A corpus-based prosodic study of Alsatian, Belgian and Swiss French

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Abstract

The object of this paper is a prosodic study of the French language as it is spoken in Alsace, Belgium and Switzerland, also compared with standard French through large corpora (over 100 hours) of scripted and spontaneous speech. The data were segmented into phones by automatic alignment; pitch values were extracted and averaged over segments. Two features are addressed: initial stress (through pitch and duration correlates) and penultimate lengthening. Different patterns enable us to distinguish the three varieties under investigation. Swiss speakers exhibit pitch rise and polysyllabic word onset lengthening in clitic–nonclitic sequences, while Alsatians tend to lengthen the initial vowel of nonclitic words. Belgians show prepausal penultimate lengthening whereas the Swiss tend to lengthen the last two prepausal vowels.

Index Terms: regional accents, French prosody

1. Introduction

Whether in terms of linguistic knowledge or for speech processing applications, we are still ill-informed about phonetic differences between French varieties. This article is a corpus-based study of prosodic variation in the French language as spoken in Alsace, Belgium and Romand Switzerland. Linguistic publications concerning these regions essentially focus on language contact, diglossia and resulting code switchings [2][7][11]. Some work on phonetic/ phonological pecularities exists [13][10], but there are fewer prosodic studies. Other languages [12] or French varieties [4] have been approached from the angle of prosody. Carton *et al.* [4] in particular highlighted the role of penultimate syllable in the perception of an eastern (Lorraine) or northern French accent. The lengthening of the vowel nuclei of penultimate and final syllables has also been studied for the French variety spoken in Belgium (especially Liège) [7]. Concerning the prosody of Alsatian French, it has been noted that the Germanic stress, usually word-initial, sharply contrasts with the word-final French stress [13]. For the French variety spoken in Romand Switzerland, a resistance to the standard French intonational scheme or a tendency to initial stress in disyllabic words may be mentioned [11]. According to other scholars, this Swiss variety presents "more pitch movement on penultimate syllables in phonological phrases than Parisian French" [6] or a pitch rise on the syllable preceding word-final stress [10] (a feature shared with other varieties according to the latter author).

These descriptions lack precision and empirical grounding since they are only based on scarce data. Singy's [11] account, for example, suggests a tendency towards initial stress but does not allow a distinction with a specific pitch pattern on the penultimate syllable. The considerable amounts of data at our disposal and advances in the domain of automatic speech processing now allow us to confront different linguistic hypothesis with large amounts of speech data. In the following, we will examine the realisation of word-initial and penultimate syllables in a large corpus which enables a comparison of the French varieties spoken in Alsace, Belgium and Romand Switzerland with "standard" French.

The next section describes the corpus analysed. Then we will successively address word-initial stress and the prosodic behaviour of prepausal syllables in line with the *clausula* concept [4]: a clausula refers to the last three syllables preceding a pause. Finally, results are discussed and possible perspectives are considered.

2. Corpus and method

2.1. Corpus

The main corpus stems from the "Phonology of Contemporary French" (PFC) project [5]. This project has undertaken to collect recordings covering a wide French-speaking territory, of informants who are firmly rooted geographically (about ten speakers per investigation point). For the present study, data were analysed from 11 investigation points: 6 in the North of the Loire, considered as standard French (Brécey, Brunoy, Dijon, Lyon-Villeurbanne, Roanne, Treize-Vents), 1 in Alsace (Boersch), 3 in Belgium (Tournai, Gembloux, Liège) and 1 in Romand Switzerland (Canton de Vaud). The data come from over 150 speakers, as many males as females of balanced age categories (45 years-old on average), from varied educational and professional backgrounds. For each speaker, we have at our disposal scripted speech (the reading of a 20-sentence text), as well as 10 minutes of spontaneous speech (directed interviews and free conversations). The total amount of data represents almost 100 hours of speech.

For this study, we have not analysed the spontaneous speech of the PFC project Alsatian speakers which were only partially available at the beginning of this work. We completed our corpus by adding 40 telephone conversations between Alsatian speakers (1/3 male). The average duration of a conversation is 13 minutes, totalling about 4 hours of speech. From the same corpus, telephone conversations between standard French speakers (over 30 hours of data) were used for comparison. Results reported in the following tables all refer to the PFC corpus, except for Alsatians' spontaneous speech.

