Modeling of a rise-fall intonation pattern
in the language of young Paris speakers

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Abstract

Intonation seems to be one of the major cues for identifying youth language in the Paris region. As part of a large-scale corpus-based analysis, this paper attempts to model a rise-fall final prosodic pattern, considered to be representative of a Paris working-class suburbs accent. Comparison with the emphatic rise-fall prosodic pattern, well-known in general French, will provide the opportunity for sociolinguistic insights. The ethnic hypothesis is dismissed in favor of a context-bound and interaction-sensitive interpretation.

Index Terms: socio-phonetics, prosodic patterns, linguistic variation and change, acoustic modeling.

1. Introduction

Among other linguistic elements, such as lexical items and segmental features[1], intonation is pointed out as one of the major cues for the identification of Paris youth language. Various studies suggest that the realization of a rise-fall final prosodic pattern, characterized by a strong pitch rise and a sharp fall in the fundamental frequency (henceforth F_0) that is particularly ample and with a possible lengthening of the penultimate syllable, is the main factor in the perception of a *banlieue*[2] accent [1]. Furthermore, such an accent is often associated with young speakers living in working-class areas of the city and coming from multicultural environments, especially of North or Sub-Saharan African origin [2], [20]. However, Paternostro [3] has shown that even though speakers in direct contact with multicultural environments seem to be the leaders of the spread of rise-fall final prosodic patterns and that their peers in indirect contact with multicultural environments seem rather to adopt and diffuse these phonetic variants, the two groups cannot be considered as two different populations. In fact they represent a methodological "artifact" which tends to separate into different populations speakers who are part of the same community of practice, sharing the same social experience and the same identity values. The ethnic hypothesis is thus dismissed and the dynamics of variation must be rather sought in a set of processes of adaptation to a feeling of communicative proximity [4]. Comparison with emphatic rise-fall prosodic patterns, well-known in general French, shows that *banlieue* intonation

contours seem to convey emphasis[3] as well and are likely to express speakers' involvement in interaction. This paper reports on a large-scale study attempting to model the acoustic features of this intonation contour, on the basis of the 'Multicultural Paris French' (MPF) corpus currently being collected in the Paris region [5].

2. Background

Conein & Gadet [6] noticed the spread of a particular 'strong' prosodic pattern in the speech of young Paris speakers, characterized by a large melodic movement and a lengthening of the penultimate syllable. However, this pattern seems to be more hereditary than innovative, since its features overlap with those of 'popular' French. Fagyal [1] focused on the prosodic realizations of middle-school students living in the northern working-class suburbs of Paris. She noticed significant lengthening of the penultimate syllable, marked by a high tonal target. Lehka & Le Gac [7] observed similar intonation contours among adolescents in the working-class suburbs of Rouen, particularly characterized by a sharp fall on the last prosodic unit. However, no significant penultimate lengthening was observed. Le Gac *et al.* [8] compared Paris and Rouen realizations and found that Paris speakers tended to produce rise-fall patterns with a rather reduced pitch range whereas the informants from Rouen produced both reduced and expanded patterns.
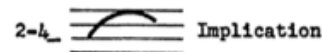

Figure 1: *Implication contour by Delattre*

Rise-fall intonation contours, such as the implication[4] contour described by Delattre [9] or the emphatic contour described by Di Cristo [10], are well-known in general French[5]. Lehka-Lemarchand [11] already noticed similar features between *banlieue* and emphatic contours. Even though, her assumption is not backed up by acoustic and statistical analyses, she concludes that the difference between the two contours is greater than their similarity and prefers to consider *banlieue* contours as a specific phenomenon linked to non-standard language.

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[1] We refer, for example, to back-slang words such as *meuf* (back-slang for *femme*, 'woman') or *keuf* (back-slang for *flic*, 'policeman'). Affrication of dental stops before high closed vowels /i/ and /y/ (such as in *voiture* [v w a t ʃ y ʁ], 'car' or *dire* [d ʒ i ʁ], 'to say') and a strong unvoiced fricative /ʁ/ seem to be among the most important segmental cues [4].
[2] Working-class suburbs of Paris.

