

Positional constraints on the initial rise in French

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Abstract

A basic constituent of French intonation is the Accentual Phrase (AP), which includes two distinct tonal events: a final LH* accentual rise and an initial LHi rise. A previous study had shown a difference between the rising movements according to the the position of the AP within the intonational phrase (IP): prenuclear (P, IP-initial) versus nuclear (N, IP-final). The present paper explains this difference through the occurrence of a LHi in P position which does not occur in N position. Specifically, we tested whether LHi can occur adjacent to LH* within the AP and whether the occurrence of LHi triggers initial strengthening of the onset consonant independent of its status (as a liaison consonant or not). Four native speakers of French read target words varying as to their distribution within the intonation phrase as well as to the segmental nature of the target syllable onset (/k/ onset versus /z/ liaison). Results confirm that LHi can be immediately adjacent to LH* within the AP, but only in P position and that the height of its H target is influenced by onset consonant type. The results are discuss relative to the phonological status of the initial rise and the phonological structure of the nuclear pitch accent in our data.

Index Terms: speech prosody, melody, intonation, initial rise, French.

1. Introduction

There is a general agreement in the literature on French intonation on the basic constituent of the prosodic hierarchy as being the domain of occurrence of two rises: an initial rise and a final rise. Following [1], we will call this basic constituent the accentual phrase (AP) and the two rises the initial rise LHi and the final accent LH*. LH* is an obligatory AP final accent, it is associated with the last full syllable of the AP and it is essentially marked by a noticeable f₀ movement and preboundary lengthening. Conversely, LHi is an optional initial rise, generally occurring on one of the first syllables of the first content word of the AP and sometimes on the preceding function word(s). LHi also appears to be marked by strengthening and lengthening of the syllable onset ([2], [3]). Furthermore, [2] claims that not only internal onset consonants but also liaison consonants are submitted to such a lengthening. One of the goals of this paper is to test this claim.

However, a major controversy concerning LHi is its phonological status: [1] and [4] assume that LHi is a phrasal tone (an edge marker) rather than a pitch accent (a tonal event associated with a metrically prominent syllable), while many authors define it as pitch accent ([5], [6]). Another goal of the present paper is to test the hypothesis of LHi being a tonal marker of phrase left edge.

The optional occurrence of LHi has been said to depend on a variety of factors like speech style (political speech, didactic speech and newsreaders’ style are known to elicit more LHi than everyday conversation ([7]) or rhythmical constraints (the greater the number of syllables in the content

word the more probable the occurrence of LHi [8]). On the metrical side, another potential constraint on the occurrence of LHi is the presence of LH* on the following syllable, though this is a matter of debate. On the one hand, [2] claims that two adjacent syllables cannot both bear an accent, which means that, under an accentual view of LHi, a disyllabic word would have little chance to take the optional LHi on its first syllable given that LH* is obligatory on its second and last syllable. [6] defines the phonological phrase (equivalent of the AP) as the domain of stress clash resolution, which prevents the two rises to occur on adjacent syllables within the domain. Alternatively, [9] claims that LHi and LH* can occur on adjacent syllables and [8] proposes that accent clash occurs only between accents of the same nature (i.e. two pitch accents): these last views build on the idea that LHi and LH* are not of the same nature (have not the same phonological status: see the controversy described above). A third goal of the present paper is to provide evidence that LHi and LH* do occur on adjacent syllables within the AP.

