AN ACOUSTIC ANALYSIS OF PALATAL OBSTRUENTS IN TWO ROMANCE VARIETIES

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ABSTRACT

Palatal stops and affricates are relatively rare in the world's languages, compared to velar stops and postalveolar affricates. In some languages, palatal stops underwent a diachronic shift and merged with postalveolar affricates.

This study undertakes a spectral analysis of palatal stops in two Romance varieties, i.e. the dialect of San Giovanni in Fiore (spoken in a small town of Calabria, southern Italy) and Vallader, a variety of Romansh (spoken in the lower Engadine, Switzerland). The results indicate that the acoustic contrast between postalveolar and palatal obstruents is less robust in Vallader than in Sangiovannese, where in turn inter-speaker differences are more sizeable.

Keywords: palatal obstruents, center of gravity, Italo-Romance, Rhaeto-Romance

1. INTRODUCTION

The first purpose of the present study is to evaluate how an acoustic analysis in terms of 'Center of Gravity' [4] may serve to differentiate between palatal stops and postalveolar affricates. A second objective is to verify to which extent speakers of two different Romance varieties still do distinguish in their production between the two phonetic categories.

2. PALATAL OBSTRUENTS

2.1. Typological markedness

Palatal stops are typologically marked, compared with the 'canonical' places of articulation (bilabial, alveolar, velar). This typological markedness is particularly evident if one also looks at the frequency of 'neighbouring' sounds like velar stops and postalveolar affricates, as results from a query of the UPSID database [9] reported in Table 1.

So far, the relative rareness of palatal stops among the 451 languages contained in the UPSID database might hint at some kind of 'inherent' difficulty related to these sounds, but we do not know if such typological markedness is to be explained on articulatory grounds (the relatively long distance between the active and the passive articulator) or rather in terms of low perceptive distinctiveness (in particular if the language under examination also contains /ʧ/ and /ʤ/).

Among Romance languages, palatal stops are considered a defining feature of the Rhaeto-Romance languages [5], but they also occur in a number of Italo-Romance varieties [12].

Table 1: Frequency of patalal stops, postalveolar affricates and velar stops in the UPSID database.

Phoneme	N. of languages	Percentage
c	54	11.97
ɟ	43	9.53
ʧ	188	41.69
ʤ	113	25.06
k	403	89.36
g	253	56.10

2.2. The dialect of San Giovanni in Fiore

The town of San Giovanni in Fiore is situated in the province of Cosenza, which forms part of the southern Italian region of Calabria. San Giovanni has about 18.000 inhabitants, most of them being bilingual speakers of both the local dialect and the regional variety of the national language.

Sangiovannese has the two palatal stops [c] and [ɟː], for instance in expressions like [ˈcaːβe] "key" and [ɛ ˈɟːʊːtʊ] "(he) is gone" [10]. Diachronically, [c] arose from the Latin clusters CL- and PL-, whereas [ɟː] is a strengthened variant of /j/. Note that [c] and [ɟː] do not occur in Standard Italian, whereas /ʧ/ and /ʤ/ are shared by both the local dialect and the national language.

2.3. Vallader

Vallader is one of the five varieties of Romansh, the fourth national language of Switzerland. It is spoken in the lower part of the Engadine valley, close to the Austrian and the Italian border. According to the 2000 census, Vallader is the first language of about 5.000 speakers who have

(Swiss) German as a second language; therefore, it may be considered an endangered language.

According to the phonetic transcription in [8], Vallader has the two phonemes /c/ and /ɟ/, which occur in words like [can] "dog" and [ɟat] "cat" (along with /ʧ/ and /ʤ/, which occur in words like [ˈʧaiɲɐ] "dinner" and [ʤɐmˈbun] "ham"). The phonemic distinction is also reflected in orthography, the palatal consonants being rendered as <ch>, <gj>, and the postalveolar consonants as <tsch>, <dsch>. Historically, /c/ and /ɟ/ are the result of the palatalisation of Latin C^A, G^A.

Quite interestingly, the two sounds we are dealing with are transcribed in a different manner in the dictionary of [14], where we find the symbols [tɕ] and [dʑ] instead. In other words, these consonants are conceived of as alveolo-palatal affricates rather than palatal plosives.

There are two issues at stake here, namely manner and place of articulation. As regards the distinction between stops and affricates, an acoustic analysis should rely on the ratio between the duration of the release phase and the whole segment. However, there are considerable differences in this regard due to the flexibility of speech organs at different places of articulation. Ladefoged [7] observes that "the palatal stops in many languages tend to be more affricated than the others, perhaps because of the mechanical difficulty of quickly withdrawing the front of the tongue, which often contacts a large area of the roof of the mouth in the formation of these stops." Therefore it seems that the distinction between stops and affricates is more of a continuum than an absolute dichotomy; we shall not tackle the duration issue in this contribution, though.

