, vu, connu, beaucoup, bout, devenu* |

**2.2. Procedures**

Speakers were recorded via a head-mounted unidirectional cardioid microphone (SHURE WH20) plugged into a solid-state digital recorder (Marantz PMD 660) digitized at 44kHz (16 bit). Both tasks were completed under the direction of the researcher; participants were given as much time as they needed to complete them.

## 3. ANALYSIS

**3.1. Measurements**

Each target vowel was inspected and coded Y/N for the presence of a devoiced portion, which was determined by a drop in intensity and a lack of voicing bar in the spectrogram. The resultant devoicing manifests itself as a short period of aperiodic high-frequency energy, as shown with the label "PFVD" in Figure 1. The crosstabs

illustrating the raw counts of PFVD occurrence by vowel are shown in Table 3.

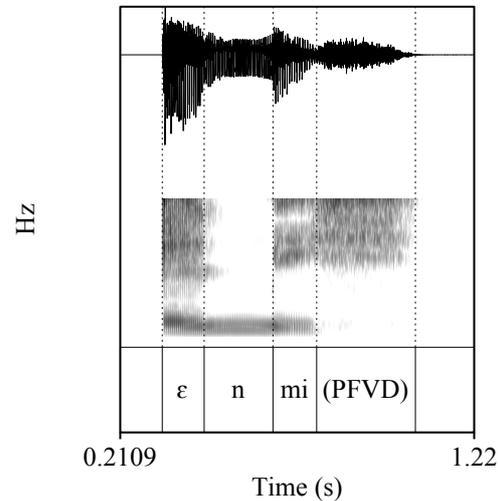**Figure 1**: Vowel devoicing on the spectrogram, word: *ennemi* 'enemy'.



**Table 3**: Raw counts of PFVD by vowel

| | Tokens | %Type V | % Overall V |
|-----------|--------|---------|-------------|
| /i/ | 569 | 33.39 | 11.13 |
| /y/ | 798 | 46.83 | 15.61 |
| /u/ | 760 | 44.60 | 14.87 |
| Total DVs | 2127 | 41.61 | 100 |
| Total Vs | 5112 | 100 | ----- |

**3.2. Statistics**

Binary measures of presence of devoicing were submitted to a logistic mixed-model regression, with the fixed factors of Vowel (3 levels: /i/,/y/,/u/), Voicing (2 levels: voiced, voiceless), Manner (4 levels: stops, fricatives, nasals, liquids), and Word Frequency (continuous). Individual speaker was treated as a random effect, to allow for individual variation among participants without the potential of Type I errors [1]. Multiple models were fitted to the data, to examine the individual role of each fixed factor and its interactions with the category Vowel. The best-fit model, shown in Table 4, was determined via a cross-model comparison of AIC and BIC fit statistics. Note that the previous 4 levels in the Manner variable were condensed to 3 after non-significant findings (i.e. stops, fricatives, nasals, liquids→ stops, fricatives, sonorants). All statistical analyses were carried out in Stata 13.1 [8].

**Table 4**: Best-fit model

| Fixed Effect | Odds Ratio | Std. Err | p-val | sig |
|--------------|------------|----------|-------|-----|
| Vowel /y/ | 2.425 | 0.443 | <.0001 | **** |
| Vowel /u/ | 1.426 | 0.211 | 0.016 | * |

| | | | | |
|---|---|---|---|---|
| Voice voiceless | 1.016 | 0.215 | 0.940 | |
| Cat. fricatives | 0.324 | 0.575 | <.0001 | **** |
| Cat. sonorants | 0.306 | 0.598 | <.0001 | **** |
| Word frequency | 1.182 | 0.371 | <.0001 | **** |
| Intercept | 0.633 | 0.147 | 0.049 | |
| Interactions | | | | |
| /y/*voiceless | 0.607 | 0.177 | 0.088 | |
| /u/*voiceless | 0.855 | 0.236 | 0.569 | |
| /y/*fricatives | 0.449 | 0.119 | 0.003 | ** |
| /u/*fricatives | 1.546 | 0.400 | 0.092 | |
| /y/*sonorants | 1.037 | 0.273 | 0.890 | |
| /u/*sonorants | 1.281 | 0.344 | 0.356 | |

*= p < .05, **= p <.01, ***= p <.001, ****= p <.0001

### 3.3. Results

#### 3.3.1. Vowel type

A main effect was observed for Vowel, such that /y/ and /u/ both devoiced at statistically different rates than the reference vowel /i/: /y/ was 2.4 times more likely to be devoiced than /i/, while /u/ was 1.4 times more likely.

#### 3.3.2. Voice and manner of preceding consonant

No main effect was observed for voicing: vowels that had preceding consonants that were voiced devoiced at rates similar to those that had preceding consonants that were voiceless.

A main effect was observed for manner of preceding consonant, such that fricatives and sonorants were both followed by PFVD at rates that were different from the reference category of stops: fricatives were 68% less likely to occur with PFVD than stops, while sonorants were 69% less likely. A significant interaction was observed between /y/ and fricatives, whereby /y/ was more likely to be devoiced after fricatives than after stops or sonorants, as shown in Figure 2.

