

A Phonological Model of French Intonation

SUN-AH JUN AND CÉCILE FOUGERON

10.1 Introduction

French intonation has been characterized as having a sequence of rising pitch movements. Recently, this intonation pattern has been phonologically analyzed by several researchers such as Hirst and Di Cristo (1984, 1996), Mertens (1987, 1993), Di Cristo and Hirst (1993a, 1993b, 1996), Post (1993), Jun and Fougeron (1995), and Hirst, Di Cristo, and Espesser (forthcoming), among others. These authors agree that a tone is associated with a stressed syllable, and that stress is rhythmic or postlexical. They also agree that an utterance is hierarchically organized into different prosodic levels, though some of these levels are not referred to in the same terminology. These models diverge principally in the levels of phrasing and their tonal representation. They also disagree in the notion of accent in French and in the degree of abstractness in the tonal representation, which is due to the conceptual differences linked to the application of the model: the focus is either on acoustic representation of models relevant for speech synthesis and recognition, or on abstract representation for phonological description, or on both levels.

In this paper, we propose a development of our previous model (Jun & Fougeron, 1995; Fougeron & Jun, 1998) based on the tonal pattern of focus in both declarative and interrogative sentences, and other syntactic/semantic constructions and intonational clichés. The organization of this paper is as follows. In section 2, we will elaborate our previous model: the underlying tonal pattern and the surface realizations of two prosodic units, an Accentual Phrase and an Intonation Phrase. We will

compare our Accentual Phrase with the existing prosodic units proposed by other intonational, especially phonological, models. In section 3, we will report on a phonetic experiment on focus intonation. We will suggest an analysis of how to represent the tonal shape of the focused phrase with our phonological model, introducing a third prosodic unit, an Intermediate Phrase. In Section 4, we will support the analysis based on other syntactic/semantic constructions and intonational clichés, and discuss an alternative analysis. All data discussed in this paper are from Parisian French.

10.2 Description of Jun & Fougeron's Early Model

Following the framework developed in Pierrehumbert (1980), Beckman and Pierrehumbert (1986), and Pierrehumbert and Beckman (1988), we assume that an intonational tune is composed of a sequence of underlying H and L tones, and that each tone is linked to a syllable which is either metrically strong or marks the boundary of a prosodic unit. It is assumed that not all syllables are specified as having a tone, and tonally unspecified syllables get their surface tone by interpolating between two adjacent tonal targets. We also assume that an intonationally defined prosodic unit is hierarchically organized, and obeys the Strict Layer Hypothesis (Selkirk, 1984, 1986; Nespor & Vogel, 1986). That is, a prosodic unit of a given level of the hierarchy is composed of one or more units of the immediately lower prosodic unit, and each unit is exhaustively contained in the superordinate unit of which it is a part. Under these assumptions, we proposed in our earlier paper (Jun & Fougeron, 1995) two intonational units in French: an Accentual Phrase and an Intonation Phrase. In the following subsections, we will describe the tonal patterns of each phrase and compare our Accentual Phrase with similar units proposed by others.

10.2.1 The Accentual Phrase

10.2.1.1 The Underlying Tonal Pattern

The Accentual Phrase (henceforth, AP) is the lowest tonal unit in French, and it can contain more than one word. The AP is the domain of primary and secondary stress, and has an underlying tonal pattern of /LHLH/. The final rise (LH) of AP has a demarcative function, similar to the AP in Korean (Jun, 1993, 1998). In order to reflect the difference between the two H tones of the AP (initial H and final H), we represent the underlying tonal pattern of AP as /LHiLH*/ (Fougeron & Jun, 1998).

The phrase final H tone (=H*) is a demarcative pitch accent associated with the primary stressed syllable of an AP, which is the phrase final full vowel (“accent primaire” or “accent final”). We assume that French has accentable syllables (i.e., the final full syllable of lexical words) and that this pitch accent is realized on one of these syllables. In other words, every word final full vowel can be the target of the primary accent (or pitch accent), but not every word final full vowel is realized with an accent. This view of accent being the property of the phrase or the group, not of the word, has been proposed by many previous researchers (e.g., Grammont, 1914; Delattre, 1939; Marouzeau 1956 (cited in Di Cristo, 1998)). Since an AP is delimited by this phrasal accent (H*), AP is quite similar to Delattre’s “groupe accentué”, “groupe rythmique”, or “groupe de sens”. The diacritic ‘*’ is used to show that the tone is associated to a stressed syllable.

The phrase initial H tone (Hi) (also known as “accent initial”, “accent secondaire”, or “ictus mélodique”) is optional in an AP. Its occurrence is influenced by several factors, mostly rhythm, style, and speaker¹. The location of the Hi is also variable. It is realized on the initial stressed syllable of the first lexical word within an AP. But in surface it is generally said to fall on one of the first two syllables of the first lexical word within a phrase (Fonagy, 1980; Lucci, 1983; Padeloup, 1990; Vaissière, 1974, 1997). To investigate the location of initial accent within a word, we ran an experiment where we varied the number of syllables within a word from two to eight (seven or eight 2~7-syllable words and three 8-syllable words): e.g. *médite*, *méditer*, *méditation*, *méditerranée*, *méditerranéen*, *méditerranéiser*, *méditerranéisation*; *invite*, *inviter*, *individu*, *individualisme*, *individualité*, *individualisation*. The target word (total 46 words) was embedded in the subject position of a carrier sentence, “X est un mot utilisé par les français” (‘X is a word used by French people’), where the secondary (initial) stress is most likely to occur (Padeloup, 1990). Each sentence was repeated four times by three speakers. Results are shown in Figure 10.1. The X-axis refers to the number of syllables in a word and the Y-axis refers to the frequency of initial peak occurrences in percent. Data show that the initial peak, Hi, was realized either on the first syllable (when the word has two or three syllables) or on the second syllable (when the word has more than three syllables²). For a few tokens, an initial peak was realized over the first two or three syllables as a plateau (e. g., ‘plateau s1-s2’ in Figure 10.1 refers to the cases where the initial peak covers the first and second syllables).

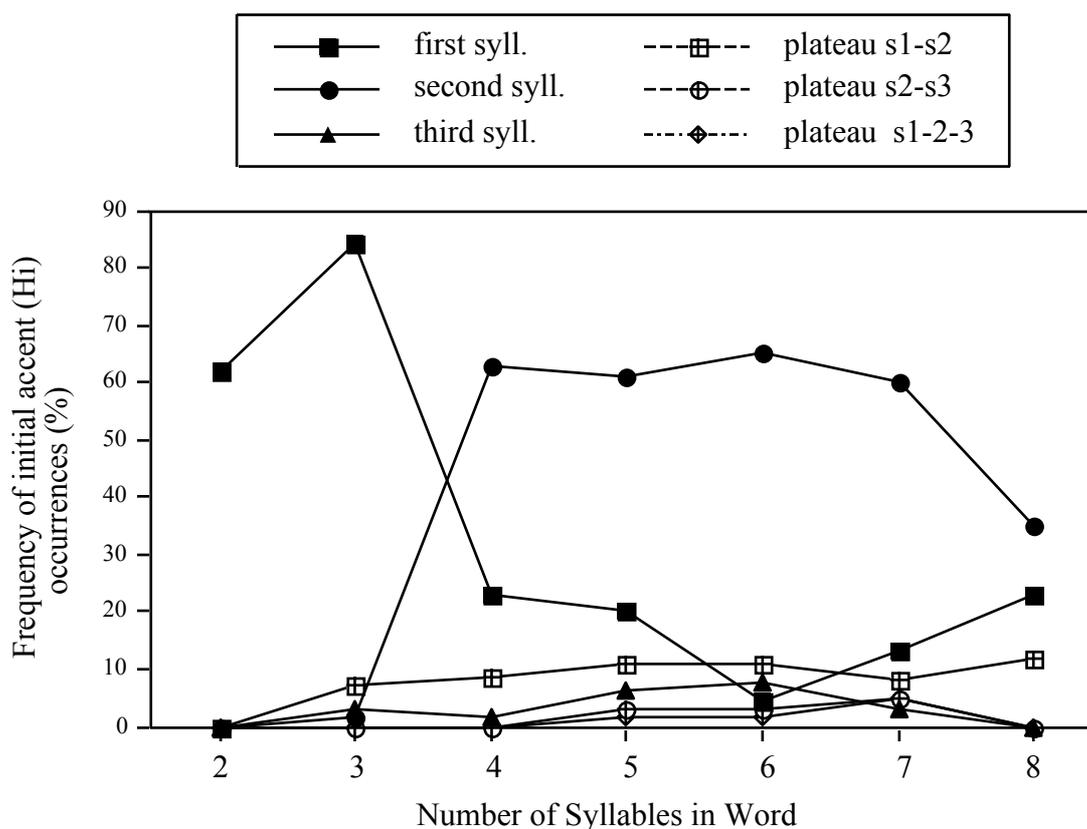


Figure 10.1. Location of initial accent (Hi) within a 2~8 syllable-word which forms an AP in sentence initial position: the frequency (in %) of realization of Hi on the 1st, 2nd, 3rd syllable, or as a plateau high realized over the initial two or three syllables (e.g., “plateau s1-s2”: Hi over the 1st and 2nd syllables).

In a different corpus including several examples of an AP beginning with a function word (e.g., in the story “La bise et le soleil” ‘The North Wind and the Sun’), we noticed that the realization of Hi is sensitive to the presence of a function word. When an AP begins with one or more function words, especially when the function words are monosyllables, Hi tends to be realized after all the function words³. For example, Hi was placed on *faire* in *à le lui faire ôter* ‘in making him take off (his coat)’ or on *bout* in *et au bout d’un moment* ‘and after a moment’. We also noticed that in cases where the function word is a bisyllable (e.g., *était*) or where there are more than one function word, Hi is sometimes realized on a function word. For example, Hi was placed on *était* in *qu’il était le plus fort* ‘that he was the stronger’ or on *sont* in *ils sont tombés d’accord* ‘They made an agreement’.

The sensitivity of initial accent to lexical information in French has also been mentioned by others. Hirst and Di Cristo (1996) shows that the initial accent is linked to the beginning of the lexical word. They found a

positive, though small, correlation ($r^2=.26$) between the number of unaccented syllables (from function words) and the syllable location of the initial peak. Vaissière (1997) claims that the initial rise is localized on the first or second syllable of the first lexical word, but when the initial syllable begins with a vowel and if there is no liaison consonant, the high target (i.e. initial accent) is delayed. In this respect, French is different from Korean, in which the underlying tonal pattern of an AP is LHLH, but the initial H is realized on the second syllable of the phrase regardless of the lexical information of the word (Jun, 1993, 1998). In our model, we temporarily assume that Hi in French is associated with the first syllable of the AP-initial lexical word, but it is realized on the preceding (if there is a function word) or the following syllables depending on the segmental context or many other factors mentioned above. Further study is needed to model the precise location of Hi and its phonetic realization rules.

In theory, Hi and H* should be considered to be pitch accents since they are associated with stressed syllables. However, we assume that Hi is not a pitch accent for two reasons. First, it is not always realized on a stressed syllable with a full vowel. Second, the Hi-toned syllable is not always significantly longer than non AP-final syllables (see Figure 10.5). In neutrally produced utterances, Hi is generally weaker than H* in its duration and pitch. The different status of these two tones is also implied in Beckman (1993). She notes that French is closer to English or Swedish than Japanese in that “the (normally final) accented syllable of each ‘rhythm group’ is longer in duration than the syllables preceding it.” In producing a focused word, however, we found that Hi is often promoted to a pitch accent (See section 3 for more detail).

Finally, the AP-initial L tone in /LHiLH*/ is realized on the syllable before Hi, or as a low plateau if there are two or more syllables. When Hi is realized on the first syllable of an AP, however, the L is not always realized. The second L tone in the AP tends to be realized on the syllable preceding the H*-toned syllable, thus on the penultimate syllable if the phrase final syllable is full. However, as the number of syllables in an AP decreases, the L tends to occur in the final syllable, i. e., the same syllable as the H*-toned syllable. Figure 10.2 shows the position of the second L tone in a one-word AP, which is located in the subject position of a sentence. This data is from the same experiment investigating the location of initial H, as shown in Figure 10.1 above.