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[3] By "emphasis" we mean "involvement" of speakers in interaction, according to Selting [14].
[4] The link between implication and emphasis (or involvement) is not fortuitous. Just as emphasis, implication presupposes implicitness and complicity between speakers.
[5] Stewart [18] compares *banlieue* intonation contours to Delattre's commandment and exclamation ones [9], which are clearly falling contours. However, Lekha & Le Gac [7] and Lekha-Lemarchand [11] argue that in the perception of *banlieue* contours the rise matters more than fall.

Banlieue contours	Emphatic contours
Ample movements of F_0	Ample movements of F_0
Steep slope and sharp fall of F_0	Normal rise, sharp fall of F_0
Shorter	Longer
Early alignment (penultimate)	Late alignment (last syllable)

Table 1: _Comparison between 'banlieue' and emphatic contours in the literature_

The link between emphatic contours and _banlieue_ accent is not fortuitous. On the one hand, Stewart & Fagyal [12] suggest that _banlieue_ intonation contours often convey aggressivity and are collectively perceived as quarrelsome, even when occurring in a neutral context. On the other hand, Paternostro [13] shows that the _banlieue_ accent is highly related to the expression of communicational proximity and speakers' involvement in interaction and can be seen as the actualization of an emphatic speech style[1]. According to Selting [14], an emphatic speech style results from communication that is strongly marked by 'emotion' and displays a shared 'involvement' of the interactants. Prosodic cues seem to play a major role, since they are used as a "device to evoke context-sensitive interpretations of emphatic 'peaks of involvement'". Ample melodic movements of F_0, associated with increased duration and intensity, are the prosodic markers mainly used by an emphatic speech style in French [15].

3. Modeling _banlieue_ contours

Our corpus consists of 593 occurrences of rise-fall intonation contours, taken from 3h05m of 6 teenagers' sample speech. The informants are 2 girls (Ana and Juline) and 4 boys (Koffi, Aziz, Hakim and Walid), living in the Paris _banlieue_. Interviews were carried out within the framework of the MPF project[2], with respect to the ecology of interactions. Informants were not selected according to a socio-demographic categorization, but rather according to an acquaintance network. Since investigators and informants were not strangers to one another, speech circulates freely, long stories emerge, and mutual speaker involvement takes place [16]. 391 contours were labeled "emphatic" and 202 "_banlieue_" by 72 Paris students, during a perception test, details of which are given below.

3.1 Perception test

The perception test consisted of two parts[3]. The first part aimed at determining whether rise-fall intonation contours are associated with the expression of emphasis. Our 72 judges were asked to listen to 50 filtered speech samples containing standard rise and/or fall contours (continuation and final intonation contours) or rise-fall contours considered to convey emphasis. Judges were asked to qualify each stimulus according to a grid of bipolar adjectives. They also had to

evaluate the level of emphasis conveyed on a four-point scale (0, 1, 2, 3). Results show that standard continuation and/or final intonation contours were referred to as "neutral" and "calm" whereas rise-fall contours were referred to as "emphatic" and "angry". Rise-fall contours also conveyed more emphasis than standard ones: 1.40 (out of 3) vs. 0.84. Results are statistically significant[4].

The second part of the test aimed at determining whether judges[5] were able to distinguish between emphatic contours (henceforth _EM_) and _banlieue_ contours (henceforth _BA_) and at evaluating the level of emphasis conveyed. It will also help us for corpus annotation and show whether _banlieue_ contours convey emphasis or not. Judges listened to 100[6] short speech samples and ticked the answer in a reply form. The level of emphasis was evaluated on a four-point scale (0-3). Results show that judges were able to distinguish EM contours from BA contours in 59% of cases[7]. BA contours seem to convey more emphasis than EM: 1.67 vs. 1.48 (out of 3)[8]. These issues are discussed below.

