

An Acoustic Study of Penultimate Accentuation in Three Varieties of French

Sandra Schwab¹, Mathieu Avanzi², Jean-Philippe Goldman¹, Pascal Montchaud², Isabelle Racine¹

¹ Geneva University, Switzerland; ² Neuchâtel University, Switzerland

sandra.schwab@unige.ch, mathieu.avanzi@unine.ch, jean-philippe.goldman@unige.ch,
pascal.montchaud@unine.ch, isabelle.racine@unige.ch

Abstract

The aim of this paper is to provide an acoustical account of penultimate accentuation in some varieties of French. We compare stretches of spontaneous speech produced by 8 Swiss speakers (4 Neuchâtel speakers and 4 Wallis speakers, hereafter "regional varieties") with the productions of a group of 4 Parisian speakers (hereafter "standard variety"). The results of our study show that penultimate accentuation is less frequent in Parisian French than in the Swiss varieties. More interestingly, the study reveals that the phenomenon has different acoustic correlates not only between the standard variety and the regional varieties, but also within the two regional varieties: while Wallis speakers tend to be closer to Parisian speakers using melodic cues to mark their penultimate syllable as prominent, speakers from Neuchâtel tend to prefer using durational cues to do so.

Index Terms: penultimate accentuation, accentual phrase, Parisian French, regional French, spontaneous speech.

1. Introduction

It is a well known fact that in French, the domain for pitch accent assignment is a larger unit than the lexical word. Depending on the theoretical background, the minimal prosodic unit is called Rhythmic Group [1], Prosodic Word [2] or Phonological Phrase [3][4][5]. In the Autosegmental-Metrical framework, this minimal prosodic unit is called **Accentual Phrase** [6] (henceforth AP). It is composed of a clitic group (one content word with its dependent functional words [7]), and it's tonally marked by an optional initial pitch rise on its leftmost syllable (LHi), and a LH* on its rightmost syllable.

One variant of this by default pattern implies the realization of a prominence on the penultimate syllable of the group. In figure 1 below, penultimate syllable (*aussi*) is marked by a prominence. Let us note at this point that in the specific cases of dissyllabic words, as in figure 1 below, it is impossible to decide if the contour on the last word of the AP should be transcribed LHiLH* (a prominence on the first syllable would be then the marking of an initial rise) or LH+LH* (the perception of a prominence would be the trace of a real marked pre-tonic). Since this kind of ambiguity cannot be solved, we will not address this issue here.

The reasons that motivate the realization of a prominent pre-tonic syllable in French still remain pretty unclear. According to [10], penultimate accentuation would be the influence of a dialectal substrate and would be the specificity of French regional varieties. Nevertheless [5] found this pattern in her study of Parisian French, and argued it was involved in the

formation of a specific Intonational Phrase contour, expressing implication. We will not focus directly on these specific issues in the main body of this paper (see discussion §6 below). Our aim is to determine whether the presence of penultimate accentuation varies across the three varieties of French, on the one hand, and, on the other one, to examine the acoustic features involved in the realization of penultimate accentuation in three varieties of French.

2. Previous Studies

Very little work has been dealing with pre-tonic syllabic marking in French. In her PhD work, [8] provided a study on the difference of F0 alignment between speakers from Nyon (a Swiss city in the Vaud district) and speakers from Paris. The author found minute differences in text-to-tune alignment within the two varieties. Indeed, in the Vaudois productions, AP final pitch rises are mostly anchored on the penultimate syllable, while in Parisian French productions, AP final pitch rises are preferentially anchored within the last syllable. In the same spirit, [9] compared Vaudois speakers productions with Hexagonal speakers productions. She concluded that in the Swiss variety, penultimate and final syllables of inter-pause groups tended to be more lengthened compared with what was observed in the productions of Hexagonal speakers.

Taken together, the result of these two studies suggest that penultimate syllables in non-central varieties exhibit a different acoustic profile compared with the penultimate in central varieties. Our goal, in this research, is to verify the existence of such differences between the productions of Parisian French speakers and the productions of speakers from two other different Swiss varieties, the variety of French spoken in Neuchâtel and the variety of French spoken in Martigny (in Wallis).

