Gradient weakening for syllable-final /s, r/ in Majorcan Catalan consonant clusters

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Abstract. *Electropalatographic (EPG) and acoustic data reveal that syllable-final /s/ and /r/ undergo a gradual weakening process in Majorcan Catalan /sC/ and /rC/ clusters. It is argued that previous accounts of phonetic changes along this weakening continuum, i.e., /s/ rhotacism, regressive assimilation and elision, have no articulatory reality in most cases. In particular, perceived C1 assimilation and elision are often incomplete*.

1. Introduction

Preconsonantal syllable-final stops undergo prominent changes in Catalan dialects, i.e., regressive assimilation in Majorcan and lenition in Valencian. Fricatives and rhotics are more resistant but show signs of instability as well. Thus, descriptive data for Majorcan in the literature (see below) indicate that /s/ stays unchanged before voiceless consonants but may undergo rhotacism, assimilation and elision before voiced consonants. All these changes could be accounted for in terms of articulatory reduction and are presumably associated with a decrease in intraoral pressure triggered by the voiced consonant following /s/. Such a decrease is expected to occur most often before laterals and nasals since consonants of these manners of articulation allow continuous airflow out of the mouth. This scenario differs from that for other languages where /s/ weakening through aspiration, glottalization and elision operate mainly before voiceless stops. The goal of this paper is to contribute to the understanding of changes affecting /s/ and /r/ in coda position before voiced consonants by looking at their realization in present-day Majorcan Catalan. This research is relevant to the understanding of the articulatory relationship between related sound change processes and of the role of contextual and non-contextual factors in their implementation.

A first research goal is to look into the contextual constraints on the application of /s/ weakening. The realization of Majorcan /s/ is entirely predictable before /z, ʒ/ (> [ddz, ddʒ]) and the trill /r/ (> [(r)r]). Previous studies agree in that the alveolar fricative undergoes optional rhotacism before other voiced consonants, and disagree as to whether regressive assimilation applies systematically before a following lateral (Bibiloni, 1983) or optionally before a following lateral, nasal and /j/ (Recasens, 1996, Wheeler, 2005). Historically, Majorcan has also undergone /s/ vocalization into [j] before a voiced consonant in several words (eima "consciousness" from Latin ADAESTIMARE, almoina "alms" ELEMOSYNA). Evidence in support of the application of these sound changes in

the context of a voiced C2 may be found in other Romance dialectal domains, e.g., in Sardinian Logudorese where /s/ assimilates to a following nasal or liquid and undergoes rhotacism before /b, d(z), g, f, v/, and in Gascon where /s/ turns into [j] before any voiced consonant (Recasens, 2002). There is also widespread evidence that /s/ elision may operate before nasals, laterals and other voiced consonants, e.g., in Old French where /s/ effacement is documented earlier in île "island" INSULA than in fête "holiday" FESTA (Pope, 1934).

The alveolar rhotic appears to undergo analogous weakening processes in Majorcan /rC/ clusters. Thus, the final rhotic of infinitives assimilates to the initial lateral or nasal of a following clitic pronoun, and regressive assimilation occurs before /l/ in lexical items such as parlar "to speak" and perla "pearl" (Bibiloni, 1983). Similar changes take place in other Catalan dialects, i.e., /r/ assimilation before /l/ and /n/ in the words parlar "to speak" and tornar "to come back" (Alguerese Catalan), and /r/ elision in the sequence per la "for the" (General Catalan) and word finally in the lexical items govern "government" (Alguerese) and dorm "he/she sleeps" (Southern Valencian zones). Moreover, frication may interfere with the articulatory and aerodynamic requirements for tapping or trilling and cause /rs/ to turn into [s], e.g., Catalan [ˈbosə] "handbag" from Latin BURSA.

A relevant question is whether articulatory reduction proceeds gradually rather than categorically such that one may find variable and poorly defined phonetic outcomes for coda /s/ and /r/ which cannot be easily ascribed to any of the sound change processes just referred to. A related research issue is whether the elision of syllable final /s/ and /r/ in clusters must be preceded by other, less extreme weakening changes. If so, preconsonantal /s/ should undergo rhotacism or vocalization in the first place, rhotacized or vocalized /s/ ought to assimilate to the following consonant in the second place, and the outcoming geminate could shorten thus causing /s/ to drop entirely. If no intermediate changes are at work, /s/ elision ought to take place through extreme reduction of the apical gesture, i.e., /sC/ > [^{s}C] > [C]. In any event, we expect to find instances of perceived but incomplete /s/ and /r/ assimilation and elision exhibiting articulatory traces of the apical raising gesture (Browman and Goldstein, 1992).