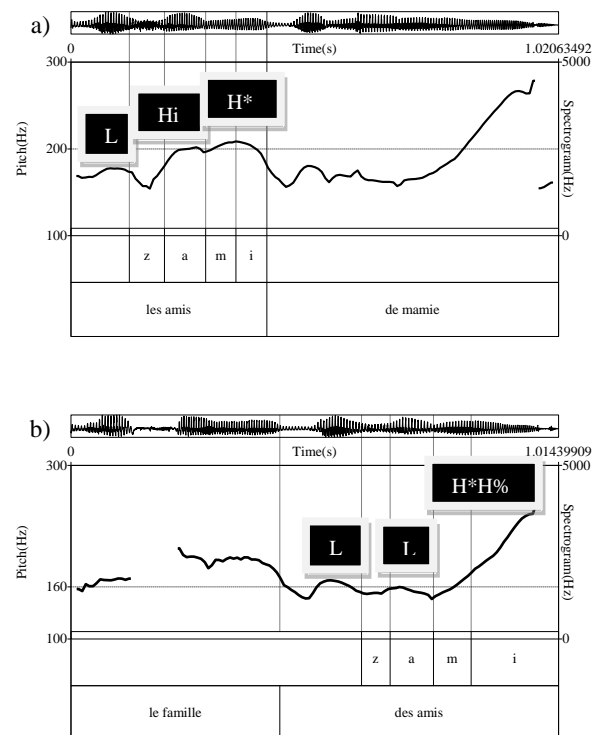


Figure 1: Waveform, spectrogram, f₀ contour and hypothesized tones on SN “les/des amis” in prenuclear position a) versus nuclear position b). The hypothesis tested here is that a LHi occurs on the syllable [za] in prenuclear but not in nuclear position.

In line with work showing left edge marking at various levels of constituency in French [10], [3] found that LHi is more likely to occur if it marks the beginning of more than one level of constituency: for instance the AP and the IP at the same time and place. A consequence of this claim is that an IP-initial AP would be more likely to receive a LHi than an IP-final AP. In a previous study [11], the authors informally noticed some regular differences between the surface shape of APs containing a disyllabic content word according their prenuclear (P) versus nuclear (N) position: while all N pitch movements were perceptually identified as clear rises, many P pitch movements were perceived as high plateaus. A clear difference is actually visible in the example given in Figure 1: *les amis* “the friends” is realized with a high plateau on both syllables of *amis* in P position (a) while it is with a rise on the final syllable /-mi/ in N position (b). A fourth goal of the present paper is to test if this perceptual difference is due to the realization of a LHi in P position which would be dispreferred in N position.

2. Method

Data collected for the purpose of the previous study [11] where analyzed by means of a crossed condition design, constructing a set of four experimental sentences: a, b, c and d in (1) below.

(1) A.: Pierre viendra ce soir.

a. B.: Oui, [(mais **leS-Amis**)APp (de mamie)AP]IP, ils n’arrivent que demain.

b. B.: Oui [(mais **la CAmille**)APp (d’Amélie)]IP, elle n’arrive que demain.

c. B.: Oui [(mais la famille)AP (**deS-Amis**)APn]IP, elle n’arrive que demain

d. B.: Oui [(mais les amis)AP (**de CAmille**)APn]IP, ils n’arrivent que demain.

The target sentences were read aloud by 4 participants (speaker B) and are all responses to the first sentence, which were read aloud by the first author (speaker A). The dialogue situation was designed to elicit a natural and interactive reading of the experimental sentences. Moreover, the target sentences were all left-dislocated sentences designed to induce a rising major contour at the right edge of the dislocated constituent.

Target APs (in bold) contained a unique disyllabic content word which would force a LHi to occur on a syllable adjacent to LH*. Among the target words, half of them started with a vowel preceded by a liaison consonants (*leS-Amis* “friends”) while the other half begin with an onset consonant (*CAmille*, a first name). Consequently, target sentences differ in absolute position of the target word within the IP (P for a. and b. = APp, versus N for c. and d. = APn); they also differ in syllable onset of the target word (liaison /z/ in a. and c., versus onset /k/ in b. and d.)

Since LHi is phonetically marked by a f0 rise and lengthening of its syllable onset, if LHi occurs on the P AP but not on the N AP, the following predictions can be made, which are summarized in Figure 2 below:

- Hypothesis 1: syllable S2 will show higher f0 values than S1 and a similar height relative to syllable S3 in IP-initial position (P), but similar values to S1 and lower values relative to S3 in IP-final position (N).

