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HAL Id: hal-00308395

https://hal.archives-ouvertes.fr/hal-00308395

Submitted on 30 Jul 2008

FROM *DILATION* TO COARTICULATION: IS THERE VOWEL HARMONY IN FRENCH ?

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This paper presents the preliminary results of an acoustic study, and a review of previous work on vowel harmony in French. It shows that harmony, initially regarded as regular sound change, is considered an optional constraint on the distribution of mid vowels. Acoustic evidence of anticipatory assimilation of pretonic mid vowels to tonic high and low vowels is shown in three speakers' readings of disyllabic words in two dialects. It is argued that vowel-to-vowel assimilation referred to as vowel harmony does exist in French, and likely to extend beyond morphological contexts in which it was previously thought to operate.

1.0. Introduction

Whether vowel harmony (henceforth, VH) exists in French might seem an incongruous question, since French is not known as one of the classic harmonic systems requiring all vowels in a prosodic domain, typically the word, to share ('harmonize' in) one or several features. While the phonological systems of Turkish and Hungarian, for instance, represent textbook examples of rounding and front/back harmonies, and many African languages, e.g. Igbo, are known for their use of [ATR] harmony, no dialect of French has ever been described as making an extensive use of VH. Yet, historical and contemporary descriptions routinely analyze cases of word-level vowel-to-vowel assimilation in such a term. As a type of vowel assimilation process, VH in these studies can be characterized as a 'form of qualitative articulatory adaptation between vowels with regard to one or more features' (Bussmann 1996:518). While previous studies of the French sound system generally agree on the existence of VH in such a broad sense, they often differ in their analyses of actual data.

VH in French is commonly described as a word-level anticipatory process affecting non-final mid vowels in open syllables that assimilate in height to the final, tonic vowel.[1] When the final vowel is a non-low vowel, such as [e] in examples (1a) and (2a), the pretonic mid vowel should be high-mid, such as [e] in (1a), and [ø] in (2a). Conversely, when the final vowel is low, like [a] in (1b), and [ɑ̃] in (2b), the pretonic mid vowel becomes low-mid, resulting in [ɛ] and [œ][2] in (1b) and (2b) (Walker 2001:54):

(1a) *aimer* [eme] 'to love'
(1b) *aimable* [ɛmabl] 'lovely'

(2a) *aveugler* [avøgle] 'to blind'
(2b) *aveuglant* [avœglɑ̃] 'blinding'

VH is also thought to operate in derivational contexts, where the mid vowel of the base may alternate depending on the height of the following suffix vowel. For instance in (3), /o/ is realized as low-mid in the derived form under the influence of the following low-mid vowel [ɛ] (Walker 2001:55):

(3) *gros* [gʁo] 'huge', adj. masc. > *grossesse* [gʁɔsɛs] 'pregnancy'

Notice, however, that the outcome in (3) conflicts with predictions that can be made in terms of 'open/closed syllable adjustment' (*la loi de position*). According to this constraint — subject to many exceptions in different dialects — the degree of opening of a mid vowel is determined by syllable structure: high-mid vowels (*voyelles mi-fermées*) appear in open syllables, while low-mid vowels (*voyelles mi-ouvertes*) occur in closed syllables. Therefore, the outcome of the derivation in (3) could also be as shown in (4), i.e. with /o/ realized as high-mid:

(4) *grosse* [gʁoːs] 'huge', adj. fem. > *grossesse* [gʁosɛs] 'pregnancy'

The realization in (4) is, indeed, the one proposed by Tranel (1987:61), but not as a generalization of *la loi de position*. For Tranel the pretonic high-mid vowel [o] in (4) is arguably due to some type of faithfulness constraint, as in derivations 'the vowel quality found in the base word may be preserved in the derived word' (idem).

As the examples in (3) and (4) illustrate, the distribution of mid vowels in these contexts has been analyzed in terms of several, sometimes conflicting,

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[1] The French vowel system has four degrees of opening, i.e. mid-vowels have two allophones. These are referred to as *mi-ouvertes* 'half-open ' ([ɛ]-[œ]-[ɔ]), and *mi-fermées* 'half-closed' ([e]-[ø]-[o]) in French (see Tranel 1987). Conceptualized as degrees of vowel 'height', these terms are commonly translated as 'low-mid' and 'high-mid' in English (see Walker 2001).

[2] Contemporary phonetic descriptions, however, consider [œ] a front rather than a central mid vowel (Fougeron and Smith 1999).

processes. It is, therefore, an open question whether VH needs to be part of this complex repertoire of generalizations. Crucially, one must ask the question: Is there empirical evidence in support of the phenomena illustrated above? Also, if it exists, does vowel assimilation in French represent instances of VH or of other types of assimilatory change? Since the vowel triggering the harmony effect is that of the suffix, i.e. the process is anticipatory, an analysis in terms of umlaut or metaphony[3] could be equally likely. Furthermore, is VH tied to specific morphological environments or it can also be shown in semantically and morphologically unrelated contexts?

The answer to the first question is straightforward: to the best of our knowledge there is currently no empirical data on VH in French. Thus, work presented in this paper represents the first such investigation. There is also a general lack of evidence on actual realizations of mid vowels in different dialects of French. This is despite the fact that words such as *chose* 'thing', *feutre* 'felt', and *(ils) veulent* '(they) want' vs. *veule* 'spineless', for instance, are actual shibboleth words, allowing a native speaker to tell the approximate geographical origin of another speaker. While front and back rounded mid vowels in closed syllables are always open ([œ] and [ɔ]) in, what is referred to as 'the South', i.e. roughly the Oc dialect area, they are realized as high-mid ([ø] and [o]) before [z] in most varieties of French spoken in 'the North', i.e. the approximate Oil dialect area. Vernacular varieties of Belgian French, however, also apply closed-syllable adjustment in these contexts (Blampin 1997:169).

In this paper we will examine two types of mid vowels in pretonic position of existing, disyllabic words in two dialects of French. We will first offer a review of previous studies in order to test some of the earlier claims empirically. We will then present evidence in support of anticipatory vowel assimilation, and will suggest relating them to metaphony phenomena known from the history of French, and other Romance languages.