3. Material

The data we used are samples extracted from the PFC database [11]. We examined three varieties of French: a variety representing the standard French, which is here the French spoken in Paris (henceforth PA), and two regional varieties of French spoken in Switzerland, more precisely in Neuchâtel (henceforth NE) and in Martigny, a city in Wallis (henceforth VS). For each of these three varieties, four speakers (2 males and 2 females), with comparable range of age in each region (NE: 67-78; VS: 58-79; PA: 60-86) were selected, and 3mn samples of monologic spontaneous speech were extracted for each of the twelve speakers. In all, the corpus is 36 minutes long.

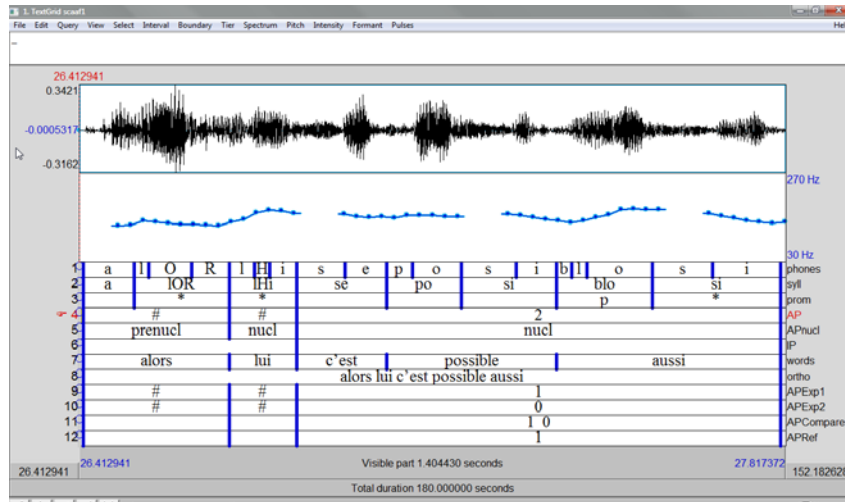


Figure 1: Praat screen shot of the utterance: “alors lui c’est possible aussi”, with, from top to down: phones and syllables tiers (both in SAMPA alphabet); prominence tier (prominent syllable associated with a pitch accent are coded “*”); AP tier (“#” indicates an excluded AP, valid APs are left blank); the position of the AP within the host IP (prenuclear or nuclear); IP tier; graphemic words and utterance tiers; expert 1, expert 2, expert 1 vs expert 2 tiers; expert 3/reference tier for the acoustic study of penultimate.

4. Data analysis

The speech samples were transcribed in the Praat software [12], and automatically aligned with the Easysalign script [13], which provides a 3-layer segmentation in phones, syllables and words. All the alignments were manually checked and corrected by one of the authors. APs boundaries (clitic groups carrying a perceptual prominence on their rightmost syllables) were identified in a dedicated tier. Intonational Phrases (IPs) boundaries were also coded by the same expert, on the basis of prosodic cues (perception of a nuclear accent) and syntactic features (extra- versus intra sentential elements). APs containing an elongation or a syntactic rupture due to a hesitation, as well as APs containing less than three syllables were excluded from the analysis, leading to 996 valid APs. In each of remaining valid APs, the number of syllables of the last graphemic word was counted. Finally, the penultimate syllables of each valid AP was coded by two experts (two of the authors) according to its perceptual prominence status (prominent/non prominent). A third expert settled between the diverging coding of the two first experts (11.34% of the cases) in order to create a reference tier. Figure 1 above resumes the steps followed during the entire coding procedure.

Praat scripts were then used to retrieve, for each syllabic nucleus of the 996 valid APs duration values (in ms). In parallel, pitch analysis was performed and inspected, and erroneous values were corrected if necessary. Finally, F0 mean (average of all the point on the vocalic nucleus) and F0 rise (difference of the F0 value at 20% of the vowel and the F0 value at 80% of this vowel) were calculated. Intensity peaks values were not taken into account since intensity is usually not considered as a strong cue in French accentuation [14].

For each parameter (duration, F0 mean and F0 rise) we computed the number of UPs (“Unité de perception”, **Perception Unit**) according to [15]. The reasons that motivate the use of UP measures instead of any other kind of prosodic relativization procedure are twofold: (i) UP measures are specifically designed for perception studies; (ii) UP measures take into account vocalic measures, which are usually considered as the most significant parameters involved in the perception of significant prosodic variations [16].

