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English summary

In this dissertation, I analyze the process of retroflexion which affect the liquid consonants in the Romance area. I consider both a diachronic/typological and an acoustic-phonetic point of view. The topic of consonant retroflexion has been widely investigated by Romance dialectologists as well as historical linguists, and by experimental phoneticians, but the convergence of the two sub-disciplines has been so far episodic. This dissertation aims at filling this gap, by exploiting the main resources of experimental phonetics with purposes of diachronic reconstruction.

One of the most revolutionary achievements of modern instrumental phonetics is the great amount of *variation* characterizing a linguistic production. As a matter of fact innumerable sources of variability are found not only among different speakers but also in the speech of one speaker. Ohalian theory of language change (cf. Ohala 1981, 1989, 1992, 1993, 1995a and 1995b) is entrenched in this simple but fundamental tenet. A detailed investigation of speech phenomena indeed shows that sound variation mostly parallels sound change, as is manifested by sociolinguistic and dialectal variation, morphophonemic alternations, or typological preferences.

Most of the studies on consonant retroflexion show the explicit purpose of setting a link between the phonological status of this consonant 'class' and some phonetic invariances which should unambigously define it. In that approach, however, the great amount of variation shaping the reality of phonetic events is reduced to bare labels such as 'apicality' or 'falling F3', fairly useless for diachronic purposes. What is more, it has been widely demonstrated that, especially from the articulatory point of view, the only way to convincingly describe the retroflex articulation and capture the multiplicity of phenomena which are hidden behind this label is to posit a *continuum* of points of articulation (Ladefoged & Bhaskararao 1983, Ladefoged & Maddieson 1996:21-30).

Following this latter approach, the object of this dissertation is the fine-grained variation of consonant retroflexion in some Romance areas. Its main goal though is not the phonetic and phonological description of a sound *class*, but rather the analysis of some *processes* of sound change which affect the retroflex and other adjacent articulations.

<u>Chapter I</u> deals with the general properties (acoustic and articulatory) of consonant retroflexion, following a cross-linguistic point of view, and reviews the phonetic, phonological, and distributional properties of Romance retroflexion.

Retroflex consonants are attested on a relatively wide area of the Romance domain. In particular, as far as Italo-Romance is concerned, they are found in many southern dialects (spoken in Calabria, Puglia, Abruzzo, Campania), as well as in Sicilian, Sardinian and Corsican. They are also present in some varieties of northern Tuscany. Retroflex pronunciations are also found in western Asturian, and they were probably present in ancient Gascon phonology.

Voiced retroflex consonants (stops and affricates) developed mostly from the geminate lateral in internal position (e.g. Ragusa Sicilian [kaˈʋaɖːo] *cavallo* 'horse') and, sporadically, between words (e.g. Minucciano Tuscan [kweɖ ˈomo] *quell'uomo* 'that man', [vak a ˈɖetto] *vado a letto* 'I go to bed', where the geminate lateral is triggerd by *raddoppiamento fonosintattico*). The output of this process can be a stop [ɖ(ː)] or an affricate [ɖ(ː)ʐ]. Gemination is generally preserved, but in some dialects a degemination process occurs. There are also varieties in which the proto-Romance cluster /lj/, after having developed to a palatal lateral ([ʎː]), underwent a retroflexion process (e.g. southern Corsican [ˈaɖːa] *aglio* 'garlic'). In some Sardinian, Sicilian and Calabrian dialects the retroflex stop can also be extended to etymological /d(:)/ (e.g. Sardinian [ˈtuɳɖu] *tondo* 'round'), but this process is lexically determined.

Beside /l:/, a rhotic after an alveodental stop is the other main source of retroflexion in the Romance area (/tr/, as well as /str/ and /ntr/). The output of this process is normally a retroflex voiceless affricate, which can be simple or geminate, depending on the original context: e.g. Sicilian [ˈʈˢɛni] *treni* 'trains', [aʈːˢoˈvare] *trovare* 'to find'.

At the beginning of the XX century, many Romance philologists explained the origin of such retroflex pronunciations through a *substratum hypothesis* (Guarnerio 1902, Merlo 1925, Bottiglioni 1927, Millardet 1933, Schmeck 1952, Menéndez Pidal 1954, Rohlfs 1955). At the end of the Sixties, the substratum hypothesis was still the most accredited theory (Blaylock 1968). More recently, three scholars, independently from one another, have demonstrated that retroflexion in the Romance area has to be considered a modern development, i.e. *posterior to the XIII century*. These studies, based on philological evidence, refer in particular to northern Tuscany dialects (Savoia 1980), Sicilian (Caracausi 1986) and Sardinian (Contini 1987).

