The Phonology of Implosive Nasals in Five Spanish Dialects: An Optimality Account

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The common assumption that coronal is the unmarked place of articulation seems to be contradicted by the tendency of implosive nasals to become velar. To cope with this unexpected behavior of nasal consonants, some linguists have proposed that coronal is the unmarked place in the syllable onset, but velar is the unmarked place in the coda (Trigo 1988). An alternative proposal is that specific grammars may select coronal or velar as the default place (Harris 1984). Others defend the view that implosive nasals become velar by sharing place features with the preceding vowel (Paradis and Prunet 1990). Yet another interpretation has been to assume that the derived velar nasals are actually not velar (Bakovic 2000). The patterns exhibited by implosive nasals in Spanish dialects are pertinent to this debate because both coronal and velar place behave as though they were the unmarked specification for nasal consonants in the coda.

In this paper, a system in which the main allophones of implosive nasals include a place-assimilated nasal, an alveolar nasal, a velar nasal, and a nasalized vowel is analyzed as the result of three independent markedness constraints (AGREE(Place), Place Hierarchy, and ALIGN-C(Nasal)), which despite being concerned with different aspects of the structure of output forms, come together to undermine the place features of implosive nasals. Data from five different Spanish dialects support the view that coronal is the unmarked place even in the syllable coda, and that the tendency of implosive nasals to become velar is not a consequence of assigning them an unmarked place articulator but of reducing their degree of consonantality. It is shown that velarization is only an intermediate step in a larger-scale change that involves the absorption of the nasal consonant by a preceding vowel.

1. The data

So-called 'radical' Spanish dialects are characterized by their tendency to weaken and lose consonants assigned to the syllable rhyme (Guitart 1996). Processes such as debuccalization (e.g. [ka**h**.pa] < /ka**s**pa/ 'dandruff'), nasal absorption (e.g. [pã] < /pa**n**/ 'bread'), vocalization (e.g. [ko**i̯**.ma.ðo] < /ko**l**ma̤o/ 'grocery store', [a.la**i̯**.ma] < /ala**r**ma/ 'alarm'), deletion (e.g. [t̪a.si] < /t̪a**k**si/ 'taxi'), among various others, manifest an aversion against postnuclear consonants. This property of 'radical' dialects opposes them to 'conservative' dialects, which allow a wider gamut of consonants to surface in the syllable coda (e.g. [ka**s**.pa], [pa**n**], [ko**l**.ma.ðo], [a.la**r**.ma], [t̪a**k**.si]).

An area of coda-consonant simplification that has been fairly well documented is the weakening of implosive nasals. In this regard, a 'radical' dialect such as Panama City Spanish contrasts sharply with a 'conservative' dialect such as Mexico City Spanish, as illustrated in (1) and (2).

The data in (1) show that, in Mexico City Spanish, nasals adopt the place features of a following obstruent, (1a), but they may disagree in place of articulation with a following sonorant consonant when that segment is another nasal (1b-d). Moreover, we see that in the absence of a following consonant, implosive nasals surface as coronal (1e-f), which is generally regarded as the unmarked place of articulation.

(1) Implosive nasals in Mexico City Spanish (From Harris 1969)

Nasal C before	**Bilabial**	**Labio-dental**	**Dental**	**Alveolar**	**Palato-alveolar**	**Velar**
a. Obstruent	ca[m]po ca[m]bio		cua[n̪]to cua[n̪]do		ra[n̠]cho	a[ŋ]ca ga[ŋ]ga
		triu[ɱ]fo		ca[n]so		aje[ŋ]jo
b. Nasal	i[n]menso			i[n]nato colu[m]na		
c. Lateral				e[n]lace		
d. Rhotic				ho[n]ra		
e. # Vowel				esta[n] allá		
f. # Pause				desdé[n]		

Although the nasal allophones that occur in the dialect of Mexico City also occur in that of Panama City, the latter differs in that it allows more than one realization for any implosive nasal.

(2) Implosive nasals in Panama City Spanish (From Cedergren and Sankoff 1975)

Nasal C before	**Bilabial**	**Labio-dental**	**Dental**	**Alveolar**	**Palato-alveolar**	**Velar**
a. Obstruent	ca[m]po c[ã]po		ca[n̪]to c[ã]to			ci[ŋ]co c[ĩ]co
	ca[m]bio c[ã]bio		cua[n̪]do cu[ã]do			co[ŋ]ga c[õ]ga
		triu[ɱ]far triu[ŋ]far tri[ũ]far		ca[n]so ca[ŋ]so c[ã]so	ra[n̠ʃ]o[1] ra[ŋʃ]o r[ãʃ]o	aje[ŋ]jo aj[ẽ]jo
b. Nasal	i[n]menso i[ŋ]menso [ĩ]menso			hi[m]no hi[ŋ]no h[ĩ]no		
c. Lateral				e[n]lace e[ŋ]lace [ẽ]lace		
d. Rhotic				ho[n]rado ho[ŋ]rado h[õ]rado		
e. #Vowel				está[n] allá está[ŋ] allá est[ã] allá		
f. #Pause				desdé[n] desdé[ŋ] desd[ẽ]		

The data in (2) show that besides place assimilation before an obstruent, implosive nasals may become velar or absorbed by the preceding vowel regardless of what follows them (2a-f).[2] As a matter of fact, although place assimilation before obstruents does occur in Panama City Spanish, its frequency is so low (only 2%) that it has been suggested that it is no longer a productive phonological process (Cedergren and Sankoff 1975:71). By contrast, the productivity of velarization and absorption is unquestionable from the frequency rates presented in (3). The statistics show that in all contexts where implosive nasals may occur, their predominant realization is as nasalization on the preceding vowel, (3c), whereas the velar nasal is the second most frequent allophone, (3b).