2.0.   Previous treatments of VH in French
2.1.   Dilation, metaphony, and umlaut

Vowel-to-vowel assimilation in French was first analyzed in the *Traité de phonétique* by Maurice Grammont (1914[1939]) in terms of 'vocalic dilation'. The term 'VH' does not appear. As dictionaries rightly point out, this label — now used only sporadically in studies of French variable phonology (Gadet 1997:74-5) — might be just another 'generic label applied in a quite bewildering fashion to a wide range of historical changes' (Trask

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[3] Some analysts restrict the term 'vowel harmony' to carry-over assimilation, preferring terms such as *umlaut* or *affection* for cases of anticipatory assimilation (see Trask 1996:383). This point is discussed in greater detail in the Conclusion.

1996:221).[4] From the Latin *dīlāto* 'to extend', dilation refers to the anticipation or persistence of articulatory movements beyond the syllable in which the segment is located. It appears to be a metaphor for assimilation between non-adjacent segments: 'certain qualities of a phoneme spread to another phoneme that is not in immediate contact with the propagating phoneme' (Grammont 1939:251). Cases of vocalic dilation — among them *umlaut* and *metaphony* — are viewed as a regular sound change, affecting all morphological classes of a certain phonetic form at once, and with great uniformity: 'Dilation is accomplished with perfect regularity and consistence when all conditions it requires are met' (p. 251). The definition provided by Grammont matches contemporary definitions of VH:

> In **Parisian French** [our emphasis], vocalic dilation is regressive; it departs generally from the stressed vowel: the first of the two vowels in two consecutive syllables tends to adjust its quality to the second one; this is a dilation in degree of opening, and as such also in point of articulation [the position of the tongue along the front-back axis] (p. 266).

The process is argued to be productive in derivational and inflectional contexts. More typical in the front-mid series, it introduces a systematic [ɛ]/[e] alternation depending on the height of the following vowel (5).

(5) *plaire* [plɛʁ], *plaisir* [pleziʁ], *plaisant* [plɛzã]
　　'to please', 'pleasure', 'pleasurable'

Somewhat diminishing his own claim about the categorical nature of this opposition, Grammont confides, however, that the alternation is a rather 'delicate nuance' which might be difficult to perceive, because it affects unaccented vowels 'articulated with little tension' (idem). The phenomenon seems less clear for /o/, and is subject to many variations in front vowels, as well.

André Martinet (1945) affirms having found no evidence that the first vowel in a disyllabic word would be affected by the quality of the following vowel. Based on questionnaires circulated in a POW camp for French officers, Martinet declares that in none of the regional pronunciations of French the assimilation process seems to be typical of 'the majority of the subjects' (p. 142). Therefore, he argues, 'it does not seem to present the universal character many phoneticians, including Mr. Grammont, wish to attribute to it' (idem). Notice, however, that the two test cases Martinet presented to his subjects (6a-b) are examples that Grammont did not include in his discussion

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[4] The title of the chapter is '*Dilation*', which is the preferred spelling of the term throughout the text. One exception is the spelling *dilatation* on p. 251 with respect to assimilation between non-adjacent consonants. Whether this change in spelling signals a meaningful conceptual difference is, however, difficult to tell.

of vocalic dilation. The pair in (6a) is not quoted in his treatise, and the example in (6b) is based on the presumed alternation of the mid vowels [œ] and [ø], which is not discussed in Grammont's dilation rule.[5]

(6a) *été* [ete] 'summer' *(il) était* [etɛ] '(he) was'
(6b) *déjeuner* [deʒøne] 'lunch' *déjeunons* [deʒœnɔ̃] 'have lunch'

The notion of dilation also appears in *Phonétique historique du français* 'Historical Phonetics of French' by Pierre Fouché (1952). It refers, however, only to historical changes that led, for instance, to the closure and subsequent nasalization of ē to ī in words in Old French (*vēnī* (Lat.) > *vĩn* (O.Fr.)).[6] Synchronic aspects of vowel-to-vowel assimilation are discussed in the *Traité de prononciation française* 'French Pronunciation Treatise' (Fouché 1956) in terms of VH, which is defined similar to Grammont's conception of dilation. A few differences between the two approaches are, however, worth mentioning.

Fouché clearly states that VH does not affect the back mid vowel /o/ which remains phonetically low (half-open) no matter what vowel follows in the tonic syllable (7). This claim is, however, attenuated by pointing to a possible influence of a tonic /i/ on the preceding /o/ in words such as *fossile* 'fossil' and *vomir* 'to vomit'. Closed syllables with a low-mid front vowel before /r/ in pretonic position are also excluded from VH, which means that words such as in (8a-b) will not show the [ɛ]/[e] alternation.

(7) *vol* [vɔl] 'flight' > *voler* [vɔle] 'to fly'; *volant* [vɔlɑ̃],'flying'
(8a) *(il) perce* [pɛʁs] '(he) drills' > *percer* [pɛʁse]'to drill'
(8b) *(il) perd* [pɛʁ] '(he) looses' > *perdu* [pɛʁdy]'lost'

VH is, therefore, restricted to the pretonic front mid vowel [ɛ] in open-syllable, assimilating in frontness / degree of opening to the following high or high-mid front vowel [i], [e], or [y]. Fouché is also the first to consider stylistic factors in VH: 'Vocalic harmonization, I repeat, characterizes conversational speech. The more the pronunciation is careful, the less it is present.' (Fouché 1956:71). This idea will surface in subsequent discussions of VH (Léon 1996:51, Dell 1972:215).

Another original point in Fouché's approach is what appears to be the consideration of prosodic factors. The VH rule is written for the '**stressed** vowel [ɛ], spelled *ai*, *aî*, *ei*, *ay*, or *ê* (other than in words with –*ême*, and **e** before *ff*, *ss*, *tt*), becoming **unstressed**, while remaining open or passing to

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[5] We doubt that the alternation in (6b) exists in contemporary French. Based on Fougeron & Smith (1999), the assimilating, final back rounded nasal vowel in *déjeunons* is more closed and rounded than Martinet's transcription in [ɔ̃] makes it appear.

[6] The fronting of Latin ē to ī in Old French (*fēci* (Lat.) > *fici* > *fis* (Old Fr.)) is also cited as an example of dilation/VH by Malmberg (1974:178).

[e] with no alternation in spelling' (p. 70). However, prosodic factors, analyzed for instance in other languages (McCormick 1982) (Hualde 1989), are merely an artifact of the formulation of morphological conditions in which VH is thought to operate. When stating that 'vowels can appear in stressed and unstressed syllables within the language' (p. 64), Fouché is, in fact, considering semantically related pairs of words that are in derivational or inflectional morphological relationship with each other. Subdivided into different word classes, monosyllabic base words in these sets contain 'stressed' vowels which become, by definition, 'unstressed' in the pretonic syllables of disyllabic derived forms (9a-b). Thus metrical stress alternation is not a factor, but a correlate of VH. In these terms, VH is viewed as an analogical process extending a morphophonemic alternation to other roots and base words in the grammar. Such processes, generalizing the results of a previous sound change are well-documented in the history of other languages as well (Hock 1991:187).

