Role of segmental and suprasegmental cues in the perception of Maghrebian-accented French

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Abstract

The general objective of this study is to clear up the relative importance of prosody in the identification of a foreign accent. The methodology we propose, based on the prosody transplantation paradigm, can be applied to different languages or language varieties. Here, it is applied to Maghrebian-accented French: we wanted to study what is perceived when the segmental and suprasegmental characteristics of Maghrebian and native French speakers are crossed. Results obtained with French listeners (accent degree rating task) and Algerian listeners (origin identification task) converge and suggest that the articulation of phonemes overrides prosody to account for Maghrebian accents in French.

1. Introduction

What is commonly meant by “foreign accent” results from the confrontation of two phonological systems in contact — from a mother tongue (L1) and a target language (L2). Beyond the relations which exist between these languages, a number of psycho- and socio-linguistic factors may come into consideration (even in the rating of a foreign accent) \cite{1}. This article is devoted to Maghrebian-accented French (spoken by Arabic or Berber natives). Is it by chance that the term accent has been chosen to designate both a prosodic prominence and a foreign way of speaking? This question also applies to regional and social accents \cite{2}, and some authors such as Rossi seem to answer it in the negative \cite{3}. Invariants probably exist, beyond regional differences, between a Parisian and a person from Marseilles speaking English. If the information carried by the segmental content (properties linked to the sound patterns) often enables us to identify a specific accent, prosody is also essential in language acquisition, and may trigger certain adjustments during second language learning. Although the characteristic categories of the mother tongue prosody are extracted very early by infants (prior to the lexicon acquisition \cite{4}), prosody is one of the most ticklish elements to teach in a second language.

If phonemic characteristics and prosodic dimensions are important, a foreign accent should reflect both segmental and suprasegmental difficulties. Recent studies thus approached the contribution of prosody to the perception of a foreign accent \cite{5; 6}. Likewise, some investigations brought to light the important or even major role of prosody in the identification of regional accents or dialectal varieties \cite{7; 8}. The TIE network (Tone and Intonation in Europe) \cite{9} in particular aims at providing a platform to coordinate these prosodic analyses of European languages and non-standard varieties (including immigrant communities) in the laboratory phonology approach. A number of studies especially within the framework of the IVIE project (Intonational Variation in English) revealed how certain intonational patterns are specific to some English varieties \cite{10}. The AMPER \cite{11} linguistic atlas of Romance languages considers French among others: it is a continuation of a series of inquiries concerning different stress patterns in patois from the North/North-East of France, and more generally from the whole French-speaking area \cite{12; 13}. To complete the survey, let us cite a few additional studies on the identification of Arabic dialects \cite{14; 15}. The latter study \cite{15} was carried out using procedures put forth in Ramus’s dissertation \cite{4} on the different rhythmic classes — especially syllable-timed vs. stress-timed. Others attempt to elucidate the role of intonation rather than rhythm (TIE and IVIE projects in particular). However, Arabic and Berber prosody has barely been tackled, and remains somewhat of an unexplored field — not to mention analyses of Arabs and Berbers speaking French. With over 900,000 adult speakers living in Metropolitan France, Arabic is nonetheless the main language other than French spoken in France, before Alsacian (600,000 speakers), according to a recent inquiry \cite{16}. For a discussion on Berber and in particular on Kabyle (Algerian Berber), one can refer to \cite{17}. For Arabic and in particular Moroccan Arabic, see \cite{18}.

In our study, the first objective of which is to appreciate what constitutes the Maghrebian accent, 20 or so native speakers of Arabic, Kabyle and French were recorded. A perceptual study was conducted to sort out what is perceived when the segmental and suprasegmental features of the different speakers are crossed. The proposed experiment could be replicated with other L1-L2 pairs, and may find applications in automatic language/dialect identification. It is described in next section, with an accent degree evaluation task performed by French listeners and an origin identification task performed by Algerian listeners. Results are provided in section 3: they suggest that the articulation of phonemes and voice quality take the first place as compared to prosody, to identify a Maghrebian accent in French.