(3) Distribution of implosive nasal variants in Panama City Spanish (From Cedergren and Sankoff 1975:72)

Variant	___ #C	___ #V	___ #//
a. Assimilated or alveolar nasal	2% 89/4460	1% 28/2759	1% 9/919
b. Velarized nasal	24% 1070/4460	41% 1131/2759	34% 312/919
c. Absorbed nasal	74% 3300/4460	58% 1600/2759	69% 634/919

It is important to note that the processes of nasal velarization and absorption are not categorical, but variable and gradient (Terrell 1975, D'Introno and Sosa 1988). Several social variables such as age, sex, socio-economic status, and urban vs. rural origin have been identified as factors that condition the probability with which these two processes occur (Cedergren and Sankoff 1975, López Morales 1980). With regard to their gradient nature, it has been observed that as the articulation of the nasal consonant is weakened, there is increasing nasalization of the preceding vowel, with the highest degree of nasalization occurring when the nasal consonant is completely absorbed. Furthermore, the velar nasal that is formed as the consonant weakens may be articulated so weakly that sometimes there is no contact between the tongue body and the velum (i.e. [$\tilde{\gamma}$]), and other times it is completely deprived of any perceptible place features (i.e. anusvara, represented here as [ɴ]).

In addition to Panama City Spanish, the weakening of implosive nasals has also been thoroughly documented for the dialects of Havana (Terrell 1975), San Juan (López Morales 1980), and Caracas (D'Introno and Sosa 1988).

Consider next the case of the dialect spoken in San Juan. As the frequency rates in (4) show, a place-assimilated nasal in the context ___ #C and an alveolar nasal in the context ___ #V are the predominant variants of implosive nasals in this dialect (4a). We find, nonetheless, that despite the high occurrence of place-assimilated and alveolar nasals in the coda, the weakening of implosive nasals has begun as it is evinced by the fact that both velarization and absorption occur, even if it is only as the second and third most frequent variants (4b,c). The effects of consonant weakening are most noticeable in the context ___ #//, where velarization triples the number of coronal realizations and absorption becomes more significant.

(4) Distribution of implosive nasal variants in San Juan Spanish (From López Morales 1980:209)

Variant	___ #C	___ #V	___ #//
a. Assimilated or alveolar nasal	80.6% 3006/3725	65.8% 1458/2214	22.4% 280/1246
b. Velarized nasal	13% 485/3725	26.6% 590/2214	69.3% 864/1246
c. Absorbed nasal	6.2% 234/3725	7.4% 166/2214	8.1% 102/1246

For Havana, Terrell (1975) found that place assimilation and velarization are in complementary distribution. In preconsonantal position, the predominant variant is a place-assimilated nasal with a frequency rate of 60%, while in prevocalic and prepausal positions it is the velar allophone that preponderates at comparable frequency rates (59% and 54%, respectively). If we compare the numbers reported for San Juan, (4), with those reported for Havana, (5), we see that in the latter dialect both velarization and absorption continue to gain generality at the expense of assimilated and alveolar allophones. It is remarkable that in Havana Spanish the number of absorbed nasals jumps up to 38-39% in all contexts.

(5) Distribution of implosive nasal variants in Havana Spanish (From Terrell 1975:263)

Variant	___ #C	___ #V	___ #//
a. Assimilated or alveolar nasal	60% 1140/1898	3% 30/983	8% 42/560
b. Velarized nasal	1% 29/1898	59% 582/983	54% 303/560
c. Absorbed nasal	39% 730/1898	38% 371/983	38% 215/560

In their study of the same phenomenon in Caracas, D'Introno and Sosa (1988) found that place-assimilation has dramatically lost latitude to velarization, (6). The statistics in (6) show that in the context of a following consonant, nasals assimilate in only 7.8% of the cases, whereas velarization occurs at a frequency rate of 76.5%. In the absence of a following consonant, implosive nasals also surface most frequently as velar (94.6% before a vowel, and 92.1% before a pause), while the alveolar articulation has a very low frequency rate (3.8% before a vowel, and 4.6% before a pause). Besides the overwhelming percentages of velarization, the occurrence of nasal absorption at rates that although small, are not negligible indicates that the weakening of the consonantal articulation is well underway.[3]

(6) Distribution of implosive nasal variants in Caracas Spanish (From D'Introno and Sosa 1988:26-27)

Variant	___ #C	___ #V	___ #//
a. Assimilated or alveolar nasal	7.8% 59/761	3.8% 17/443	4.6% 24/522
b. Velarized nasal	76.5% 582/761	94.6% 419/443	92.1% 481/522
c. Absorbed nasal	15.7% 120/761	1.6% 7/443	3.3% 17/522

In sum, all four 'radical' dialects discussed above exhibit signs of weakening of implosive nasals. Quantitative studies have found that in San Juan and Havana, the processes of nasal velarization and absorption are still incipient to moderate, whereas in Caracas and Panama City they have become highly productive. Panama City Spanish seems to be the dialect where the weakening of implosive nasals is most advanced, but even in that system syllable-final nasals have not yet completely disappeared. To the best of my knowledge, there is still no variety of Spanish where the process of nasal absorption has become categorical, which would have given rise to a new system of nasal vowel phonemes, as it occurred in the history of French.

2. Nasal place assimilation

It is well known that in 'conservative' Spanish dialects, both word-internal and word-final nasals are subject to place assimilation in the context of a following obstruent consonant provided that speech is connected (Navarro Tomás 1967, Harris 1969). The fact that in such dialects nasals are subject to place assimilation but not to velarization or absorption indicates that the cause behind the former process is independent of the force responsible for the attrition of implosive nasals. Following much work in Optimality Theory, I assume that assimilation is caused by a constraint that requires sharing of features (AGREE), whose satisfaction may be obtained at the expense of the identity between input and output forms. On this view, place assimilation arises when AGREE(Place) takes precedence over two faithfulness constraints: one that prohibits the change of underlying place features, (8), and another one that bans multiple linkage, (9). Tableau (10) shows how the ranking AGREE(Place) >> {IDENT(Place), UNIFORMITY} induces place assimilation.

