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# Final accent and lengthening in French

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## Abstract

An experiment was carried out to examine the possibility of word-final F0 rise without lengthening in French. The results show that, although a variability is observed depending on speaker, syllable structure and syllable number, the final rise can be unaccompanied by vowel lengthening in the phrase-median final syllable of a noun, in difference to the phrase-final syllable which is lengthened to signal the prosodic boundary. The duration of infra-syllabic components is also investigated.

## 1. Introduction

French word-final accent has traditionally been described as an "accent of duration" which is essentially characterized by lengthening of the final full vowel, also accompanied by a tonal movement [1]. Although the potential location of this final accent is determined morphemically, its domain is a group of words which forms a certain sense unit, and a word can be "deaccented" when it does not occupy the final position of a prosodic group [4].

It is observed that the grouping by the final accent has a hierarchical structure, the intonational level and another inferior level which marks the components of an intonational group. These two levels have been described as Major / Minor Intoneme [1][6], Intonational Phrase / Accentual Phrase [4][5], or Intonational Phrase / Prosodic Phrase [2] and the two levels are distinguished by the significant difference in the lengthening of the group-final vowel.

One of the divergences in the literature concerns the prosodic structure inside the inferior level, namely the phonological status of an F0 rise realized without vowel lengthening. Jun & Fougeron [5] include this phenomenon as Hi in their phonological unit of French intonation described as /LHiLH*/, where H* is a high tone associated to a lengthened syllable. While the second L tone collaborate with H* to mark the right boundary as a group-final accent, the first L tone serves, together with Hi, to indicate the left boundary of a prosodic group (Accentual Phrase). Hi is realized on "one of the initial syllables of the first content word of the AP". The default pattern /LHiLH*/ has variant forms where some of the components are truncated depending on various factors as in example (1) b.

(1) a. Le mauvais garçon *(The bad boy)* b. Marie
{L Hi L H*} {L H*}

(2) a. les dé)claration}
b. {Président de la République}
c. [La jolie) voiture) italienne} qu'il lui avait offert} pour son anniverSAIRE}]

*([ ]: Intonational Phrase, {}: Prosodic Phrase, ): Tonal Unit)*

In the model of Di Cristo [2], the F0 rise without lengthening can occur on the word-final as well as the word-initial position and the two realizations share the same prosodic properties. The F0 rise forms the elementary rhythmic unit (Tonal Unit) <LH>, which reflects the basic metric structure of the language at a level inferior than the boundary operation by the final accent, as in (2).

Final accents without lengthening indicate the realization of the <LH> Tonal Unit and not a boundary of certain higher domain. In (2)b, a likely F0 rise on the initial syllable *Pré-* no longer indicates the location of Tonal Unit but marks the right boundary of a Prosodic Phrase. The latter is distinguished from the former by the global concave contour throughout the phrase as well as a likely short pause [2]. As in (2)c, F0 rises without lengthening are not necessarily realized on initial syllable as a marking of the initial boundary. Jun & Fougeron observe that an F0 rise can appear on final syllable of a functional word before the first lexical word in AP [5] or on medial syllables of a exceptionally long polymorphemic word [6]. Di Cristo's modelling in (2)c differs from these observations in that it also includes the final syllable of a content word as the location of F0 rise without lengthening.

The present study aims to examine whether the F0 rise without lengthening can be realized on the word-final position as Di Cristo's model predicts, in which case it is supposed to reflect the basic metric structure inside a lowest prosodic group, or its occurrence is rather confined to the word-initial position to indicate the right boundary of a prosodic group. An experiment was carried out to test the hypothesis of a lengthening-less accent in French produced in the content word-final position but not at the right boundary of prosodic or intonational phrase.

## 2. Methods

### 2.1. Materials

Three types of sentences are chosen to examine the duration of the target syllable in three different positions as in (3):

(3 a) J'aime le carna**val** musical de Saint-Denis.
*(I like the music carnival of Saint-Denis.)*
b) J'adore la ca**val**cade infernale des Rapetout.
*(I like the infernal cavalcade of the Beagle Boys.)*
c) Le grand carna**val** commence mardi prochain.
*(The big carnival begins next Tuesday.)*

In (3a), the target syllable is the final vowel of a noun in <noun+adjective> type noun phrase as a verb compliment. In (3b), it is situated in the middle of a noun in the same type of phrase. In (3c), it is the final vowel of a noun phrase which serves as the subject of the sentence. The target syllables at these three positions realize different prosodic properties and also differ in their phonological status. We expect that (i) the target syllable in (3a), which accompanies an F0 rise without lengthening at the final position of a content word (noun), would serve to indicate a smaller rhythmic unit inside the group, i.e. a non-demarcating Tonal Unit final accent; (ii) the

target syllable in (3b) has no F0 rise nor lengthening, being unaccented position; (iii) the target syllable in (3c) has an F0 rise accompanied by lengthening, realizing a demarcating Prosodic Phrase accent which marks a boundary of this larger prosodic group.