Chapter II deals with the process of retroflexion of the /tr/ clusters. A previous attempt to phonetically explain the process converting /tr/ into a retroflex affricate can be found in the paper by Sorianello & Mancuso (1998), with reference to the Cosentinian variety (but see also Hamann 2003:87 for a very similar proposal). These scholars hypothesized that the cluster was firstly affected by rhotic retroflexion (/r/ > [ɽ]), a process which naturally occurs due to the strong acoustic similarity existing between rhotics and retroflexes (both characterized by a lowering of F3 in vowel transitions; Stevens 1998:554). It was then postulated, as a second stage, a regressive assimilation ([tɽ] > [ʈɽ]). Finally, an assibilation occurred ([ɽ] > [ʂ]). The latter stage would be grounded in the general tendency for retroflex rhotics to assume a sibilant pronunciation (e.g. Ruffino 1991 for /r:/ in the Sicilian dialect; see also the spectrogram in Sorianello & Mancuso 1998:154 for /r:/ in the Cosentinian realization of *che ruota* 'which is rotating'). However, three problems at least arise from this kind of reconstruction. First of all, a sibilant realization is attested, in Calabrian as well as Sicilian (and possibly in other dialects), for the only geminate rhotic in internal position, or in initial position when produced as long (Sicilian); no data speak about the possibility that a post-consonantal rhotic may assume a sibilant character in any Romance or non-Romance dialect. Moreover, and more importantly, no stage with a biphonemic retroflex realization ([ʈɽ]) is attested, neither in synchrony nor in diachrony. Third, any reconstruction only based on the acoustic similarity between rhotics and retroflexes does not fit with the Romance data, where the context of rhotic-induced retroflexion is specifically marked by (1) cluster tautosillabicity, and (2) cluster homorganicity. A reliable explanation must then account for such contextual restriction.

An alternative account is presented in the following section of Chapter II, where the acoustic similarity between rhotics and retroflexes is still a relevant factor, but the focus is shifted to rhotic *manner* changes; additionally, the concept of *assimilation* as a fundamental mechanism for the development of the retroflex affricate is here rejected.

It is well-known that articulatory reduction for any consonant is sensitive to syllabic position: consonants are reduced in syllable final position more than in initial position, and in tautosyllabic sequences more than in heterosyllabic ones (Straka 1964, Ohala & Kawasaki 1984, Fougeron 1999; and see Recasens 2004 for rhotic reduction in Catalan). In many Romance languages, as the Italo- and Ibero-Romance ones, trills are realized in intervocalic position, especially if they are geminate, or in heterosyllabic clusters (/rC/). Flap/taps or even approximants are instead preferred (or mandatory) in other contexts, first of all in tautosyllabic clusters (Farnetani & Kori 1986, Bakovic 1994; see also Dietrich 2002 for Brazilian Guaraní). This pattern, which is grounded in some articulatory and aerodynamic prerequisites involved in the production of /r/, governs the production and distribution of rhotic sounds universally (Ladefoged & Maddieson 1996:215-217, Solé 2002).

In the case of /tr/ and /Ctr/ clusters, the rhotic, occupying the second or third position in a tautosyllabic cluster, is subject to a strong articulatory reduction process, leading to a flap/tap realization. Since flaps/taps are extremely short in post-consonantal position (Farnetani & Kori 1986), and rhotics are strongly characterized by variation in point of articulation (Ladefoged & Maddieson 1996:215-217), an oscillation is likely to be introduced between a [ɾ] and a [ɽ] pronunciation (alveolar vs. postalveolar flap/tap). As articulatory reduction goes further, an approximant can arise (i.e. [ɹ] and [ɻ] freely alternate). At this stage, the rhotic tends to lose its consonantal status and to reduce itself to a voiced appendix of the preceding stop: an *affrication process* then applies, following a diachronic typology widely attested in Romance phonology. In this approach, [tr] > [tɾ] ~ [tɽ] > [tɹ] ~ [tɻ] > [ʈ^{ʂ}] exactly how [tĕ] > [tj] > [tː^{s}] in the change from Lat. *platĕa* to Italian *piazza* 'square'.