2. Method

Acoustic and electropalatographic (EPG) data were recorded and analyzed for the /sC, rC/ clusters in the sequences presented in Table I. 5 Majorcan speakers (AR, BM, MJ, ND, CA) read seven times the 15 sequences of the table with the Reading artificial palate in place. Several clusters with a voiceless C2 were also recorded and analyzed for comparison. Sentence 13, which is not entirely correct in Standard Catalan (it should be els deutes els cobr), was recorded by speaker CA only. Speaker BM's productions of sentence 10 were recorded but were not subject to experimental analysis since this speaker often paused between the two consonants of the cluster /sl/. Regarding the clusters /sb, sd/, /b/ was basically produced as a voiced stop and /d/ could alternate between approximant and stop realizations. Acoustic and EPG data were also processed for the same 15 clusters in spontaneous speech sentences recorded by the same speakers.

Linguopalatal contact patterns and several acoustic properties (frication noise, formant structure, duration) were analyzed for preconsonantal /s/ and /r/ on simultaneous

waveform, spectrographic and EPG displays using MultiSpeech 3700 of Kay Elemetrics. As shown in Figure 2, electrodes on the EPG linguopalatal contact patterns are distributed into rows horizontally (from 1 to 8 starting at the dental zone at the top of each EPG pattern) and into columns vertically (from 1 to 4 at each side of each pattern). In the Results sections 3 and 4, we will refer to row 1 as dental or front alveolar, to rows 2 and 3 as centroalveolar and to row 4 as postalveolar.

(/sb/)	1. é**s b**ona tela	(“it is a good fabric”)
	2. toquen do**s b**alls	(“they play two dances”)
(/sm/)	3. l’avi é**s m**olt ric	(“my grandfather is very rich”)
	4. l’arbre é**s m**olt lluny	(“the tree is very far away”)
(/sd/)	5. l’amic é**s d**alt	(“my friend is upstairs”)
	6. l’amic é**s d**alt i no baixarà	(“my friend is upstairs and will not come down”)
	7. el pi**s d**e sota	(“the downstairs flat”)
	8. litre**s d**e llet	(“liters of milk”)
(/sn/)	9. jo els compte**s n**o els quadr	(“the expense accounts do not come out right according to my calculations”)
(/sl/)	10. les llavor**s l**es sembr	(“I sow the seeds”)
	11. les feine**s l**es concentr	(“I do all jobs at the same time”)
	12. aquestes pece**s l**es acopl	(“I fit these parts together”)
	13. les deute**s l**es cobr	(“I charge the debts”)
(/rn/)	14. un perill inte**rn**	(“an internal danger”)
(/rl/)	15. pa**rl**a zulú bé	(“he/she speaks the Zulu language correctly”)

Table I. Read sentences in Catalan orthography with the clusters under analysis in boldface. See Method section regarding sentence 13.

3. Results (fricative clusters)

Both for the read and spontaneous speech material, /s/ exhibited a robust fricative noise before all voiceless consonants. As for /sC/ clusters with a voiced C2, seven /s/ weakening outcomes ***(a)*** through ***(g)*** were identified which will be characterized in sections 3.1, 3.2 and 3.3. Table II reports the occurrence of these seven /s/ realizations for all clusters and speakers.

3.1 Audible frication noise

In outcome ***(a)***, the fricative is heard more or less successfully and exhibits an approximant-like period with some low intensity noise overlaid on it. Frication is more salient when the lingual constriction is especially narrow (for speakers BM, MJ and ND), and may have an /r/-like quality (e.g., for the cluster /sb/ in the case of speakers BM and MJ). Regarding speaker AR, preconsonantal /s/ exhibits a less salient frication noise and just some tongue contact at the two lateralmost columns of electrodes (see the waveform amd spectrographic displays for [sb] in the upper left graph of Figure 1 and the EPG

contact pattern in the left graph of Figure 2). For speakers AR, ND and CA, rhe frication noise may extend to more or less unoccluded productions of C2=/d/ in the cluster /sd/ ([(ð)ð]).