3.2 Methods and materials

Rise-fall intonation contours were annotated manually under _Praat_ according to 3 points: (1) beginning of the rise; (2) the top; (3) end of the fall (see: Fig. 2). Pitch values were verified and corrected manually, in order to avoid octave leaps and other detection errors.

Pitch values were extracted with their temporal position for each point. They were then converted to semi-tones (henceforth _st_), for the purpose of comparison between male and female voices. The last 3 syllables were also segmented to find out whether EM and BA contours align on the same syllable or not. The length for each syllable as well as for the complete contour (from point 1 to point 3, see: Fig. 2) was also calculated. Rise slope and fall slope were also estimated through the formula 'semi-tones per second' (henceforth _st/s_). Annotations and values were cross-checked several times, both manually and automatically.

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[1] See also Fagyal & Stewart [19], as far as interactivity is concerned.
[2] MPF is the French part of the research project 'Multicultural London English – Multicultural Paris French' (www.mle-mpf.fr). It aims at investigating language variation and change occurring in Western European cities, in a situation of linguistic contact.
[3] Only details that are relevant for this paper will be discussed here.

[4] F (1.46) = 10.04 p < 0.002.
[5] The 72 judges were the same for both the first and the second part of the perception test.
[6] We were only able to test the judges' perception for 100 intonation contours, randomly selected out of 593. Testing the whole amount of data would have been impossible. The remaining intonation contours were labeled according to the annotator's perception.
[7] Results are statistically significant. Statistical significance was calculated using a chi-squared test for each stimulus. The limited space available here does not allow the results to be shown individually.
[8] Results are statistically significant: t 15.31 p = 0.0001 for EM, and t 15.54 p = 0.0001 for BA. Otherwise, interaction does not reach the significance level: F (1.58) = 2.637 p < 0.10.
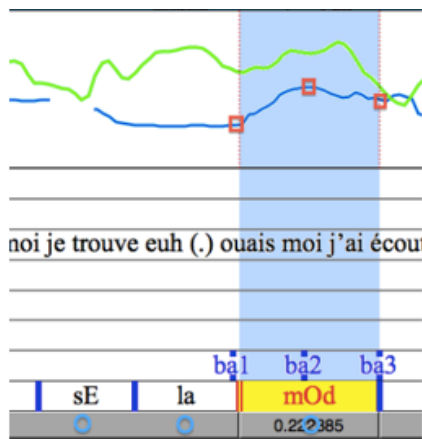

Figure 2: *Sample of 3-point annotation for a BA contour. Red squares, from left to right, correspond to the beginning of the rise (point 1 = ba1), the top (point 2 = ba2) and the end of the fall (point 3 = ba3). Blue circles, from right to left, correspond to the last syllable (syll 0, 'mOd'), the penultimate (syll 1, 'la') and the ante-penultimate (syll 2, 'sE').*

3.3 Analyses and results

3.3.1   Rise and fall

Results concerning rise and fall range show that BA contours rise and fall slightly more than EM contours (fig. 4). Results are statistically significant[1]. We will discuss below whether such a tonal difference is likely to be perceived or not.

Rise / Fall		S. dev.	Difference
EM rise	4.621	2.306	0.947
BA rise	5.568	2.592	
EM fall	-4.030	-1.955	-0.711
BA fall	-4.741	-2.420	

Table 2: *EM and BA contours' rise/fall range*

3.3.2   Duration and penultimate lengthening

As far as duration is concerned, there is no significant difference between the global duration of EM and BA contours (point 3 - point 1, on fig. 2)[2]. However, the fall of the EM contours is significantly longer (0.036 s) than that of BA.

Global duration		S. dev.	Difference
EM	0.240 s	0.075	0.002
BA	0.233 s	0.077	

Table 3: *EM and BA contours' global duration*

We also tried to determine whether the penultimate syllable is significantly lengthened compared to the last one. The French language usually has a fixed final stress on the last syllable of the prosodic group, which is mainly expressed by duration.