Besides the position in the sentence, the syllable number of the noun and the structure of the target syllable (open / closed) are controlled as follows:

Table 1: *Target syllables by syllable number of the noun and by the syllable structure*

| syllable number | open syllable | closed syllable |
|---|---|---|
| **1** | **ʃa** | **sɔl** |
| **2** | **ti** | **nal** |
| **3** | **la** | **val** |
| **4** | **ka** | **nal** |

The onset consonants and the nuclear vowels are not totally controlled, but the coda is always [l]. The phoneme number of the whole sentence and of the <article+noun+adjective> portion is equalized for each set of (3a)-(3c) to attenuate the possible sentence-length effect. However, the interspeaker variation of 1-3 phonemes is observed depending on the realization or not of final schwa or liaison. In total, 24 sentence-types are analyzed.

### 2.2. Subjects and Procedure

4 speakers, 1 male (SP1 from Tour) and 3 females (SP2 and SP3 from Provence, and SP4 from Loraine) participated in the experiment. None of them had a strong regional accent.

The sentences are randomized and the participants read the corpus 12 times. 10 cases other than the shortest and the longest ones are retained for analysis. In total, 320 cases for (3b) and (3c) and 319 for (3a) are analyzed, 1 case of (3a) with a pause being excluded. The recordings are digitized at 16kHz and the target syllables are labeled phonemically by hand on PRAAT. Two parameters are examined: F0 and duration. The whole sentence duration is also measured to check that the speech rate remains constant. For F0, the tonal patterns of <article+noun+adjective> part are labeled using L, Hi, H1, and H2. H1 is assigned to the target syllable when it accompanies F0 rise or peak. H2 is labeled to the adjective-final syllable when it accompanies an F0 rise. Hi indicates the initial rise or peak on the first syllable(s) of nouns or adjectives. The syllables where the pitch is low or going down are represented by L. Figure 1 shows an example of tonal pattern [LLH1LLH2] where both the target syllable on noun and the final syllable of adjective have an F0 rise with no initial rise.

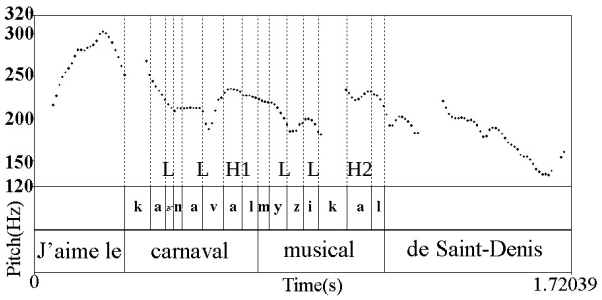



Figure 1: *Example of the tonal pattern [LLH1LLH2] on the noun phrase "le carnival musical (the music carnival)"*

For sentences (3a), only the cases where the target syllable is labeled H1, i.e. the ones which matched our hypothesis, were retained for further duration analysis. That is, the vowel duration of target syllables with H1 in (3a) is measured and compared statistically with the vowel duration of target syllables in (3b) and (3c). All the target syllables in (3b) have no F0 rise, and on the contrary, all of those in (3c) are realized with the expected F0 rise. In this paper we don't treat the tonal difference between perceptual "rise" and "peak" which will be examined in our further studies.