	Clusters	Weakening outcomes	Speaker AR	Speaker BM	Speaker MJ	Speaker ND	Speaker CA
Audible frication	**/sb/**	***a***	1	1,2	1,2	1,2	sp
	/sv/	***a***					sp
	/sm/	***a***		3	3, sp	3, 4	
	/sd/	***a***	5,6,7,8	5, 6,7,8	5, 6,7,8	5, 6,7, 8,sp	5,6
	/sn/	***a***			9, sp	9	
	/sl/	***a***		sp		11,12	
No frication	**/sd/**	***b***	5,6,sp	6,7,sp		6,sp	
	/sb/	***c***	1,2,sp				
	/sm/	***c***	4				
	/sb/	***d***				sp	
	/sm/	***d***			4	3,sp	4
	/sd/	***d***		6,7			
	/sn/	***d***	9		9		
	/sg/	***d***					sp
	/sm/	***e***	3	4,sp			
	/sd/	***e***					5
	/sn/	***e***	9	9			9
	/sl/	***e***	10,11,12	11,12	10,11,12	10,11	10, 11, 12, 13
Rhotacism	**/sb/**	***f***					1,2
	/sm/	***f***					sp
	/sd/	***f***					5,6,p
	/sb/	***g***					2
	/sm/	***g***					3
	/sd/	***g***					7,8
	/sd/	***g***					2,7,8,sp

Table II. /s/ weakening outcomes ***(a)*** through ***(g)*** for the 13 sequences of Table I and for the spontaneous speech sequences («sp»).

3.2 No frication noise

In outcome ***(b)***, C1=/s/ is implemented as a frictionless approximant, and articulated with some alveolar constriction (speakers BM, ND) or with just some lateral alveolar contact fronting (speaker AR). Further /s/ weakening results into perceived assimilation or elision, e.g., [(d)d, (m)m, (n)n] for /sd, sm, sn/. The corresponding alveolar fricative realizations lack a well-defined approximant period but may show variable degrees of waveform amplitude narrowing and either some contact fronting at the lateralmost column of the palatal or alveolar zone (outcome ***(c)***) or some alveolar constriction (outcome ***(d)***). Outcome ***(d)*** is exemplified in the upper right graph of Figure 1 and in the central graph of Figure 2.

In outcome ***(e)***, i.e., /s/ elision, the fricative shows no approximant period, waveform amplitude narrowing or specific articulatory configuration. An amplitude drop at nasal murmur onset in the clusters /sm, sn/ (e.g., for speakers AR and MJ) suggests however that complete /s/ elision may not be at work even in this case.

As shown in Table II, there is a trend for nasals /m, n/ to trigger the absence of the /s/ frication noise to a larger extent than stops /b, d/ (outcomes ***(b)*** through ***(e)***). Moreover, /s/ elision (outcome ***(e)***) is practically the only possible option for the cluster /sl/. Speakers differ as to whether they favor the presence vs. absence of frication noise (MJ, ND) or viceversa (AR, CA).

3.3 Rhotacized /s/

In addition to presumable instances of /s/ elision, speaker CA allows for rhotic realizations of /s/ involving complete closure and absence of formant structure before voiced stops and nasals (see outcome ***(f)*** in Table II). These realizations are articulated with some continuous fronting (from rows 3 or 4 to row 2 of the artificial palate), and trigger F3 lowering in the adjacent vowel and the insertion of a short epenthetic vocalic element between the two consonants of the cluster much in the same way as underlying /r/ in /rC/ clusters. Another possibility is for rhotacized /s/ to exhibit no closure but some central lingual constriction and some formant structure. Waveform, spectrographic and EPG displays for rhotacized /s/ may be found in Figure 1 (bottom graph) and in Figure 2 (right graph), respectively.

Other productions of preconsonantal /s/ by speaker CA have no /r/-like quality, and exhibit complete occlusion, some waveform amplitude narrowing and no approximant period (outcome ***(g)***). Closure may be fixed at about row 2 in the centroalveolar zone, or else undergo continuous fronting from rows 2 or 3 to row 1. These realizations occur before voiced stops and nasals (see Table II) and could be transcribed as [bb, dm, dd] (/sb, sm, sd/).