Concerning the second articulatory parameter, place, things are even more complicated. As for Vallader, the palatograms provided by Brunner [2] do indeed suggest that there is both an alveolar and a palatal closure, the fricative noise being generated at the release of the latter. The articulatory mechanisms of palatal obstruents are extremely complex (cf. [6, 11]) and we will not go into detail here, focusing instead on an acoustic property of these consonants, i.e. their Center of Gravity.

3. DATA AND METHOD

3.1. Recording procedure

In order to build a small corpus of the San Giovanni dialect, four male speakers (AM, AB, GA, GC – aged respectivelly 70, 48, 47 and 43), were recorded in a private house, using a digital field recorder (sample rate: 44.1 kHz at 16 bit) and a highly directional supercardiod microphone (frequency response: 50 Hz-20 kHz ± 2.5 dB).

In the case of Vallader, the subjects are five women of different ages. The first three speakers (MD, MP, MN – aged approximately 70, 50 and 30) were recorded in a private house and a University office, using the same technical equipment and recording settings as for the San Giovanni speakers. The two younger subjects (BV, AM – about 20 years old) were recorded directly on a computer in a sound-proof booth (sample rate 48 kHz at 24 bit), using another cardioid microphone (frequency response: 20 Hz-20 kHz).

Speakers had to read three repetitions of words placed in a carrier sentence. The lexical items contained the consonants /ʧ c k ʤ ɟ g/ in wordinitial position. In order to neutralise coarticulatory effects, the consonants were possibly followed by all stressed vowels of the two varieties, respectively /ɪ ɛ a ɔ ʊ/ in Sangiovannese and /i ɛ a ɔ u y ø/ in Vallader. All in all, this procedure yielded a corpus of 356 tokens for San Giovanni and of 551 tokens for Vallader. The two corpora are quantitatively balanced in the sense that there are at least 12 tokens for every consonant and speaker.

3.2. Spectral analysis

As is well-known, there are two basic approaches to the acoustic analysis of place of articulation. The first method looks at the consonant's locus frequencies, i.e. at the formant transition patterns of the following vowels. A recent version of this methodology, the so-called 'locus equations' [13] has been successfully applied to the palatal stops of a Piedmontese (northern Italian) dialect [12].

Another method analyses the inherent acoustic properties of the consonant release, looking at different aspects of its noise spectrum. Drawing on concepts of probability theory, an analysis in terms of 'spectral moments' calculates spectral mean, variance, skewness and kurtosis [3]. The first spectral moment, also called 'Center of Gravity' (hence CoG), is most easily interpretable as an acoustic correlate of place of articulation [4]: similarly to the second formant of vowels, the CoG value decreases as the backness of a consonant increases.

The CoG approach has been employed in this study. First, we segmented and labelled release

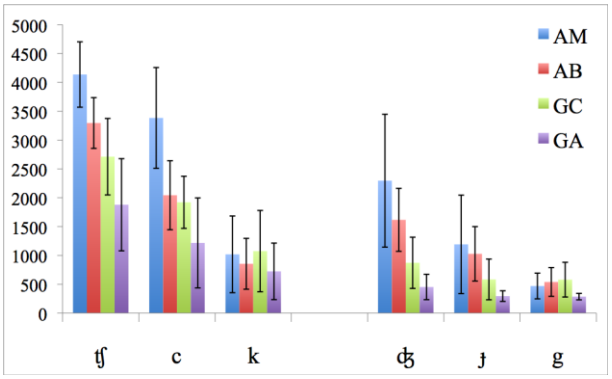
phase of the examined consonants in a TextGrid of the *Praat* software [1]; subsequently, we applied a script (courtesy of Volker Dellwo) that uses the apposite CoG function to calculate the spectral mean of the isolated consonantal noise.

4. RESULTS

4.1. CoG of Sangiovannese consonants

Figure 1 reports the CoG values for the six consonants under analysis /ʧ c k/ and /ʤ ɟ g/ (thus proceeding on the horizontal axis from voiceless to unvoiced obstruents and, within these two major classes, from more front to more back articulations); more precisely, the figure shows mean values and standard deviations in Hz for the four speakers AM, AB, GC and GA.

Figure 1: Center of Gravity (in Hz) of postalveolar, palatal and velar obstruents in Sangiovannese. (four male speakers).



On the basis of Figure 1, the Center of Gravity does indeed permit to differentiate between the three places of articulation: postalveolar affricates have a higher CoG than palatal obstruents, which in turn have a higher CoG than velar stops.

Two univariate ANOVAs (consonant*CoG) yield a highly significant effect both for the three voiceless consonants /ʧ c k/ ($F[2,172]=23.3$, $p<.001$) and the three voiced obstruents /ʤ ɟ g/ ($F[2,184]=78.5$, $p<.001$). A post hoc test proves this significance for all oppositions except /ɟ/~/k/ ($p=.06$).