(9a) *fraîche* [fʁɛʃ] 'fresh' > *fraîcheur* [fʁɛʃœʁ] 'freshness'
(9b) *fête* [fɛt]'fresh'   > *fêter* [fete] 'freshness'

All reference to the term dilation disappears in Bertil Malmberg's phonetic treatises. In *La Phonétique* (1966), VH is treated synonymously with metaphony and umlaut, while in *Phonétique Française* (1969), no general definition of VH is provided. It is referred to as an assimilatory process causing the neutralization of the /ɛ/-/e/ distinction in unaccented syllables. Consequently, only examples from the front-mid series are provided. In his *Manuel de phonétique générale* (Malmberg 1974), all reference to metaphony is omitted, and VH is treated as a case of vocalic dilation similar to umlaut (10).

(10) *(vous) laissez* [lese] '(you) leave' / *(nous laissons)* [lɛsɔ̃] '(he) was'

Yet, the use of four different terms for a possibly unique phenomenon forces Malmberg (1969:178) to comment on the diversity of denominations: 'It is unlikely that all phenomena that received, in Germanic historical phonetics, the name of umlaut, would involve the same phonetic mechanism'. No further comment is, however, provided as to what this phonetic mechanism might be.

2.2.   From generative phonology to current approaches

One of the first analyses of VH in French within generative phonology is that of François Dell (1972)[7], whose VH rule depicts an optional process applying relatively late in the grammar, and affecting only non-rounded front-mid vowels in word-medial position. Contrary to previous analyses,

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[7] Previous approaches by Morin (1971) and Selkirk (1972) are cited by Dell (1973:215).

Dell's HARM rule (11) states two important points: the triggering vowel should belong to another morpheme, and the assimilated vowel can be either low or non-low:

> [The rule] rewrites [e] to [ɛ] when the following syllable contains a low vowel that does not belong to the same morpheme, and it rewrites [ɛ] to [e] when the following syllable contains a non-low vowel in a separate morpheme (Dell 1972:214).

(11) [+ syll, - round, - high, - back] → [α low] / __C_1 + C_0 [+ syll, α low]

Similar to Fouché's conception, Dell's VH rule is style-dependent in that in hyper-articulated speech 'it only applies sporadically' (p. 215). Its variable aspect is made clear by the statement that 'a systematic investigation would surely find quite important inter-speaker differences' (idem). Based on Dell's examples, most of which also appear in previous treatises, VH does not seem to be blocked by segments intervening between the assimilated and the triggering vowels. Trisyllabic words containing a word-medial schwa (e.g. *aiderez* '(you) will help', *céderez* '(you) will conceed', and *lèverez* '(you) will lift') also appear among Dell's examples, but due to schwa-lenition applying before the HARM rule, these words should be considered disyllabic.

Jean Casagrande's (1984) approach brings further details to generative analyses. It restricts VH to low-mid vowels, insisting that the 'tendency is toward closure' (p. 89), but as a novelty, it also extends it to the rounded mid vowel [œ], as illustrated in the following example:

(12) *beuglement* [bœgləmã] 'lowing'   vs.   *beugler* [bøgle] 'to low'

Although no examples are supplied for the back mid vowel, for which VH is 'negligible if it exists at all' (idem), mid vowels are ranked with respect to their sensitivity to VH. According to the author, VH would be more frequent for [ɛ] than for [œ], and for [œ] than for [ɔ]. Casagrande is also the first to explicitly restrict VH to the mid vowel series, arguing that even though a vowel tends to close under the effet of VH, it can never become [+high] in the process. For instance, the posttonic vowel in *bêtise* can never become [i] under the effect of VH:

(13) *bête* [bɛt] 'stupid' > *bêtise* [betiz] but *[bitiz] 'stupidity'

Bernard Tranel's (1987) *The Sounds of French* conceive of VH as one of the many constraints influencing the distribution of mid vowels in non-final syllables. Distancing himself entirely from historical aspects that are not even mentioned, Tranel presents VH as optional even in the front-mid series where other factors, such as spelling, faithfulness to the base, and

open/closed-syllable adjustment also play a role (see 1.0.). As in all previous approaches, the majority of examples involve disyllabic words. In these, VH is strictly anticipatory and most frequent when the triggering vowel is high or high-mid, and the assimilated vowel is low or low-mid (14).

(14) *bête* [bɛt] 'stupid *>* *bêtise* [betiz] 'stupidity'

There is also room for variation, since VH is considered optional when the triggering vowel is low or low-mid, and is preceded by a vowel that is high-mid (15).

(15) *thé* [te] 'tea' *>* *théière* [tejɛʁ] or [tɛjɛʁ] 'tea kettle'

According to Tranel, the vowels [œ] and [ɔ] can also undergo VH, but only under the influence of their high-mid counterparts (16) (17). No examples are quoted for the opening / lowering of high-mid back vowels.

(16) *heureux* [œʁø] or [øʁø] 'happy'
(17) *auto* [ɔto] or [oto] 'car'

Stylistic factors are pointed out, suggesting that VH occurs 'naturally in spontaneous speech, where a relatively rapid and unmonitored delivery is generally maintained' (Tranel 1987:61). Spelling is a factor that previous studies relied on when subdividing words into different lexical classes, but did not examine. Tranel suggests that some orthographic representations might be directly tied to phonological representations, for instance, '**é** favors the pronunciation of [e], whereas the spellings **è, ê, ai,** and **e** before two written consonants may favor the pronunciation [ɛ]' (idem). Another novelty in this approach is that VH is exemplified mostly in citation forms. Although base words from which possible derivations can stem from are sometimes indicated in brackets, VH does not seem to be tied to specific morphological environments. Examples, such as (16) and (17) show the working of the process in single lexical items rather than in chains of derivation (14) (15). In other words, Tranel's conception seems to be the closest to a view of VH as a non-morphologically driven, general assimilatory process.