- Hypothesis 2: S2 will have a longer onset consonant in P than in N position (represented by the dotted lines in Figure 2).
- Hypothesis 3: the lengthening of S2 in P position will be observed independent of the liaison status of the onset consonant (/z/ in *les amis* or /k/ in *la Camille*).

Seven repetitions of each experimental sentence were interspersed with fillers and short dialogues, and separately randomized for each participant. We asked four female native speakers of French to read aloud target and filler sentences, in interaction with speaker A. A total of 112 experimental sentences (4 sentence types x 4 speakers x 7 repetitions) were hence recorded in an anechoic room and sampled at 44.100 kHz.

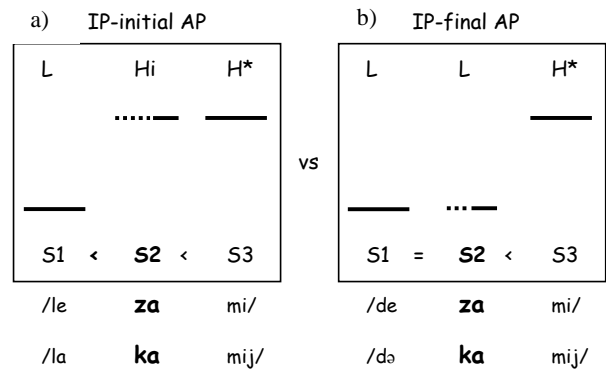


Figure 2: Hypothesized f0 level and tonal structure on S1, S2 and S3, and onset length on S2 (dotted lines) within the SN *les/des amis* or *la/de Camille* in P position a) versus N position b).

Using Praat waveforms and spectrograms to guide the segmentation [12] we manually tagged segment boundaries for each target accentual phrase.

The experimental factors manipulated were the following: position of the syllable within the AP (S1, S2 or S3), position of the AP within the IP (P vs N) and the onset consonant (/k/ vs /z/). In order to compare the f0 scaling of the last three syllables within target phrases (S1, S2 and S3), we measured the f0 mean of the vocalic nucleus of each syllable in P as well as in N position. We chose a mean measurement instead of a tone target measurement because neither S1 nor S2 showed clear f0 targets. We also measured the duration of the onset and rhyme within the penultimate syllable S2 of both prenuclear and nuclear APs.

3. Results

Statistical analyses were performed using the R package [13] and we employed linear mixed models [14].

The results for f0 mean measurements are presented in Figure 3 below. We tested the effect of the syllable position within the AP (the predictor) on f0 mean of the vocalic nucleus (the dependent variable). The position was coded as an ordered factor with three levels (S1, S2 and S3) and its effect was tested through a contrast with a linear and a quadratic component. Speakers and target sentences were random factors. The nature of S2 consonant (onset vs. liaison) was coded as a fixed factor and its interactions with the components of the contrast for the position factor were tested:

we will limit our discussion to its interaction with the position factor. Significance levels were obtained through Markov Chains Monte Carlo simulations and will be referred to as pMCMC.

Two different models were run: one for P position and the other for the N position. In both models the linear component of the contrast applied to the position factor has a significant positive effect (N: estimate= 13.061 Hz, pMCMC<10⁻⁴; P: estimate=33.043 Hz, pMCMC<10⁻⁴), meaning that f0 increases from S1 to S3. Concerning P position, the quadratic component has a significant negative effect (estimate=21.845 Hz, pMCMC<10⁻⁴); which means that the f0 on S2 is higher than predicted by the linear component and pulled toward the values observed on S3 (S2 = S3). The interaction between the nature of S2 consonant and the quadratic component of the contrast applied to the position factor is significantly positive for the liaison consonant /z/ (estimate=22.028 Hz, pMCMC<10⁻⁴). This suggests that the effect of the quadratic component is canceled for that consonant (f0 on S2 is lower as shown in Figure 3). Concerning N position, only the main effect of the quadratic component of the position factor is significant with a positive sign (estimate=21.104 Hz, pMCMC<10⁻⁴). This means that the f0 values on S2 are pulled toward values observed on S1 (S2=S1).