The postalveolar point of articulation emerging from the process of /tr/ affrication can easily be explained by articulatory blending. Both a [tɹ] and a [tɻ] realization can induce the alveodental stop [t] to assume a posterior point of articulation, as an effect of the increased coarticulation between the two members of the cluster. In the course of the affrication process, the tongue body assuming a retracted configuration, lets the apex free to rise against the palate, leading to an apical pronunciation. Moreover, articulatory blending (but not the acoustic-perceptual explanation reviewed above) accounts for the fact that retroflexion does not apply to non-homorganic clusters such as /pr/ and /kr/.

The explanatory advantages of this articulatory proposal, with respect to the previous ones, are then the following:

1. the phonetic mechanism from which retroflexion arises is not stop assimilation to the following retroflex rhotic, but *affrication* of the stop-approximant sequence, which is highly unmarked in the synchrony and diachrony of the Romance languages; this process applies:

2. when the rhotic undergoes an increasingly strong *articulatory reduction* in post-consonantal position in a tautosyllabic cluster, becoming an approximant;

3. when coarticulation is particularly strong, since the two consonants are *homorganic*;

4. as a general consequence, the rhotic does not assume a fricative character as a separate segment ([ɽ] > [ʂ̹]), but it takes part to the development of a sibilant affricate ([ʈ^{ʂ}]) as a result of *articulatory blending* with the preceding stop.

The three following chapters are dealing with retroflexion of the geminate lateral.

In Chapter III, I discuss the process of /l:/ retroflexion in two southern Corsican dialects: the Fiumorbu dialect, where /l:/ > [ɖ(ː), d, ɾ, ð] and /lj/ > [lː], and the Alta Rocca dialect, where both /l:/ and /lj/ > [ɖː, dː] (but a great deal of phonetic variation is always present, as specified later).

The first section of this chapter deals with diachrony: I review some philological, chronological and comparative data, drawn from Celata (2002-2003), that may shed light on the history of retroflexion in the Corsican dialects, and account for the atypical distribution depicted above. The main results are the following:

1. retroflexion in /l:/ context, attested in Corsican after the XV century, developed before retroflexion in /lj/ context;

2. the southern dialects of Corsica did not differ from the northern ones, nor from proto-Romance in general, where /lj/ massively palatalized ([ʎː]);

3. no cases of <ll> for /lj/ are found in the old documents of southern origin; hence, the contemporary Fiumorbu [lː] pronunciation for /lj/ was not common to larger areas in the medieval epoch;

4. as a consequence of all these facts, a *recent depalatalization process* [ʎː] > [lː] is likely to be at the origin of this [lː] pronunciation (probably, post-XVIII century);

5. moreover, [ʎː] and [lː] are articulatory similar enough, to allow the first sound to naturally change into the second, a process which is also attested in other Romance dialects;

6. again on philological basis, we can state that the development of the retroflex pronunciation in the /lj/ context (Alta Rocca) did not require that a depalatalization process took place previously;

7. synchronic alternations in Alta Rocca also speak about the implausibility of an [lː] development as the preliminary stage for retroflexion in /lj/ context: no *[lː] variant is attested for /lj/;

8. therefore, we can assess that retroflexion in Alta Rocca has been *analogically extended to the palatal pronunciation* [ʎː].

The second part of Chapter III introduces the acoustic analysis of Corsican retroflexes. Speech data show that many variants are in competition within these phonological systems and retroflexion undergoes an amount of simplification processes. In particular, the retroflex in Fiumorbu is frequently degeminated and tends to lose its postalveolar character, merging with a short alveodental [d]. A further weakening process may also apply, leading to a [ð] or a [ɾ] realization. Moreover, retroflexes (or their vestiges) are only attested in the internal position of the word, never within words. In Alta Rocca, on the contrary, length and point of articulation are better preserved (even if many other variants for /lː/ and /lj/ are also attested: e.g. [lː, dː], [ʎː, jː]), and retroflexion appears to be present even in *sandhi* position ([ˌɛɖiˈʃtesːu] *è lo stesso* 'it doesn't matter'). The comparison between the two dialects leads us then to postulate that, while retroflexion originated as a *phonetically-driven* process in Alta Rocca, it has been lexically imported in Fiumorbu as a consequence of *language contact*.