With a few modifications, other contemporary studies and treatises subscribe to the interpretation of VH as an anticipatory process affecting primarily front-mid vowels. Landick (1993), the only author taking a lexicological approach to the question, declares that, in isolation, e.g. in citation forms in dictionaries, VH is not a significant feature of contemporary French. Walker (2001) presents examples only in derivational and inflectional contexts, while Battye & al. (2000) extend VH to the closing of [ɔ] to [o] under the

effect of a following [i] in words, such as *dormir* [doʁmiʁ][8] and *automobile* [ɔtɔmobil].

In this paper, we intend to test some of these earlier claims empirically. Following up on Grammont's hint on the 'delicate nuance' that VH represents, and Ohala's (1994:4.1) suggestion that VH is a 'fossilized remnant of an earlier phonetic process involving vowel-to-vowel assimilation', we propose an acoustic study of vowel assimilation processes presented above. Similar to our predecessors, we expect an anticipatory assimilation of pretonic mid-vowels to tonic vowels in terms of height, i.e. opening and frontness/backness. As in most previous studies, our corpus will be composed of disyllabic words, and will involve both low and high vowels. While not testing for stylistic variation, we propose to take into account geographical variation.

3.   Corpus, method, and expectations

The corpus was composed of 136 pairs of disyllabic nouns, adjectives, and infinitives. The first syllable always contained a mid vowel (henceforth, V1), and was phonemically identical in both words of the pair. The second syllable contained a non-low vowel in one word and a low vowel in the other word of the pair (henceforth, V2 for both). The onset of each syllable of each pair was either a single consonant or a consonant cluster. The complete list of target words grouped in eight sets is shown in Table 5 in the Appendix.

We restrict our analysis to words in which the first syllable was open. Table 1 shows the sets of target word pairs with one pair referring to each set, the underlying representation of V1, the underlying representation of V2, and the total number of word pairs in each set. Vowel quality in V1 is determined following the rule of open-syllable adjustment. Since we are reporting only on words in which the first syllable is open, we expect all V1 to be non-low (high-mid) underlyingly. The labeling of V2 in Table 1 follows the expected alternation of a non-low vowel with a low vowel in Northern Metropolitan French dialects ([e]/[ɛ], [ø]/[œ], and [i]/[a]). This means that the realization of V2 in some of the target words in the Southern speaker's, S3, readings can be different from this labeling (see 1.0.). Words in which the underlying vowel quality of V2 might differ from the Northern pattern are indicated in bold in Table 5 of the Appendix, and will be analyzed among the results.

A total of six speakers, four female and two male, were recorded in two dialects of French. Results of the first acoustic analyses are presented here for three female speakers. Background information about each speaker were

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[8] Although the phonetic transcription proposed by the authors is [doʁmiʁ] (Battye & al. 2000:93), if VH exerts its influence as they suggest it does, the first vowel in *dormir* should be high-mid, as it appears in our transcription.

obtained via biographic questionnaires administered after the final recording session (Table 2). Based on our interactions with the speakers, we found the vernacular of female speakers S1 and S2 to be typical of the Île-de-France variety of Northern Metropolitan French, while speaker S3's speech represents a Southern variety of French commonly heard in Aix-en-Provence. The speakers' age, and educational level were comparable. All lived at their place of permanent residency until at least the end of their secondary education.

Table 1. Type and number of word pairs with a non-final open syllable (119 out of a total of 136 pairs).

set of word pairs	V1	V2	N (=119)
été — éther	e	e / ɛ	18
prêteuse — prêteur	e	ø / œ	8
dévot — dévote	e	o / ɔ	6
potée — poterne	o	e / ɛ	33
poseuse — poseur	o	ø / œ	20
auto — automne	o	o / ɔ	4
épice — épate	e	i / a	14
notice — nota	o	i / a	16

Speakers S1 and S2 were taped in the Phonetics Laboratory of the University of Illinois at Urbana-Champaign. They had been living in the United States for less than three years, using and teaching their native language on a daily basis. Speaker S3 was recorded in the 'Laboratoire Parole et Langage' of the University of Provence in Aix-en-Provence. At both locations, the recordings took place in an anechoic chamber using a high-quality microphone and a DAT recorder (input sampling frequency of 44.1 kHz). Despite our expectations, speaker S3 seemed to have 'style-shifted' during her recording in laboratory condition. At several instances, she seemed to have adopted a reading style close to standard French, dropping some of the expected characteristics of her Southern Metropolitan accent. The possible implications of this reading style are discussed among the results.

The target words were presented to the speakers on slides shown on a computer screen. Each word appeared twice on each slide, and was included in a carrier sentence shown in (18). The sentence referred to a man typing words on a keyboard. The first instance of the target word appeared between two symmetrical phonetic sequences (/ap/ and /pa/), while the second repetition represented a full intonation phrase. The extra-buccal bilabial stops to the left and right of the utterance-medial target word were chosen for their minimal influence on the target vowels. The utterance-final target words were intended as stimuli for future perceptual experiments, but results of acoustic analyses of their vowels are also incorporated in this study:

(18) *Il retape_____ parfois*; _____.
      'He retypes (target word) sometimes; (target word).'

Each speaker was recorded twice in two separate sessions, with at least a week interval between the sessions. Target sentences were presented in varying random orders. The speakers were asked to read each sentence at a normal rate, with no special emphasis on any word. They were instructed not to pause between words in the first phrase (up to *parfois* 'sometimes'). The utterance-final rendition of the target word had to be as similar to the first one as possible, exhibiting the same speech rate, rhythm, and intonation. Although there were no distractor sentences, breaks were incorporated in each reading after thirty slides each time. During these breaks, special effort was made to distract the speaker from his/her reading task. Before the recording started, written instructions to speakers were also explained verbally, and one training sentence was provided to check whether the speaker understood the instructions. The data, four repetitions of each word for each speaker, were then transferred onto the computer with a sampling rate of 22kHz at 16 bits for further computer processing.

Table 2. Speaker characteristics.

	S1	S2	S3
sex	F	F	F
age (years)	28	31	34
birth place	Fort-de-France	Bretagne	Salon-de-Provence
length of years at birth place	0.4	8	20
permanent residency	Paris intra muros	greater Paris	Aix-en-Provence
length of years at residency	22	20	14

The target vowels were manually segmented using the waveform and wide-band spectrograms obtained in the Praat 4.0 and the Enthropic ESPS/Xwaves speech analysis programs at the University of Illinois and the University of Provence, respectively. The onset of target vowels preceded by a stop consonant was set to the release of the burst. After pause, and for speaker S2 who seemed to have unusually long VOTs after voiceless plosives[9], it was set to the onset of the second formant. The default offset of the target vowels was the offset of the first three formants. When there was a gradual and continuous transition from the vowel into the preceding or following acoustic segment, the edges of the vowel were set within the transition, their point of location determined perceptually.