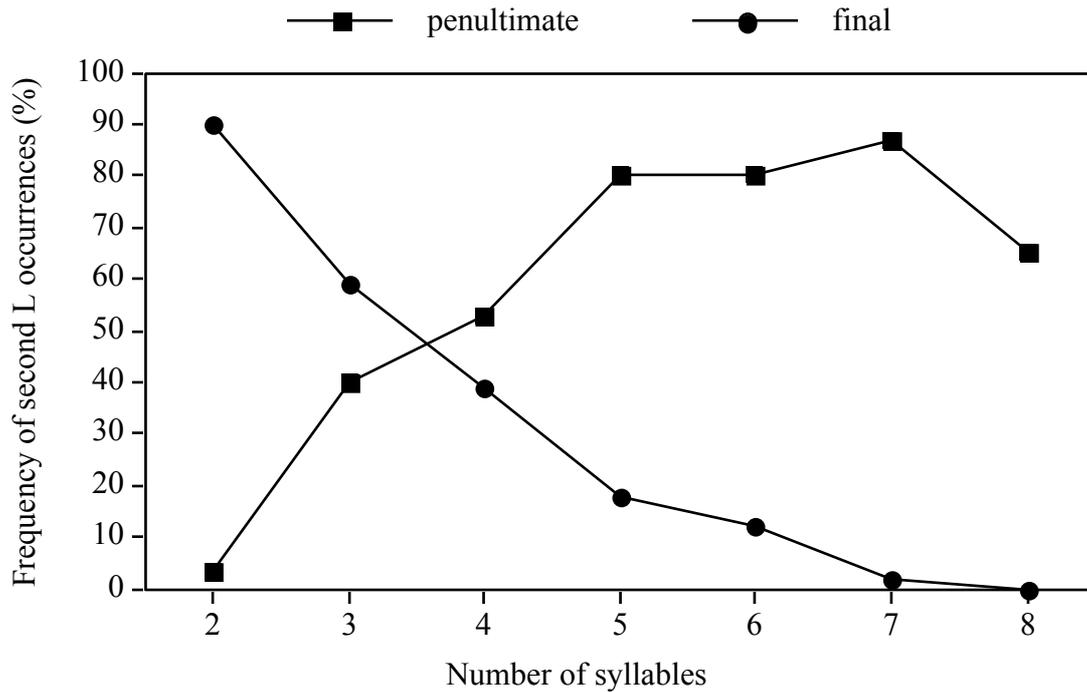


Figure 10.2. Position of second L in one-word AP located in sentence initial position. The location of L in each word is shown relative to the number of syllables in the word.

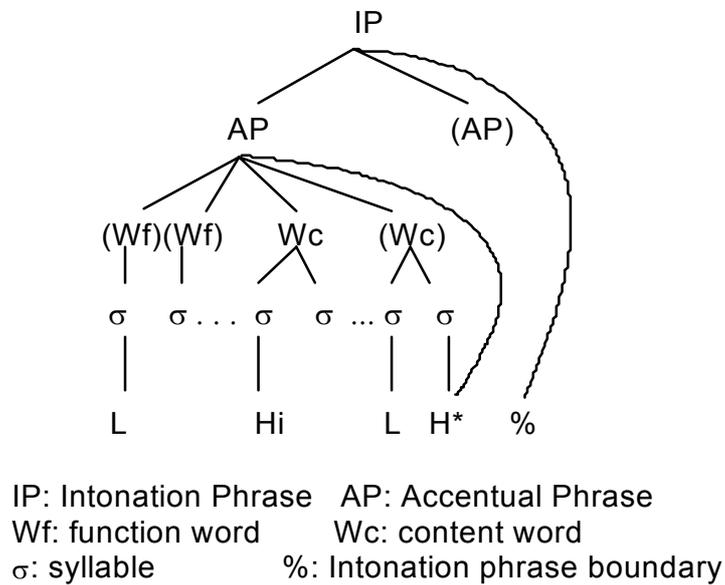


Figure 10.3. Schematics of underlying tones in AP (LHiLH*) and their affiliation.

In sum, when there are four syllables in an AP, each tone can be realized on its own syllable. But when there are more than four syllables in an AP, the first two tones are aligned with the first two syllables of the AP

and the second two tones with the last two syllables of the AP (assuming that the AP begins with at most one monosyllabic function word, and ends with a full vowel). The syllable(s) between Hi and the following L are not specified with underlying tones. Their surface tonal values are determined by interpolation between Hi and the following L target. A schematic representation of the underlying tones in AP (LHiLH*) and their affiliation to a syllable or to a prosodic unit is shown in Figure 10.3. Next section describes various realizations of the underlying tones in AP.

10.2.1.2 Realization of AP

By assuming the underlying four tones associated with certain syllables within an AP and phonetic implementation rules (Beckman & Pierrehumbert, 1986; Pierrehumbert & Beckman, 1988) we can explain various realizations of French phrasal intonation.

The four underlying tones of an AP tend to be realized on the surface if the AP has more than three syllables. Example sentences parsed with AP boundaries, marked with {}, are shown in (1). Examples in (1a, 1b, 1c) show that the four underlying tones are all realized when there are at least four syllables in an AP with the LHi being realized at the initial two syllables and the LH* being realized at the final two syllables. When an AP has fewer than four syllables, all four underlying tones can still be realized if some of the syllables are lengthened. But without extra lengthening, either Hi, or the following L, or both may not surface. Examples in (1d) and (1e) illustrate the case when both Hi and L are not realized.

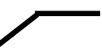
(1) Example sentences marked with AP boundaries (only the first AP is tonally specified)

- (a) Européen est un mot utilisé par les français ‘European is a word used
 {L Hi L H*} { } { } { } by French people’
- (b) Le mauvais garçon ment à sa mère ‘The bad boy lies to his mother’
 {L Hi L H*} { }
- (c) Le désagréable garçon ment à sa mère ‘The unpleasant boy lies to his mother’
 {L Hi L H*} { }
- (d) Marie mangera des bananes ‘Marie will eat some bananas’
 {LH*} { } { }
- (e) Le garçon coléreux ment à sa mère ‘The irascible boy lies to his mother’
 {L H*} { } { }

In our data, we have observed five surface tonal patterns of AP, as schematized in Table 10.1. The variability in surface realization of AP can be explained by assuming tonal undershoot linked to temporal constraints (cf. Lindblom, 1963, 1964). The tone in a parenthesis in Table 10.1 refers

to the tones not realized due to undershoot. That is, when there are one or two syllables in an AP, the AP surfaces as [LH*] with Hi and the following L being undershot. When there are three syllables in an AP, the AP has four possible surface patterns: a. [LH*], b. [LLH*] when Hi is undershot, c. [LHiH*] when second L is undershot, and d. [HiLH*] when the initial L is undershot. Among these, the [LHiH*] pattern was the least frequent. The [HiLH*] pattern is not limited to a three-syllable AP, but is also observed in an AP of 4 or more syllables. This pattern is therefore not triggered by the number of syllables, but by the lexical components of an AP: the AP initial L may not be realized when the AP begins with a content word and Hi is realized on the first syllable of the word. Finally, an AP can have a [LHiL*] pattern (or [LHiLL*] when the AP has enough syllables to carry four tones) when the AP has a Hi tone and is followed by another AP which begins with Hi. In this case, the AP final H* is sometimes realized as a L* due to a constraint on tone sequences to avoid two or three consecutive H tones: *HH(H). I.e., H* -> L*/__Hi or /Hi__Hi. This phenomena of tone clash or tone repulsion is also observed in Korean (Jun, 1996) and other tone languages such as Shona (Stevick, 1965, cited in Kenstowicz, 1994) and Miya (Schuh, 1998).

Table 10.1. Five types of surface realizations of AP (/LHiLH*/) when not all four underlying tones are realized. The tone(s) in a parentheses refers to the tone(s) not realized due to undershoot.

	/L Hi L H*/
	a. [L (Hi L) H*]
	b. [L (Hi) L H*]
	c. [L Hi (L) H*]
	d. [(L) Hi L H*]
	e. [L Hi (L) L*]

The last pattern [LHiL] is the most common pattern when an AP is final in an Intonation Phrase whose boundary tone is L%. Since the AP final syllable is also the Intonation Phrase final syllable, the AP final H* and Intonation Phrase final L% are supposed to be realized on the same syllable. In this case, the AP final H* is preempted by the higher level (Intonation Phrase) boundary tone.

In addition to the tonal shape, an AP is also marked by a lengthening of the H*-toned syllable. This syllable is significantly longer than non AP-final syllables (see Figure 10.5).

Finally, since an AP is delimited by a word final full vowel, in theory, every word-final full vowel could be the final syllable of an AP. But depending on many factors such as speech rate, length of the phrase, or syntactic and semantic constraints (Lucci, 1983; Pasdeloup, 1989; Delais-Roussarie, 1995; Fougeron & Jun, 1997), not every word final syllable becomes an AP-final syllable. For example, an AP tends to contain more words at fast speech than slow speech, and can contain more words when each word is short. In our data, we found that an AP contains on average 2.3~2.6 words (or 1.2 content words), and 3.5-3.9 syllables. This data is based on the story “La Bise et le Soleil” (‘The North Wind and the Sun’) read by three speakers at normal rate three times. The number of syllables in an AP is similar to that of Fonagy’s (1980) “arc accentuel”: 3.36 syllables in spontaneous conversation. The size of French AP is also very similar to the size of Korean AP which contains in average 1.2 content words and 3.2 syllables, based on the same story (Korean version) read by three speakers of Seoul Korean at normal rate four times.

10.2.1.3 Comparison of AP with Other Units

Due to undershoot of a certain underlying tones, our AP can contain one or two rising movements. In Di Cristo and Hirst’s model (Hirst & Di Cristo 1984, 1996; Di Cristo & Hirst, 1993a, 1996; Di Cristo, 1998) each rising movement has been analyzed as one prosodic unit, a Tonal Unit. In their model, Tonal Unit (TU) and Intonation Unit (IU) are the only prosodic units defined by a tone. The TU is the lowest tonal unit and has a LH tonal pattern. The IU is the higher unit and has a phrase final boundary tone, L or H, and a phrase initial boundary tone, L.

When a lexical word is monosyllabic, an AP can be equivalent to one TU, as shown in (2a) (The examples 2a and 2c are modified examples from Hirst & Di Cristo, 1984, and the example 2b is from Di Cristo, 1998). This is because an AP is often realized as one rising tone when there are fewer than four syllables in the AP, or when the initial H is not realized. In other cases, our AP can be equivalent to two TUs as shown in (2b), since their TU delimits either the end of initial accent (= our Hi) or the final accent (= our H*). However, an AP is not a combination of any two TUs. As shown in (2c), the first AP matches the first TU, but the second AP matches the following two TUs. It is not possible to form an AP by combining the first two TUs because an AP boundary should match a Word boundary (observing the Strict Layer Hypothesis).

two falling movements, where the first fall occurs within an AP (indicated by '1') and the second fall occurs across an AP boundary (indicated by '2'). Figure 10.4b shows the duration of '1' (left panel, based on 374 data points) and '2' (right panel, based on 146 data points) against the number of syllables in the first and second AP, respectively. As shown in the figure, the duration of the fall is dependent on the number of syllables in the AP when it is AP internal, i.e. when the two surrounding rises belong to the same AP (fall '1'). In this case, the duration increases as the number of syllables increases. On the contrary, the duration of the fall is fairly constant, about 100-200 ms., when the two rises belong to different APs (fall '2'). Furthermore, the final syllable of the first rising (=Hi) is not consistently lengthened compared to non-final syllables, but that of the second rising (=H*) is significantly longer than other syllables (see Figure 10.5) for all cases. The tonal cohesion between the two LH rises and the different degrees of finality between these two would not be explained if we assume that each rising movement is a separate prosodic unit.