4. Results (rhotic clusters)

According to our database, the cluster /rl/ in the word <u>parla</u> “he/she speaks” (sentence 15 in Table I) undergoes regressive assimilation and exhibits a fixed closure at the front or central alveolar rows 1 and 2 for some speakers (BM, MJ), but changes in alveolar constriction location from /r/ (more posterior) to /l/ (more anterior) for other speakers (AR, ND, CA). On the other hand, data from the spontaneous speech database

reveal that /r/ may assimilate to /n/ in the cluster /rn/ for speaker CA: indeed, /rn/ sounds [nn] in the word torna "he/she returns" and related forms independently of whether the alveolar closure remains fixed or exhibits continuous fronting as for /n/ in the string /ona/ in other words produced by the same speaker. A closer inspection of the acoustic signal for these /rn/ tokens reveals, however, the presence of some possible constriction narrowing at the /n/ murmur onset which could be associated with the rhotic and would thus argue against complete assimilation being at work. A similar scenario applies to this speaker's productions of intern "internal" (sentence 14 of Table I). Speaker BM's realizations of /rn/ show a fixed alveolar closure location or some increase in alveolar closure size as we proceed from /r/ to /n/, and some waveform amplitude narrowing at nasal onset suggesting that the rhotic is being produced. Regarding speaker MJ, the rhotic is more or less audible and there is continuous constriction fronting from the postalveolar zone (for /r/) to the central or front alveolar zone (for /n/).

EPG, spectrographic and perceptual evidence for the spontaneous speech data sample indicates that /r/ drops before /s/ in the sequence per sa "for the" (speakers CA, BM). Though hardly audible, the rhotic stays in per sebre "in order to know" where it may involve the activation of two lateral electrodes at the postalveolar zone (speaker MJ), and in por(c) senglar "wild pig" where /r/ may exhibit lateral constriction fronting from the postalveolar to the centroalveolar area (speaker CA). In other /rC/ combinations, the rhotic also leaves some articulatory trace at the alveolar zone whether audible (in the case of speaker MJ's productions of /rk/ in the word cercar "to look for") or inaudible (in the case of speaker BM's productions of /rm/ in the word germanes "sisters").

4. Discussion

Results reported in this paper show that the path from full identification to elision of syllable-final /s/ and /r/ in Majorcan clusters is gradient which questions the validity of previous phonetic descriptions. The alveolar fricative may be implemented through a weak frication period resulting from large degrees of oral opening at constriction location, no obvious acoustic manifestation, and intermediate approximant realizations involving different degrees of articulatory activity. Some but not all cases of perceived assimilated or elided /s/ may have some articulatory activity associated with them. Complete elision appears to be possible at the end of the weakening continuum and occurs systematically for the cluster /sl/. Regarding /rC/ clusters, tokens yielding perceived assimilation show traces of the /r/ gesture. In summary, assimilation and elision are more prone to occur in perception than in production.

Speaker CA proceeds from cluster realizations showing some frication noise during C1 or all throughout the cluster to productions of /s/ exhibiting full closure and sounding /r/ or /d/. Highly constricted /s/ productions for other speakers may also have an /r/-like quality. Therefore, rhotacism may arise from reduced realizations of /s/ and becomes more regular for some speakers than for others.

Nasals, laterals and other voiced consonants may trigger perceived assimilation, rhotacism and elision in preceding /s/. There is also preference for articulatory reduction of /r/ before (quasi-)homorganic laterals, nasals and /s/. As argued in the Introduction, C1 weakening before voiced consonants may be associated with anticipatory intraoral pressure lowering effects.