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[9] Long VOTs have been recently observed for at least one other native female speaker of Parisian French (see Michaud 2002:154). The influence of English cannot be discarded in either case.

First and second formant frequencies were automatically measured every 5 ms on each vowel sequence, using the ESPS function *formant*. One measurement for F1 and one for F2 were extracted at the exact midpoint of the vowels. Extreme formant frequency values were checked using both an FFT spectrum and an LPC spectrum computed over a 50 ms window centered at the midpoint of the vowel. Measurements in the two readings were then compared, and in case of important deviations, they were revised manually. Measurements from the two repetitions were then subjected to statistical analyses.

Our expectations were to find acoustic evidence for anticipatory assimilation in all word classes, and in all three speakers' readings. In other words, we expect to show a statistically significant influence of V2 on V1 with respect to F2 in all contexts, and for all speakers. The back vowel [o] is also expected to assimilate to the following final vowel in the front/back dimension. In the Southern variety, the absence of low-mid (half-open) front vowels in final open syllables (in words like *béquet*, *Bobet*), and the lack of high-mid (half-closed) vowels in closed syllables (in words such as *bosseuse*, *causeuse*, *chauffeuse*) can have an impact on the degree of vowel-to-vowel assimilation in our data. Thus each speaker's rendition, and each word class have to be examined separately.

4. Results and discussion

Systematic variations, consistent with assimilatory phenomena referred to as VH in French, were found in the acoustic structure of V1 depending on the place of articulation of V2. However, contrary to our expectations, not every speaker showed significant anticipatory assimilation in all word sets.

Mean F2 values and corresponding standard deviations for the *été-éther*, *prêteuse-prêteur*, *dévot-dévote*, and *épice-épate* sets, i.e. in which V1 was the mid front vowel [e], are shown in Table 2 and Figure 1. Each pair of bars corresponds to the set of target words indicated on the parallel axis, with the first bar representing V1, the second V2. Asterisks indicate statistically significant differences between the F2 frequencies of the two vowels, as computed in two-tailed, paired t-tests for each set[10].

In speaker S1's readings V1 was more [e]-like in words such as *été*, and more [ɛ]-like in *éther*. Likewise, V1 was closer to [e] than to [ɛ] in words such as *épice*, when compared to words like *épate*. The difference of 42 Hz in the first case, and of 126 Hz in the second were highly significant. In the

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[10] F2 values showed normal distribution by checked whether roughly 95% of all values were comprised between ± two standard deviations from the mean. Word pairs in which measurements were impossible were discarded, which explains occasional mismatches in some t-tests' degree of freedom across the speakers (Tables 3 and 4.)

prêteuse-prêteur and *dévot-dévote* sets, however, the differences of 28 Hz and 5 Hz between the means were not significant. Notice, however, that these sets contained only eight and six word pairs, respectively, which means that the observed small differences could become larger when more target words examined. Speaker S2 was the only speaker whose readings reflect significant V1 to V2 assimilation in all word sets. For her, mean F2 frequencies were consistently higher before a non-low vowel than before a low vowel. Differences in F2 ranged from 61 Hz and 72 Hz, in the *été-éther* and *prêteur-prêteuse* sets, to 117 Hz in the *épice-épate* set. A significant difference of 84 Hz was also obtained between the means in the *dévot-dévote* set.

Table 3. Differences between mean F2 values, 't' and 'p' values for paired, two-tailed t-tests in four sets of target words with V1 as a high-mid vowel.

speaker/set	*été-éther*	*prêteur-prêteuse*	*dévot-dévote*	*épice-épate*
S1				
diff. means	42.4638	27.96	5.1667	125.93
t value	$t(68) = 3.6596$	$t(28) = 1.174^{ns}$	$t(23) = 0.234^{ns}$	$t(47) = 6.877$
p value	$p=0.0005$	$p=0.2504$	$p=0.8168$	$p=0.0001$
S2				
diff. means	60.9861	84.53	72.5	117.02
t value	$t(71) = 6.003$	$t(29) = 5.258$	$t(23) = 3.507$	$t(47) = 10.95$
p value	$p=0.0001$	$p=0.0001$	$p=0.0019$	$p=0.0001$
S3				
diff. means	22.29	-1.593	-74.875	65.89
t value	$t(71) = 1.038^{ns}$	$t(31) = -0.09^{ns}$	$t(23) = -1.81^{ns}$	$t(55) = 2.259$
p value	$p=0.3024$	$p=0.9296$	$p=0.0827$	$p=0.0278$

Similar to the other speakers, S3 pronounced V1 significantly more like [e] in words such as *épice* compared to words like *épate*. The three other word sets, on the other hand, do not show statistically significant differences. The relatively large, -74.87 Hz difference between the means turned out to be non-significant in the *dévot-dévote* set[11], as did the differences of –1.6 Hz and 22 Hz in the *prêteuse-prêteur* and *été-éther* sets, respectively.

The absence of V1 to V2 assimilation in the *prêteuse-prêteur* set could be due to dialectal differences, since S3, the only Southern speaker in the sample, could pronounced the final vowel identically as low-mid ([œ]) in both words of these pairs. Contrary to the Parisian pattern, V1 in her readings would then not be realized high-mid ([ø]) in closed syllables before voiced consonants (see 1.0.). This, however, was not the case. Although the above pattern is typical in her every day vernacular, speaker S3 largely hyper-corrected her speech for the purposes of the recording: she pronounced

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[11] The relatively large difference between the means, however, might call for retesting the normality of the distribution by other statistical means.

all final vowels high-mid rather than low-mid, i.e. closer to the Northern rather than the Southern pattern. Also, the lack of assimilation in the *prêteuse-prêteur* set in S1's speech (a Northern speaker) reinforces the impression that dialectal differences alone do not explain these variations.

Figure 1. Mean F2 values and standard deviations for two Parisian (S1 and S2) and one Southern (S3) female speakers for four sets of target words containing the front-mid vowel [e] in the pretonic, and the vowels [e]/[ɛ], [o]/[ɔ], [ø]/[œ] or [i]/[a] in the tonic syllables ([**]significant at p<0.01, [*] significant at p<0.05, [ns] non-significant).