Our AP is similar to the "arc accentuel" of Fonagy (1980), or "mot phonologique" of Milner and Regnaud (1984) in that it includes the beginning and the end of lexical or syntactic units (ex. ZERo HEUre, VINGT quatre HEUre, les ILes britanniQUE, la MAjeur partie) (see Hirst & Di Cristo, 1996, for a review of our model⁴), and is similar to Rossi's (1985) "Intonème Mineur", or Vaissière's "prosodic word" (1974, 1992) or "Syntagme prosodique" (1997) in that these units are delimited by the final stress. Our AP is also similar to Mertens' Intonation Group (IG) (Mertens, 1987, 1993) since both units are the lowest prosodic unit based on tone, and include the final accent as well as the initial accent. The difference between our AP and Mertens' IG is in the number of underlying tones and the degree of abstractness: we assume four underlying tones with the initial and penultimate tones being L and the second and the final tones being H; Mertens assumes only one underlying tone (AF) and an optional tone after the final stressed syllable (IG=((NA)AI) (NA) AF (NA)), where NA is a non-accented syllable, AI is an initial accented syllable, and AF is a final accented syllable). Furthermore, each tone in Mertens' IG, if realized, can be L or H with four levels of height. His model is closer to the phonetic representation than ours, and has been implemented as the input to speech synthesis and recognition.

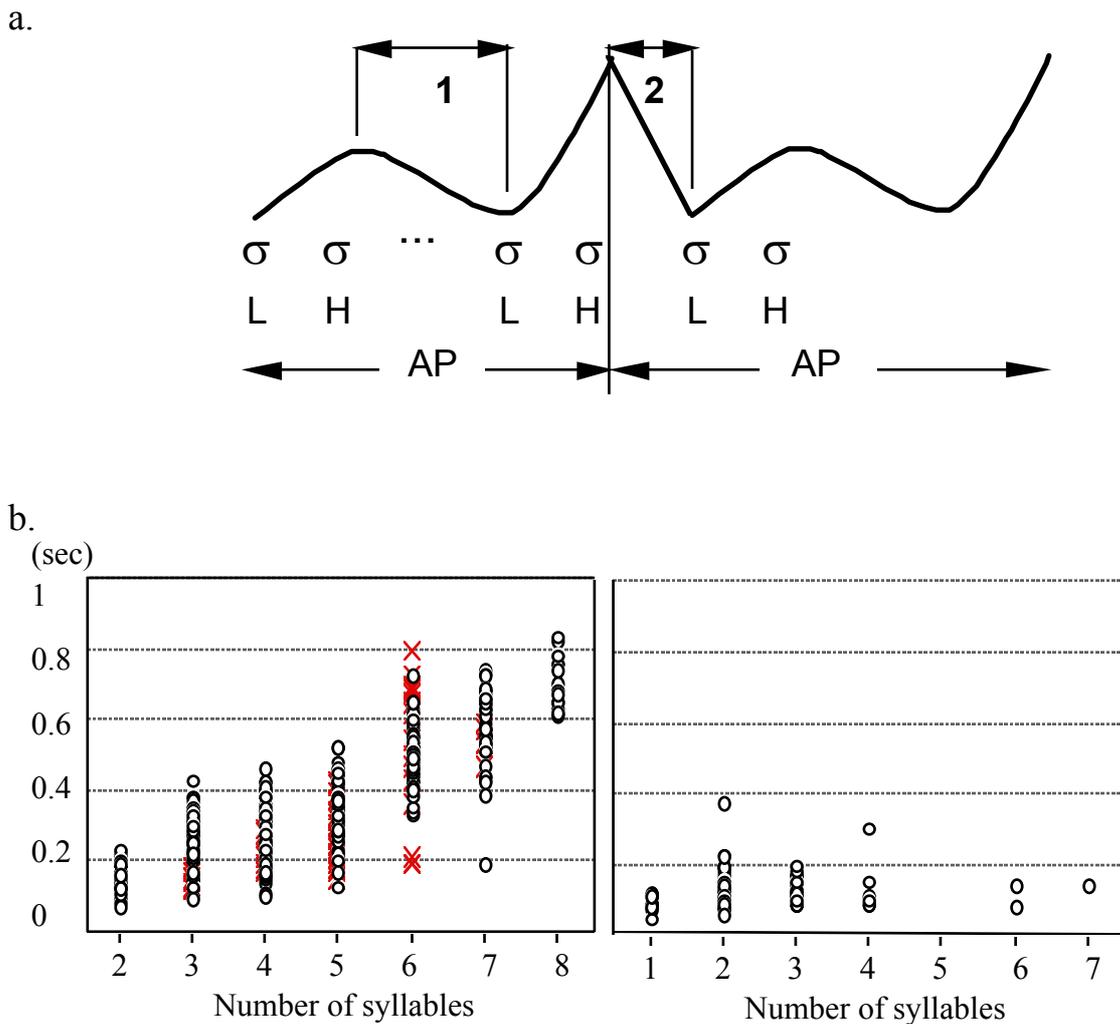


Figure 10.4. a) Schematics of F_0 contour of two APs. b) Left: duration of fall within an AP ('1' in (a)) against the number of syllables in the AP. Data from one-word APs are marked as 'o', and more-than-one-word APs are marked as 'x'; Right: duration of fall across two APs ('2' in (a)) against the number of syllables in the following AP.

10.2.2 Intonation Phrase

An Intonation Phrase (henceforth, IP) is a prosodic level higher than an AP, and the highest level in this model. This level in French roughly corresponds to the "Intonème Majeur" (Rossi 1985, 1993), the "Unité Intonative" (Hirst & Di Cristo, 1984; Di Cristo, 1998), and the "Breath Group" (Vaissière, 1997).

The IP is marked by a major continuation rise or a major final fall. Following the notation developed for English by Pierrehumbert (1980), we will note the right tonal boundary of the IP by a $H\%$ or a $L\%$ tone, which is realized on the last syllable of the IP. This level is also marked by a large final lengthening and is optionally followed by a pause (e.g., Hirst & Di

Cristo, 1984; Padeloup, 1990; Fougeron & Jun, 1998). Figure 10.5 shows the duration of IP final syllables, AP final syllables, Hi-toned syllables and unaccented syllables. The data is from “La Bise et le Soleil”, produced by 3 speakers. The IP final syllable is significantly longer than the AP final syllable, and the AP final syllable is significantly longer than unaccented syllables. Here, unaccented syllables refer to all syllables other than the Hi-syllable and H* syllable. A lexical word final syllable is not lengthened if it is not AP-final. The duration of Hi is not consistently different from either H* or unaccented syllables. Some speakers show no difference between H* and Hi, while others show no difference between Hi and unaccented syllables. Thus, both prosodic levels, AP and IP, are cued by the duration of their final syllable. Finally, it was found that in the story, “La Bise et le Soleil”, an IP contains an average of 2.0~2.7 APs and 7.3~10.1 syllables, averaged across speakers.

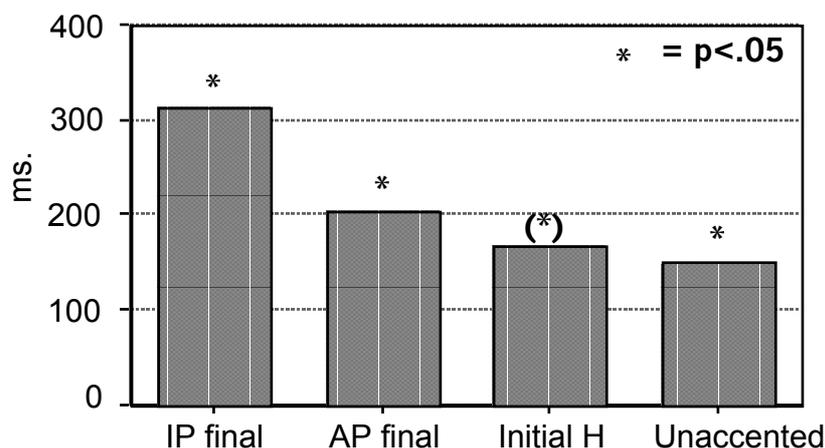


Figure 10. 5. Duration of syllable in different prosodic positions. See text above for explanations.

10.3 Experiment: Focus realization

10.3.1 Background and Procedure

Narrow focus in French has generally been described as a large, sharp rise and fall of pitch contour (e.g. Rossi, 1985; Touati, 1987; Di Cristo & Hirst, 1993b; Clech-Darbon, Rebuschi & Rialland, 1997; Di Cristo, 1998). The location of the peak has been described to be realized on the initial accented syllable (Hi), or on the final accented syllable (H*), or on both, and more often on the initial syllable than the final syllable. Di Cristo (1998) notes that the timing of the peak on a focused item depends on the

objective or expressive character of the focus. For an objective contrastive focus (e.g. *Le professeur a la clé (pas l'étudiant)* 'The teacher has the key (not the student)', the peak can be aligned with any syllable of the focused item except the last (i.e. *pro*, or *fe*, but not on *sseur*). In the case of an expressive contrastive focus, the peak occurs on the final stressed syllable of the focused item. He also notes that the fall from the peak is always associated with the rightmost full syllable of the item in contrast.

The sequence after focus has generally been described as "flat", "deaccented" or "dephrased", with a reduced register (Touati, 1987; Di Cristo, 1998; Clech-Darbon, Rebuschi & Rialland, 1997). In declaratives, focus is followed by a low plateau until the end of the phrase, while in interrogatives focus is followed by a reduced copy of the pre-focus sequence (low or high plateau followed by a sharp rise at the end). Touati (1987) describes that in the sequence after focus, pitch accents are deleted, and in the sequence before focus, the amplitude of pitch accents is reduced. Since post-focus sequence has no tonal variation, the sequence is often perceived as being shorter than that of a neutral sentence. This kind of flat tonal pattern is also found in English after early focus in a phrase. Erickson & Lehiste (1995) showed that the duration of post-focus words in English is indeed reduced compared to that in the neutral sentence. This suggests that a post-focus sequence in English is deaccented and dephrased, meaning that the pitch accents are deleted and durational differences linked to the pitch accent or phrasal tone are also lost.

To investigate how the tonal characteristics of a focused sentence are represented in our intonation model, we examined the location of rise and fall for a focused item in a sentence, and the tonal pattern after and before focus, both in declaratives and interrogatives. Interrogatives are based on an incredulous echo-question, so that the order of words is exactly the same as that of declaratives. We also examined the duration of a post-focus sequence in a focus sentence compared to the same sequence in a neutral sentence to investigate whether a post-focus sequence is "deaccented and dephrased (i.e., loses both the tone and phrase boundary lengthening) or "deaccented" only (i.e. loses the phrase boundary tone only, but keeps phrase boundary lengthening). Di Cristo (1998) notes that in the post-focal part which is produced with a slightly declining parenthetical pitch pattern without pitch prominence, rhythmic units (UR) were signalled by temporal organizations. In our study, we test if post-focal APs are also maintained based on the temporal properties.

Five Parisian French speakers participated in this experiment, but most analysis reported here are based on two or three speakers. Speakers were given three sets of 15 sentences: Neutral Declarative, Focus Declarative,

and Focus Interrogative. Sentences were varied in terms of the syntactic organization, the length of the focused word, and the location of contrastive focus. Each sentence was repeated five times. An example from each set is given in (3) below. The focused word is shown in bold capitals. In order to trigger narrow focus on the target word, a cue sentence was written in parenthesis just before each target sentence where the cue sentence has a form of ‘Not A, but B’ for declaratives and ‘A or B’ for interrogatives. This type of focus would be categorized as Di Cristo’s (1998) objective contrastive focus. The nature of focus type (objective vs. expressive) was confirmed by the authors’ judgments. For focus interrogative, a paragraph of background information was additionally given at the beginning of the whole list. Speakers were not given any other information regarding the type of focus or how to produce the sentences.