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[1] EM vs. BA rise: F (1.592) = 22.21 p < 0.0001. EM vs. BA fall: F (1.592) = 15.71 p < 0.0001.
[2] Given the large amount of data, values have not been normalized.

Final stressed syllables are twice as long as unstressed syllables. Our results show that while the EM penultimate seems to be slightly shorter (-18%) than that of BA, there is no significant lengthening of the penultimate syllable.

3.3.3   Pitch alignment according to syllable

Results concerning intonation contour alignment show that 51% of EM contours align on the last syllable (syll 0) whereas 64% of BA contours align on the penultimate (syll 1). Only a small percentage of both contours align on the antepenultimate (syll 2), as can be seen below (fig. 3). Results are statistically significant (p < 0.01).
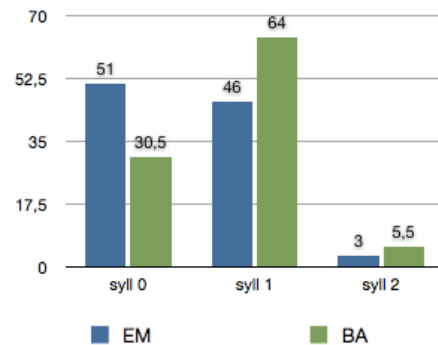

Figure 3: *EM and BA contour alignment according to syllables*

Nevertheless, interpretation of the results is not straightforward. BA contours show a general tendency to align earlier than EM ones. EM contours start to rise 18% later[3] than BA. EM contours also reach the high pitch target 5.8% later[4] and fall 3% later[5] than BA contours (see fig. 4 below). Results are statistically significant, p < 0.01.

Finally, we found that BA contours rise faster (10.5 st/s) and fall faster (12.7 st/s) than EM contours (p < 0.001).

3.3.4   Summary

To summarize, BA intonation contours seem to rise higher and fall lower than EM. BA contours are slightly shorter than EM, especially as far as final syllables are concerned. BA penultimate syllables are actually a bit longer than EM. However, BA and EM penultimate syllables are never significantly longer than final ones. BA contours align earlier and rise faster than EM.

These results may indicate that there is a difference between BA and EM intonation contours. The question now is whether this difference is marked enough to be perceived.

4. Discussion

Our results concerning the BA contours' rise and fall range show lower values than those found by Lehka-Lemarchand [11] in Rouen suburbs (9.6 st for rise and -8.6 st for fall). No quantitative values can be found in the literature for Paris, apart from the study comparing Paris and Rouen [8]. Paris

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[3] Point 1, on fig. 2.
[4] Point 2, on fig. 2.
[5] Point 3, on fig. 2.

speakers do not seem to realize very strong BA contours, compared to the rise-fall configurations found in Rouen.

As far as alignment is concerned, the beginning of the rising slope always aligns on the last syllable for BA contours in the Rouen corpus, while Fagyal [1] found that they always align on the penultimate in Paris. Our study showed that BA mainly aligns on the penultimate whereas EM mainly aligns on the last syllable. However, the percentage difference is not that high and does not reach the significance threshold. BA and EM do not differ much as far as alignment is concerned: 46% of EM contours actually align on the penultimate syllable, as do BA contours. In fact, further analyses have shown that globally both BA and EM intonation contours mainly align before the beginning of the last syllable (see fig. 7 below)

With regard to rise and fall speed, not only do BA rise higher and fall lower than EM, they also rise and fall faster. This probably induces the perception of stronger intonation contours, which is also strengthened by early alignment on the penultimate. Intensity has not been measured, but we hypothesize that it can play a significant role in intensifying the perception of 'stronger' high-low prosodic patterns.