(7) AGREE(Place): The members of a consonant cluster must agree in place features. (cf. Lombardi's 1999 AGREE)

(8) IDENT(Place): Correspondent segments must agree in place features. (McCarthy and Prince 1995)

(9) UNIFORMITY: Elements in the input and the output must stand in a one-to-one correspondence relationship with each other. (Lamontagne and Rice 1995, McCarthy and Prince 1995)

(10) The members of a consonant cluster are forced to become homorganic

Input: /enfoke/ 'approach'	AGREE (Place)	IDENT (Place)	UNIFORMITY
a. [en.fo.ke]	*!		
☞ b. [em.fo.ke]		*	*

The underlining is used to highlight those elements of output candidates that are in multiple correspondence with input structure. In this tableau, candidate (10b) is favored over (10a) because its two flaws (failure to preserve the place features of the underlying nasal and the generation of a linked structure between the segments [m.f]) are justified by the overriding need to satisfy the dominant constraint AGREE(Place).

Following Beckman (1999), I attribute the role of determining the directionality of assimilation to a positional faithfulness constraint requiring the preservation of the place features of onset segments, (11). This approach grants greater faithfulness to onset segments on the assumption that the syllable onset is a prominent linguistic position. According to this, feature faithfulness breaks down into a positional and a general faithfulness constraint, which obey the universal ranking $\text{IDENT}^{\text{ONS}}$(Place) >> IDENT(Place).

(11) $\text{IDENT}^{\text{ONS}}$(Place): Onset segments and their input correspondents must agree in place features. (Beckman 1999)

While domination of AGREE(Place) over both IDENT(Place) and UNIFORMITY induces assimilation, the higher rank of $\text{IDENT}^{\text{ONS}}$(Place) prevents assimilation from working to the detriment of onset consonants. As a result of this, assimilation must be regressive. Tableau (12) shows that if place assimilation were progressive, (12c), a fatal violation of $\text{IDENT}^{\text{ONS}}$(Place) would ensue; whereas if assimilation is regressive, (12b), both $\text{IDENT}^{\text{ONS}}$(Place) and AGREE(Place) may be satisfied.

(12) Nasal place assimilation must be regressive

Input: /enfoke/ 'approach'	$\text{IDENT}^{\text{ONS}}$ (Place)	AGREE (Place)	IDENT (Place)	UNIFORMITY
a. [en.fo.ke]		*!		
☞ b. [em.fo.ke]			*	*
c. [en.so.ke]	*!		*	*

Another issue that must be addressed is why nasals are so prone to assimilate to obstruents. This fact can also be captured in terms of prominence-based faithfulness constraints, as suggested by Padgett (1996). Under the ranking $\text{IDENT}^{\text{OBSTR}}$(Place) >> IDENT(Place), the place features of obstruent consonants are prioritized. Support for this approach is provided by the finding that the phonetic cues that signal place in obstruents are more salient than those that signal place in nasals and other consonant classes (Ohala and Ohala 1993, Henton et al 1992). By ranking $\text{IDENT}^{\text{OBSTR}}$(Place) above AGREE(Place), obstruents become exempt from place assimilation, (13c).

(13) Nasals fall prey of assimilation, but not obstruents

Input: /infekt̪a/ '(s)he infects'	IDENT^{OBSTR} (Place)	IDENT^{ONS} (Place)	AGREE (Place)	IDENT (Place)	UNIFORMITY
a. [in.fek.t̪a]			**!		
b. [in.sek.t̪a]		*!	*	*	*
c. [iṃ.fet̪.t̪a]	*!			**	**
☞ d. [iṃ.fek.t̪a]				**	**

Because higher priority is granted to the preservation of the place features of obstruent and onset segments, the only cases where the demands of AGREE(Place) can be met are those where one of the consonants of the cluster is both sonorant and syllabified as part of the rhyme, (13d). Given Spanish phonotactics, this analysis predicts that aside from NC clusters, the only other clusters where AGREE(Place) can be obeyed are those where the first member is a liquid consonant. This prediction is borne out as it is indeed the case that liquid consonants also undergo place assimilation in Mexico City Spanish and other 'conservative' dialects (e.g. [fal̪.d̪a] < /fald̪a/ 'skirt', [al̪̟.θaɾ] < /alθaɾ/ 'to raise', [kol̪.ʧa] < /kolʧa/ 'blanket'). As it can be seen in (14), none of the dominant constraints can rescue the place features of a syllable-final liquid, (14b).

(14) Liquids are also subject to place assimilation

Input: /fald̪a/ 'skirt'	IDENT^{OBSTR} (Place)	IDENT^{ONS} (Place)	AGREE (Place)	IDENT (Place)	UNIFORMITY
a. [fal.d̪a]			*!		
☞ b. [fal̪.d̪a]				*	*
c. [fal̪ .da]	*!	*		*	*

Despite their common origin, the processes of nasal and liquid place assimilation differ substantially. Whereas nasals assimilate to obstruents at all places of articulation, liquids only do so within the coronal region. I hypothesize that the reason for this is that segments with a lateral or rhotic manner of articulation are more difficult to produce by the tongue dorsum or lips than by the tongue front (cf. Ladefoged and Maddieson 1996). As a matter of fact, even within the coronal area, dental and interdental rhotics are highly marked segments. What I am suggesting is then that the limited productivity of liquid place assimilation is an effect of additional markedness constraints; but the issue is left for future research because it falls beyond the scope of this paper.

Turning now to NN clusters, which in Mexico City Spanish may be heterorganic (1b), Harris (1984) has pointed out that [mm] and [ɲɲ] are impossible clusters both inside and across morpheme boundaries. Harris also notes that morpheme-internal clusters consisting of two alveolar nasals are extremely rare. In fact, *pere*[nn]*e* is the only word that is in general use where an [nn] sequence occurs within a morpheme. Except for a handful of uncommon words (e.g. *pinnado, pinnípedo*, and *estannífero*), all other [nn] clusters occur across morpheme boundaries (e.g. [in.no.βle] < /in+noble/ 'ennoble',

[in.ne.se.sa.ɾjo] < /in+nesesario/ ‘unnecessary’, etc.), and there is a strong tendency to reduce such clusters to a single consonant in casual speech (Quilis 1996). The above observations point to the generalization that homorganic NN clusters are prohibited, at least within morphemes. With the addition of a positional markedness constraint against morpheme internal geminates, (15), the possibility that the members of an NN cluster differ in place features is granted, (16a). That is to say that the reason why heterorganic NN clusters are tolerated is to avoid forming a geminate consonant, (16b).