(3) **neutral declarative**

Marion mangera des bananes au petit déjeuner.

‘Marion will eat some bananas at breakfast’

focus declarative

(Marion ne mangera pas des ananas au petit déjeuner, mais ...)

Marion mangera des **BANANES** au petit déjeuner.

‘(Marion won’t eat pineapples at breakfast, but...)

Marion will eat some BANANAS at breakfast’

focus interrogative

(je veux savoir si Marion mangera des bananes ou des ananas)

Marion mangera des **BANANES** au petit déjeuner?

‘(I want to know if Marion will eat bananas or pineapples)

Marion will eat some BANANAS at breakfast?’

10.3.2 Results

10.3.2.1 The Tone-syllable Affiliation of Focus

As mentioned in previous studies, the focused item was always marked by a large peak on the first or the last, or on both syllables of the item, and was followed by a flat contour, low for the declaratives and mid or high for the interrogatives. The sequence before the focused item also differed from that of the neutral sentence in having a reduced pitch range and amplitude as well as a reduced number of phrase boundaries.

For focus declarative sentences, the location of the focus peak (focus H, henceforth Hf) differed depending on the speaker and the length of the

word. Though the type of our focus sentences was close to Di Cristo's objective contrastive focus, we found many examples where the rise occurs on the final stressed syllable of the focused word. Figure 10.6 shows the location of Hf for five speakers: a white bar refers to the cases where Hf is on the initial syllable, Hi; a black bar refers to the cases where Hf is on the final syllable; and a mixed color bar is for the cases where Hf is on both syllables. The upper panel shows when the words are short (two to three syllables: e.g., *Marion, bananes, mangera*), and the lower panel shows when the words are long (four to six syllables: e.g., *inadmissible, inimitable, irrémédiable*). For short words, Speaker 1F had Hf more on H*, while the other speakers had Hf more on Hi. However, this pattern was not the same for long words. Speaker 1F always focused Hi, and Speaker 2F and 3M focused H* more often than Hi. No speakers focused H* only. In general, speakers focus Hi more often than H*, and when they focus H*, they also put focus on Hi.

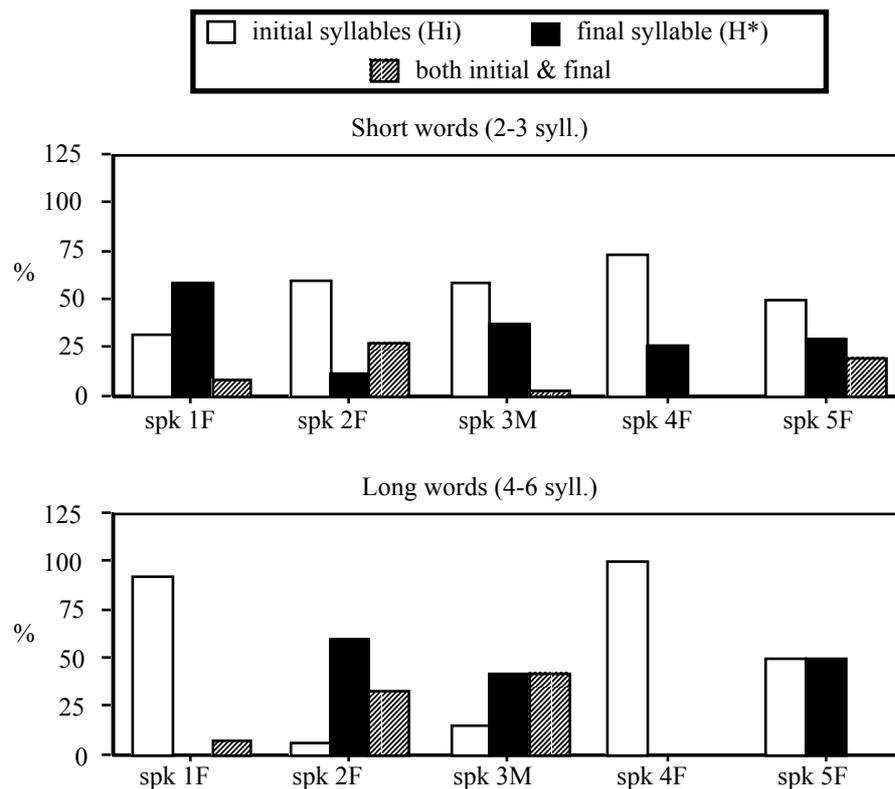
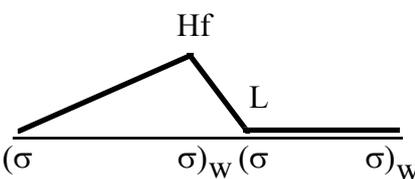
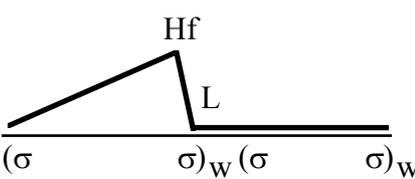
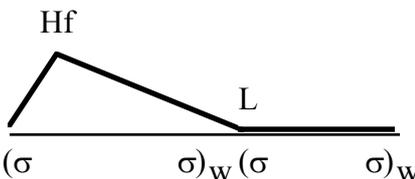
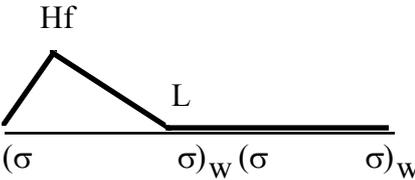
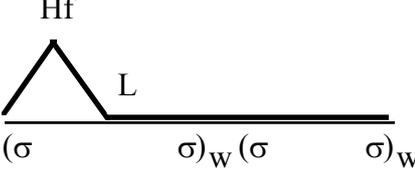


Figure 10.6. Frequency (in percent) of focus realization in declarative sentences, divided into two groups: short words, vs. long words. A white bar signifies focus H (Hf) on the initial accent (Hi), a black bar signifies Hf on the final accent (H*), and a mixed color bar signifies that Hf is on both.

A Phonological Model of French Intonation

The location of L tone after focus H (Hf) is mostly realized on the first syllable of the next word or the beginning of the next word regardless of the location of the peak (Hi or H*). Hence, the duration of the fall from Hf to the following L depends on the placement of Hf: it is short when Hf is on H*, but long when Hf is on Hi. In a few cases, L falls on the focused word final syllable or earlier (mostly for speaker 1F's long words). Table 10.2 shows the frequency of each pattern, depending on whether the focus is realized on H* or Hi.

Table 10.2. The location of L after focus H.

	short words (2-3 syll.)			long words (4-6 syll.)		
	1F	2F	3M	1F	2F	3M
<p>Focus on H*</p> 	23 (100%)	11 (100%)	0 (0%)	1 (100%)	12 (85%)	3 (100%)
					2 (15%)	
<p>Focus on Hi</p> 	9 (100%)	20 (95%)	6 (100%)	4 (33%)	1 (100%)	1 (50%)
		1 (5%)		7 (58%)		1 (50%)
				1 (8%)		

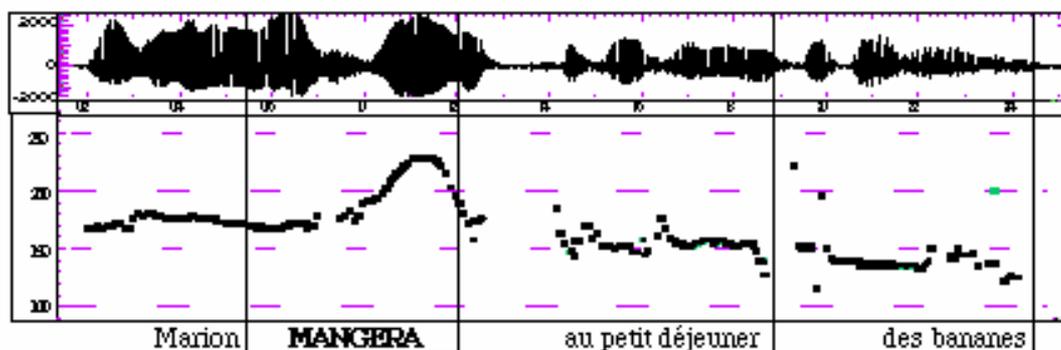
For focus interrogative sentences, the focused item was realized as a sharp rise on the final syllable of the item, reaching the peak at the end of the word, and sometimes even after the word. The location of Hf was always on the H* of all focused words except for *mangera* ‘will eat’ as produced by Speaker 3M. In this case, the speaker put a High Intonational phrase boundary (H%) after the focused word, and realized the initial syllable, *man-*, as Hf. That is, he produced a H on ‘*man-*’, followed by a low tone and then rise at the end of the word with lengthening of the word final syllable. For other cases where speakers put an Intonational phrase boundary after focus, they produced a low tone on the initial syllable of the focused word and a high tone (in this case, Hf=H%) on the focused word final syllable.

In focus interrogatives, the peak of Hf was realized later than that in focus declaratives, i.e., mostly on the word immediately following the focused word. An example is shown in Figure 10.7, (a) declarative (b) interrogative. This is probably due to the type of tones following the focused word: a low plateau in declaratives, but a high or mid-high plateau in interrogatives.

10.3.2.2 Post-focus Sequence

Post-focus sequence has previously been described as a deaccented, flat, parenthetical, or subordinate contour (Rossi 1985; Touati 1987; Di Cristo 1998). This description is confirmed in our study, but not always. Speakers sometimes paused after focus and made the post-focus sequence a new IP, with the same tonal variation (i. e., same phrasing) as in a neutral sentence, or they rephrased the sequence with fewer phrase boundaries than that of a neutral sentence. When there was no pause after focus, however, the post-focus sequence did not show any of the tonal variation observed in a neutral sentence, but was realized either as a low plateau in declaratives or as a high or mid-high plateau in interrogatives. In interrogatives, the plateau was either the same height as Hf or somewhat lower than Hf, then raised to a higher F₀ (i.e. upstepped H%) at the end of the sequence. Figure 10.7 shows examples of a pitch track for (a) a low plateau in declaratives, and (b) high and mid-high plateaus in interrogatives⁵. The height of the plateau in interrogatives varied depending on the length of the phrase and the speakers. The plateau was high when the post-focus sequence was short, one or two words, as in the first figure in Fig. 10.7(b). When the sequence became longer, the contour was either high as in the second figure in Fig. 10.7(b) or mid-high, as in the third figure in Fig. 10.7(b). In many cases, the contour showed a slight sagging in the center, or slowly declined toward the end of the phrase before rising to a H%.