## 3. Results

### 3.1. Tonal pattern

On the target syllables in (3a), the expected F0 rise is realized on 121 of 319 cases, i.e. 37.9% of all the realizations by 4 speakers. The interspeaker variation is observed for the frequency of H1: 32.9 % (SP1), 68.8% (SP2), 20.0% (SP3), and 30.0% (SP4). Its frequency varies also by syllable number of the noun : while the nouns of 2 and 3 syllables accompany an F0 rise on final syllable for more than half cases (67.1% and 53.7% respectively), those of 1 an 4 syllables realized less final F0 rises (16.3% and 15.0% respectively). Table 2 represents the distribution of tonal patterns for the cases with H1 (final F0 rise on the noun) in (3a). The tonal patterns can be categorized by the occurrence of Hi on the noun or/and adjective. Table 1 shows that the recurrence of L and H (LH1LH2 or LHiLH1LH2) is preferred to the collision of H tone (HiH1 or H1Hi), being realized on 83.5% of all the cases. Hi appears mainly on the adjective (20/23 cases), indicating the beginning of the 2nd element of the noun phrase. Hi on the 1st element appears only on the noun of more than 2 syllables.

Table 2: *Distribution of tonal patterns on <noun + adj.> with final F0 rise on noun (number in brackets: percentage; contiguous Ls are indicated by a single L)*

| | **without Hi on Adj.** | | **with Hi on Adj.** | | ***total*** |
|---|---|---|---|---|---|
| **without Hi on N** | LH1LH2 | 98 | LH1HiLH2 | 19 | *117* |
| | | (81.0) | | (15.7) | *(96.7)* |
| **with Hi on N** | LHiLH1LH2 | 3 | LHiLH1HiLH2 | 1 | *4* |
| | | (2.5) | | (0.8) | *(3.3)* |
| ***total*** | | *101* | | *20* | *121* |
| | | *(83.5)* | | *(16.5)* | *(100)* |

We also labeled the tonal patterns of the cases without H1 (62,1% of 319 cases) which are excluded from the duration analysis. Table 3 represents the observed tonal patterns by noun syllable number. The noun-final L tone is indicated separately from the next L on the beginning of the adjective.

Table 3: *Distribution of tonal patterns on <noun + adj.> without final F0 rise on noun*

| **Tonal pattern** | | **syllable number of N** | | | | ***total*** |
|---|---|---|---|---|---|---|
| **Art.+N** | **Adj.** | **1** | **2** | **3** | **4** | |
| L | LH2 | 13 | 16 | 5 | 8 | *42* |
| LHiL | LH2 | | | 6 | | *6* |
| L | HiLH2 | 43 | | 3 | 25 | *71* |
| L | HiLH2 | 8 | 9 | | 15 | *32* |
| L | HiH2 | 3 | | | | *3* |
| L | LHiL | | 1 | | | *1* |
| LHiL | HiLH2 | | | 23 | 20 | *43* |
| ***total*** | | *67* | *26* | *37* | *68* | *198* |

Also on the cases without final F0 rise (H1) on the noun, the same tendency to prefer the recurring 'LH' is observed, the collision of Hi and H2 appearing on 32 of 198 (16.2%) cases. The most frequent pattern (35.9%) was L|HiLH2 where the two intervals between two H tones are equilibrated in comparison with the other patterns. As for the next frequent pattern L|LH2 (21.2%), it appears more frequently on the nouns with less number of syllables (1 or 2) where the sequence of L does not exceed 3 syllables. Generally, it can be said that the speakers prefer the recurrence of the elemental rhythmic pattern 'LH' where H was realized as either initial Hi or final H1.

### 3.2. Duration of target syllables

Here we examine the durational properties of the noun-final H1 tones (from (3a)) in comparison with phrase-final tones (from (3b)) as well as with word-median unaccented syllables (from (3c)). We expect that it does not accompany lengthening as the boundary tones do. Therefore, only the cases with H1 accent (37.9% of (3a)) will be treated in the further analysis.

#### *3.2.1. Speech rate control*

Preliminarily, the possible inter- and intra-speaker variation of speech rate is examined. Table 4 shows the average speech rate (ms per phoneme) by speaker and by sentence type.

Table 4: *Average speech rate by speaker and by sentence type (ms per phoneme)*

| | sentence(3a) | sentence(3b) | sentence(3c) | Average |
|---|---|---|---|---|
| SP1 | 68.8 | 70.4 | 66.4 | 68.5 |
| SP2 | 66.6 | 68.0 | 66.0 | 66.9 |
| SP3 | 68.6 | 70.6 | 67.1 | 68.8 |
| SP4 | 68.5 | 70.2 | 68.2 | 68.9 |

As the table shows, the inter- and intra- speaker variation of average speech rate does not exceed 5 ms. It was also observed that the maximum difference throughout the corpus does not exceed 11 ms. We can conclude that the speech rate is closely similar between speakers or sentences, variation being negligible in our corpus.