(15) *GEM(Morph): Morpheme internal geminates are prohibited.

(16) Morpheme-internal NN clusters are allowed to be heterorganic

Input: /kolumna/ ‘column’	*GEM (Morph)	IDENT^{OBSTR} (Place)	IDENT^{ONS} (Place)	AGREE (Place)	IDENT (Place)	UNIFORM
☞ a. [ko.lum.na]				*		
b. [ko.lun.na]	*!				*	*
c. [ko.lum.ma]			*!		*	*

3. Nasal place neutralization

Besides place assimilation, ‘conservative’ Spanish dialects such as the one spoken in Mexico City exhibit neutralization to the unmarked place of articulation (i.e. [coronal]). This is clearly observable when the nasal consonant is word final and not under the influence of a following consonant (1e-f). In such context, one would expect that the three-way contrast that exists in initial position (e.g. [**m**a.t̪a] ‘(s)he kills’ ~ [**n**a.t̪a] ‘milk skim’ ~ [**ɲ**a.t̪a] ‘flat nosed’) would be able to emerge. Yet, contrary to that expectation, there are no patrimonial words ending in [m] or [ɲ], and whenever foreign words such as *album*, *boom*, *tang, ring,* etc. are nativized, they are turned into [al.bun], [bun], [tan], [rin]. The fact that /m/ and /ɲ/ neutralize to [n] in the syllable rhyme is corroborated by alternations such as *ada*[n] ‘Adam’ vs. *ada*[m]*ita* ‘adamite’ and *desde*[n] ‘disdain’ vs. *desde*[ɲ]*a* ‘(s)he disdains’, as Harris (1984) first noted.

Following McCarthy and Prince (1993, 2002) and De Lacy (2002), I attribute this restriction on the place of articulation of word-final nasals to a family of markedness constraints that prohibits place features, (17). These place markedness constraints are organized in a fixed hierarchy, according to which Dorsal is the most marked place articulator, whereas Coronal is the least marked. In direct conflict with the place markedness constraints is a principle requiring segments to bear place features (18).

(17) Place Hierarchy: *DORSAL >> *LABIAL >> *CORONAL

(18) HAVE PLACE: All segments must have place features.

Tableau (19) demonstrates that the place neutralization that affects final nasals follows from the ranking HAVEPLACE >> *DOR >> *LAB >> *COR >> IDENT(Place). Although the best way to comply with the Place Hierarchy would be to leave the nasal consonant deprived of place features, (e.g. [N]), this option is ruled out by the dominant constraint HAVEPLACE, (19d). When the decision is passed on to the Place Hierarchy, an

alveolar nasal is selected as the optimal allophone because it violates the lowest of the place markedness constraints, (19c). It is important to clarify here that the palatal nasal incurs two violations of the Place Hierarchy due to the fact that the articulation of palatal sounds engages both the front and back parts of the tongue (Keating 1988). Also note that the only violations of *PLACE that are being counted are those incurred by consonants.

(19) Coronals are the least costly place-specified consonants

Input: /aḏam/ 'Adam'	HAVE PLACE	Place Hierarchy			IDENT (Place)
		*D	*L	*C	
a. [a.ðam]			*!	*	
b. [a.ðaŋ]		*!		**	*
☞ c. [a.ðan]				**	*
d. [a.ðaN]	*!			*	*

In partial summary, the proposed analysis hinges on the fact that nasal place assimilation and neutralization are triggered by separate constraints (AGREE(Place) and the Place Hierarchy), both of which outrank the faithfulness constraint IDENT(Place). Assimilation is restricted by prominence-based faithfulness constraints that exempt onset and obstruent consonants, whereas neutralization to a placeless nasal is prevented by the markedness constraint HAVEPLACE. The interplay between the two processes is illustrated in (20) with the English borrowing *ping-pong*, which the grammar of 'conservative' Spanish dialects turns into [pim.pon]. Not being crucial for this example, the constraint IDENT^{OBSTR}(Place) has been left out for lack of tableau space.

(20) Both place assimilation and neutralization affect nasal consonants in the rhyme

Input: /piŋpoŋ/[4] 'ping pong'	IDENT^{ONS} (Place)	AGREE (Place)	HAVE PLACE	Place Hierarchy			IDENT (Place)	UNIF
				*D	*L	*C		
a. [piŋ.poŋ]		*!		**	**			
b. [pim.poŋ]				*!	**		*	*
☞ c. [pim.pon]					**	*	**	*
d. [pim.poN]			*!		**		**	*
e. [piŋ.gon]	*!			*	*	*	**	*

4. Nasal velarization and absorption

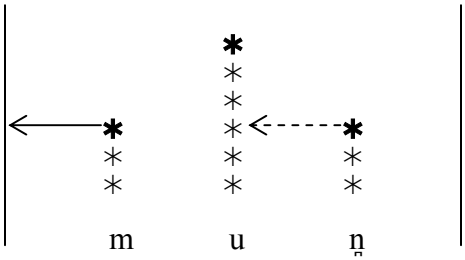
The velarization of implosive nasals that occurs in 'radical' Spanish dialects could not be caused by AGREE(Place) because in most instances the members of the NC cluster disagree in place features (e.g. *co*[ŋp]*adre* 'with father', *ra*[ŋʃ]*o* 'ranch', *triu*[ŋf]*ar* 'to triumph', *hi*[ŋn]*o* 'hymn, *e*[ŋl]*ace* 'link', etc.). Neither could velarization be caused by the Place Hierarchy because the velar nasal that is formed uses the most marked of the three place articulators. I propose that the processes of nasal velarization and absorption have a common cause, which is an alignment constraint that governs the distribution of nasal consonants within the syllable, (21).[5] Hence, rather than relying on one constraint

to force the change to the velar place of articulation (i.e. CODACOND) and a different one to trigger the absorption of the entire nasal segment (i.e. *CODA), I attribute the responsibility for all degrees of attrition of implosive nasals to the constraint ALIGN-C(Nasal). The degree to which an implosive nasal is weakened will then depend on the number of faithfulness constraints that ALIGN-C(Nasal) outranks.