2.2. Automatic alignment and feature extraction

The orthographically transcribed corpus was phonemically labelled by automatic alignment [1], using different context-independent acoustic models with Gaussian mixtures for face-to-face and telephone speech. The segmentation allows to compute the average durations and the standard deviations for both vowels and consonants (see Table 1). Whether considering all phone segments (pauses excluded) or only

vowels or consonants, the Swiss and Alsatian speakers show a slightly slower speech rate than the other speakers, particularly in spontaneous speech. This feature is sometimes cited as characteristic of the Swiss accent (or at least its representations); here it is also observed for Alsatians. Duration distributions (not shown here) reveal that Swiss and Alsatian speakers exhibit fewer short segments and more long segments than the other speakers.

Table 1. *Average segment duration [standard deviations] (in ms) for the text reading and spontaneous speech (for vowel, consonant, both).*

		Vowel duration	Consonant duration	Phone duration
Text	Standard	86 [50]	77 [39]	81 [44]
	Alsace	92 [53]	80 [42]	85 [47]
	Belgium	87 [57]	78 [38]	82 [48]
	Switzerland	91 [52]	83 [37]	86 [48]
Spont.	Standard	81 [69]	74 [45]	77 [57]
	Alsace	91 [73]	82 [53]	86 [63]
	Belgium	80 [70]	74 [46]	77 [58]
	Switzerland	91 [78]	81 [48]	85 [63]

The fundamental frequency (F_0) was extracted by using the standard options of the PRAAT software (www.praat.org): for instance, values under a 75 Hz threshold are considered as undefined. The mean value of measurements taken every 10 ms was then computed in order to obtain one F_0 value per phone segment.

3. Word-initial stress

To characterise initial stress, clitic–nonclitic sequences, which are good candidates to receive a stress on the nonclitic word-initial syllable [1] were examined. For clitics, we kept a set of about 30 monosyllabic words among the most frequent French words: *le, la, les* (“the”)*, un, une* (“a”)*, de* (“of”)*, du, des* (“some”)*, en* (“in”)*, pour* (“to”)... These words allow for a good coverage of the selected pattern [3]. For nonclitics, the study is restricted to polysyllabic words (without counting the final schwa which can be pronounced).

F_0 and duration variations between the clitic vowel and the first vowel of the following nonclitic word were measured, as well as the duration of the nonclitic onset. For example, in the case of the sequence *pour trouver* (/puʁ tʁuve/, “to find”), the vowel nuclei are the two /u/s and the onset is /tʁ/.

3.1. Pitch rise

We computed the cumulative percentages of occurrences in which the pitch difference $\Delta F_0 = F_{0\ \text{nonclitic}} - F_{0\ \text{clitic}}$ in semitones (ST) was greater than a given threshold. Table 2 shows results for percentages of ΔF_0 greater than 0, 1, 2 or 3 ST (3 ST corresponding to the threshold above which a prosodic prominence can play a linguistic role [14]). The numbers of occurences from which percentages are computed are also reported, for the read texts and spontaneous speech. For all speech styles and thresholds, it can be seen that percentages are greater for the Swiss than for the other speakers. The phenomenon can easily be observed in the distribution curve (see Figure 1 for spontaneous speech). It is even more marked on reading: in Table 2, the difference with standard French reaches 20%, as compared to 14% (41%–27%) for spontaneous speech. On the contrary, the values obtained for Alsace and Belgium are lower than those of standard French. As a comparison, the values computed on the telephone speech corpus for standard French are the same as the ones presented here within a margin of 3%.

Table 2. *Number of occurrences and percentage of ΔF_0 (nonclitic–clitic) greater than a given threshold.*

		#occ	%>0ST	%>1ST	%>2ST	%>3ST
Text	Standard	2050	72	55	40	29
	Alsace	439	52	36	22	15
	Belgium	1323	65	46	30	20
	Switz.	440	88	75	60	47
Spont.	Standard	7958	49	27	17	12
	Alsace	2371	46	26	16	10
	Belgium	3031	42	21	12	8
	Switz.	1876	59	41	26	17

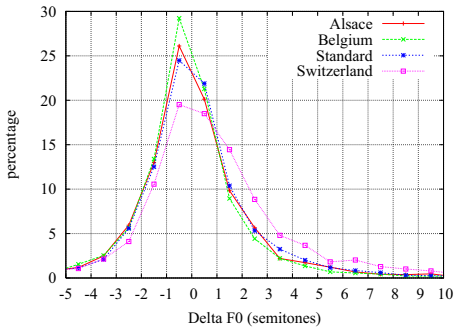

Figure 1. *ΔF0 between polysyllabic word-initial and clitic vowels (in semitones) for spontaneous speech.*