#### *3.2.2. General tendency*

ANOVA was carried out with 4 factors: Prosodic Position of the target syllable ((3a)-(3c)), Speakers (1-4), Syllable Number of the noun (1-4) and Syllable Structure (open or closed). The results of the 4-way ANOVA show that, at a 5% significant level, all the factors and interactions are significant ($p<0.0001$ except $p<0.008$ for Syllable Structure) except the Speaker-Syllable Number interaction ($p = 0.604$). We examine below the effect of the Position factor and its interactions with three other factors, by means of Tamhane and of Fischer's PLSD post-hoc tests (with a significant level at 5%).

#### *3.2.3. Main effect of the Prosodic Position*

Henceforth, the positions (3a), (3b) and (3c) of target vowels are called respectively WfA (Word-final Accent), UNA (unaccented) and PfA (Phrase-Final Accent). The post-hoc tests on vowel duration show that vowels in WfA position are not significantly lengthened compared with those in UNA position ($p=0.499$), PfA differing significantly ($p<0.0001$) from the two other positions (Figure 2). In other words, a word-final F0 rise can appear without lengthening.

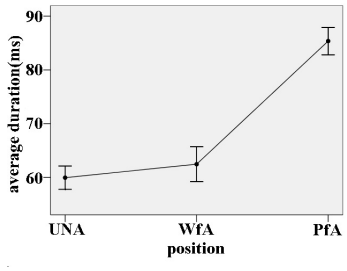



Figure 2: *Average vowel duration of three positions (error bar: 95% confidence intervals)*

#### *3.2.4. Interactions of Position with the other factors*

The closed syllables do not have exactly the same behavior as the open ones. WfA and PfA are significantly different with the open syllables ($p<0.0001$) as well as with the closed ones ($p<0.0001$), but their difference is near 30 ms for the open syllables while it is less than 15 ms for the closed syllables (Figure 3). The open and closed syllables also differ from each other in that WfA is not distinguished significantly from UNA for the open syllables ($p=0.997$) while it is for the closed syllables ($p<0.0001$). However, the difference between WfA and UNA remains very small, that is less than 10 ms.

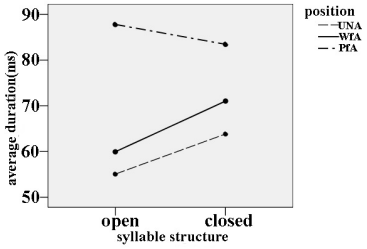



Figure 3: *Average vowel duration of three positions by syllable structure*

The investigation of standardized duration (by *z-transform*, see [7]) of the sub-syllabic components enhances an important interaction of the syllable structure with the prosodic positions (Figure 4). The distribution of lengthening among the syllabic components seems to be modified by the [l] syllable-closing.

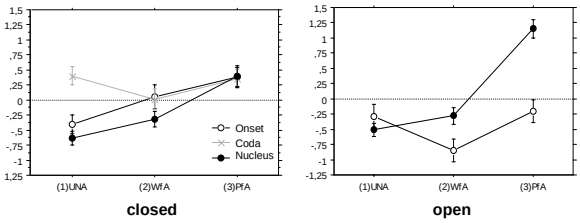



Figure 4 *Average standardized duration (y axis) of onset, nucleus and coda by positions for closed and open syllables*

Thus in an unexpected way, at prosodic boundary (PfA), vowel lengthening is reduced and the coda duration does not increase at all. Instead, a compensatory lengthening of the onset consonant seems to take part in syllable-final lengthening. Concerning WfA, the onset duration is affected by syllable structure: with regard to the unaccented position, it is significantly reduced in open syllables while significantly increased in closed ones ($p<0.0001$ for both). Nevertheless,

both of these opposite differences do not exceed on average about 10 ms. Besides, regarding the onset and nucleus duration for closed syllables, WfA might be considered as an intermediate level between UNA and PfA. These results do not match the patterns of sub-syllabic duration drawn by previous studies on accentual and boundary lengthening in French [8]. Furthermore, they are largely weakened when the interaction of the other factors are considered.