(a) Low plateau after focus in a declarative



(b) High and mid-high plateau after focus in an interrogative

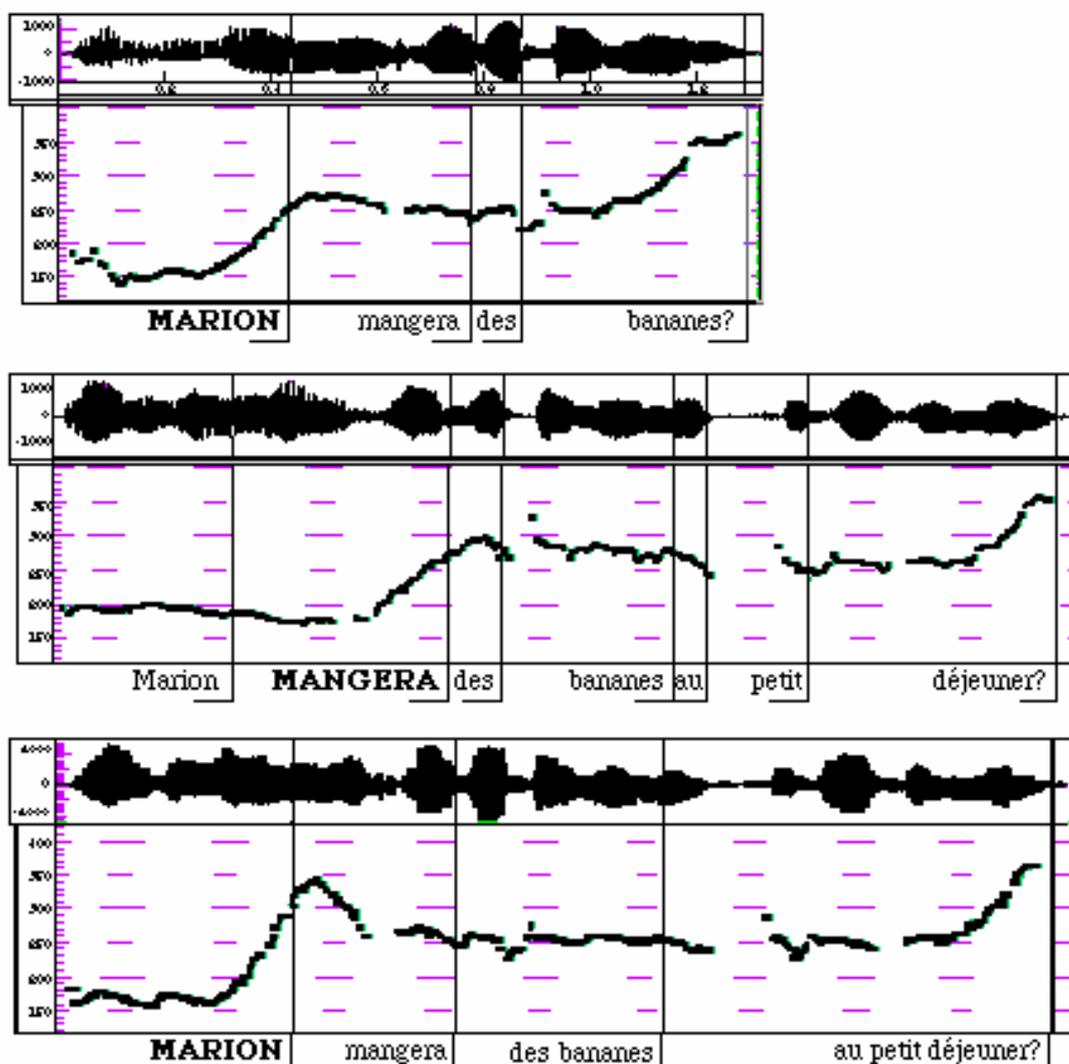


Figure 10.7. Example pitch tracks of (a) Low plateau in a declarative, and (b) High and mid-high plateau in interrogatives.

For both declaratives and interrogatives, the post-focus sequence (when it did not form a new IP separated from the focused word) did not show any of the pitch accents observed in neutral sentences; the sequence was “deaccented”. Phonologically, the plateau tones can be represented by a L tone for a declarative or a H (phonetically high or mid) for an interrogative. There seems to be no pragmatic meaning contrast between high and mid-high plateau after focus in interrogatives, but there may be a meaning associated with a mid tone boundary which appears in intonational clichés such as vocative and implicature contours (See section 10.3.3.1).

Next, the possibility of dephrasing ”after focus is investigated by comparing the duration of the post-focus sequence in focused vs. neutral sentences. The results are shown in Figure 10.8. The duration of the post-focus sequence in declaratives was not consistently shorter than that of the same sequence in a neutral sentence. This is different from the English post-focus sequence, which is shorter (Erickson & Lehiste 1995).

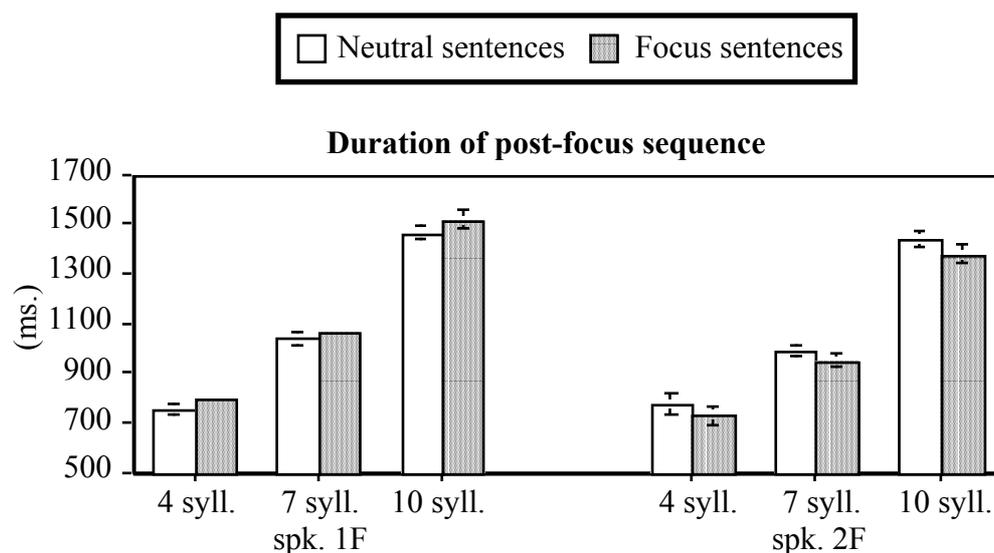


Figure 10.8. Duration of post-focus sequence compared to the same sequence in neutral sentences. Data for sequences containing 4, 7, & 10 syllables.

The data in Fig. 8 suggest that the post-focus sequence is not dephrased. But this does not prove that the AP final lengthening is still preserved within this sequence. It would be still possible that the duration of the sequence remains the same by reducing the AP final lengthening and increasing the durations of other non-final syllables. To confirm whether the post-focus sequence still preserves the AP boundaries in terms of durational cues, we compared the duration of AP-final syllables (H*-toned) in neutral sentences with the duration of the same syllables in focused sentences (i.e. potential AP-final syllables). This comparison is shown in

the upper panel of Figure 10.9. The lower panel of the figure shows the duration difference between the AP-final syllable (or the potential AP-final syllable in focus sentences) and the preceding syllable in focused vs. neutral sentences. In both graphs, the duration data come from four words given in (4): H*-syllables are in bold, and the preceding syllables are underlined. The letters ‘A’ to ‘D’ in the graphs refer to the letters in (4).

- (4) A. Neutral: Marion mangera des bananes. ‘Marion will eat bananas’
 Focus: MARION mangera des bananes.
 B. Neutral: Marion mangera des bananes au petit déjeuner. ‘... bananas at breakfast’
 Focus: MARION mangera des bananes au petit déjeuner.
 C. Neutral: Marion mangera des bananes au petit déjeuner.
 Focus: Marion MANGERA des bananes au petit déjeuner.
 D. Neutral: Marion mangera des bananes au petit déjeuner.
 Focus: MARION mangera des bananes au petit déjeuner.

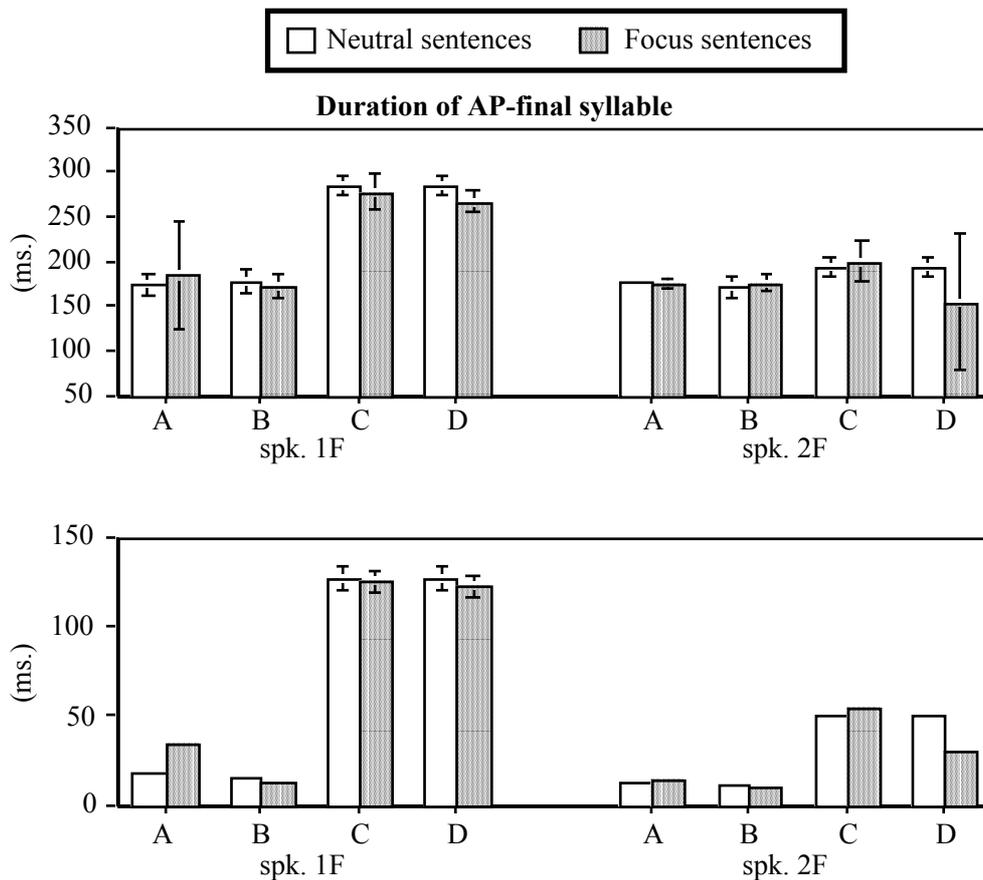


Figure 10.9. Durational comparison of AP-final syllable in neutral sentences with the same syllable in post-focus sequence, in terms of absolute syllable duration (upper panel) and relative final lengthening: i. e., final syllable minus preceding syllable (lower panel).

Results show that both absolute duration and relative lengthening of AP-final syllables in neutral sentences are maintained in focus sentences. The post-focus sequence seems not to be dephrased. Though it loses its intonational phrasal cues, it maintains its durational phrasal cues. The post-focus sequence in French is therefore *deaccented, but not dephrased*.

10.3.2.3 Representation of Focus Intonation

The intonation contour of a focused utterance is different from that of a neutral utterance. The peak of the focused word is not always on the final full syllable of the word, and the post-focus sequence does not show any of the tonal variation observed in the neutral rendition of the same sentence. Though the post-focus sequence preserves the AP boundaries of a neutral utterance in terms of duration, it is not parsable into a sequence of APs in terms of tones: the post-focus sequence is tonally flat, L for a declarative or H for an interrogative. This plateau tone covers syllables from the beginning of the word immediately following the focused word until the end of the phrase, regardless of whether the H_f is realized on H_i or H*_i. When the sentence is an interrogative, the phrase final boundary tone at the end of the phrase is realized even higher than the H-plateau. We assume that the plateau tone after focus in French is a phrasal tone associated with the phrasal node of an Intermediate Phrase (henceforth ‘ip’), and the boundary tone at the end of the phrase is the property of an Intonation Phrase. That is, an ‘ip’ is a prosodic unit lower than an IP and higher than an AP. After a focus H tone (H_f), all AP tones are deleted, and the ip phrasal tone spreads to the toneless syllables right after the focused word. The ip tone is not associated with a particular syllable. Deaccenting after a focused word ” is also found in English and Korean. In English, there is no pitch accent after focused word, and a plateau tone begins after the focused word as in French. The plateau in English is also analyzed as an ip phrasal tone covering the syllables between the focused word and the phrase boundary (Beckman & Pierrehumbert, 1986). In Korean, all AP tones after focus are deaccented, but there is no plateau tone after the focused word. Rather, all syllables after focus are reorganized so as to belong to the same AP as the focused word. That is, in Korean, the focused word starts a new AP with an expanded pitch range, and follows the default tonal pattern of an AP: F₀ reaches the peak on the second syllable, and gradually falls over many syllables after focus, as in other long APs of a neutral utterance (Jun & Lee, 1998).