Results go the same way when the analysis is restricted to nonclitic words of at least 3 syllables instead of considering all polysyllabic words. (The number of occurrences is of course lower.) The ranking is preserved: Switzerland, standard French, Belgium and Alsace from the greatest to the lowest percentages. On words with at least three syllables, the proportion of ΔF_0 greater than 3 ST varies between 16 and 58% in reading and between 7 and 18% in spontaneous speech according to the region.

3.2. Stress syllable nucleus lengthening

The difference $\Delta\text{duration} = \text{duration}_{\text{nonclitic}} - \text{duration}_{\text{clitic}}$ was calculated for vowels. Results for polysyllabic and at least trisyllabic words are presented in Table 3. Alsatians show the highest percentage of Δduration greater than each of the proposed thresholds (0 and 20 ms) in spontaneous speech and to a lesser extent in reading. The same tendency is observed with a 30 ms threshold. When the nonclitics are restricted to at least trisyllabic words, which allows us to distinguish between initial and penultimate syllables, the difference between Alsatians speakers and the others is more marked.

In the standard French telephone corpus, the values obtained are similar to those of Table 3 (within 5%). Percentages of Δduration greater than 20 ms are lower than in the PFC corpus, which leaves a 10% difference between Alsatian and standard French. We may consider that the difference observed is not only due to the corpus.

Table 3. *Number of occurrences and percent Δduration nonclitic–clitic greater than a given threshold (for polysyllabic and at least trisyllabic nonclitics).*

		Polysyllabic			Trisyllabic +		
		#occ	%Δ >0ms	%Δ >20ms	#occ	%Δ >0ms	%Δ >20ms
Text	Standard	2050	56	32	538	58	30
	Alsace	439	62	42	112	67	44
	Belgium	1323	63	35	347	64	35
	Switz.	440	55	29	118	52	24
Spont.	Standard	7958	54	29	1454	50	27
	Alsace	2371	62	38	459	60	35
	Belgium	3031	56	31	545	50	26
	Switz.	1876	56	35	361	50	30

Average durations of the clitic vowels and the subsequent nonclitic word-initial vowels are given in Table 4. The average duration of the nonclitic vowel nucleus is indicated even though it does not add much information: we simply notice that there is little cross-region variation of this average duration, especially in spontaneous speech. As for the first vowel of the content word that follows, it behaves as expected from Δduration calculations: Alsatians have the longest average durations, which is not only attributable to a slower speech rate because Swiss speakers, who also have a slow speaking rate, exhibit a very different behaviour when reading texts.

3.3. Onset lengthening

According to [9][8], onset lengthening is a correlate of word-initial stress. The average duration of content word onsets following a clitic were measured: results are given in Table 4 (also restricted to simple onsets). The number of occurrences considered in each case can be deducted from the figures reported in Table 3, from which clitic–nonclitic sequences without onset (about 15% of cases) must be subtracted. Occurrences with a simple onset represent about 2/3 of the numbers of occurrences given in Table 3.

Alsatians, who produce the longest polysyllabic word-initial vowels following clitics, do not seem to lengthen onsets,whereas the Swiss tend to have longer onsets.

Table 4. *Average duration in ms of the clitic nucleus (Vc), the onset and the word-initial nucleus (Vnc) of polysyllabic or at least trisyllabic nonclitics. Between brackets, only simple onsets are taken into account.*

		Polysyllabic			Trisyllabic +		
		Vc	onset [simple]	Vnc	Vc	onset [simple]	Vnc
Text	Standard	72	88 [80]	72	70	105 [92]	70
	Alsace	76	92 [82]	83	73	106 [91]	81
	Belgium	68	89 [81]	72	64	102 [86]	65
	Switz.	69	97 [90]	70	63	114 [100]	60
Spont.	Standard	76	91 [78]	63	78	89 [77]	61
	Alsace	78	92 [83]	75	78	91 [84]	72
	Belgium	76	90 [75]	65	76	87 [74]	60
	Switz.	78	98 [85]	71	77	97 [85]	68

Thus, initial stress for the Swiss speakers seems to be achieved by a pitch rise and a slight onset lengthening — features which are well described in the literature [9][8]. Alsatians instead show polysyllabic word-initial vowel lengthening. Whether these features should be interpreted in terms of word-initial stress or differently, our results suggest that acoustic correlates differentiate the prosody of French varieties spoken in Alsace and Romand Switzerland. Belgium shows little specificity compared to standard French with regard to these parameters; but it might be distinguished by other prosodic features.