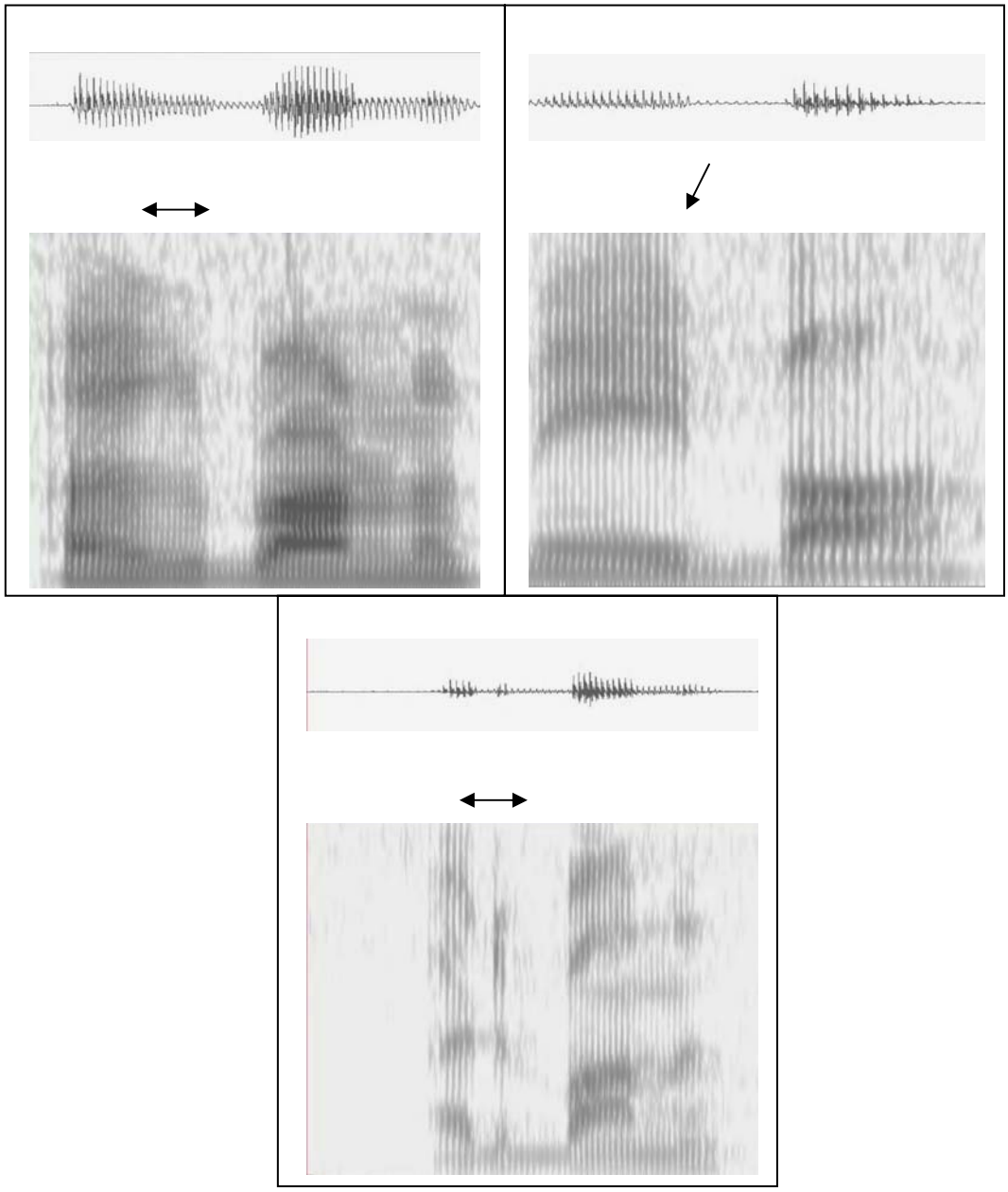

Figure 1. Waveform and spectrographic displays for tokens of the cluster /sb/ showing different /s/ weakening outcomes. Arrows point to /s/ location. (Top left) sequence é**s b**ona (tela) «it is a good fabric», speaker AR . (Top right) mé**s b**o « better», speaker ND. (Bottom) é**s b**ona (tela) «it is a good fabric», speaker CA.

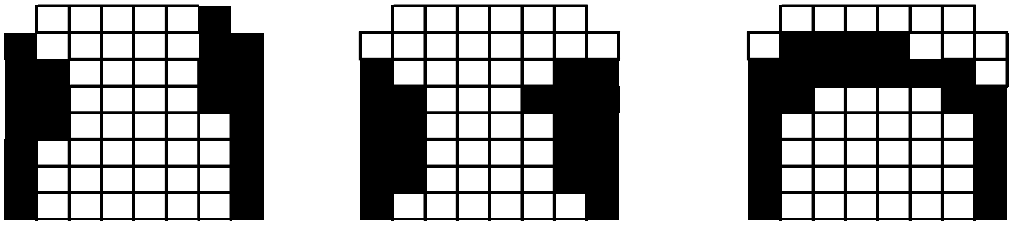

Figure 2. EPG linguopalatal contact configurations for the same tokens of the cluster /sb/ in Figure 1. (Left) sequence é**s b**ona (tela) «it is a good fabric», speaker AR . (Middle) mé**s b**o «better», speaker ND. (Right) é**s b**ona (tela) «it is a good fabric», speaker CA. Electrodes are grouped into horizontal rows and vertical columns, and contact activation occurs at filled electrodes.

5. References

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6. Acknowledgments

This research was funded by projects BFF2003-09453-C02-01 (Ministry of Spanish Education and Science and FEDER) and 2005SGR864 (Catalan Government).