Formant trajectories in VC and CV transitions have been analyzed, with specific reference to F3 and F4. In retroflex articulations, F3 and F4 lowering is generally said to be related to posteriority and articulatory retraction (Stevens & Blumstein 1975, Spajic et al. 1996). In order to determine the global trajectory of formants in adjacency to the relevant consonant, measurements have been done of F3 and F4 values at the steady-state of the preceding and the following vowels, and these have been compared with formant values measured at VC and CV transitions, respectively. As for statistic analysis, a paired samples *t*-test was used. The comparison between formant trajectories for [dː] and [ɖː] shows that retroflexes are generally characterized by an *F3 and F4 lowering in both VC and CV transitions*, while no reliable effect can be found for the alveolar stops. However, there is strong variation that depends on the quality of the adjacent vowel. Data for the retroflex consonants are presented in Table 1. A significant lowering of both F3 and F4 is found in /uɖ/ and /ɖu/ contexts; in addition, F4 lowering is significant in /ɖa/ context, while F3 lowering is significant in /eɖ/ context. No other contexts are interested by any significant formant lowering. The back high vowel /u/ is then the only target of systematic formant lowering. Hence, Corsican retroflexes appear to be *only contextually posterior/retracted*.

The acoustic analysis was also concerned with some spectral characteristic of the consonant release. This articulatory component is often neglected in the analysis of retroflexes. In the case of Corsican, the release of the retroflex is significantly longer, as opposed to the alveodental stop: the average duration is 20-30 msec, with a maximal value of 38 msec. On the other hand, the release of the alveodental stop is always less than 10 msec long. In many instances of [ɖ], the release is clearly fricative with a noise over 1600 Hz for male speakers, 2000 Hz for female speakers. These values indicate an alveolar or postalveolar point of articulation. Such a long and noisy release then shows that the retroflex is an apical consonant, which tends to develop a fricative appendix in the contact with a following vowel. Some examples are given in Table 2.

Apical retroflexes may therefore be acoustically and perceptually distinguished from laminal articulations even in the absence of articulatory retraction, i.e. on the basis of the *durational properties of the release*. In these dialects, the retroflex consonant has two positional variants, one is retracted, the other is not, but both avoid merger with the laminal stop /d(ː)/, as well as with the affricates /d(ː)^{ʒ}/ and /d(ː)^{z}/, thanks to the release durational properties. Moreover, across the phonetic *continuum* that ranges from stops to affricates, the boundaries of *three* distinct categories are drawn up.

In <u>Chapter IV</u>, a second corpus of speech data is presented, which illustrate the patterns of /lː/ retroflexion in Sicilian. In this region, retroflexion of both /lː/ and /tr/ clusters is very common, with very little or no differences in local sub-varieties, social classes, gender differences, and speech styles. The historical origins of Sicilian retroflexes have been exhaustively sketched out by Caracausi (1986). Therefore, my research only focuses on the synchronic aspects of phonetic variation, with the purpose of elucidating mechanisms and conditions underlying the phonetic process of lateral retroflexion.

In Sicilian, geminate consonants are always preserved; coherently, the retroflex is always long. Moreover, the retroflex is significantly longer than the geminate alveodental [d(ː)]. This is mainly due to the *release*, which is significantly longer in the retroflex than in the alveodental (even if shorter than in Corsican: average duration 12 msec). The range of variation is very large: from 0 (no audible release) to 40 msec. At least some realizations of the retroflex consonant are then apical (while alveodentals are essentially laminal). Moreover, in retroflexes the duration of the release appears to be significantly correlated with the total consonant duration (positive correlation), with stress position (longer in VCV́ than in other contexts) and vowel quality (longer before /u/, shorter before /i/). Apicality is then favoured by a following stressed back vowel.

Formant analysis shows that, in comparison with the alveodental, the retroflex consonant is generally defined by a relatively strong F4 and (partially) F3 lowering in VC and CV transitions. The relevant data are presented in Table 3. All back vowels are affected by formant lowering in both transitions, and especially in the case of vowel /u/. With front vowels, on the contrary, lowering is only significant in VC transition, and never for the vowel /e/. The central vowel /a/ never carries formant lowering. With respect to stress position, formant lowering is always significant when stress is on the preceding vowel *and* the following vowel is back (compare data in Table 4).

To summarize, formant lowering is evident for both F3 and F4, but for F4 more often and more strongly than for F3. Vowel quality is a relevant factor, since back vowels are systematically affected by formant lowering, front vowels are only sporadically affected, and the /a/ vowel is completely unaffected. Stress position is also a relevant parameter since lowering is maximally realized when the preceding vowel is stressed. Taken together, these data show that articulatory retraction and posteriority are only *contextually* present in Sicilian.