2. Experiment

2.1. Material

We instructed 18 speakers to read a 400 word text: 6 Arab (2 Moroccan, 2 Algerian and 2 Tunisian), 6 Kabyle and 6 French speakers living in the Paris region. The subjects were 25 years old on average, and the Maghrebians had arrived in France for 2 years on average. Six other speakers of these different origins were recorded, for a learning phase. All of them were students or young doctors, and there were as many males as females in each group. The speakers had no precise idea on the present study. They were requested to read the text of the PFC
project (Phonology of Contemporary French) [19], which was
split into sentences: this way, if they came up against a
t sentence or hesitated, they would resume the reading from
the beginning of the sentence. The recordings took place in Orsay,
in a soundproof booth with a high-quality microphone located
about 20 cm from the mouth, and were digitised at 22.05 kHz,
16 bits, mono.

We extracted a dozen sentence pairs (the ones stemming
from Maghrebian speakers, the others from French speakers or
Maghrebian speakers of different origins). Energy was
normalised, and the segmental and suprasegmental
characteristics of the different populations were crossed. The
sentences were selected on the basis of 3 criteria:

- presence of presumed typical (supra)segmental feature, as
  in previous studies [5];
- matching realisations of liaisons and schwas;
- matching realisation of pauses and pitch — even if we
can play on the latter parameters.

The sentences, which ranged from 2.4 to 15.7 seconds, were
8.7 seconds long on an average.

2.2. Prosody transplantation: methodology

In order to copy the prosodic parameters from a speaker to
another one, a script was written for the PRAAT software
(http://www.fon.hum.uva.nl/praat/), which enables signal
handling and re-synthesis with the help of the PSOLA
algorithm. It follows the upcoming scheme: extraction and
then transplantation, phoneme by phoneme, of durations and
then pitch.

Before starting on this phase, a segmentation into
phonemes is required: it was made by an expert, under PRAAT,
on the basis of perceptual and visual clues — on spectrograms.
The analysis of phoneme durations, pauses and fundamental
frequency ($F_0$) is then automatic. After possible hand-
corrections, the transplantation of these parameters amounts to:

- checking that the number of segments in the two
  sentences of the chosen pair are equated;
- calculating lengthening or shortening coefficients for
each phoneme or pause of a speaker with respect to
another one;
- for each phoneme or pause, building new durations which
will replace the original durations of either sentence;
- grafting $F_0$ from one of the sentences onto the other one,
  and vice versa.

Two new stimuli are thus obtained: the block diagram of
Fig. 1 displays the different steps of the process.

2.3. Perceptual tests

In order to disentangle the influence of segmental vs.
suprasegmental feature in the perception of Maghrebian-
accented French, two types of perceptual tests were run: the
first one concerns French listeners (with an accent degree
estimation task); the second one involves Algerian listeners
(with an origin identification task). The choice in favour of
this second population is dictated by their geographical
position in the heart of Maghreb and their familiarity with
Kabyle. Not counting a learning phase (or more exactly of
familiarisation with the type of stimuli), each test was
composed of about 40 stimuli, whether original or resulting
from the different prosody transplantations. Each experiment
lasted about 15 minutes. The listeners, all with normal
hearing, were not specialist in linguistics, and were not paid
for this task. They were not urged to answer; but they could
listen to each stimulus only once. The tests were conducted in
the Paris region, in a quiet room, over headphones, through
the E-prime software, which offers a user-friendly interface
to read the instructions, listen to the stimuli and capture the
answers.

Firstly, native French listeners were asked to rate the
degree of accentedness on a 9-point scale (from 0 to 8).
0 represents standard Parisian French, without any marked
accent; 1 designates a very mild accent (only punctually
marked); 2 a mild accent; 3 a moderate accent; 4 an average
accent; 5 a rather strong accent; 6 a strong accent; 7 a very
strong accent; and mark 8 designates so strong an accent that
it poses intelligibility problems. The learning corpus is
composed of 10 stimuli, providing landmarks to assess the
degree of accentedness of male and female natural voices as
well as prosody modifications not used in the sequel. As for
the test, it comprises 42 randomised stimuli (18 originals + 24
French-Maghrebian crossings).