4. Behaviour of prepausal syllables

The behaviour of penultimate and final syllables before a pause (a silence of over 50 ms) was examined. No clear tendency appears when the analysis is not restricted to prepausal words. Also, we did not observe marked region-dependent tendencies concerning pitch variation between penultimate and final syllables before a pause. Nevertheless, the percentage of penultimate vowels that are longer than final vowels (schwa excluded) allows us to capture a kind of penultimate lengthening. This percentage is given for each region in Table 5 with the average durations of the vowel nuclei of the two prepausal syllables. Similar patterns are obtained when the duration of each vowel is normalised by its average duration computed on the whole corpus.

For the read speech style, percentages are quite close between regions, when considering polysyllabic or at least trisyllabic words. Again, this configuration avoids confusions between initial and penultimate lengthening.

Results differ more on spontaneous speech: Belgian speakers (from Liège, Tounai and Gembloux) realise more $\Delta duration_f = duration_{penultimate} - duration_{final} > 0$ ms than standard French speakers (around 10% difference), while Alsatian and Swiss speakers produce fewer penultimate lengthenings. Yet the differences observed should be taken with caution as far as Alsatians' spontaneous speech is concerned. Figures for standard French were very similar between PFC and the telephone corpus regarding initial stress, whereas considerable variation is here observed, with 12–18% lower percentages for the telephone corpus. These differences may be due to the type of interaction which, in telephone conversations, favours penultimate lengthening especially at the end of speaker turns.

Table 5. *Number of occurrences and percentage of prepausal positive $\Delta duration_f$ (penultimate–final); average durations of the last two vowels in ms.*

		Polysyllabic				Trisyllabic +			
		#occ	%Δ >0ms	Pen dur	Fin dur	#occ	%Δ >0ms	Pen dur	Fin dur
Text	Standard	1162	23	83	148	433	25	82	144
	Alsace	288	27	86	134	110	21	77	134
	Belgium	932	29	86	142	334	27	82	146
	Switz.	326	23	90	154	114	25	93	153
Spont.	Standard	3302	32	68	123	790	26	66	129
	Alsace	1406	18	85	170	352	14	76	165
	Belgium	2176	40	72	122	494	37	73	133
	Switz.	1077	30	82	154	252	23	79	166

Nasal vowels are known to be longer than oral vowels (112 *vs* 80 ms on average, in our corpus). Indeed, the gap slightly

widens (reaching 15%) between Belgian and standard French speakers when considering polysyllabic words whose penultimate vowel is a nasal vowel.

Based on average durations or percentages of occurrences longer than a given threshold, the Swiss have long final vowels. In comparison to standard French, they also have long penultimate vowels, which explains the lower $\Delta duration_f$ values. The latter result does not support a tendency toward penultimate lengthening in Romand Switzerland, but it leaves open the possibility that the Swiss lengthen both penultimate and final vowels.

To study it, we looked at antepenultimate vowels of at least trisyllabic words preceding a pause, and computed $\Delta duration_p = duration_{penultimate} - duration_{antepenultimate}$ (see Table 6).

Table 6. *Percentage of prepausal positive $\Delta duration_p$ (penultimate–antepenultimate), average durations of antepenultimate vowels in ms and percentages of antepenultimate vowels longer than 70 ms in at least trisyllabic words.*

		Trisyllabic +			
		#occ	%Δ >0ms	Ant dur	%dur >70ms
Text	Standard	433	66	70	37
	Alsace	110	55	78	39
	Belgium	334	71	66	28
	Switzerland	114	81	65	26
Spont.	Standard	790	65	61	27
	Alsace	352	52	84	43
	Belgium	494	70	62	27
	Switzerland	252	69	65	26