In order to answer our question as to whether the acoustic difference between BA and EM contours can be perceived or not, the *glissando* threshold put forward by t'Hart *et al.* [17] can be taken into account. *Glissando* threshold refers to the variation of F_0 and defines when this range is perceived as a rise and/or fall tone. It is usually expressed in semi-tones per second and indicates the speed needed for the rise-fall pattern to be perceived. The authors indicate that it should be equal to or greater than 0.16 st/t^2. Our results show that the *glissando* threshold of rising BA contours is 0.83 st/t^2, which is 0.16 higher than the *glissando* threshold of rising EM ones (0.67 st/t^2). This result is significant enough for the BA contour rise to be perceived as different from the EM one ($p < 0.05$). On the contrary, the results are not significant as far as falling BA and EM contours are concerned.

Finally, amongst our numerous results, early alignment and the *glissando* threshold of BA intonation contours seem to be the two key elements leading to the perception of 'stronger' BA intonation contours.

5. Conclusions

Acoustic analysis has shown that there is a slight difference between *banlieue* and emphatic contours. BA intonation contours start to rise earlier, rise higher, faster, and fall lower than EM intonation contours. Nevertheless, their similarities seems to be greater than their differences, since the features of BA contours are defined in comparative terms.

Closer analyses of judges' perception showed that the stimuli evaluated at a 100% rate of agreement were all BA contours whereas stimuli evaluated at a < 30% rate of agreement were EM contours. The higher the rate of agreement, the 'stronger' the contour. The lower the rate of agreement, the 'weaker' the contour.

As can be seen below (fig. 4), the modeling of BA and EM does not in fact show two different kinds of rise-fall intonation contours. This suggests that BA contours are similar to EM but 'stronger'. Comparison with a control group of 119 standard continuation contours (CONT), annotated in the same corpus (fig. 4), reinforces this assumption in that BA and EM intonation contours are quite different from other contours in general French, but they are not substantially different from each other.

Acoustic differences alone are not sufficient in themselves to assert the existence of two different high-low prosodic patterns. Extra phonetic, linguistic and semiotic details are required for a *banlieue* accent to be perceived.
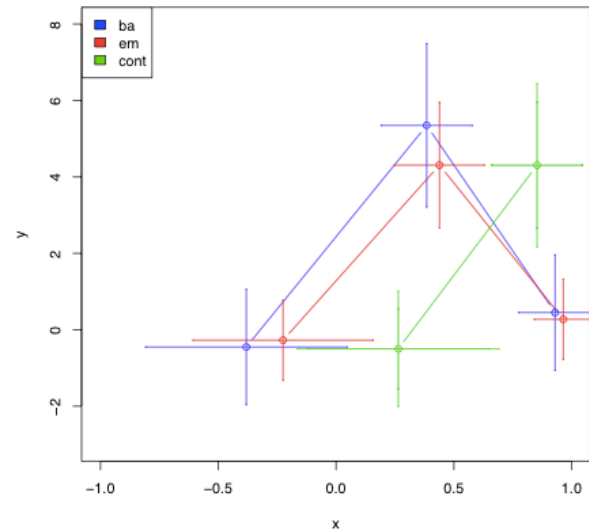

Figure 4: *Comparison between EM (red), BA (blue) and CONT (green) alignment with regard to final syllable (normalized between 0 to 1 on x-axis) and penultimate syllables (prior to 0.0 on x-axis). The y-axis represents the tonal difference (in semi-tones). The reference point of the pitch is set on the beginning of the rise. Crosses represent mean and standard deviation in temporal (x-axis) and tonal (y-axis) dimensions.*

The acoustic data seem then to match sociolinguistic insights: the high-low prosodic pattern cannot be considered a new phenomenon and is far from being specific to young people coming from working-class suburbs and/or from immigration. The novelty resides in the fact that EM/BA contours are likely to be used in context for pragmatic purposes, according to speakers' mutual involvement in interaction and communicational proximity. "*La vie dans la cite, c'est chaleureux*"[1], said one of our informants. That is why we suggest that the two kinds of intonation contours, emphatic and *banlieue*, can be considered as a single phenomenon, situated on a continuum, and that they are context-bound and interaction-sensitive. Thus, the realization of such a prosodic pattern ranges from one extreme to the other, depending on the speakers' shared understanding of the communicative situation and the speakers' level of interactivity.

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