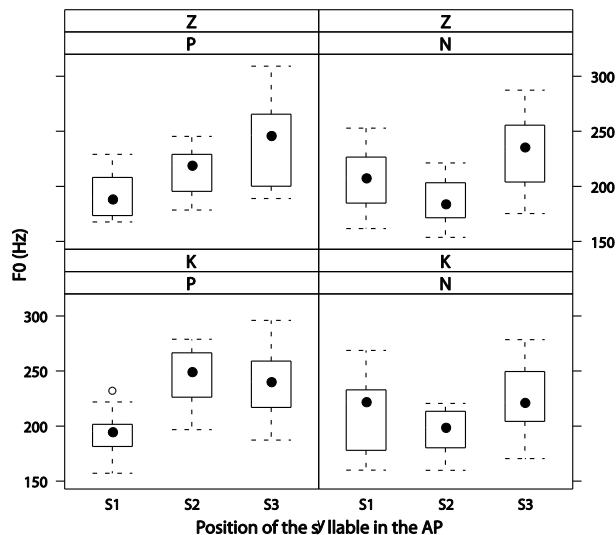


Figure 3: Mean f0 of the syllable's nucleus (y axis) of S1, S2 and S3 (x axis) in P position (left) versus N position (right). Results for /z/ are shown on the upper panels and for /k/ on the lower panels.

Other two linear mixed models were run to test the effects of two fixed factors, i.e. the position of the AP in the IP (P vs.N) and the nature on S2 consonant (/z/ vs. /k/) on the duration of S2 onset and rhyme. The random factor was the identity of the speaker.

As shown in Figure 4, results show that the syllable onset is significantly longer in P than in N position (estimate=6.3 ms., pMCMC<0.005). Conversely, rhyme duration is significantly shorter in P than in N position (estimate=-16.4 ms., pMCMC<0.001) as shown in Figure 5. The latter result was not expected but does not contradict our claim (see discussion).

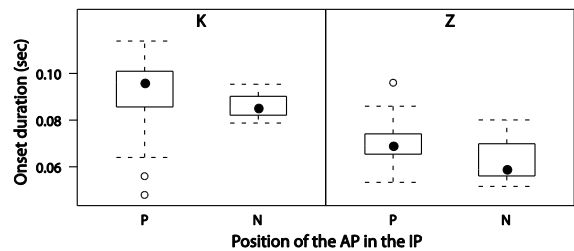


Figure 4: Duration of the onset of S2 (y axis) according to position of the AP within the IP: P (left) versus N (right). Durations for onset /k/ are shown on the left panel and durations for liaison /z/ on the right panel.

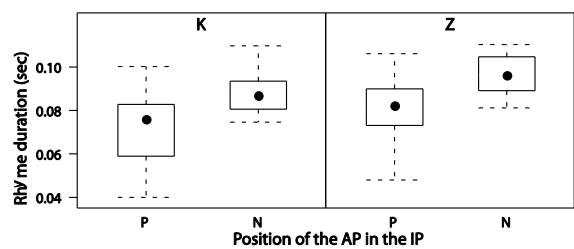


Figure 5: Duration of the rhyme of S2 (y axis) according to position of the AP within the IP: P (left) versus N (right).