For our purposes, the number of UPs was computed for each penultimate syllable, according to the following formula:

$$\text{Nb UP} = \frac{\log_{10}(\text{penult}/\text{unstressed})}{\log_{10}(\text{diff_threshold})} \quad (1)$$

For duration UP, “penult” represents, the value in the penultimate syllable of the AP and “unstressed” the mean value of all unstressed (non-prominent) syllables within the AP. For F0 UP, “penult” notes the value in the penultimate vowel of the AP and “unstressed” the mean value of all unstressed (non-prominent) vowels within the AP. According to [15], the differential threshold (“diff_threshold”) is 1.2 for duration and 1.05 for F0.

Following the same lines, we also computed the UP of F0 rise within each AP penultimate vowel, according to the following formula:

$$\text{Nb UP} = \frac{\log_{10}(\text{finalF0}/\text{initialF0})}{\log_{10}(1.15)} \quad (2)$$

where “finalF0” and “initialF0” namely represents the values at final and the initial points of F0 on the vocalic nucleus of the penultimate syllable.

Furthermore, articulation rate, i.e. syllabic duration (in ms/syll), was calculated within each AP. We found more relevant to consider articulation rate in ms/syll (as in [17]) instead of syll/sec, given that some short APs (3 syllables) were examined.

5. Results

This section is divided into two subsections. In the first one, we present the results about the perception of penultimate accentuation in the three varieties of French (NE, VS and PA). The second one is dedicated to the acoustic features involved in the realization of penultimate syllables perceived as prominent in three varieties of French. On the one hand, analyses were conducted on the prominent/non-prominent perceived status of the penultimate syllable (hereafter Prom/Non-prom variable) by means of logistic regression. On the other hand, analyses were performed on duration and F0 UPs, as well as F0 rise UPs, using GLM ANOVA type 4.

5.1. Perceived penultimate accentuation across to the three varieties (NE, VS and PA)

A logistic regression was run with perceptual prominence status (Prom/Non-Prom) as dependent variable, and with the following predictors: speaker's variety, AP's articulation rate, speaker's age and sex, number of syllables of the last graphemic word of the AP, AP position within the host IP. As the last three predictors had no effect on the presence of a perceived penultimate prominence, we ran a new model with only speaker's variety, AP's articulation rate, speaker's age as predictors.

Table 1: Total number of valid APs, number and percent of penultimate syllables perceived as prominent in the three varieties (NE; VS and PA).

Variety	Total number of valid APs	Penultimate syllables perceived as prominent	
		Number	Percent
NE	288	47	16.32
VS	336	41	12.20
PA	372	28	7.53

As can be seen in Table 1, results show an effect of variety, with more prominent penultimate syllables in NE than in PA ($\beta = 0.61$, $z = 2.32$, $p < .05$), as well as in VS than in PA ($\beta = 2.56$, $z = 2.1$, $p < .05$). Despite the fact that slightly more penultimate syllables seem to be perceived as prominent in NE than in VS, this difference is not statistically significant ($\beta = .06$, $z = 0.27$, n.s.).

Interestingly, articulation rate within the AP influences the number of perceived prominent penultimate syllables ($\beta = 0.006$, $z = 3.98$, $p < .001$): the slower the articulation rate, the more penultimate are perceived as prominent, whatever the variety may be. Moreover, the speaker's age also has an influence on the perception of prominent syllables ($\beta = 0.03$, $z = 2.64$, $p < .001$): the older the speaker, the more the penultimate syllable are perceived as prominent, whatever the variety may be. It should be pointed out that that articulation rate and age are not correlated ($r = -0.15$, n.s.). Therefore, they can be considered as two independent factors.

5.2. Acoustic features involved in the realization of penultimate syllables perceived as prominent in three varieties of French

5.2.1. Duration

Figure 2 presents duration (expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). Results show an effect of variety ($F(2, 973) = 13.41$, $p < .001$), an effect of the perceptual prominence status of the penultimate syllable (Prom/Non-Prom) ($F(1, 973) = 67.16$, $p < .001$), and, more interestingly, an interaction between both variables ($F(2, 973) = 6.58$, $p < .001$). Pairwise comparisons indicate that, while perceived prominent syllables are significantly longer than non prominent ones in NE and VS, there are equally long in PA. Moreover, prominent syllables are longer in NE and VS in comparison with PA. We can then conclude that duration plays a similar role for NE and VS speakers, compared to PA speakers, in the realization of a penultimate perceived as prominent.