(21) ALIGN-C(Nasal): Every nasal consonant must be aligned with the left edge of a syllable. (Itô and Mester 1994, 1999, Piñeros 2001, 2004)

Nasal consonants in the syllable rhyme are challenged by ALIGN-C(Nasal) because they cannot be aligned with the left edge of the syllable that parses them. This is illustrated in (22) with the initial syllable of the word *mundo* 'world'. In this syllable, the first nasal consonant is aligned but the second one is misaligned. To indicate successful left alignment an arrow with a continuous line is used, whereas the arrow with a broken line indicates failure to obtain such alignment.

(22) Consonants can be aligned with the left edge of their syllable when parsed by the onset but not when parsed by the rhyme



Following Itô and Mester (1999), segment-to-syllable alignment is assessed in terms of a sonority grid, which is constructed according to the sonority value of each segment. In (22), for example, the vowel [u] is assigned a greater number of marks than the two nasal consonants that flank it because the former type of segment has greater sonority. Due to the fact that the organization of segments within the syllable is such that more sonorous segments appear closer to the peak, the grid tends to have the shape of a slope. In syllables with an onset and a coda as in (22), there is an incline from the left margin to the nucleus, and also a decline from the nucleus to the right margin. What is crucial for segment alignment is the highest mark on the sonority column of each segment because it is at this level that alignment is checked. It follows from this that the first nasal consonant in (22) is in compliance with ALIGN-C(Nasal) because nothing intervenes between its highest mark and the left syllable margin. By contrast, the second nasal consonant in (22) is in violation of ALIGN-C(Nasal) because the sonority column of the nuclear segment (e.g. the vowel [u]) blocks its alignment. That is to say that all postnuclear consonants are at a disadvantage because the sonority column of the segment that functions as the syllable nucleus will always act as an insurmountable barrier since this is the segment of maximum sonority within the syllable.

Given that in none of the 'radical' Spanish dialects are implosive nasals completely lost, the constraint MAX(Seg) must take precedence over ALIGN-C(Nasal).[6] According to this, implosive nasals do not undergo deletion but coalescence, as it is

evinced by the fact that the consonant is never removed without there being heavy nasalization of the preceding vowel (Cedergren and Sankoff 1975:70, Terrell 1975:261, López Morales 1980:212, D'Introno and Sosa 1988:25). Yet, as the members of the VN sequence fuse into a single segment, it is unavoidable to lose most of the features of the nasal consonant. The ranking MAX(seg) >> ALIGN-C(Nasal) >> {IDENT(Consonantal), IDENT(Continuant), IDENT(Place), IDENT(Nasal), UNIFORMITY} accounts for the process of nasal absorption, (27).

(23) MAX(Seg): Every segment in the input must have a correspondent in the output. (McCarthy and Prince 1995)

(24) IDENT(Cons): Input segments and their output correspondents must agree in their specifications for the feature [consonantal].

(25) IDENT(Cont): Input segments and their output correspondents must agree in their specifications for the feature [continuant].

(26) IDENT(Nas): Input segments and their output correspondents must agree in their specifications for the feature [nasal].

(27) Implosive nasals are subject to coalescence rather than deletion

Input: /konfun̪den/ 'they confuse'	MAX (seg)	ALIGN-C (Nasal)	IDENT (Cons)	IDENT (Cont)	IDENT (Place)	IDENT (Nas)	UNIF
a. [kon.fun.d̪en]		*!**					
b. [kom̲.fun̪.d̪en]		*!**					**
☞ c. [kõ̲.fũ̲.d̪ẽ]			***	***	***	***	***
d. [ko.fu.ðe]	*!**						

The problem with candidate (27a) is that it contains a total of three nasal consonants that cannot be aligned with the left edge of a syllable because they are in postnuclear position. Neither place assimilation nor neutralization, (27b), help remedy this situation because even if the nasal adopts the place features of another consonant or uses the least costly articulator, it continues to be a consonantal segment in postnuclear position. By contrast, the coalescence of the nasal consonant with the preceding vowel effectively removes the offending segment from the right syllable margin, (27c). This solution comes at the cost of violating the faithfulness constraints IDENT(Consonantal), IDENT(Continuant), IDENT(Place), IDENT(Nasal), and UNIFORMITY, but given their dominated status, the mismatch between input and output forms is inescapable. The more drastic solution of deleting the offending segment, (27d), is ruled out by MAX(seg), which still holds strong above ALIGN-C(Place).

We must recall, however, that even in highly 'radical' dialects such as Panama City Spanish, syllable-final nasals are not always completely absorbed, (3). The most detailed phonetic studies have found that the absorption of implosive nasals exhibits a spectrum of realizations (D'Introno and Sosa 1988). The following are the five more distinct variants. The weakest case of absorption is when the nasality of the consonant

starts to migrate to the preceding vowel causing light nasalization on that segment, yet the nasal still retains a full oral closure that is not limited to the velar place of articulation (e.g. [k**õ**ŋ.fwe.ɣo] < /kon fuego/ 'with fire'). Greater cohesion between the members of the VN sequence occurs when in addition to spreading its nasality to the vowel, the consonant shifts its articulation to the velar place (e.g. [k**õŋ**.fwe.ɣo]). As coarticulation with the preceding vowel progresses, the velar constriction of the nasal consonant gives in so that the complete closure between the tongue dorsum and the velum is lost (e.g. [k**õ**ɣ̃.fwe.ɣo]); or there is no constriction at all but merely a nasal transition from the nasalized vowel to the postnasal consonant (e.g. [k**õ**ɴ.fwe.ɣo]). Lastly, total absorption is obtained when the vowel becomes maximally nasalized and no traces of velar constriction or nasal transition remain (e.g. [k**õ**.fwe.ɣo]). These allophones, connected in a chain-like fashion, are the main steps in the evolution from Vn]$_\sigma$ to Ṽ]$_\sigma$.