Regarding the basic research question of our study we may conclude that palatals are kept distinct from postalveolars in the dialect of San Giovanni in Fiore. We also can interpret the results in the sense that Sangiovannese palatals have a more backward articulation than postalveolars, which means that the phonetic characterisation of these consonants is appropriate both in terms of articulatory labels and IPA symbols.

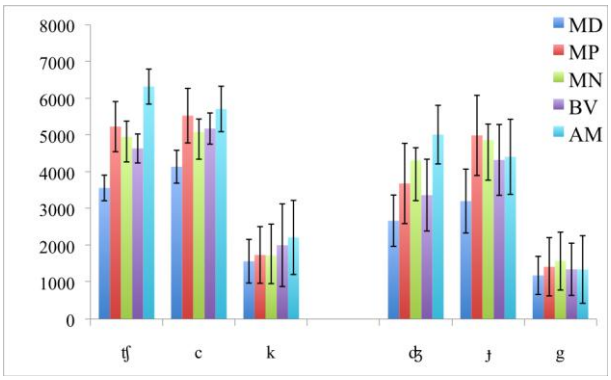
As regards voicing, from Figure 1 appears that the three unvoiced consonants to the left /ʧ c k/ have, on average, higher CoG values than the corresponding voiced consonants /ʤ ɟ g/. While this result is expectable (considering that vocal fold vibration generates additional energy in the lower frequency domains), it proves, nevertheless, that /ʤ ɟ g/ are indeed realised as voiced segments.

It is worth noting that the inter-speaker variation displayed in Figure 1 is relatively high for postalveolars and palatals, but not for velars. For instance, AB's /ʧ/ has about the same mean CoG (3296 Hz) as AM's /c/ (3384 Hz); similarly, GA's mean CoG for /ʧ/ (1879 Hz) nearly coincides with GC's mean CoG for /c/ (1921 Hz). Still, the single speakers themselves show a rather consistent behaviour: in general, the mean CoG decreases as the consonant's backness increases, maintaining more or less the same ratio between the three places of articulation (except for /ɟ/ and /g/ of the speakers GC and GA). Note that the speakers are ordered from left to right according to their age: quite curiously, thus, the mean CoG would seem to be higher in older subjects, regardless of place of articulation.

4.2. CoG of Vallader consonants

Figure 2 reports the results of the Vallader data, proceeding from the three voiceless consonants /ʧ c k/ to the three voiced consonants /ʤ ɟ g/. Mean CoG values and standard deviations in Hz are illustrated for the five speakers MD, MP, MN, BV and AM, which are again ordered from left to right according to their age (MD being the oldest and AM being the youngest subject).

Figure 2: Center of Gravity (in Hz) of postalveolar, palatal and velar obstruents in Vallader. (five female speakers)



At first glance, the Center of Gravity clearly permits to distinguish velars from more front consonants, whereas the difference between

postalveolars and palatals is much less evident in Vallader. Moreover, 'palatals' even display a higher CoG than postalveolars.

An univariate ANOVA (consonant*CoG) for the six categories /ʧ c k ʤ ɟ g/ yields a highly significant effect ($F[5,549]=254.8$, $p<.001$). A post hoc analysis indicates a significant effect for the opposition between /ʤ/~/ɟ/ ($p=.03$), but the difference between the corresponding voiceless consonants /ʧ/~/c/ is not significant ($p=.7$).

In Vallader, the contrast between the voiced consonants and their voiceless counterparts is much smaller than in Sangiovannese. In the spectrograms, voicing is mostly present during the closure phase of [ʤ ɟ g], but often lacking during the release. For instance, for the /k/~/g/ contrast a post-hoc test yields an effect which is not highly significant ($p=0.01$).

Moreover, inter-speaker variation also appears to be smaller in Vallader than in Sangiovannese; still, a rather coherent idiosyncratic behaviour is detectable. Contrarily to San Giovanni, it is the oldest Vallader speaker MD who exhibits the lowest average CoG across the three places of articulation, whereas AM (one of the two youngest speaker) has in general the highest CoG.

5. CONCLUSION

The spectral analysis of six types of consonants in two Romance varieties has proved that the Center of Gravity constitutes a valuable cue to place of articulation, allowing to distinguish between postalveolar and palatal obstruents in particular. Nevertheless, some differences between the two varieties arise: in San Giovanni, the phonetic realisation of the contrast between /ʧ ʤ/ and /c ɟ/ appears to be rather robust, whereas a possible confusion of these two categories emerges from the Vallader data. In line with the typological markedness relations we might predict that in the future Vallader will substitute palatals with post-alveolar obstruents. The vitality of the contrast might be tested by means of a perception experiment or an apparent time analysis focusing on different age groups. However, the high inter-speaker variability must be taken into account, possibly by developing some sort of normalisation procedure.

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