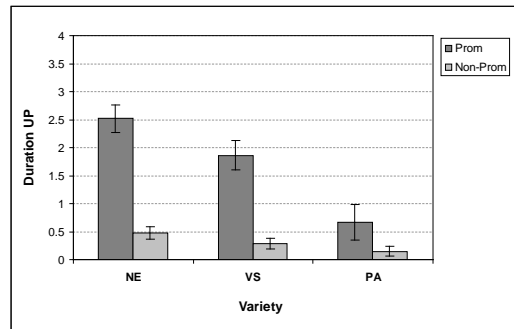


Figure 2: Duration (expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). Error bars are standard errors of the mean.

5.2.2. F0

Figure 3 presents F0 (expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). We observe, as for duration, an effect of variety ($F(2, 884) = 3.83$, $p < .05$), an effect of Prom/Non-Prom ($F(1, 884) = 193.67$, $p < .001$), and an interaction between both variables ($F(2, 884) = 4.2$, $p < .05$).

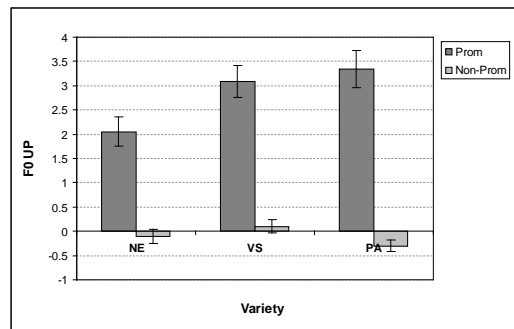


Figure 3: Fundamental frequency (F0 expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). Error bars are standard errors of the mean.

Pairwise comparisons reveal that, while the difference in F0 between penultimate prominent perceived syllables and non prominent ones is significant within the three regions, F0 is higher on prominent penultimate in VS and PA compared to NE. It seems thus that VS and PA speakers use F0 in a similar way, compared to NE speakers, to realize a penultimate syllable perceived as prominent.

5.2.3. F0 Rise

Figure 4 presents F0 rise (expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). We note an effect of variety ($F(2, 722) = 6.8$, $p < .01$), an effect of Prom/Non-Prom ($F(1, 722) = 83.64$, $p < .001$), but no interaction between both variables ($F(2, 722) = 1.77$, n.s.). This means that, although we observe lower values for PA, the difference in F0 rise between prominent and non-prominent penultimate syllables is similar across the three varieties. Prominent penultimate syllables always show a pitch rise, while non prominent penultimate syllable present a fall.

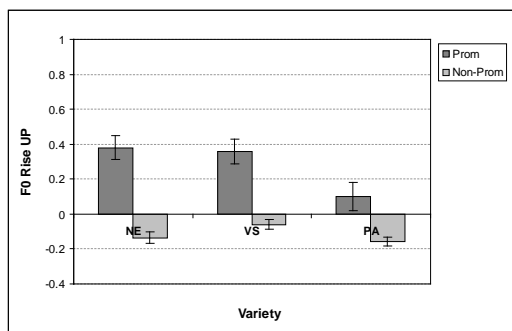


Figure 4: *F0 rise (expressed in UP) as a function of variety (NE, VS and PA) and perceptual prominence status (Prom/Non-Prom). Error bars are standard errors of the mean.*

6. Discussion

In this section, we would like to discuss the implications of these results on the status of penultimate accentuation in the prosodic phonology of French. The analyses conducted in §5.1 reveal **quantitative differences** between the three varieties: penultimate syllables of APs are more often perceived as prominent in the Swiss varieties than in the Parisian French variety. Incidentally, since we showed that the AP position within the host IP (nuclear or pre-nuclear) has no impact on the perception of a prominent, our results do not support [5]'s claim, which stipulates that prominent penultimate syllables only occur at IPs boundaries. On the other hand, the fact that the only significant parameters involved in the perception of a penultimate syllable are the origin, the age and the articulation rate of the speakers leads to the conclusion that the perception of a penultimate syllable do not have functional correlates, but should rather be considered as a phonetic phenomenon. As for the analyses conducted in §5.2, they reveal **qualitative differences** between the three varieties. Contrary to what [10] postulates, what defines the regional character of a variety is not only the presence of prominent penultimate syllables, but also the prosodic cues involved in the perception of prominent syllables. Thus our results confirm [9]'s conclusions on French spoken in Vaud: duration is an important cue involved in the perception of penultimate syllables of Swiss speakers productions (here NE and VS), and does not constitute a significant parameter to categorize prominent penultimate syllables in standard speakers productions (here PA). Our results nevertheless show that there are significant distinctions among the speakers of regional varieties: F0 is not as important in NE speakers' productions as in VS speakers' productions. Indeed, VS tend on this point to exhibit the same behavior than PA speakers. Finally, the fact that the F0 rising criterion has the same importance in the perception of penultimate syllables in the three varieties does not seem to validate [8]'s conclusions. However, it would be hazardous to compare results of studies that do not share the same protocol. Further research is thus needed to deeper examine this issue.