(28) Spectrum of VN allophones

Vn	>	Ṽn	>	Ṽŋ	>	Ṽɣ̃	>	Ṽɴ	>	Ṽ	
(a)		(b)		(c)		(d)		(e)		(f)	

Part of the difficulty in unraveling this phenomenon has been that the differences between these allophones are subtle, and not all of the studies on implosive nasals observe such fine distinctions. The allophones (28a,b), for example, are normally regarded as the same one (e.g. a place-assimilated or alveolar nasal), despite the light change in nasal quality on the preceding vowel. Similarly, (28c,d) are both classified as velar nasals regardless of the degree of constriction, and (28e,f) tend to be grouped as instances of absorption, which is often incorrectly referred to as deletion.

When we look at the phonetic variants not in isolation, but as part of the spectrum depicted in (28), it becomes clear that what we are witnessing is a change in progress whereby a VN sequence merges into a single segment through the incorporation of the consonant into the structure of the vowel. The variation that we observe in 'radical' Spanish dialects such as those of San Juan, Havana, Caracas, and Panama City is the result of the progression of this change.

To capture this progression, I propose that in the grammar of 'radical' Spanish dialects the markedness constraint ALIGN-C(Nasal) is gradually gaining precedence over the cluster of faithfulness constraints represented by IDENT(Feature). Hence, when only a few members of IDENT(Feature) are overtaken by ALIGN-C(Nasal), absorption of the nasal consonant by the precedent vowel can only be incipient; but when most or all members of IDENT(Feature) succumb to ALIGN-C(Nasal), absorption is heavy or complete. The claim I am making is then that while 'conservative' Spanish dialects (e.g. Mexico City Spanish) obey the ranking IDENT(Feature) >> ALIGN-C(Nasal), 'radical' Spanish dialects are in the process of reversing this ranking. Going more to the point, I argue that the reason why all of the phonetic variants in (28) can coexist within the same speech community is because the promotion of ALIGN-C(Nasal) over IDENT(Feature) is not an abrupt but gradual change.

To develop this proposal, it is important to recall that place-assimilated and neutralized nasals, (28a), arise not only in 'conservative', but also in 'radical' dialects.

This follows naturally if we assume that both types of dialect share the assimilation and neutralization ranking illustrated in (20). The crucial fact in which the grammar of 'radical' dialects differs from that of 'conservative' dialects is that the constraint ALIGN-C(Nasal) is in the process of moving from being bottom ranking to the position it occupies in (27). To make this point clear, let us examine each step in the ascension of ALIGN-C(Place). First of all, the start of nasal absorption, which consists of light nasalization on the preceding vowel, (28b), arises when IDENT(Nasal) and UNIFORMITY are the only faithfulness constraints that surrender to ALIGN-C(Nasal). See (29).

(29) Vowel nasalization

Input: /enlase/ 'link'	MAX (seg)	IDENT (Cons)	IDENT (Cont)	IDENT (Place)	ALIGN-C (Nasal)	IDENT (Nas)	UNIFOR
a. [en.la.se]					*(----!)		
☞ b. [ẽn.la.se]					*(---)	*	*
c. [ẽŋ.la.se]				*!	*(--)	*	*
d. [ẽɣ̃.la.se]			*!	*	*(-)	*	*
e. [ẽ.la.se]		*!	*	*		*	*
f. [e.la.se]	*!						

Candidates (29a-d) call for our attention in this evaluation. While it is clear that these four output forms are in violation of ALIGN-C(Nasal) for having a nasal consonant parsed as the coda of the initial syllable, there are subtle, yet important, differences to observe between them. As it was hypothesized above, the phonetic variants Ṽn, Ṽŋ, Ṽɣ̃, ṼN, and Ṽ stand for a series of progressive steps in the process of incorporating the nasal consonant into the structure of the preceding vowel. We have seen that rather than an immediate change; the merging of these segments comes about by gradually transferring the nasality of the consonant to the segmental span of the vowel. Therefore, those output forms where the nasal consonant has started to migrate out of the position where it is banned cannot be regarded as equal to an output form where no attempt has been made to remove the unwanted segment, (29a). We must then recognize that although candidates (29b-d) are unsuccessful in solving the problem, they have buffered the clash with ALIGN-C(Nasal) by sending off the nasality of the offending consonant to another segment and, in some cases, even giving up some of the consonant's features. Accepting that languages can assess violations of ALIGN-C(Nasal) gradiently will allow us to capture the fact that some of the strategies used to 'fix' the misalignment of an implosive nasal are more effective than others. An attempt to do this has been made in (29) by positing four degrees of violation of ALIGN-C(Nasal), one for each of the allophones Vn, Ṽn, Ṽŋ, and Ṽɣ̃. Hence, when reading tableau (29) keep in mind that each of the hyphens written in parenthesis in the column of ALIGN-C(Nasal) represents a different degree of non-compliance with this constraint. Vn, being the least compliant of this set of allophones, receives four hyphens; Ṽn, 3; Ṽŋ, 2; and Ṽɣ̃, 1.[7]

Operating on these assumptions, we can now see how the evaluation in (29) unfolds. Candidates (29c-f) are ruled out by the set of faithfulness constraints (i.e.

MAX(Seg), IDENT(Consonantal), IDENT(Continuant) and IDENT(Place)) that at this transitional state of the grammar still outrank ALIGN-C(Nasal). Of the remaining candidates, ALIGN-C(Nasal) rules against (29a) and in favor of (29b) because, by having started the process of shifting the nasal consonant out of the coda, the latter form disobeys ALIGN-C(Nasal) to a lesser degree.

Consider now the evaluation in (30), which illustrates how the proposed system of constraints accounts for cases of nasal velarization. When the next faithfulness constraint to be surpassed by ALIGN-C(Nasal) is IDENT(Place), the grammar favors candidate (30c). Observe that whereas candidates (30d-f) are still ruled out by the set of dominant faithfulness constraints (i.e. MAX(Seg), IDENT(Consonantal), IDENT(Continuant)), candidate (30c) is now added to the pool of finalists from which ALIGN-C(Nasal) will choose the winner. The alignment constraint selects (30c) as optimal because the strategy that it uses to remedy the problem of having a nasal consonant in the rhyme is more productive than the strategy used by the closest competitor, (30b).