The vowel duration also varies by the syllable number of the noun (Figure 5). The post-hoc tests show that the difference between WfA and PfA is always significant and generally longer than 20 ms ($p<0.0001$). The increase of syllable number of the noun from 1 to 4 does not seem to affect differently the durational property related to these three prosodic positions: WfA and PfA remain two different phonological categories. WfA is not statistically distinguished from UNA, except with the three syllable nouns. However, we cannot explain this only difference.

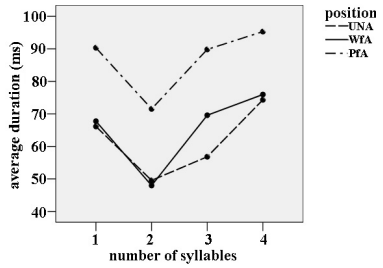



Figure 5: *Average vowel duration of three positions by syllable number of the noun (Note that the shorter vowel for two-syllable nouns in all positions is due to the intrinsic shorter duration of [i] used in only this context.)*

Finally, we also observed a speaker variation where the general vowel duration of SP1 is significantly different from those of SP2 and SP4 ($p<0.0001$). Figure 6 shows that the general inter-speaker variation is mainly due to that of PfA, for which the same significant differences as the general variation are observed. There is no significant inter-speaker difference for vowel duration in WfA. As for UNA, a significant difference is observed only between SP1 and SP4 ($p<0.0001$). The non-significance of inter-speaker difference for WfA seems to indicate that F0 rise without lengthening is a prosodic property of this position. In contrast, the important variability at PfA suggests that speakers may realize different kinds of prosodic boundary, i.e. either Prosodic Phrase or Intonational Phrase [2], or may use differently tonal and temporal features to signal the same boundary level: SP1, for example, uses lengthening much less than the other speakers.

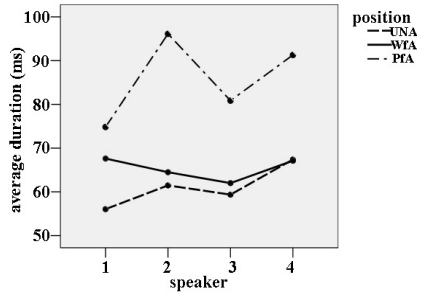



Figure 6: *Average vowel duration of three positions by 4 speakers*

## 4. Discussion and Conclusion

Overall, the results seem to attest the occurrence of final F0 rise without lengthening on content words, which could be called a 'final rhythmic accent' in the sense that it does not demarcate a prosodic boundary but rather serves to form the elemental rhythmic pattern inside the boundaries. No strong interactions of the syllable number of accented words or of the speaker variability on vowel duration are observed which importantly weaken this main result. Nevertheless, complex crossing effects of the syllable structure on sub-syllabic durations blur this conclusion. Further investigations on sub-syllabic temporal pattern seems be needed to test if WfA could be distinguished from PfA, UNA and/or word-initial accent, as previous studies let us envisage.

Besides, it is observed in our corpus that the recurrence of 'LH' is preferred and that the final F0 rise, in concurrence with the initial F0 rise, participated in the realization of this recurring pattern. This final F0 rise without lengthening differs from both Hi and H* in /LHiLH*/ or medial H by Jun & Fougeron [4][5]. According to Jun & Fougeron [5], Hi occurs on 'some initial (i.e. 1st or 2nd, and rarely the 3rd)' syllable of the AP-initial content word and marks the initial boundary of an AP together with the preceding L tone. However, it is difficult to consider the final F0 rise as a delayed Hi which happens to fall on the final syllable when the target syllable is no longer at the initial position of an AP, as in the cases with the nouns of 3 or 4 syllables. Furthermore, the co-occurrence of the initial and final rise before the group-final accent are observed ([LHiLH1LH2] and [LHiLH1HiLH2] in Table 2), even if they are rare cases. The final F0 rise without lengthening observed in our corpus also differs from the medial H [5] in that it was realized at the final syllables of content words.

Di Cristo's model [2], which sees the final F0 rise without lengthening as a part of the Tonal Unit, would seem to be better able to integrate this low accent-level. However, it is to be verified if the initial and final F0 rise without lengthening share the same prosodic property as [2] predicts. This point and the possible distinctive temporal infra-syllabic patterns of initial *vs* final accent inside AP will be the focus of further investigations with the aim of discussing about a hypothetical lowest prosodic constituent (i.e. TU) inside the Prosodic Phrase [2] or Accentual Phrase [4] [5] in French.

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