Insert Figure 1 somewhere here

In the *dévot-dévote* set, our conclusions remain temporary. The fact that each speaker shows a different pattern of realization prompts us to believe that the assimilatory influence of a back rounded vowel on a high-mid front vowel is likely to involve acoustic parameters, such as rounding and height, which have yet to be investigated. Mean values of F2 for V1 are virtually identical, although statistically non-significant, in S1's speech (Δ mean = 5 Hz), they are significantly higher (p<0.05) before the high-mid vowel [o] for S2, and somewhat lower before the same vowel for speaker S3. Since the place of articulation of the vowel [o] is further back than that of the vowel [ɔ], the lowering of F2 before [o]in S3's speech could be interpreted as anticipation of the backness and rounding of [o]. On the other hand, [e] becomes more [e]-like by becoming more closed and more fronted before [o], which can be viewed as an enhancement of the vowel in its quality of a high front-vowel in S2's speech.

Results for the *potée-poterne*, *poseuse-poseur*, *auto-automne*, and *notice-nota* sets containing [o] in V1 are shown in Table 4 and Figure 2. Notice that variations in F2 exhibit the same general pattern in all speakers' renditions: F2s in V1 were systematically higher in words containing a low rather then a high mid vowel in the tonic syllable, but they were lower if V2 was an [a] as opposed to an [i]. Only two non-significant differences were obtained: one for S1 in the *poseuse-poseur* set, and one for S3 in the *auto-automne* set. The latter contained only four word pairs. Patterns of V1 to V2 assimilation were again the strongest in S2's readings. The general trend in terms of differences between the means (see Table 4) shows that V1 was more like a high-mid vowel when it was followed by a high-mid vowel, i.e. it was more [o]-like with lower F2, in words such as *potée* and *poseuse*. Also, V1 resembled more a low-mid vowel before another low-mid vowel, i.e. it was more [ɔ]-like with higher F2, in words like *poterne* and *poseur*. Thus, except for the two non-significant patterns for S1 and S3, the general assimilation pattern seems to be assimilation by backness/frontness <u>and</u> height.

Table 4. Differences between mean F2 values, 't' and 'p' values for paired, two-tailed t-tests in four sets of target words with V1 as a low-mid vowel.

speaker/set	*potée-poterne*	*poseuse-poseur*	*auto-automne*	*notice-nota*
S1				
diff. means	-63.8702	-76.875	-60.8	106.75
t value	t(130) = -4.592	t(15) = -2.06[ns]	t(74) = -3.979	t(63) = 3.955
p value	p=0.0001	p=0.0575	p=0.0002	p=0.0002
S2				
diff. means	-54.8433	-64.75	-53.027	39.5
t value	t(133) = -6.77	t(15) = -3.728	t(73) = -5.429	t(61) = 2.669
p value	p=0.0001	p=0.0002	p=0.0001	p=0.0097
S3				
diff. means	-29.3897	-101.625	-22.658	30.39
t value	t(135) = -2.829	t(15) = -3.645	t(75) = -1.663[ns]	t(63) = 2.132
p value	p=0.0054	p=0.0024	p=0.1005	p=0.0369

In the *notice-nota* set, all speakers' F2 frequencies turned out to be higher, i.e. resembling more the low-back vowel [ɔ], when V1 was followed by [i] rather than [a]. Although this pattern is consistent with the idea of an assimilatory process, because it means that the place of articulation of V1 is probably further front when the final vowel is a high-front vowel, it goes beyond the classical definition of VH as assimilation by height. Let's suppose, for the purpose of demonstration, that VH would also be operating in the *notice-nota* set in the front/back dimension, as it does in the three other sets. If this would be true, then under the assimilatory influence of the tonic vowel [i], VH would have turned V1 into a more closed high-mid vowel in *notice*, i.e. the second formant of V1 would have been lowered, and the vowel become more [o]-like. Similarly, through VH, [a] would have made the preceding vowel a more open, [ɔ]-like low-mid vowel in *nota*, which would then have showed higher F2 frequencies. None of this is, however, the case. F2 frequencies go contrary to this hypothetical pattern: they are higher before [i] than before [a]. Thus we can conclude that the vowel is fronted, but probably not less open under the influence of [i].

Again, we might speculate at this point whether reasons for the assimilation patterns observed in the *notice-nota* set do not lie in the many factors likely to come into play in VH. Among these is the higher tongue body position, and greater lip rounding of the assimilated vowel. The latter could be due, for instance, to on-going sound change, i.e. the centralization of /o/ to /oe/ attested in French of Île-de-France. The potentially concurrent influences of VH and the general fronting of the vowel system in middle-class Parisian French already signaled by Lennig (1978) can be difficult to sort out even in an empirical investigation (Malderez 1995, Fagyal et al. 2002).

Figure 2. Mean F2 values and standard deviations for two Parisian (S1 and S2) and one Southern (S3) female speakers for four sets of target words containing the back-mid vowel [o] in the pretonic, and the vowels [e]/[ɛ], [o]/[ɔ], [ø]/[œ] or [i]/[a] in the tonic syllables ([**]significant at $p<0.01$, [*]significant at $p<0.05$, [ns] non-significant).

Insert Figure 2 somewhere here

5. Conclusion and general discussion

In summary of this, yet preliminary, investigation on vowel-to-vowel assimilation referred to as VH in French, one must first answer the question in the title: does VH exist in French? From an empirical point of view, the answer is: yes. Our data indicate statistically significant anticipatory assimilation in the front/back dimension in most disyllabic word sets we examined in three female speakers' speech. Therefore, according to the broadest definition of 'harmony', i.e. 'the way the articulation of one phonological unit is influenced (is 'in harmony' with) another unit in the same word or phrase' (Crystal 1997:180), the observed assimilation phenomena can be called vowel harmony.

We found systematic differences in the acoustic shape of a mid vowel contingent upon the following vowel by taking the second formant frequencies (F2) of the target vowels. For the front mid vowel, as contained in initial syllables of target words in the *été-éther*, *prêteuse-prêteur*, *dévot-dévote*, *épice-épate* word sets, the results look reasonably clear: F2 is higher before a non-low vowel than before a low vowel in 58% of all cases (7 out of 12 word sets), and all speakers combined. Among the two Northern speakers, the trend is even stronger (83%). As for the back vowel in the pretonic syllables of words in the *potée-poterne*, *poseuse-poseur*, *auto-automne*, and *notice-nota* sets, one can conclude that the tendency fror fronting/backing under the influence of the following vowel is even stronger: 83% of all target word sets and speakers combined, and over 90% when examined in the two Northern speakers' readings.