In reading especially the Swiss have the highest percentage of positive $\Delta duration_p$ (i.e. penultimate vowels longer than antepenultimate vowels), the lowest average duration of antepenultimate vowels and the lowest percentage of antepenultimate vowels longer than 70 ms. The latter percentage is also the lowest in spontaneous speech (with the same 26% value): Swiss, Belgian and standard French speakers have antepenultimate vowels of comparable duration. The Swiss have rather short antepenultimate vowels compared to penultimate and final vowels. Unsurprisingly, Alsatian speakers have the longest antepenultimate (in most cases also the initial) vowels of prepausal words with at least three syllables. This is in keeping with the word-initial vowel lengthening described in 3.2. At least in spontaneous speech, Belgian speakers have the highest percentages of penultimate vowels longer than antepenultimate and final vowels (see Tables 5 and 6). This reinforces the penultimate lengthening hypothesis in Belgian French which holds true when restricting the analysis to the longest segments. Also, when comparing the pitch patterns of the last three prepausal vowels across regions, Belgian speakers show more valleys while Swiss speakers show more peaks on penultimate vowels. Pitch contours definitely deserve more in-depth investigation.

5. Discussion and perspectives

Automatic alignment of large spoken corpora and pitch tracking enabled us to reveal or at least quantify prosodic differences between French varieties spoken in Alsace, Belgium and Romand Switzerland. While prepausal penultimate vowel lengthening seems to be typical of Belgian speech, lengthening the last two syllables and a tendency to initial stress (pitch rise and onset lengthening) would rather characterise Romand Swiss contrary to certain predictions. In Alsace, what can also be interpreted as initial stress under the influence of language contact would be manifested by word-initial vowel lengthening.

In spite of different data sources for Alsace (which may also be viewed as an additional validation), these acoustic correlates appear to be relatively robust to style changes (scripted or spontaneous speech). The study should be continued for this region and enriched by consonant devoicing cues. Voicing rates, zero-crossing rates and the alignment of voiced consonants as unvoiced should allow this devoicing to be measured. Finally, the same type of analysis may be extended to the intensity parameter. It shows that large-scale quantitative prosodic studies are possible, beyond "lab speech" and impressionistic accounts.

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7. References

[1] Adda-Decker, M., "De la reconnaissance automatique de la parole à l'analyse linguistique de corpus oraux", JEP, Dinard, 389–400, 2006.

[2] Bothorel-Witz, A., "Les langues en Alsace", DiversCité Langues, volume 5, 2000.

[3] Boula de Mareüil, P., Rilliard, A., Allauzen, A., "A diachronic study of prosody through French audio archives", Speech Prosody, Campinas, 531–534, 2008.

[4] Carton, F., Espesser, R., Vaissière, J., "Étude sur la perception de l''accent' régional du nord et de l'est de la France", XII[e] Congrès International des Sciences Phonétiques, Aix-en-Provence, 422–425, 1991.

[5] Durand, J., Laks, B., Lyche, C., "Le projet 'Phonologie du Français Contemporain' (PFC)", La Tribune Internationale des Langue Vivantes, 33:3–9, 2003.

[6] Grosjean, F., Carrard, S., Godio, C., Grosjean, L., Dommergues, J., "Long and short vowels in Swiss French: their production and perception", French Language Studies, 17:1–19, 2007.

[7] Hambye, P. & Simon, A.-C., "The production of social meaning via the association of variety and style: A case study of Liège Belgian French vowel lengthening", Canadian Journal of Linguistics, 49:1001–1025, 2004.

[8] Jankowski, L., Astésano, C., Di Cristo, A., "The initial rhythmic accent in French: Acoustical and perceptual prosodic cues", ICPhS, San Francisco, 257–260, 1999.

[9] Mertens, P., "Accentuation, intonation et morpho-syntaxe", Travaux de linguistique, 26:26–69, 1993.

[10] Métral, P., "Le vocalisme du français en Suisse romande : considérations phonologiques", Cahiers Ferdinand de Saussure, 31:147–176, 1977.

[11] Singy, P., "Les francophones de périphérie face à leur langue : étude de cas en Suisse romande", Cahiers Ferdinand de Saussure, 49:213–235, 1995–1996.

[12] Vaissière, J. & Boula de Mareüil, P., "Identifying a language or an accent: from segments to prosody", MIDL Workshop, Paris, 1–6, 2004.

[13] Vajta, K., "Le français en Alsace : premiers résultats d'une enquête", Romansk Forum, 16:823–834, 2002.

[14] 't Hart, J., Collier, R., Cohen, A., "A perceptual study of intonation: an experimental-phonetic approach to speech melody", CUP, Cambridge, 1991.