Secondly, 15 native Algerian listeners were asked to
identify the origin (Kabyle, Moroccan, Algerian or Tunisian
Arab) of the speakers they would hear. The listeners, who had
arrived in France for 3 years on average, did not know the
used voices. The learning corpus is composed of 4 stimuli,
giving a sample of male and female voices of Kabyle,
Moroccan, Algerian or Tunisian Arabian origin, as well as
prosody transplantations not used in the remainder of the trial.
As for the test, it comprises 40 randomised stimuli (12
Maghrebian originals + 12 Maghrebian-French crossings + 16
inter-Maghrebian crossings).

3. Results

3.1. Test with French listeners

The test conducted with French listeners shows that the
Maghrebian accent, rated as average (about 4 out of 8) is
judged as stronger after prosody modification: this artifact is
due to the acoustic degradation, which listeners judge even
though their orders were not to concentrate on it. The weak
degree (<1) attributed to the original French speakers is
reassuring as for the methodology. But above all, if we
compare all other things being equal, a Maghrebian voice with
a French prosody is judged as having a stronger accent degree
than a French voice with a Maghrebian prosody. The
difference is highly significant according to a paired t-test
($df=179$; $p<0.01$), and it is more important than between
original/modified Maghrebian voices (see Table 1).
Table 1: Degree of accentedness judged by 15 French listeners, on a 0-8 scale.

<table>
<thead>
<tr>
<th>Voice Type</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>original French voice</td>
<td>0.8</td>
</tr>
<tr>
<td>French voice, Maghrebian prosody</td>
<td>3.2</td>
</tr>
<tr>
<td>Maghrebian voice, French prosody</td>
<td>4.4</td>
</tr>
<tr>
<td>original Maghrebian voice</td>
<td>3.9</td>
</tr>
</tbody>
</table>

This tendency in favour of a greater role played by segmental cues is illustrated by the Maghrebiens’ tendency to pronounce [i] for /e/, for example in the word télévision. Formant measures confirm this fact (with F1 values in the order of 300 Hz for Algerians). Instead, if we compare F0 targets and phoneme durations, we can see that these ones are very close even between sentences which sounded to indicate a reliable effect of prosody.

If segmentals override supra-segmentals in what is perceived as a Maghrebian accent, the question which naturally arises is to know to what extent the articulation of phonemes enables us to identify the origin within Maghreb of this accent. Preliminary tests showed that French listeners albeit familiarised with the Maghrebian accent found it hard to distinguish Arabian and Kabyle accents: hence the follow-up test.

3.2. Test with Algerian listeners

The results of the test conducted with Maghrebian listeners reveal the difficulty in identifying the origin of the stimuli taken as a whole, even for Algerians (see Table 2). This is at variance with the listeners’ impression that they can easily recognise a Kabyle speaker, for instance, whose L1 is not Arabic. Now the Kabyle origin is not better recognised than chance level (25%). Only the Moroccan origin (by more than 56%) is well recognised, and highly significantly better than chance (according to a $\chi^2$ test, $df=3$, $p<0.01$). As for the speakers’ origin with respect to their prosody, it is recognised even worse.

Table 2: Identification scores of the origin of 12 Maghrebian speakers with respect to their segmentals — in row the origin of voices, in column responses (%).

<table>
<thead>
<tr>
<th>Voice \ answer</th>
<th>Moroccan</th>
<th>Algerian Ar.</th>
<th>Kabyle</th>
<th>Tunisian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moroccan</td>
<td>56.2</td>
<td>13.3</td>
<td>12.4</td>
<td>18.1</td>
</tr>
<tr>
<td>Algerian Ar.</td>
<td>32.5</td>
<td>20.0</td>
<td>20.0</td>
<td>27.5</td>
</tr>
<tr>
<td>Kabyle</td>
<td>21.8</td>
<td>26.3</td>
<td>28.1</td>
<td>23.7</td>
</tr>
<tr>
<td>Tunisian</td>
<td>16.2</td>
<td>41.9</td>
<td>11.4</td>
<td>30.5</td>
</tr>
</tbody>
</table>

A principal component analysis was performed, so as to determine the influence of sentence length and accent degree (rated by the 15 French listeners) on the Algerian listeners’ judgements, in terms of correct answers on the voices of various origins. The following $r$ correlation coefficients were found: respectively -0.15 (no correlation) and 0.40 (weak correlation, as confirmed by a comparison with Student’s $t$-distribution tables [$t_{0.05}>1.39; p>0.05$]).