The second question, whether VH is the right term to use with reference to the type of assimilation phenomena observed in our data, is more difficult to answer. First, even in the phonology literature, as Anderson (1980:1) pointed out out more than twenty years ago, 'there is less of a consensus than meets the eye as to just what the characteristics are that set vowel harmony apart from other types of rule'. According to Hyman's (2002) more recent reformulations, 'What is vowel harmony? Where does it come from? How is it the same as or different from other things?', the issue is far from being resolved. In lack of general consensus on how VH, metaphony, umlaut and possibly other vowel assimilation phenomena should be separated from each

other in a precise way, we retain the following arguments for the purposes of our investigation.

According to the narrowest definitions vowel assimilation phenomena inherited from nineteenth century historical phonetic studies, we would reserve the term VH to phonological processes well-known from languages, such as Turkish and Hungarian. That is, VH is a process responsible for the selection of an allomorph for a given base word from two or three candidates. Whether the directionality of this process is an artifact of sampling in phonological studies, or a universal bias in processing and/or perception, as Hyman (2002) seems to argue, still awaits an answer. Recent empirical studies indicate that anticipatory front/back assimilation can represent a production advantage at the word-level (Cole et al. 2002), and that anticipatory assimilation does not conflict with carry-over vowel harmony in languages such as Turkish (Inkelas et al. 2000). Until these factors are sorted out, however, directionality can be used to distinguish between VH, in the narrowest sense of the term, and metaphony. Vowel assimilation observed in French seems to be better described in terms of latter. Metaphony phenomena triggered by final high vowels are well-known from the history of French, and are abundant in other Romance languages as well (see e.g. Posner 1997, Hualde 1989). Therefore, following the Romanist tradition that reserved the term metaphony for such anticipatory assimilatory changes at the word-level, we suggest that vowel assimilation observed in our data be called metaphony rather than VH.

As for the final question, whether anticipatory vowel assimilation in French operates in specific morphological environments or also in words not tied to derivational or inflectional paradigms, we can only speculate about the answer. Based on the non-significant influence of V2 on V1 in the *prêteuse-prêteur* set (for speakers S1 and S3) and the *poseuse-poseur* et (for speaker S3), containing only semantically related word pairs, we can speculate that semantic relatedness might not be determining factor. This impression is further supported by word sets that contain a majority of morphologically and semantically unrelated word pairs (*épice-épate*, *notice-nota*), and, yet, indicate strong anticipatory assimilation between the two neighboring vowels. Further investigations might investigate this in greater detail by separating, and individually testing each of these word pairs.

APPENDIX

Table 4. Total number of word-pairs (N=136) subdivided in sets according to the quality of their first (V1) and second (V2) vowels. The 17 pairs containing an initial closed syllable, shown in italic, were not included in the analysis. Words in bold are pronounced differently in the two dialects.

Label of the set	V1	V2	Word pairs in the set
été — éther	e	e / ɛ	ailé-ailette, aîné-aînesse, *berger-bergère*, béquet-Beckett, clairet-clairette, défait-défaite, épée-épaisse, *fermé-fermette*, fléché-fléchette, *germé-Germaine*, méfait-méfaire, mémé-mémère, pépé-pépère, rainé-rainette, réglé-réglette, rêvé-rêveil, sellé-sellette, séné-sénestre, télé-télex, terrer-terrestre, *verger-Vergès*;
prêteuse — prêteur	e	ø / œ	*chercheuse-chercheur*, fraiseuse-fraiseur, gêneuse-gêneur, payeuse-payeur, plaideuse-plaideur, prêcheuse-prêcheur, rêveuse-rêveur, veilleuse-veilleur;
dévot — dévote[*]	e	o / ɔ	écot-école, **épaule**-époque, Esso-essor, étau-étoffe, *recto-rectum*, vélo-véloce;
potée — poterne[#]	o	e / ɛ	**Bobet**-bobèche, *bordée-bordel*, bosser-bossette, broché-brochette, causer-causette, chaussée-chaussette, chorée-chorège, clocher-clochette, cocher-cochère, coder-codex, coller-collecte, **coquet**-coquette, *cordée-cordette*, *cornée-corneille*, *corsé-corsaire*, *corvée-corvette*, croquer-croquette, forer-foraine, *forcer-forceps*, *former-formel*, fossé-fossette, *gauffré-gauffrette*, *lorgner-lorgnette*, **mauvais**-mauvaise, **mollet**-mollesse, moquer-moquette, **motet**-motel, noter-notaire, orée-oreille, oser-oseille, pocher-pochette, pommer-pommette, protée-prothèse, **roquet**-roquette, rosé-rosette, sauter-sauterne, **sommet**-sommeil, sonner-sonnette, tollé-Tolède, tonner-tonnelle, **violet**-violette;
poseuse — poseur[±]	o	ø / œ	**bosseuse**-bosseur, **causeuse**-causeur, **chauffeuse**-chauffeur, **chômeuse**-chômeur, **colleuse**-colleur, **croqueuse**-croqueur, **donneuse**-donneur, **fauteuse**-fauteur, **faucheuse**-faucheur, **foreuse**-foreur, **fraudeuse**-fraudeur, **moqueuse**-moqueur,

Label of the set	V1	V2	Word pairs in the set
auto — automne	o	o / ɔ	**noceuse**-noceur, ***porteuse**-porteur*, **rôdeuse**-rôdeur, **sauteuse**-sauteur, **sonneuse**-sonneur, **trotteuse**-trotteur, **veilleuse**-veilleur, **voleuse**-voleur; coco-cocotte, mono-monocle, sono-sonore;
épice — épate	e	i / a	bêtise-bêtasse, béquille-bécane, dédit-dédale, éthyle-étal, ferrite-ferraille, fléchir-fléchage, hélice-hélas, Messire-message, réglisse-réglage, sénile-sénat, série-sérail, terrine-terrasse, vieilli-vieillard;
notice — nota	o	i / a	bobine-bobard, choriste-chorale, coquine-cocagne, colline-collage, Corinne-coral, Dorine-dorade, *forcir-forçage*, mollir-mollah, Monique-monarque, motif-motard, otite-otage, postiche-postal, potiche-potache, protide-protase, Rosine-rosace, sonie-sona;

[*] Due to the strict observance of the closed-syllable adjustment rule, in Southern French dialects, V2 in *épaule* is low-mid [ɔ] underlyingly.

[#] All final front mid vowels are expected to be high-mid, [e], in the South.