Some characteristics of the *closure phase* are also relevant to differentiate a retroflex from a laminal alveodental. Typically, Sicilian retroflexes are realized as stops. Yet there are spectrograms that reveal the possibility for retroflexes to have a more "sonorant-like" realization. Two types can be identified. In the first one (compare Table 5), F2 and F3 traces are visible on the spectrogram during the whole closure phase, even though they have a very low amplitude (the perceptual impact must indeed be completely irrelevant). They presuppose however that a partial obstruction of the oral cavity is realized during the closure phase of these consonants. In the second one (compare Table 6), one or two spikes are visible during the closure phase, and followed by some sort of noise, which is particularly evident at frequencies corresponding to F2 and F3 onset in CV transitions. Contrary to the first type, this realization has a clear perceptual impact (it sounds like a sort of [dl] sequence), even if short duration makes auditory recognition very difficult. The foremost auditory impression is that of a stop, but articulation clearly undergoes some rapid changes near the end of the consonant, with some continuant-like acoustic and perceptual results. It is also possible that these realizations derive from a process of pre-occlusion of the lateral consonant (or from a laterally released stop; see Ladefoged & Maddieson 1996:201 for some relevant examples). In any case, we must conslude that retroflexes can acoustically and perceptually approach *the class of continuant consonants*.

Chapter V contains some phonological considerations on lateral retroflexion in Romance and the general conclusions. In the first part, I review some previous phonetic accounts which connected the origin of the retroflex stop to different factors:

a. the development of a retroflex lateral [ɭː], as common source for both the retroflex stop [ɖː] and the palatal lateral [ʎː] (Rohlfs 1966[=1949], 1970[=1928), 1981);

b. the development of a palatal lateral [ʎː] (Rohlfs 1966[=1949], Hock 1986);

c. gemination and strengthening of the alveolar lateral, which tended to assume an apical realization and a postalveolar point of articulation like all other voiced coronal geminates in Sardinian (Contini 1987).

Authors in a. and b. assume that both Proto-Romance /lː/ and /lj/ followed the same developmental path.

The hypothesis in a. cannot be integrally maintained since the retroflex lateral (IPA symbol [ɭ]) is *a flap or approximant typically realized as short or extra-short* in every language where it is attested (see Ladefoged, Cochran and Disner 1977 for Malayalam, Penzl 1955 for Pashto, Rajasingh 2001 for Jarawa, Laughren & McConvell 1996 for Pama-Nyungan languages of Australia, Livijn 2002 for Swedish). On the contrary, it is much more probable that a velarized apical lateral (IPA symbol [ɫː]) developed from [lː] during the first stages of the transition to [ɖː]. Moreover, it is not at all necessary to postulate that [ʎː] developed from [ɭː] as well, in contrast with the whole theory of Romance consonant palatalization (see Sanchez Miret 2001:463-480 for a review).

The hypothesis in b. was formulated so that it could account for the same substratum interference in both Southern Italian dialects and Ibero-Romance (Menendez Pidal 1954, Rohlfs 1988). Even if an analogical extension of the retroflex pronunciation to the [ʎː] < /lj/ context cannot be excluded for some specific dialects (recall the case of Alta Rocca mentioned earlier), the retroflex is much more likely to be the output of a phonetic process that firstly affected the alveolar lateral, and only afterward extended to other contexts.

Finally, the hypothesis in c. presupposes that a retrflexion process should apply to all voiced geminate coronals in Sardinian (e.g. /nː/, /rː/, and /dː/), but this is not the case (Wagner 1984).

In order to really understand the origin of the retroflex articulation, we must consider two important factors that are normally neglected: the *relative timing of articulatory events* which concur to realize the complex consonant, and the role of *suprasegmentals*.

Farnetani & Kori (1986) found that, in Italian, pretonic consonants in CVCV́CV trisyllables are significantly longer than in other contexts. This agrees with our Sicilian data, reviewed above, where retroflexes in VCV́ context were longer than in V́CV ones (words were always three or four syllables long). We can then affirm that, *after* a stressed vowel (V́CV contexts), consonants tend to be shorter. In that context, the retroflex showed the strongest acoustic effects of posteriority/retraction (formant lowering). We must conclude that, *in post-tonic context*, retroflexes are affected by a two-fold process of (a) durational reduction, and (b) perceptual strengthening of articulatory retraction in VC transition. As far as the origin of the retroflex is concerned, these segmental phenomena generated by suprasegmental conditions may account for the phenomena of partial occlusion, that I have found in speech data (pre-occluded laterals, and preservation of formant cues during the closure phase).