Table 3: Identification scores of the origin of the Maghrebian speakers having a strong accent with respect to their segmentals. Percentages are given with respect to 15 listeners $\times$ 4 types of prosody per voice.

<table>
<thead>
<tr>
<th>Voice \ answer</th>
<th>Moroccan</th>
<th>Algerian Ar.</th>
<th>Kabyle</th>
<th>Tunisian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moroccan</td>
<td>63.3</td>
<td>5.0</td>
<td>10.0</td>
<td>21.7</td>
</tr>
<tr>
<td>Algerian Ar.</td>
<td>18.3</td>
<td>25.0</td>
<td>11.6</td>
<td>45.0</td>
</tr>
<tr>
<td>Kabyle</td>
<td>18.3</td>
<td>10.0</td>
<td>60.0</td>
<td>11.6</td>
</tr>
<tr>
<td>Tunisian</td>
<td>22.7</td>
<td>28.3</td>
<td>11.6</td>
<td>38.3</td>
</tr>
</tbody>
</table>
If however we extract the speakers of each origin judged as having the strongest accent according to the French listeners, we can observe better origin identification scores — even if these ones are established from smaller data. The accent degrees are 4.2 for the Moroccan speaker, 4.0 for the Algerian Arab speaker, 7.0 for the Kabyle speaker and 4.5 for the Tunisian speaker. Results on the basis of their sole voices (their segmentals, whatever the prosody) are very revealing (see Table 3): the identification scores of the Moroccan and Kabyle origins are highly significantly above chance (according to a \( \chi^2 \) test, \( df=3, p<0.01 \)). The Tunisian origin is also recognised with scores significantly above chance (according to a \( \chi^2 \) test, \( df=3, p<0.05 \)). Only the Algerian Arabian origin is poorly recognised.

By and far, also, the prosody of these speakers having a rather strong accent, when applied to various voices, is not so well recognised in the confusion matrix of Table 4 below as it is in Table 3. The same happens with Kabyle, which again suggests that the very strong accent degree (7 out of 8) would be due to segmentals rather than suprasegmentals. The Moroccan and Tunisian origins are rather well identified, but the results are not (highly) significant. The Algerian Arabian origin, for its part, remains badly recognised.

**Table 4:** Identification scores of the origin of the Maghrebian speakers having a strong accent with respect to their prosody. Percentages are given with respect to 15 listeners \( \times \) 3 voices per type of prosody.

<table>
<thead>
<tr>
<th>pros. answer</th>
<th>Moroccan</th>
<th>Algerian Ar.</th>
<th>Kabyle</th>
<th>Tunisian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moroccan</td>
<td>40.0</td>
<td>15.6</td>
<td>31.1</td>
<td>13.3</td>
</tr>
<tr>
<td>Algerian Ar.</td>
<td>13.3</td>
<td>37.8</td>
<td>8.9</td>
<td><strong>40.0</strong></td>
</tr>
<tr>
<td>Kabyle</td>
<td>37.7</td>
<td>15.6</td>
<td>35.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Tunisian</td>
<td>28.9</td>
<td>17.8</td>
<td>15.6</td>
<td><strong>37.8</strong></td>
</tr>
</tbody>
</table>

4. Conclusion

At the term of this analysis and given the achieved results, segmental factors seem to be more relevant than prosody in the perception of Maghrebian-accented French. A fortiori, segmental parameters take the first place when speakers have a strong accent. Nevertheless, the accent origin identification, except for the strongest accents, proves delicate: this is in keeping with earlier studies on the identification of Maghrebian dialects, within which a considerable variability is prevalent [14]. Interestingly however, the Moroccan accent origin is honourably recognised: better than the Kabyle origin, despite a lower accent degree, and although Kabyle speakers have a mother tongue which distinguishes them from other Maghrebian speakers, of Arabic L1. The question this raises deserves to be addressed more thoroughly, as well as the perception of Maghrebian vs. Middle Eastern accents in French, with more speakers and listeners. Finally, results might be different on no longer read but spontaneous speech: it is fitting to remain cautious.

5. References