7. Conclusion

In this study, we provided an acoustical study of penultimate accentuation in three varieties of French. The productions of 8 Swiss speakers from Neuchâtel and Wallis (NE and VS, representing "regional varieties") were compared with the productions of a group of 4 Parisian speakers (PA,

representing the "standard variety"). The main results of an analysis conducted on a set of 996 APs, coded by three experts according to the perceptual status of their penultimate syllable (prominent/non-prominent), can be resumed in two points. On the one hand, origin, age and articulation rate of the speakers are significant parameters involved in the perception of a prominent penultimate syllable. This fact reveals that penultimate accentuation is rather a performance effect rather than a phonological phenomenon. On the other hand, results show that the prosodic features which activate the perception of a prominent penultimate syllable differ according to the varieties: while duration is a strong cue involved in the perception of prominent penultimate syllables in NE and VS production, F0 plays a greater role in the perception of VS and PA varieties. It confirms what segmental studies already showed: French spoken in Switzerland is not uniform. The analysis of more numerous varieties of French spoken in and out of Europe, and implying more speakers, should allow us to enhance the conclusions drawn in this study.

8. References

- [1] Delattre, P., "Les dix intonations de base du français", *The French Review*, 40/1: 1-14, 1966.
- [2] Martin, P., "Prosodic and rhythmic structures in French", *Linguistics*, 25: 925-949, 1987.
- [3] Selkirk, E., "Phonology and Syntax: The Relation between Sound and Structure", Cambridge: MIT Press, 1984.
- [4] Delais-Roussarie, E., "Phonological Phrasing and Accentuation in French", in M. Nespors and N. Smith [Eds.], *Dam Phonology: HIL phonology papers II*, 1-38, The Hague: Holland Academic Graphics, 1996.
- [5] Post, B., "Tonal and phrasal structures in French intonation", The Hague: Thesus, 2000.
- [6] Jun, S. A. and Fougeron, C., "Realizations of accentual phrase in French intonation", *Probus*, 14: 147-172, 2002.
- [7] Garde, P., "L'accent", Paris: PUF, 1968.
- [8] Sterling Miller, J., "Swiss French prosody. Intonation, rate, and speaking style in the Vaud Canton", PhD, University of Illinois, 2007.
- [9] Woerhling, C., "Accents régionaux en français. Perception, analyse et modélisation à partir de grands corpus", Thèse de doctorat, Université Paris Sud, 2008.
- [10] Carton, F., Espesser, R. and Vaissière, J., "Etude sur la perception de l'accent régional du Nord et de l'Est de la France", *Proc. 12th ICPHS*: 422-425, 1991.
- [11] Durand, J., Laks, B. and Lyche, C., "Le projet PFC: une source de données primaires structurées", in J. Durand, B. Laks and C. Lyche [Eds.], *Phonologie, variation et accents du français*, 19-61, Paris: Hermès, 2009.
- [12] Boersma, P. and Weenink, D., "Praat: doing phonetics by computer (Version 5.2)". www.praat.org, 2011.
- [13] Goldman, J.-P., "EasyAlign: an automatic phonetic alignment tool under Praat", *Proc. 12th Interspeech*: 3233-3236, 2011.
- [14] Delattre, F. "L'accent Final en Français: Accent D'intensité, Accent de Hauteur, Accent de Durée", *12/2*: 141-145, 1938.
- [15] Rossi, M., "L'intonation, le système du français – description et modélisation", Paris/Gap: Ophrys, 1999.
- [16] Hart, J. T., Collier, R. and Cohen, A., "A perceptual study of intonation: an experimental-phonetic approach", Cambridge: University Press, 1990.
- [17] Miller, J.L., Grosjean, F. and Lomato, C., "Articulation rate and its variability in spontaneous speech: A reanalysis and some implications". *Phonetica*, 41, 215-225, 1984.