In this approach, retroflexion of [lː] would be generated by a process with the following characteristics:

a. *articulatory motivation*

b. *graduality*

c. from an acoustic point of view, a progressive *impoverishment of formant structure* in the transition from the lateral sonorant to the stop, mainly in post-tonic position.

As we have already mentioned, the retroflex consonant can preserve some of the articulatory features of the continuant consonant from which it has developed. It is a matter of categorical perception whether the output of such progressive delateralization is phonologized as stop (or affricate). Crucially, there are languages where the retroflex analogically extends to the lateral palatal, but not to the etymological alveodental stop: we have seen this in Corsican, but other cases are attested in some Abruzzi dialects (Hastings 1997). This fact can only be explained by assuming that even the continuant feature can emerge as perceptually relevant.

The choice between a stop or an affricate realization is also a matter of categorical perception. What is articulatorily important, however, is that even the release durational properties of the retroflex have to be considered in terms of a *continuum* (Ladefoged & Bhaskararo 1983), besides tongue curling and posteriority.

Table 1 F3 and F4 values in steady-state (V1, V2)and transitions (VC, CV) of vowels adjacent to the retroflex consonant in Corsican. Significant contrasts are in bold.

	F3(V1) (m, σ)	*F3(VC) (m, σ)*	*F4(V1) (m, σ)*	*F4(VC) (m, σ)*
/aɖ/	2434 (252,10)	2370 (213,94)	3313 (293,93)	3122 (329,10)
/ɛɖ/	2522 (120,68)	2479 (149,25)	3384 (536,15)	3278 (329,10)
/eɖ/	**2642 (357,31)**	**2453 (277,41)**	3415 (656,90)	3367 (664,86)
/iɖ/	2799 (330,28)	2781 (370,08)	3626 (762,76)	3706 (400,49)
/ɔɖ/	2472 (119,50)	2211 (637,10)	3304 (136,47)	3309 (119,50)
/oɖ/	2927 (56,60)	2705 (273,06)	-	-
/uɖ/	**2723 (196,40)**	**2476 (245,52)**	3420 (192,10)	3461 (315,92)
	F3(V2) (m, σ)	*F3(CV) (m, σ)*	*F4(V2) (m, σ)*	*F4(CV) (m, σ)*
/ɖa/	2593 (312,13)	2599 (360,71)	**3307 (277,71)**	**3192 (332,31)**
/ɖo/	2627 (188,50)	2544 (167,58)	3441 (383,54)	3195 (257,22)
/ɖu/	**2784 (278,82)**	**2594 (324,50)**	**3493 (441,33)**	**3381 (546,53)**

Table 2 The release of some retroflex and non-retroflex realizations in Corsican.

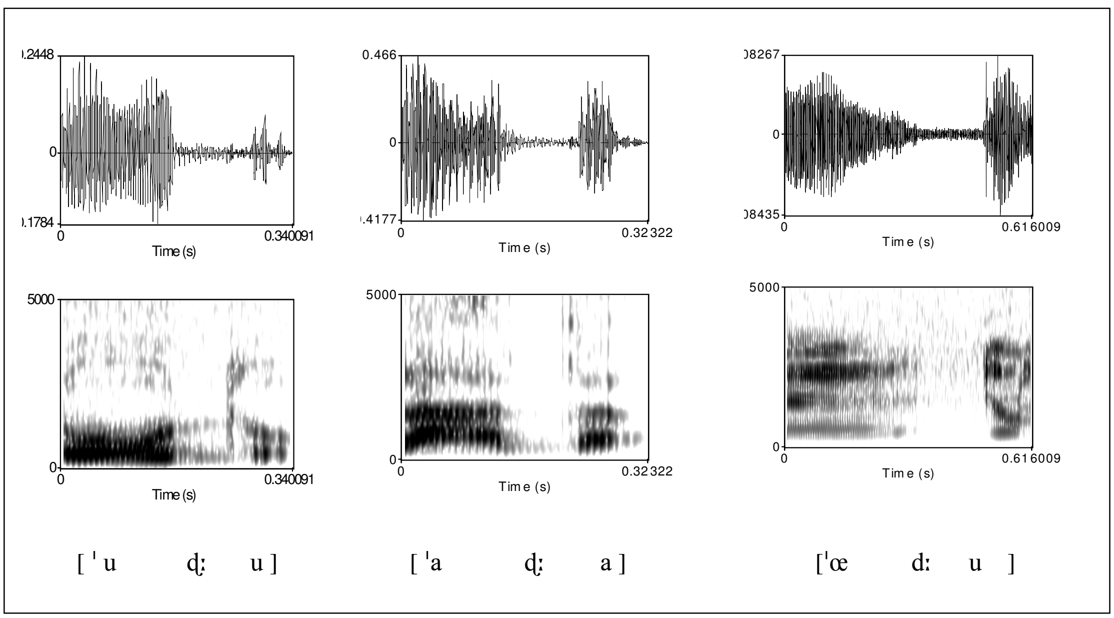


Table 3 F3 and F4 values in steady-state (V1, V2)and transitions (VC, CV) of vowels adjacent to the retroflex consonant in Sicilian. Significant contrasts are in bold.