**Figure 2:** Odds ratios of devoicing occurrence by manner type
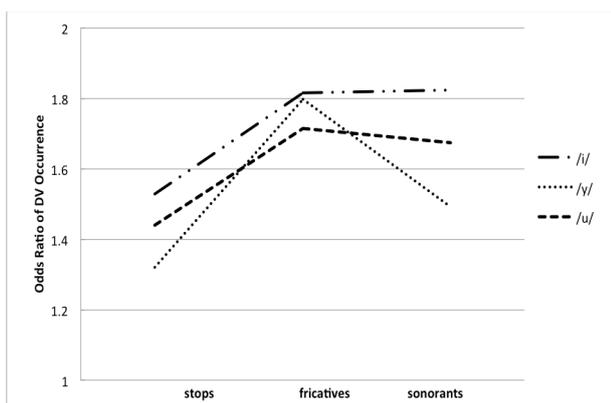


#### 3.3.3. Word frequency

A slight main effect was observed for word frequency, such that for every one-unit increase of 150,000 in a word's lexical frequency score, that word was 1.18 times more likely to feature a devoiced vowel.

## 4. DISCUSSION

### 4.1. Vowel type

Both /y/ and /u/ were significantly more likely to be devoiced than /i/. Overall devoicing percentages (shown in Table 3 above) ranged from 33-47% per individual vowel, much lower than those cited in [4] and [2]. Previous studies' low number of target items, participants and/or not controlling for lexical frequency most likely accounts for these differences. Results revealed the following hierarchy among high vowels, as shown in (3), in terms of tendency to devoice. Since the model did not directly compare /y/ to /u/, we may not rank them with respect to one another. The ranking from previous studies is listed for comparison, where only raw averages, not tests for statistical significance, were examined.

(3) /y/, /u/ >> /i/          (present study)
    /u/ > /y/ > /i/          [4]
    /i/ > /y/ > /u/          [2]

The results here lend support to Martin's [4] claim that high rounded vowels are devoiced more frequently than high unrounded ones. A possible articulatory explanation for this is that two mechanisms must take place in the mouth for a high unrounded /i/ to be devoiced, while only one must take place for high rounded /y,u/. For devoiced /i/, (1) the egressive airstream must maintain enough energy to articulate the vowel in final lengthened position [2, 10], and (2) the tongue must be maintained high in the mouth for the duration of its articulation, so the exiting air has a narrow constriction to fricate in. Comparatively, high rounded /y,u/ need only perform step (1), on the condition that the egressive airstream has enough exiting energy to blow through the lips, which is the site of frication for all [+round] vowels.

### 4.2. Voice and manner of preceding consonant

The voicing of the preceding consonant played no significant role in predicting the presence of PFVD on the following vowel. Significance was reached in terms of manner type, suggesting that stops are more likely to occur with PFVD than fricatives or sonorants. This finding is significant because it

confirms Martin's [4] observation in a two-way comparison between stops and fricatives that stops were more frequently followed by PFVD. The additional manner types added in this study (i.e. nasals and liquids) did not devoice at significantly different rates when maintained in separate groups, but did when condensed into the larger class of sonorants. Results yielded the following hierarchy among manner types, as shown in (4), in terms of tendency to be followed by a vowel with PFVD. Since the model did not directly compare fricatives to sonorants, we may not rank them with respect to one another. The ranking from [4] is listed for comparison, where only raw averages, not tests for statistical significance, were examined.

(4) stops >> fricatives, sonorants    (present study)
    stops > fricatives                [4]

This hierarchy requires further testing, particularly between the categories of fricatives and sonorants, to examine if a difference in PFVD co-occurrence exists between the two, or if the hierarchy is purely binary. On a more general level, it presents the idea that a preceding segment with low sonority appears frequently with PFVD. This behavior could be explained in stops by the excess of energy emitted during stop burst articulation versus other manner types: once released, any remnant energy finds its exit from the mouth, creating detectable turbulence via the palate or lips on its way out. Stop + high vowel combinations would then be favored over other manner types and vowel heights due to the combined high energy and closed nature of the mouth during their articulation.

### 4.3. Word frequency

The higher a word's frequency, the more likely it was to be realized with PFVD. This finding supports Smith's [7] observation that PFVD may now/also be lexicalized in certain high-frequency items. It is important to note that she made this observation from several devoiced tokens of the word *oui* 'yes', but that the evidence presented here to support it did not contain this item. It remains to be seen if the high-frequency lexical items associated with PFVD are all of the *oui* type, namely items that are high vowel-final, can phrasally stand alone and/or frequently exist at phrase boundaries.

## 5. CONCLUSIONS

In this paper, we showed that high vowels in CF with the [+round] feature exhibit PFVD more frequently than high unroundeds. No effect was found for voice in the preceding consonant, but manner type revealed that stops appear more frequently followed by PFVD than their fricative or sonorant counterparts. We also examined the role of word frequency, revealing that the more frequent a word is, the more likely it is to exhibit PFVD.

The present work has far-reaching implications for studies of phonetics and phonology because it opens the articulatory and theoretical discussion of why [+round] might be a favorable feature for the apparition of PFVD in high vowels. Since devoicing also occurs in CF mid vowels (albeit less frequently), the findings presented here for high vowels now warrant testing on the mid roundeds.

There are now multiple sources of evidence to suggest that low sonority segments, particularly stops, co-occur more frequently with PFVD than their high sonority counterparts. Further testing is required to see if the significant contrast is one of stops versus all other manner types or a more nuanced multi-tiered ordering, akin to a reversed sonority hierarchy.

In terms of lexical frequency, the frequency threshold and lexical items associated with PFVD must still be determined. This has implications for language change and language acquisition, as naïve listeners of French often perceive this turbulence in the input as a meaningful sound, and map it to its own segment in their spoken and written output, e.g. *Fanny_hhh* heard as [faniʃ], represented "Faniche."

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