(30) Nasal velarization

Input: /enlase/ 'link'	MAX (seg)	IDENT (Cons)	IDENT (Cont)	ALIGN-C (Nasal)	IDENT (Place)	IDENT (Nas)	UNIFOR
a. [en.la.se]				*(---!-)			
b. [ẽn.la.se]				*(---!)		*	*
☞ c. [ẽŋ.la.se]				*(--)	*	*	*
d. [ẽỹ.la.se]			*!	*(-)	*	*	*
e. [ẽ.la.se]		*!	*		*	*	*
f. [e.la.se]	*!						

There are several phonetic arguments that lend support to this account. Based on acoustic primitives, Ohala and Ohala (1993:234-235) conclude that the further back a nasal consonant is articulated the less consonantal it becomes. This is due to the fact that as the oral constriction of the nasal is moved backwards, its oral antiresonances are weakened. As a consequence of this, the spectrum that remains is dominated by the resonances of the pharyngeal-nasal airway, which makes the nasal consonant sound very similar to a nasalized vowel. Another factor that undermines the consonantality of all back consonants is the presence of longer and slower transitions, which is an inevitable consequence of being produced by a massive articulator such as the tongue dorsum. Due to the quality of their transitions, the property that is considered to be the defining trait of a good consonant (an abrupt change in amplitude and spectrum with respect to neighboring vowels) is considerably diminished in back consonants (Ohala and Ohala 1993, Stevens 1989). These acoustic properties lead us to conclude that although [ŋ] is certainly a consonant; it is not a particularly good one.

Proceeding to the next stage, (31), the implementation of implosive nasals as [ỹ] is favored when the constraint ALIGN-C(Nasal) continues its ascend by defeating IDENT(Continuant). Although full satisfaction of ALIGN-(Nasal) is still precluded by the two faithfulness constraints that remain dominant (i.e. MAX(Seg) and IDENT(Consonantal)), a higher degree of compliance is possible by weakening the oral

closure of the offending consonant. Among the three finalists, (31a-d), the constraint ALIGN-C(Nasal) picks (31d) as the optimal output form because it makes the most productive effort to meet its demands. The advantage of (31d) over its closest competitor, (31c), is that by ridding the nasal consonant of its complete oral closure the acoustic abruptness that a good consonant should have is further undermined.

(31) Loss of velar closure

Input: /enlase/ 'link'	MAX (seg)	IDENT (Cons)	ALIGN-C (Nasal)	IDENT (Cont)	IDENT (Place)	IDENT (Nas)	UNIFOR
a. [en.la.se]			*(--!--)				
b. [ẽn.la.se]			*(--!-)			*	*
c. [ẽŋ.la.se]			*(--!)		*	*	*
☞ d. [ẽỹ.la.se]			*(-)	*	*	*	*
e. [ẽ.la.se]		*!		*	*	*	*
f. [e.la.se]	*!						

Finally, we get to the stage where ALIGN-C(Nasal) gains rank over IDENT(Consonantal), and thereby over the entire family of IDENT(Feature) constraints, (32). When that happens, categorical satisfaction of the segment-alignment imperative becomes possible, (32e). It is at this point that the process whereby the nasal consonant is gradually moved out of the syllable coda comes to its completion. Total eradication of the underlying nasal consonant is not yet possible in any of the Spanish dialects under study because the faithfulness constraint MAX(Seg) continues to hold its ground ahead of ALIGN-C(Nasal), (32f).

(32) Total absorption

Input: /enlase/ 'link'	MAX (seg)	ALIGN-C (Nasal)	IDENT (Cons)	IDENT (Cont)	IDENT (Place)	IDENT (Nas)	UNIFOR
a. [en.la.se]		*(-!---)					
b. [ẽn.la.se]		* (-!--)				*	*
c. [ẽŋ.la.se]		*(-!-)			*	*	*
d. [ẽỹ.la.se]		*(-!)		*	*	*	*
☞ e. [ẽ.la.se]			*	*	*	*	*
f. [e.la.se]	*!						

In sum, the fact that in 'radical' Spanish dialects place assimilated and alveolar nasals are being replaced by velarized or absorbed nasals is due to the ascension in rank of ALIGN-C(Nasal). Since this constraint objects against the entire consonantal segment, rather than just against its place features, the consonantal allophones that meet the demands of AGREE(Place) and the Place Hierarchy are inadequate solutions to solve the problem of having a misaligned consonant. Postnuclear nasals must then look for an alternative escape hatch. As they are being forced out of the coda because of being

consonants, implosive nasals opt to become velar because this is the place of articulation that makes them less consonantal, or more similar to vowels.

5. Contrast with previous accounts

The analysis proposed above views velarization as an intermediate step in the process of transferring the nasal consonant from the syllable coda into the nucleus. Failure to establish the connection that exists between velarization and two coexisting processes (the nasalization of the preceding vowel and the total absorption of the nasal consonant) led to serious shortcomings in the past.

Harris (1984), for example, had to stipulate that in 'non-velarizing' dialects the unmarked place of articulation is coronal, whereas in 'velarizing' dialects it is velar. Harris' analysis is problematic not only because of positing two different unmarked places of articulation, but also because it fails to capture important facts. Velarization never occurs without there being nasalization of the preceding vowel; and in all dialects where velarization has been attested, there are also instances of nasal absorption. Rather than negligible detail, these are key elements to understand why implosive nasals have a tendency to become velar.

Although Trigo (1988) recognizes the close relationship that exists between velarization and absorption, she also assumes that there are two choices for the unmarked place of articulation: coronal in the onset, velar in the coda. As it turns out, this view is incompatible with the process of nasal place neutralization that occurs in 'conservative' dialects such as Mexico City Spanish. If velar were the unmarked place of articulation in the coda, we would expect that the loss of contrast between /m/, /ɲ/ and /n/ that we find in word-final position would produce velar rather than coronal nasals. It is [n], however, that emerges.