A schematic representation of deaccenting after focus, and a new prosodic structure including an ip node is shown in Figure 10.10. The upper half shows that either the initial or final syllable of the focused word

is accented for focus, Hf, while all AP tones after Hf, if any, are deleted. When both the initial and the final syllable are focused, all AP tones after the final Hf are deleted. The lower half shows that the ‘ip’ phrasal tone, noted T- following the convention in Beckman and Pierrehumbert (1986), spreads to all toneless syllables after the focused word up to the final syllable which is realized with an IP boundary tone.

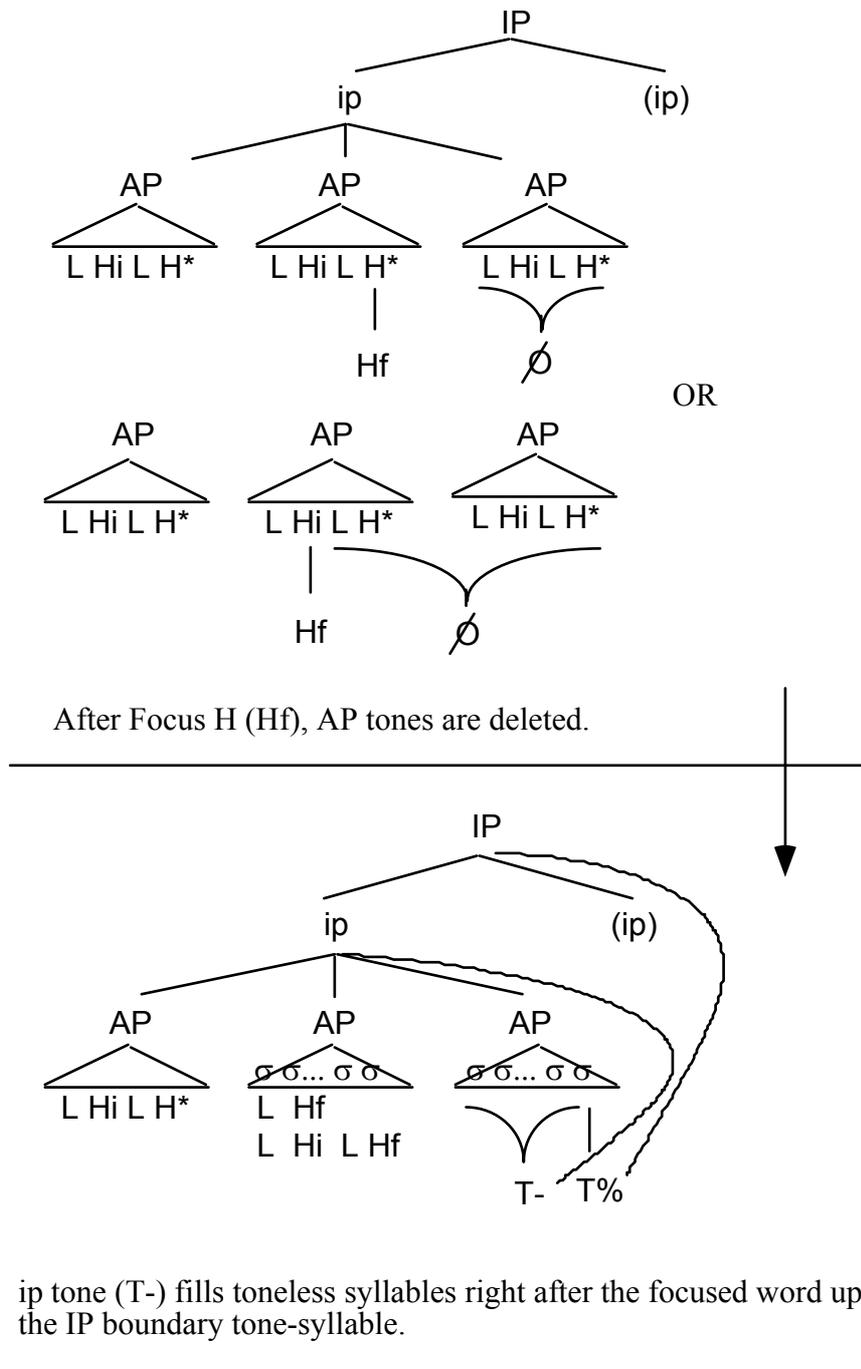


Figure 10.10. Schematics of AP tone deletion after focus (upper) and the realization of an intermediate phrasal tone, T- (lower).

10.3.3 Discussion

10.3.3.1 Further Evidence for an ‘ip’ Phrasal Tone

In addition to focus utterances, further evidence for an ‘ip’ phrasal tone can be found in intonation patterns of complex syntactic/semantic constituents such as tag-questions and dislocated theme/rheme structures, as well as in intonational clichés and wh-questions.

First, a sentence ending with a tag question separates the tag phrase from the main clause by a comma in orthography, but in speech, its boundary is cued prosodically by a low or high tone covering the tail part of the main clause and a final lengthening of the clause final syllable. The juncture between the main clause and the tag phrase is somewhat bigger than that of an AP boundary but smaller than that of an IP boundary. The intermediate nature of this juncture has also been captured by Di Cristo and Hirst (1996) as a unit called “segment d’UI”. This means that the main clause of the tag question forms an IP by itself, but is embedded in a big IP, the whole sentence. For example, *une bonne bouteille de champagne, ça lui plairait?* ‘a good bottle of Champagne, would he like it?’ is parsed as $[[\textit{une bonne bouteille de champagne}]IP \textit{ça lui plairait}]IP$, just like a recursive IP (cf. Ladd 1986). In our model, the embedded IP (the main clause) would form an ‘ip’ with a L- tone, and the tag-phrase itself would form another ip with a H- tone. That is, this sentence has two ‘ip’s within one IP: $[[\textit{une bonne bouteille de champagne}]ip [\textit{ça lui plairait}]ip]IP^6$.

A preposed or topicalized thematic constituent (or given information), whose trace is marked by a resumptive pronoun in the rhematic constituent (or old information), can also be analyzed as two ‘ip’s within one IP. For example, an utterance such as *Mon voisin, il est toujours malade* ‘My neighbor, he is always ill’ (as an answer to a question about the health of a person’s neighbor) can be analyzed as one IP with two ips, when produced with no pause after the preposed constituent (example from Di Cristo, 1998): i. e., $[[\textit{Mon voisin,}]ip[\textit{il est toujours malade}]ip]IP$, with H- for the first ip and L- for the second ip. Here, the boundary between *voisin* and *il* is more likely to be stronger than the AP boundary between *voisin* and *est* in the simple sentence, $\{\textit{Mon voisin}\}AP\{\textit{est toujours malade}\}AP$ ‘My neighbor is always ill’. Di Cristo (1998) also implies this relative strength of boundaries by saying that “the preposed constituent can be pronounced either with a typical continuation rise or by a question pattern (i.e., *Mon voisin? Il est toujours malade*) which carries an additional character of emphasis. However, for the subject of a simple sentence, only the continuation pattern is possible”.

Another construction whose intonation pattern is similar to focus intonation can be found in postposed thematic constituents and wh-

questions (Di Cristo, 1998: pp.26-30). Di Cristo claims that a postposed thematic constituent (underlined in the following examples) is characterized by a low plateau in a declarative (e.g., [[*Il est toujours malade*] mon voisin] ‘He is always ill, my neighbor’), and by a high plateau in an interrogative (e.g., [[*Tu l’as vendue*] ta belle maison]?’ ‘Have you sold it, your beautiful house?’ (in the context where ‘your beautiful house’ is already mentioned). A wh-question with a focused wh-word also shows a low plateau after the wh-word: e.g., [[*Qui*] va te rencontrer?] ‘Who is going to meet you?’. The low or high plateau in these examples was analyzed as a “segment d’UI” as in a post-focus sequence (e.g., [[*Le professeur*] a la clé] ‘The teacher has the key (not the student)’). In our model, the plateau tone can be analyzed as an ‘ip’ phrasal tone, L- or H-, starting after the last pitch accented word and spreading up to the phrase final syllable.

So far, we have shown that an ip boundary can occur as a plateau, starting from the syllable right after the last pitch accented word and up to the final syllable: e.g., in a focused phrase, wh-question, and postposed thematic constituent. We also showed that more than one ip boundary can occur within an IP: e.g. in a tag question and preposed thematic constituent. In Di Cristo (1998) and Di Cristo and Hirst (1996), all these example constructions are analyzed as including a segment d’UI: 1. [[focused word] post-focus sequence]; 2. [[wh-word] rest of a question sentence]; 3. [[rhematic constituent] postposed thematic constituent]; 4. [[main clause] tag-Q]; 5. [[preposed thematic constituent] rest of a sentence with a resumptive pronoun]. Some of these constructions do have a plateau-like tonal contour, but we believe that the boundary (i.e. perceptual degree of juncture) between focus and post-focus sequence or that between a wh-word and the following word do not have the same degree of strength as that observed between a main clause and a tag-phrase or that between a preposed thematic constituent and the rest of the sentence with a resumptive pronoun. We believe that the boundary in the latter group (i.e., a tag-question and a preposed thematic sentence) is stronger than that in the former group⁷. This difference in boundary strength is reflected in our model by a grouping of ip. That is, the former group consists of one ip, while the latter group consists of two ips.

Next, there are intonational clichés where the final boundary tone after the last pitch accent shows either a mid plateau or a complex pitch movement, low-high (mid-plateau data below are from Fagyal, to appear).

First, the mid plateau at the end of a phrase can be found in several clichés: ‘vocative or chanting’ contour, ‘list’ contour, and ‘implicature’ contour. In a simple vocative (e.g. *Joanna!*), F_0 peak is on the *penultimate* syllable of the word, and is followed by a mid-plateau until the end of the

word. In a complex vocative (e.g. *Bonjour, Madame Durand!, Venez-vous!*), F_0 peak can be on either H_i or H^* of a vocative phrase initial word, *Bonjour*, or *Venez*, and is followed by a mid plateau until the end of the phrase. Figure 10.11 shows examples of F_0 tracks for (a) a simple vocative and (b) a complex vocative with the peak realized on H_i of the first word. This type of vocative contour has been modeled as a LHM sequence (Dell 1983) or a sequence of LH followed by a lowered H boundary tone. Di Cristo describes the simple vocative as an ‘upstep’ followed by a fall, and the complex vocative, or cliché vocative, as rise-fall followed by a sustained plateau with the rise being aligned with the penultimate or the last syllable of the vocative word (Di Cristo, 1976, 1981). The same pattern occurs in English vocatives (Ladd, 1978, 1980, 1996; Pierrehumbert, 1980), and has been analyzed as “ $H^*+L\ H-\ L\%$ ” under Pierrehumbert’s system. In this case, the ‘ip’ tone, $H-$, is realized as a downstepped H after the bitonal pitch accent, and the ‘IP’ tone, $L\%$, is realized as upstepped L after $H-$, thus surfacing as a mid plateau. In our model, both simple and complex vocatives in French are represented as $H^* H-\ L\%$, capturing the similar shape of F_0 contours between these two vocative types. H^* is for the F_0 peak before the mid plateau, $H-$ is realized as a mid-high, and $L\%$ is realized as an upstepped $L\%$ after $H-$.

Similarly, the mid plateau boundary can be found in the ‘list’ contour or ‘implicature’ contour. As in a simple vocative, the peak (H^*) occurs on the penultimate syllable of the phrase final word, and is followed by a mid plateau. We represent this sequence as $H^* H-L\%$ (or as $H^* H-$ for an ip boundary). An example sentence of each type is shown in (5a) and (5b), respectively, and the tones relevant to H^* and a mid plateau only are labeled. A pitch track of (5b) is shown in Figure 10.12 (data from Faygal’s spontaneous speech corpus).

- (5) a. Il y avait l’Allemagne, la Roumanie, le Venezuela, la Méditerranée.