4. Discussion

To sum up, our results show that the target syllable S2, which is the first and penultimate syllable of the target content word, presents a higher f0 than the preceding S1 when the word is in P position, but not in N position. Also, S2 appears to be marked by a longer onset and a shorter rhyme in P compared to N position. Since the presence of high pitch and the lengthening of the syllable onset are the phonetic marks of the initial LHi rise, this further supports the claim that LHi occurs on S2 (on /za/ in “les amis” and on /ka/ in “la Camille”) only in P but not in N position. This finding has several theoretical consequences.

A first important consequence is that it confirms the claim by [9] that LHi and LH* can occur on adjacent syllables, since H* always occurs on S3 (see the clear high pitch on syllable S3 in all conditions in Figure 3 above). Therefore, stress clash does not occur between LHi and LH* in our data, giving support to the idea that the two rises are not of the same nature, since LHi is an edge tone and not an accent. This gives the advantage to the phrasal tone hypothesis proposed by [1] and [4], contra [5] and [6]. However, it is also well documented that LHi often associates with a metrically strong syllable (see [15]), hence sometimes behaving as a pitch accent. A better account would then be that LHi is similar to the “hybrid tone” proposed by [16], namely a phrasal tone that can optionally and secondarily associates with a stressed syllable.

A second important finding is that LHi occurs in P APs but not in N ones in our data. How could this be explained? First, this is compatible with [2]'s claim that LHi is more likely to occur if it marks the beginning of more than one level of constituency: we actually observe that LHi is more likely to occur in P position where it marks the beginning of both the prenuclear AP and the IP. But this does not explain why we

did not observe LHi in nuclear APs. Here, we propose an alternative, phonological explanation to this finding. In Jun & Fougeron's proposal, the phonological underlying structure of the AP is /LHiLH*/ where surface realizations may delete one or two of these underlying tones, giving rise to six different patterns (see [1]). Two of them were shown by our speakers: [LHiH*] in P position and [LLH*] in N position. This would explain the perceptual difference observed by [10]: a plateau is perceived in P APs versus a sharp rise in N APs. The occurrence of the first pattern [LHiH*] in P position is explained by the fact that our target words are all disyllabic, which makes difficult (even if not impossible) to keep an intermediate L target between Hi and H*.

Why is it different in N position? Following [11], we propose that the nuclear rise found in our data has an obligatory L target which realization competes with the optional realization of Hi. Such a proposal may be reformulated through three theoretical assumptions that have to be explored by further work: 1) tonal crowding on the penultimate syllable is resolved by tonal deletion of Hi; 2) tonal crowding on the penultimate syllable results from the use of a bitonal L+H* in N position; 3) bitonal L+H* is used in N position but not in P position in French. This last assumption is in line with Ladd's nuclear/pre-nuclear distinction in English [17], which is also kept in Post's grammar of French intonation where a bitonal H+H* pitch accent occurs only before an IP boundary [6].

The difference observed between /k/ and /z/ for mean f_0 on S2 in P position (see Figure 3) can be explained by the fact that in French, voiceless consonants such as /k/ are known to raise the f_0 height of the following vowel [18]. While this effect could explain that the rise of LHi is more marked on *la Camille* (/k/ onset) than on *les amis* (/z/ onset) in P APs, it is crucial to note that it has no influence at all in the case of N APs because of the occurrence of a L target in this position.

Our results also show that the lengthening of syllable onset due to the occurrence of LHi in P position affects the liaison syllable /z/ as clearly as the word internal onset consonants /k/, hence confirming the claim that both onset and liaison consonants are lengthened when bearing an initial rise ([2]). The observed difference in duration between /k/ and /z/ in both P and N position (see Figure 4) has two different explanations: i) /k/ and /z/ have different intrinsic durations, since /k/ is longer (around 210 ms) than /z/ (163 ms, [19]); ii) French liaison consonants are known to be shorter than the corresponding word internal onset consonants [20].