	F3(V1) (m, σ)	*F3(VC) (m, σ)*	*F4(V1) (m, σ)*	*F4(VC) (m, σ)*
/aɖ/	2621 (335,87)	2719 (359,67)	3876 (349,62)	3780 (486,01)
/ɛɖ/	2928 (310,36)	2862 (293,53)	**4017 (404,53)**	**3827 (417,23)**
/eɖ/	2795 (314,57)	2768 (304,37)	3815 (373,85)	3745 (452,17)
/iɖ/	**2924 (325,76)**	**2810 (300,99)**	3838 (270,51)	3819 (272,89)
/ɔɖ/	2673 (301,62)	2391 (499,45)	**3633 (283,69)**	**3096 (393,03)**
/oɖ/	2549 (368,25)	2251 (225,14)	**3444 (119,65)**	**2838 (324,20)**
/uɖ/	**2680 (281,78)**	**2499 (282,90)**	**3615 (180,50)**	**3383 (393,99)**
	F3(V2) (m, σ)	*F3(CV) (m, σ)*	*F4(V2) (m, σ)*	*F4(CV) (m, σ)*
/ɖa/	2709 (338,10)	2825 (316,92)	3846 (314,81)	3820 (382,55)
/ɖə/	2868 (39,46)	2924 (62,48)	3905 (98,15)	3879 (205,81)
/ɖe/	2752 (287, 38)	2764 (307,50)	3915 (372,35)	3786 (423,62)
/ɖi/	2883 (278,62)	2875 (249,80)	3909 (305,87)	3897 (281,94)
/ɖo/	**2708 (259,60)**	**2484 (255,85)**	**3534 (228,58)**	**3247 (263,47)**
/ɖu/	**2604 (230,80)**	**2501 (263,01)**	**3555 (253,72)**	**3303 (324,37)**

Table 4 F3 and F4 values of vowels adjacent to the retroflex consonant in Sicilian, as a function of vowel quality and stress position. Significant contrasts are in bold.

V1 stressed	*V2*	*F3(V1)*	*F3(VC)*	*F4(V1)*	*F4(VC)*	*F3(V2)*	*F3(CV)*	*F4(V2)*	*F4(CV)*
front V	front V	2939 (360,52)	2857 (322,90)	3938 (378,41)	3862 (388,33)	2822 (257,02)	2832 (256,10)	3949 (295,15)	3888 (309,58)
back V	back V	**2582 (309,65)**	**2389 (378,13)**	**3613 (217,71)**	**3150 (406,60)**	2594 (232,41)	2463 (306,10)	**3565 (239,77)**	**3163 (359,05)**
front V	back V	**2896 (320,05)**	**2786 (296,29)**	**3874 (385,83)**	**3729 (397,28)**	**2619 (261,08)**	**2499 (261,37)**	**3498 (221,26)**	**3270 (251,67)**
central V	back V	2596 (348,67)	2711 (372,99)	3856 (358,80)	3721 (516,75)	**2667 (249,14)**	**2483 (279,14)**	**3575 (214,15)**	**3255 (292,41)**
back V	central V	2708 (262,81)	2510 (272,70)	3580 (183,18)	3370 (362,90)	2769 (286,56)	2786 (283,52)	3872 (276,11)	3771 (470,57)
central V	front V	2619 (345,18)	2762 (387,92)	3975 (361,05)	3929 (540,35)	2813 (269,95)	2864 (288,62)	3849 (313,09)	3852 (369,80)
front V	central V	2856 (294,77)	2843 (316,94)	3955 (377,08)	3850 (421,50)	2795 (318,94)	2909 (320,78)	3913 (345,33)	3887 (347,25)
V1	*V2 stressed*	*F3(V1)*	*F3(VC)*	*F4(V1)*	*F4(VC)*	*F3(V2)*	*F3(CV)*	*F4(V2)*	*F4(CV)*
front V	back V	2994 (298,85)	2834 (229,89)	3742 (237,83)	3643 (254,50)	2672 (236,33)	2528 (139,68)	3628 (336,09)	3475 (321,38)
back V	central V	-	-	-	-	2720 (904,39)	2770 (480,83)	3829 (373,35)	3552 (104,65)
central V	front V	2719 (334,20)	2767 (289,53)	3904 (369,22)	3945 (327,25)	2988 (378,25)	2852 (306,35)	3796 (423,13)	3803 (390,95)
front V	central V	2760 (244,31)	2732 (246,99)	3792 (207,62)	3844 (191,50)	2520 (233,38)	2681 (239,05)	3706 (213,22)	3753 (384,36)