Bakovic (2000) adheres to the common view that coronal is the only unmarked place of articulation, but in order to explain why in non-standard Spanish dialects implosive nasals tend to be velar, he is forced to make a questionable reinterpretation of the data. He claims that velar nasals are actually not velar, but placeless consonants. Contrary to this assumption, the studies conducted by Cedergren and Sankoff (1975), Terrell (1975), López Morales (1980), and D'Introno and Sosa (1988) unambiguously state that the attested velar nasals are velar, not placeless. D'Introno and Sosa, for example, found that although placeless nasals do arise in the Spanish of Caracas (6.5%), a nasal consonant with a complete velar closure is by and large the most common realization of implosive nasals (76.5%).

More compatible with the attested behavior of implosive nasals is the proposal that they become velar by sharing place features with the preceding vowel (Paradis and Prunet 1993). By adopting the place features of a vowel, implosive nasals would become less consonantal. The challenge that this proposal faces is to explain how a segment with no oral closure (the vowel) and one that has complete oral closure (the velar nasal) can share place features when they have two completely different degrees of stricture. The analysis I propose has the advantage that it does not require the members of the Vŋ sequence to share place features. The reason why an implosive nasal becomes velar is to reduce its consonantality, in spite of the fact that this forces it to adopt the most marked place of articulation.

5. Conclusion

In this paper I analyzed the main changes that affect implosive nasals in five Spanish dialects. In addition to place assimilation and neutralization, which are the only processes that affect implosive nasals in 'conservative' dialects, there are two additional processes of increasing productivity that target nasal consonants in 'radical' dialects: velarization and absorption. Three markedness constraints have been identified as the propellers of these changes. Assimilation is caused by AGREE(Place), neutralization is induced by the Place Hierarchy, and velarization and absorption are the workings of ALIGN-C(Nasal).

In grammars where ALIGN-C(Nasal) is bottom ranking, nasal consonants are allowed to surface in the syllable coda, where AGREE(Place) and the Place Hierarchy can force a reduction in the number of contrasts through place assimilation and neutralization. These two markedness constraints never threaten the preservation of implosive nasals because their concerns do not conflict with consonants per se, but with the kind of place features they bear. On the other hand, when ALIGN-C(Nasal) ascends in the ranking, it can not only eclipse the processes of place assimilation and neutralization, but also challenge the preservation of implosive nasals because the only way to obtain categorical satisfaction of this constraint is if the offending consonant is completely removed from the syllable coda.

Based on data from four different Spanish dialects, which show that the removal of the nasal consonant from the syllable coda is a gradual process, I proposed that grammars may assess violations of ALIGN-C(Nasal) gradiently. On this view, nasal velarization is only one step in a larger-scale change intended to dispense of the misaligned nasal through its gradual incorporation into the structure of the preceding vowel. Not surprisingly, we find that between the stage where the VN sequence is implemented as two separate segments and the stage where it surfaces as a single segment, there are several intermediate steps where the unwanted nasal has become a less efficient consonant.

According to this analysis, when the priority of the grammar is to use the least costly place of articulation, coronal nasals are optimal in the syllable coda. However, velar nasals are preferred in this position when the grammar is more concerned with producing the least consonantal nasal.

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Notes

[1] In Panama City Spanish, the affricate /ʧ/, which in Spanish orthography is represented as 'ch', undergoes deaffrication to [ʃ].

[2] Although word-internally syllable-final nasals do not have a velar alternant before stops, this option does occur across a word boundary (e.g. co[m] padre ~ co[**ŋ**] padre ~ c[õ] padre 'with father').

[3] D'Introno and Sosa (1980) is the only study that counts the instances of absorption separately from those in which the nasal is deprived of any perceptible place features (e.g. [N]). Since they note that researchers tend to assign [N] to the category of absorbed nasals (p. 29), I have combined the instances of [N] with those of [Ṽ] in order to put their results into categories that are comparable with those used by the rest of studies.

[4] Note that regardless of the place of articulation that we posit for the nasal consonants in the input form (e.g. /pi**m**po**m**/, /pi**ɲ**po**ɲ**/ or /pi**n**po**n**/), the proposed grammar will select [pi**m**.po**n**] as the optimal output form.

[5] ALIGN-C(Nasal) belongs to a family of consonant-alignment constraints (i.e. ALIGN-C(Stop), ALIGN-C(Fricative), ALIGN-C(Lateral), ALIGN-C(Rhotic)), which requires all consonants to be aligned with the left edge of a syllable. This alignment requirement is grounded on the fact that the left syllable margin guarantees that a consonant will be released into a segment of greater sonority. The effect of this is enhanced prominence of the consonant as the release aids to implement a greater number of phonetic cues that signal the identity of consonantal segments.

[6] The study by D'Introno and Sosa (1988) is the only one that reports cases of loss of the implosive nasal without concomitant nasalization of the preceding vowel. However, as the same authors clarify, of a total of 1726 implosive nasals, there were only 8 instances of this, and they can all be explained as the consequence of grammatical factors. In this regard, it is significant that all 8 cases of deletion occurred in verbs. For some of them, the omission of the word-final nasal may be the result of a failure to express subject-verb agreement given that the plurality signaled by the nasal consonant is redundant (e.g. *Me fascina(n) todas las cosas vivas* 'I like all live things'). The remaining cases can be explained as a change from [+count] to [−count] that affects the head of certain noun phrases as in the sentence *Ahí vive mucho estudiante* 'A lot of students live there', where it is clear that *mucho estudiante* has a collective meaning. According to the authors, this phenomenon is quite common in the Spanish of Caracas (D'Introno and Sosa 1988:30).

[7] I have not posited a fifth degree of non-compliance to accommodate the allophone [N] because when compared to [ỹ] the former does not exhibit unfaithfulness to any additional underlying features. What distinguishes [N] from [ỹ] is simply the lack of place features, which is penalized by the markedness constraint HAVEPLACE.