Our results concerning the rhyme remain to be explained. In fact, we had not hypothesized that S2 rhyme would be longer in N than in P position. This could be explained by a preboundary lengthening effect, targeting not only the IP final syllable but also preceding syllables in various languages ([21]). Thus, our data suggest that preboundary lengthening could have scope not only on the final syllable but also on the penultimate syllable (i.e. S2) of the IP in French. This observation has to be confirmed by future work considering the influence of the different possible kinds of final pitch accents.

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6. References

- [1] Jun, S.-A., and Fougeron, C., "A phonological model of French intonation", In A. Botinis (Ed.), *Intonation: Analysis, modelling and technology*. Boston: Kluwer. 2000.
- [2] Grammont, M., "Traité de phonétique". Delagrave, 1933.
- [3] Astésano, C., Bard, E. G., and Turk, A., "Structural influences on initial accent placement in French". *Language and Speech*, 50, 423-446, 2007.
- [4] Welby, P., "French intonational structure: Evidence from tonal alignment". *Journal of Phonetics* 34(3): 343-371, 2006.
- [5] Di Cristo A., "Le cadre accentuel du français contemporain". *Langues* 3(2): 184-205, *Langues* 4(2): 258-267, 1999.
- [6] Post, B., "Tonal and phrasal structures in French intonation.", The Hague: Holland Academic Graphics, 2000.
- [7] Fonagy, Y. & Leon, P. R. eds., "L'accent en français contemporain", *Studia Phonetica*, 15, 123-233, 1980.
- [8] Padeloup, V., "Modèle de règles rythmiques du français appliqué à la synthèse de la parole". Doctoral thesis, Institut de Phonétique d'Aix-en-Provence, Université de Provence, 1990.
- [9] Mertens, P., "L'accentuation de syllabes contiguës", *ITL* 95/96, 145-165, 1992.
- [10] Fougeron, C. & Keating P., "Articulatory strengthening at edges of prosodic domains". *Journal of the Acoustical Society of America* 101 (6), 3728-3740, 1997.
- [11] D'Imperio, M., Bertrand, R., Di Cristo, A. and Portes, C., "Investigating phrasing levels in French: Is there a difference between nuclear and pre-nuclear accents?" In J. Camacho, V. Deprez, N. Flores, L. Sanchez, *Selected Papers from the 36th Linguistic Symposium on Romance Languages (LSRL)*. New Brunswick: John Benjamins Publishing Company: 97-110, 2007.
- [12] Boersma, P. & Weenink, D., Praat: doing phonetics by computer (Version 5.1.05) [Computer program], 2009, retrieved April 31, 2011, from <http://www.praat.org/>
- [13] R Development Core Team, "R: A language and environment for statistical computing". R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, 2009, URL: <http://www.R-project.org..>
- [14] Bates, D., "lme4: Linear mixed-effects models using S4 classes", R package version 0.99875-9", 2007.
- [15] Dell, F., "L'accentuation dans les phrases en français", in Dell, Hirst & Vergnaud (eds) *Les développements récents en phonologie: quelques idées centrales*, Hermann, 65-122, 1984.
- [16] Grice, Martine & Hubert Truckenbrodt (2001). *Hybrid Tones in Optimality Theory*. Paper presented at the HILP5, Potsdam.
- [17] Ladd, R.D., "Intonational Phonology". Cambridge University Press, 2008.
- [18] Di Cristo, A. & Chafcouloff, M., "Les faits microprosodiques du français", *Actes des 8èmes Journées d'études sur la parole*, 148-158, 1977.
- [19] Bartkova, K. & Sorin, C., "A model of segmental duration for speech synthesis in French". *Speech Communication* 6, 245-260, 1987.
- [20] Douchez, C. & Lancia, L., "Caractéristiques articulatoires des consonnes de liaison : Etude pilote". *Proceedings of the Journées d'études sur la parole*, Avignon : June 9-13, 2008.
- [21] Turk, A. & Shattuck-Hufnagel, S., "Multiple targets of phrase-final lengthening in American English words", *Journal of Phonetics* 35(4), 445-472, 2007.