$H^* H-L\%$	$H^* H-L\%$	$H^* H-L\%$	$H^* H-L\%$ or
$H^* H-$	$H^* H-$	$H^* H-$	$H^* H-L\%$

‘There were Germany, Rumania, Venezuela, the Mediterranean.’

- b. Alors, il y a tout de même les circonstances objectives.

$H^*H-L\%$

‘So, there are still the objective circumstances.’

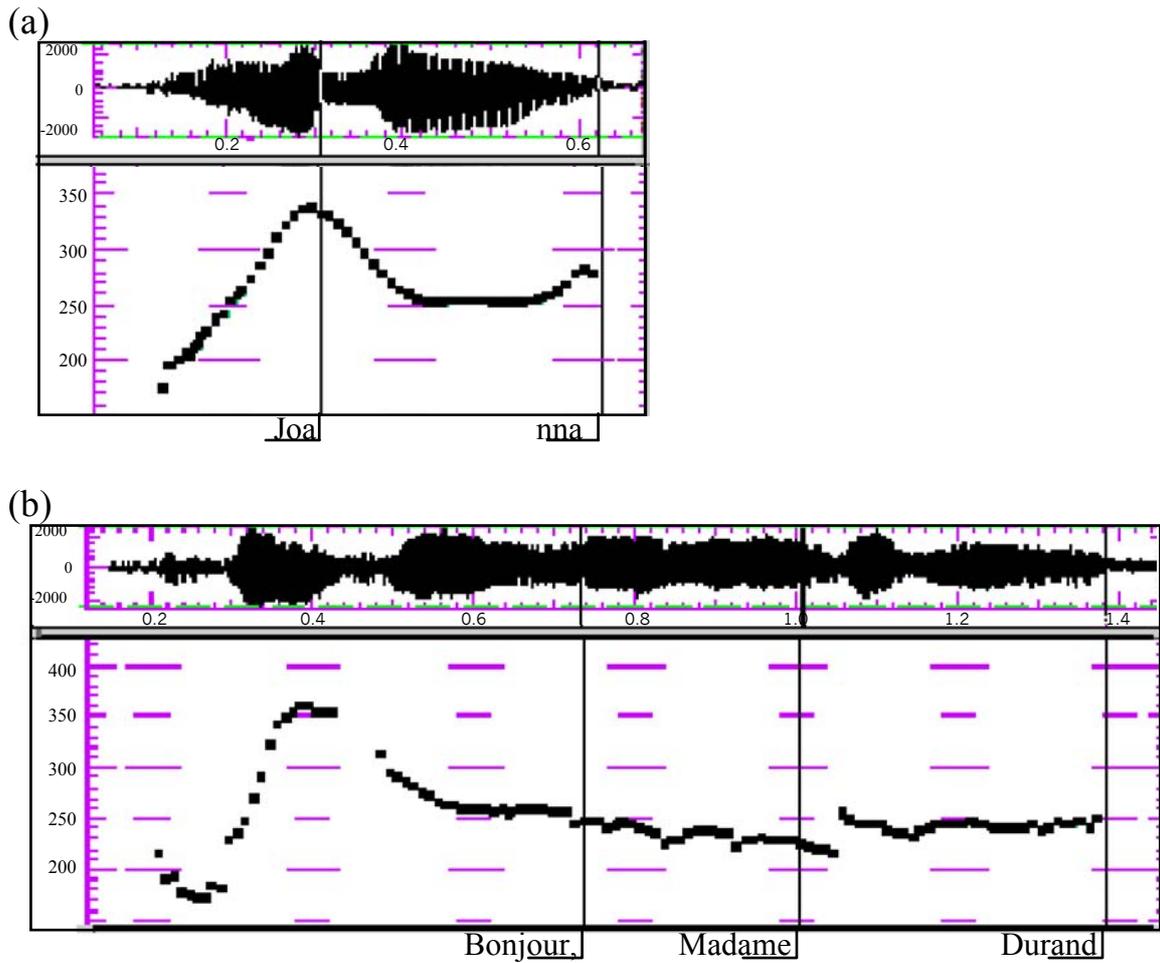


Figure 10.11. F_0 tracks of (a) a simple vocative and (b) a complex vocative

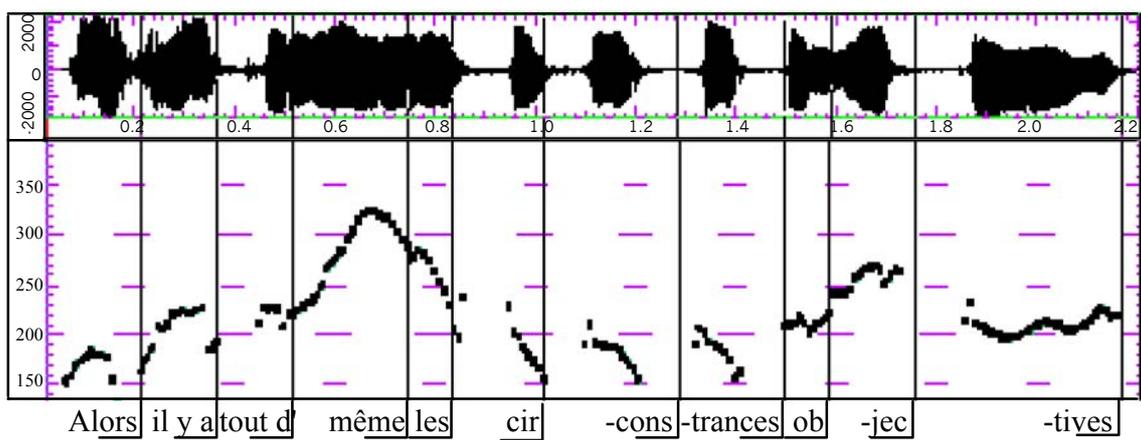


Figure 10.12. A F_0 track of the example in (5b) produced with 'implicature' meaning.

Second, the low-high complex pitch movement after the peak occurs in the well-known “incredulous” cliché, which has generally been described as a rise-fall-rise contour associated with the last three syllables of a sentence (ex. *Au garage?*, *comptabilité?*, *Jamais moi?*). In our model, the peak on the penult of the phrase is analyzed as H*, and the following rise is analyzed as a sequence of an ip tone, L-, and an IP tone, H%, on the same final syllable of the phrase.

In sum, by assuming three levels of prosodic units, AP, ip, and IP, and tones affiliated with each unit, we can represent the intonation pattern of a sentence with a high, mid or low plateau and a complex contour at the end of a phrase. In a neutral sentence produced without any stylized intonation, the final full syllable of an AP is realized with a H*, and when this syllable is also the last syllable of a higher prosodic unit, the AP final tone is preempted by the tone of a higher unit. An ip tone is not visible on the surface when an IP phrase final syllable is also an AP final syllable, but is visible otherwise. For intonational clichés, it seems that the AP final H* is realized on the penultimate syllable of the word, and the AP final syllable provides room for the realization of the phrasal tone (ip) and boundary tone (IP), the combination of which carries a different pragmatic meaning.

10.3.3.2 An alternative Analysis

As an alternative to the analysis of adding an ‘ip’ phrasal tone, the fall-rising tone or mid plateau tones occurring at the end of a phrase can be analyzed as a complex boundary tone. The sequence of L- and H% could be represented as a LH% and that of H- and L% can be represented as a HL%. In this case, we would have to introduce two more boundary tones in French, in addition to the simple boundary tones, L% and H%.

Furthermore, the low or high plateau found in the post-focus sequence or the postposed thematic constituent could be explained by spreading the boundary tone leftward and aligning it with the beginning of the word after the peak. This non-peripheral realization of boundary tones has been proposed by Gussenhoven (1996). He claims that, in Roermond Dutch, the realization of an intonation phrase boundary tone after a focused syllable is not confined to the phrase final location, but spreads its domain up to the word or syllable right after the focused syllable. For the plateau boundary tone, he adopted the notion of alignment in Optimality Theory (Prince & Smolensky, 1993; McCarthy & Prince, 1993; Pierrehumbert, 1993), and proposed that the left-edge of the boundary tone is ‘aligned’ (or ‘associated’ if there are legitimate Tone Bearing Units) with the first stressed syllable after focused syllable, and the right-edge of the boundary tone is ‘aligned’ with the phrase boundary. Thus, the single boundary tone

is subject to two alignment constraints, left edge and right edge, achieving the effect of leftward spreading of the boundary tone. He argues that an ‘aligned’ tone is less likely to have a precise location of the tone target, both in the time-dimension and the F_0 dimension, than is the ‘associated’ tone. In addition, the F_0 transition between the focus H and the aligned Intonational Phrase L boundary tone (his ‘Li’) is realized as a ‘drooping’ interpolation. In the case of a focus interrogative where a H plateau is followed by a L boundary tone, he proposed two boundary tones (his ‘HiLi’).

If we adopt Gussenhoven’s model, the L plateau in French can be represented by a $L\%$ with two alignment constraints (left and right). The H plateau examples found in interrogative focus would be more challenging to explain since the end of the plateau is upstepped at the phrase final syllable. This can be represented either by an $H\%$ with three alignment constraints (left, penult, right) or by an $HH\%$ boundary tone with two alignment constraints for the first H, (left, right).

The advantage of this alternative analysis is that we do not need to add a new prosodic unit (ip). It seems that this alternative works for all examples whose IP boundary is preceded by a plateau (e.g. post-focus sequence) or whose IP boundary consists of a sequence of two tones (e.g. clichés). However, this alternative cannot explain the cases where an IP has more than one ip such as a tag question and a preposed or topicalized construction. Therefore, we assume that a better solution at this moment is to add an ip phrasal tone instead of modifying a boundary tone and adding alignment constraints. At the same time, however, we are aware of the fact that to further support an addition of an ip level to our model, we need to find more examples where an IP has more than one ip. We expect that spontaneous speech data will provide us with further evidence. In this paper, we cited examples from a tag question and a preposed or extraposed thematic constituent. Though the boundary within these examples seems to be intermediate between an AP and an IP, further evidence is needed to prove that there exists a categorically distinct intermediate prosodic unit in terms of perception data and the interaction with other tonal or segmental rules. It is also possible that there is a phonetic difference in the height or shape of F_0 rise between H^* and H^*H^- , and/or durational cues for this intermediate phrase level.

10.4 Summary

In this paper, we first describe a phonological model of French intonation with two tonally defined prosodic units: Accentual Phrase and Intonation Phrase. These prosodic units are compared with the prosodic units of other models. This model is further developed to explain the intonation pattern of focus sentences and other intonational clichés. We propose that the plateau tones after focus can be represented as phrasal tones of an Intermediate Phrase, and show that the addition of a phrasal tone can also explain other intonation patterns. Under this newly developed model, we propose a phonological model of French intonation with three tonally defined prosodic units. The Accentual Phrase (AP) is the lowest tonal unit, and its underlying tonal pattern is /LHiLH*/. The Intermediate Phrase (ip) is the next higher level, and has a phrasal tone covering syllables or words after the last H* of the phrase and before the IP boundary tone. The presence of a phrasal tone is, therefore, apparent when H* is realized in non-phrase final position. Finally, the IP is the highest tonal unit and is demarcated by a boundary tone (H% or L%). Further research is needed to further support the level of an ip.