Table 5 Waveform, wide-band spectrogram and consonant mean spectrum of [ˈaɖːu] *gallo* ‘cock’ pronunced by a male Sicilian speaker from Trapani.

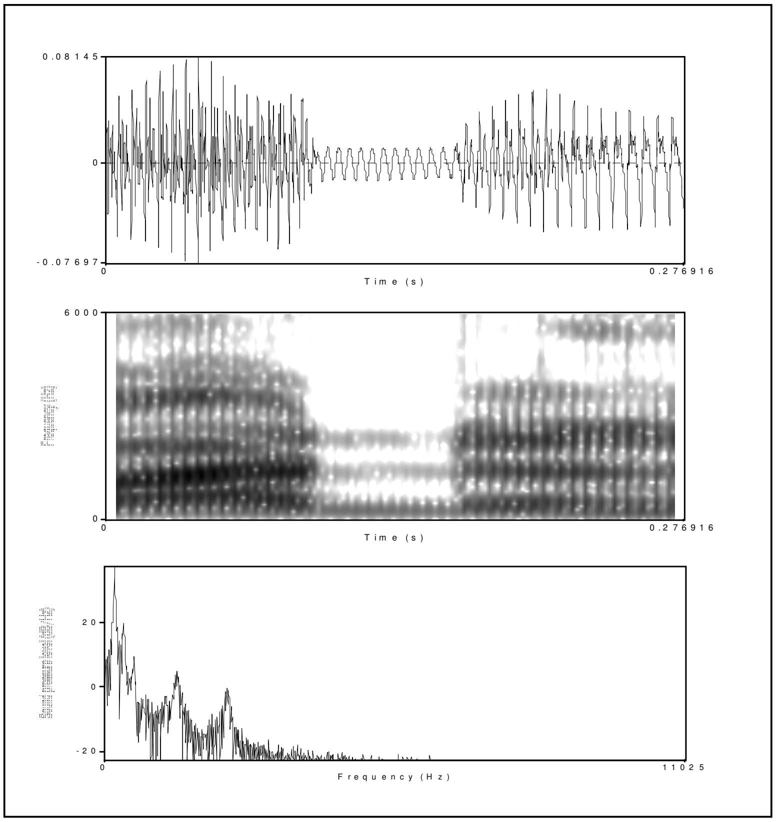
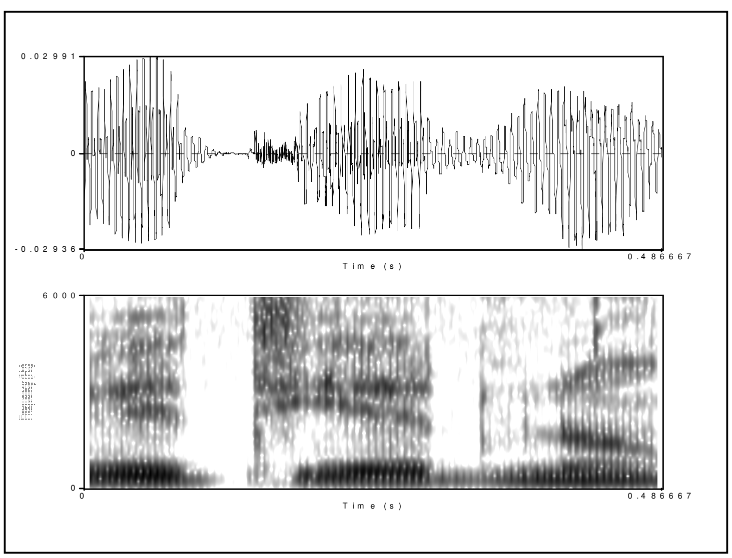


Table 6 Waveform and wide-band spectrogram of [viˈtjɛɖːo] *vitello* ‘calf’ pronunced by a female Sicilian speaker from Ragusa.



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