[±] In Southern French dialects, regardless of the type of the coda consonant, all non-front mid-vowels are low-mid, [œ]or [ɔ], in closed syllables.

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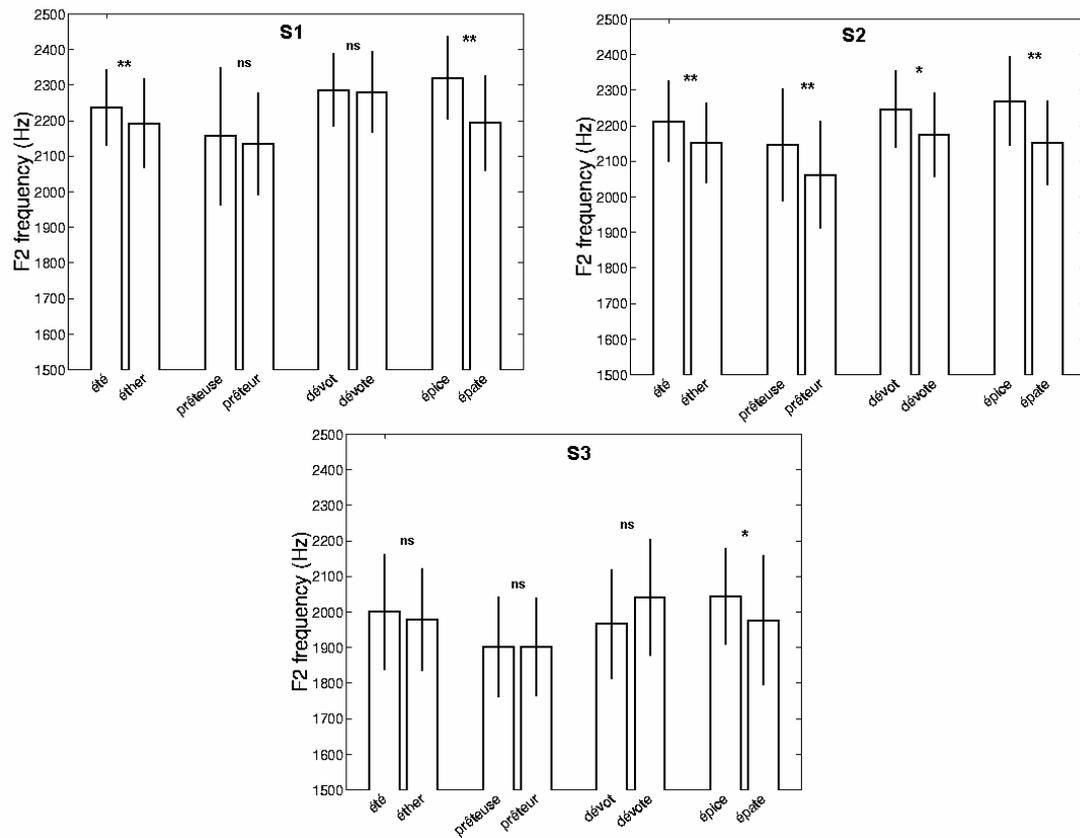
Figure 1. Mean F2 values and standard deviations for four sets of words containing a word-initial mid front vowel [e], and followed by the vowels [e]/[ɛ], [o]/[ɔ], [ø]/[œ], and [i]/[a] for two Parisian (S1 and S2) and one Southern (S3) female speakers ([**] significant at p<0.01, [*] significant at p<0.05, [ns] non-significant).
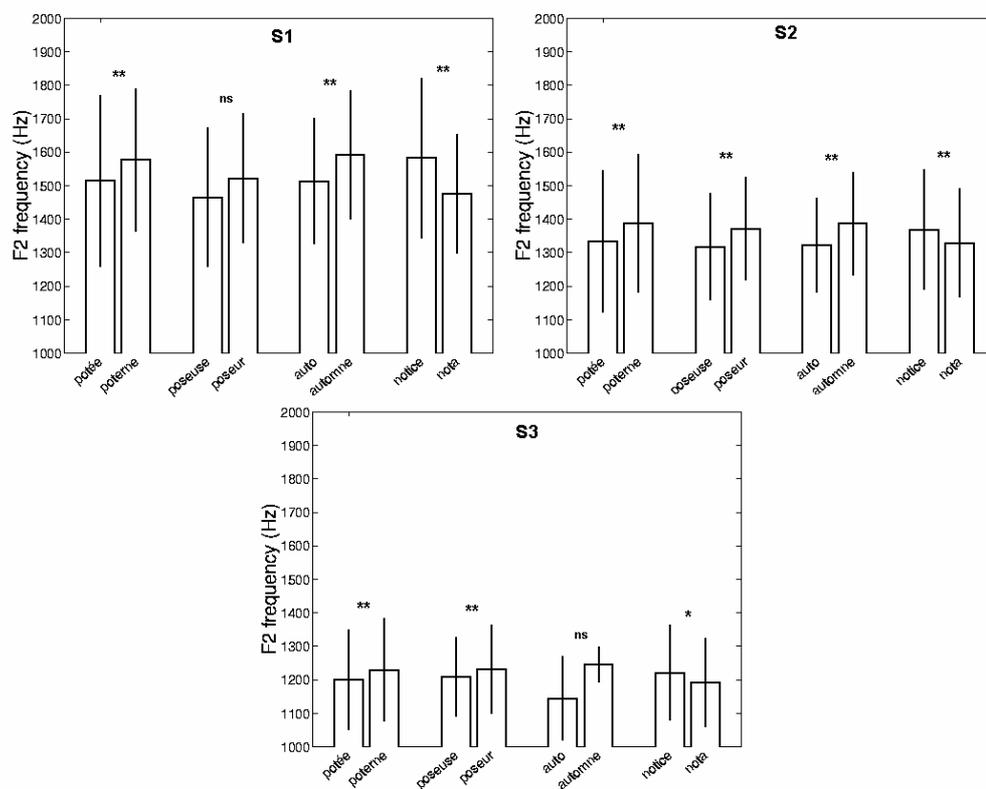
Figure 2. Mean F2 values and standard deviations for four sets of words containing a word-initial mid back vowel [o], and followed by the vowels [e]/[ɛ], [o]/[ɔ], [ø]/[œ], and [i]/[a] for two Parisian (S1 and S2) and one Southern (S3) female speakers ([**] significant at $p<0.01$, [*] significant at $p<0.05$, [ns] non-significant).