Notes

1. Fonagy (1980) discusses several factors conditioning the occurrence/appearance of the initial (also known as secondary or intellectual) accent: 1. modality - initial accent is more frequent in imperative or exclamation; 2. speaking styles - initial accent is more frequent in reading or conference style, or in TV or radio news, than in spontaneous speech (also in Vaissière, 1974); 3. segmental context - stops attract initial accent more than liquids; nasal vowels attract initial accent more than oral vowel; close syllables attract initial accent more than open syllables. Lucci (1980) includes several other factors: length of a word or rhythmic group (the longer, the higher tendency of having an initial accent), syllable structure (a syllable with an onset is more likely to have initial accent than a syllable with a vowel only), semantic conditioning (a word with high information load tends to have initial accent), and the location within a phrase. Padeloup (1990) also claims that various factors such as phonotactic, rhythmical, contextual constraints may account for this variability. In addition to all these factors, there are speaker dependent characteristics and variations (Vaissière, 1975; Duez, 1978 in political discourse).
2. The three 8-syllable words are: *panindoeuropéen*, *méditerranéisation*, and *incompréhensibilité*. Among these, *panindoeuropéen* very often had an initial accent on the prefix (*pan-*), the first syllable. Note that the frequency of Hi occurrence in Figure 10.10.1 is based on a sentence initial word, forming one AP. In general, Hi occurs more often when the word is in sentence initial than in sentence medial position. The high percentage of Hi in 2-syllable and 3-syllable words is due to the

fact that these words are lengthened; in 2-syllable words, the word initial syllable was often realized as LHi and the final syllable was realized as LH*.

3. We showed in Jun and Fougeron (1995) that the timing of the initial rising of French AP is not correlated with the number of syllables within an AP, but is fairly constant (i.e., taking about 200-300 ms) regardless of the number of syllables. This data was based on content words located at the initial position of a sentence, thus not preceded by any function word within an AP.
4. We are grateful to Hirst and Di Cristo for providing these two references.
5. In (a), the focused word 'mangera' is not followed by pause, but is immediately followed by 'au', and then a devoiced vowel in the first syllable of 'petit'. In the examples in (b), it is interesting to note that the plateau F_0 is around 250Hz whether it is phonetically high plateau or mid-high plateau. These are produced by the same speaker. It is possible that the target F_0 of the plateau is fixed for interrogatives, and the peak F_0 of a focused word varies, sometimes reaching higher than their neutral H target. Similar data are found in Chinese (C. Shih, this volume). We thank Chilin Shih for pointing this similarity to us.
6. Di Cristo and Hirst (1993b) and Sabio, Di Cristo, and Hirst (1995) treat this sentence as a left dislocated question. But in either analysis, this sentence is analyzed as two ips in our model. We thank Di Cristo for providing this information.
7. Though we use this perceptual difference as evidence of an ip level, we are aware of the fact that a perceptually different boundary would not guarantee the existence of a prosodic level. As shown in Wightman et al. (1996), listeners can perceive more levels of juncture than the levels of a prosodic unit in English.

Acknowledgments

We would like to thank Mary Beckman for her valuable comments on the representation of focus intonation, Zsuzsanna Faygal for generously sharing her data with us and for stimulating many valuable discussions, Albert Di Cristo and Chilin Shih for their helpful comments, Victoria Anderson for her conscientious proofreading of this paper, and Russ Schuh for providing references for tone dissimilation. We also thank A. Di Cristo, E. Grabe, C. Gussenhoven, D. Hirst, and B. Post for their interest in our model and encouragement given at the ESCA Intonation Workshop, Athens, Greece, in Sept. 1997. Finally, we thank the speakers who participated in the experiment.

Références

- Abercrombie, D. 1964. Syllable quantity and enclitics in English. In Abercrombie *et al.* (eds.), 216-222. London: Longmans.
- Abercrombie, D., D.B. Fry, P.A.D. Mc Carthy, N.C. Scott and G. L. Trim (eds.). 1964. In Honour of Daniel Jones. London : Longman.
- Beckman, M. 1986. Stress and Non-Stress Accent. Dordrecht: Foris.

- Beckman, M. and J. Pierrehumbert. 1986. Intonational structure in Japanese and English. *Phonology Yearbook* 3, 255-309.
- Clech-Darbon A., G. Rebuschi and A. Rialland. Are There Cleft Sentences in French? In Rebuschi and Tuller (eds.), 83-118 (forthcomming).
- Delais-Roussarie, E. 1995. *Pour une Approche Parallèle de la Structure Prosodique*. PhD Dissertation, Université Toulouse le Mirail.
- Delattre, P. 1939. Accent de mot et accent de groupe. *The French Review* XIII, 2, 141-46.
- Dell, F., D. Hirst and J-R. Vergnaud (eds). 1983. *Forme Sonere diu Langage*. Paris: Herman.
- Dell, F. 1983. L'accentuation dans les phrases en français. In Dell et al. (eds).
- Di Cristo, A. 1976. Des indices prosodiques aux traits perceptuels: Application d'un modèle d'analyse prosodiques à l'étude du vocatif en français. *Travaux de l'Institut de Phonétique d'Aix* 3, 213-58.
- Di Cristo, A. 1981. Le vocatif en français. In Rossi *et al.* (eds.), 99-137..
- Di Cristo, A. 1998. Intonation in French. In Hirst and Di Cristo (eds), 195-218.
- Di Cristo, A. and D. Hirst. 1993a. Rythme syllabique, rythme mélodique et représentation hierarchique de la prosodie du français. *Travaux de l'Institut de Phonétique d'Aix* 15, 9-24.
- Di Cristo, A. and D. Hirst. 1993b. Prosodic regularities in the surface structure of French questions. *Proc. ESCA Workshop on Prosody* (Lund, Sweden), 268-71.
- Di Cristo, A. and D. Hirst. 1996. Vers une typologie des unités intonatives du français. *XXIème JEP* (Avignon, France), 219-222.
- Erickson and I. Lehiste. 1995. Contrastive emphasis in elicited dialogue: durational compensation. *Proc. 13th ICPhS* (Stockholm, Sweden), vol. 4, 352-55.
- Fagyal, S. Chanting Intonation in French. *Proc. 21st Annual Penn Linguistics Colloquium*. (forthcomming).
- Fónagy, I. 1980. L'accent français: accent probabilitaire. L'Accent en français contemporain. *Studia Phonetica*, 15,123-233.
- Fougeron, C. and S.-A. Jun. 1998. Rate Effects on French Intonation: Phonetic Realization and Prosodic Organization. *Journal of Phonetics* 26, 45-70
- Grammont, M. 1914. *Traité de Phonétique*. Paris: Delagrave.
- Gussenhoven, C. 1996. The boundary tones are coming: on the Nonperipheral realization of boundary tones. Paper presented in Laboratory Phonology V, Evanston, IL.
- Hirst, D. and A. Di Cristo. 1984. French intonation: a parametric approach. *Di Neueren Sprache* Bd 83, Heft 5, 554-569.
- Hirst, D. and A. Di Cristo. 1996. "Y a-t-il des unités tonales en français?" *XXIème JEP*, (Avignon, France), 223-226.
- Hirst, D., A. Di Cristo and R. Espesser. forthcoming. "Levels of description and levels of representation in the analysis of intonation". In Horne (ed.).
- Hirst, D.J. and A. Di Cristo (eds). 1998. *Intonation Systems: A survey of Twenty Languages*. Cambridge University Press.
- Horne, M. *Prosody: Theory and Experiment*. Kluwer Academic Publishers. (forthcomming).
- Jun, S.-A. 1993. *The Phonetics and Phonology of Korean Prosody*. PhD Dissertation. The Ohio State University (published 1996 by Garland Publishing Inc., New York).

A Phonological Model of French Intonation

- Jun, S.-A. 1996. The influence of the microprosody on the macroprosody: a case of phrase initial strengthening. *UCLA Working Papers in Phonetics* 92, 97-116.
- Jun, S.-A. 1998. The Accentual Phrase in the Korean prosodic hierarchy. *Phonology* 15, 189-226.
- Jun, S.-A. and H.-J. Lee. 1998. Phonetic and phonological markers of Contrastive focus in Korean. *Proceedings of ICSLP '98* (Sidney, Australia).
- Jun, S.-A. and C. Fougeron. 1995. The Accentual Phrase and the Prosodic structure of French. *Proc. ICPhS* (Stockholm, Sweden), vol. 2, 722-725.
- Kenstowicz, M. 1994. *Phonology in Generative Grammar*. Blackwell Publishers.
- Ladd, D.R. 1978. Stylized intonation. *Language* 54, 517-540.
- Ladd, D.R. 1980. *The Structure of Intonational Meaning*. Bloomington: Indiana University Press.
- Ladd, D.R. 1986. Intonational phrasing: the case of recursive prosodic structure. *Phonology Yearbook* 3, 311-340.
- Ladd, D.R. 1996. *Intonational Phonology*. Cambridge University Press.
- Lindblom, B. 1963. Spectrographic study of vowel reduction, *J. Acoust. Soc. Am.* 35, 1773-1781.
- Lindblom, B. 1964. Articulatory activity in vowels. *STL-QPSR*, 2, 1-5.
- Lucci, V. 1983. *Etude Phonétique du Français Contemporain à Travers la Variation Situationnelle*. Publ. Univ. de Grenoble.
- Marouzeau, J. 1956. Accent de mot et accent de phrase. *Le Français Moderne* 24, 241-248.
- McCarthy, J. and A. Prince. 1993. *Prosodic Morphology I: Constraint Interaction and Satisfaction*. (ms. University of Massachusetts at Amherst and Brandeis University).
- Mertens, P. 1987. *L'Intonation du Français*. PhD Dissertation, Katholieke Universiteit Leuven.
- Mertens, P. 1993. Intonational grouping, boundaries and syntactic structure in French. *Proc. ESCA Workshop on Prosody* (Lund, Sweden), 155-159.
- Nespor, M. and I. Vogel. 1986. *Prosodic Phonology*. Dordrecht: Foris.
- Pasdeloup, V. 1990. *Modèle de règles rythmiques du français appliquées à la synthèse de la parole*. PhD Dissertation, Université de Provence.
- Pierrehumbert, J. 1980. The phonology and Phonetics of English Intonation. PhD Dissertation, MIT (published 1988 by IULC).
- Pierrehumbert, J. 1993. Alignment and Prosodic Heads. *Proc. Eastern States Conference on Linguistics* 10, 268-286. The Ohio State University.
- Pierrehumbert, J. and M.E. Beckman. 1988. Japanese Tone Structure. *Linguistic Inquiry Monograph* 15. MIT Press.
- Post, B. 1993. *A Phonological Analysis of French Intonation*. MA thesis, University of Nijmegen.
- Prince, A. and P. Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar* (ms. Rutgers University, at New Brunswick and University of Colorado at Boulder).
- Rebuschi, G. and L. Tuller (eds.), *The Grammar of Focus*. Amsterdam: Benjamins. (forthcoming).
- Rossi, M. 1985. L'intonation et l'organisation de l'énoncé. *Phonetica* 42, 135-153.
- Rossi, M. 1993. A model for predicting the prosody of spontaneous speech (PPSS model). *Speech Communication* 13, 87-107.

- Rossi, M., A. Di Cristo, D. Hirst, Ph. Martin, and Y. Nishinuma. 1981. *L'Intonation, de l'Acoustique à la Sémantique*. Paris: Klincksieck.
- Sabio, A. Di Cristo, and D. Hirst. 1995. The prosodic structure of left-dislocated phrases in French interrogative utterances. *Proc. ICPHS* (Stockholm, Sweden), vol. 2, 714-17.
- Schuh, R.G. 1998. *A Grammar of Miya*. Linguistics, vol.130. University of California Press
- Selkirk, E. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. MIT Press.
- Selkirk, E. 1986. On Derived Domains in Sentence Phonology. *Phonology Yearbook* 3, 371-405.
- Stevick, E. 1965. *Shona Basic Course*. Washington, DC: Foreign Service Institute.
- Sundberg, J., L. Nord and R. Carlson (eds.). 1992. *Music, Language, Speech and Brain*. Stockholm: Wenner-Gren Int. Symposium Series.
- Touati, P. 1987. *Structures Prosodiques du Suédois et du Français*. Lund University Press.
- Vaissière, J. 1974. On French prosody. *Res. Lab. Electr. Prog. Report*, MIT., 115, 212-23.
- Vaissière, J. 1992. Rhythm, accentuation and final lengthening in French. In Sundberg, Nord and Carlson (eds.), 108-120.
- Vaissière, J. 1997. Langues, prosodies et syntaxe. *Revue Traitement Automatique des Langues*, 38, 53-82.