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Kirk A. Widdison

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Kirk A. Widdison
Illinois State University & Brigham Young University

Introduction

Spanish has three nasal phonemes—bilabial /m/, alveolar /n/, and palatal /ñ/—that yield a high rate of contrastive oppositions in word-internal, syllable-initial position as illustrated in (1).

(1)	cama	cana	caña
	"bed"	"grey hair"	"reed"

At the beginning of words, the palatal nasal is quite rare, being limited to a handful of loanwords of rather low frequency. Spanish maintains no phonological distinctions on nasal sounds when they appear in the syllabic rhyme and their exact realization is highly variable according to the allophonic rule stated in (2).

(2) /N/ → [N] place$_{(i)}$ / _C place$_{(i)}$

The rule is a rather natural one of contact assimilation in which the nasal acquires the point of articulation of the following consonant, whether the conditioning consonant appears word-medially or across word boundaries. The naturalness derives from the observation that nasality is crucially determined by the lowered velum, while the tongue is relatively unconstrained and free to anticipate the position of the following gesture. Application of this rule yields the examples illustrated in (3).

(3)	e[m]vase	si[ ]fonía	die[ ]te
	"container"	"symphony"	"tooth"
	u[n] lío	co[ ] yeso	mo[_]xa
	"a mess"	"with a cast"	"nun"

The nasal variation I wish to discuss in this essay concerns speakers who forego rule (2) and instead produce the syllable-final nasal as a velar sound [_] or efface it altogether with a concomitant nasalization of the preceding vowel [V]. Nasal velarization and effacement have been documented throughout extensive regions of the Spanish-speaking community, including Southern and Atlantic Spain, coastal South America, the Caribbean, Central America, and among hispanics in the United States (Canfield 1981). Quantitative studies indicate that such nasal variation appears variably throughout the areas mentioned, approaching the status of speech norm in the Caribbean dialects (Hammond 1979; Terrell 1982), and is not stigmatized as a marker of subordinate speech groups as other dialectal pronunciation features often are (López Morales 1980). Examples of this phenomenon from Panamanian Spanish (Cedergren & Sankoff 1975: 68–69) are given in (4).

(4)	allí está[_]	allí est[ã]	'there they are'
	u[_] hijo	[_] hijo	'a son'
	co[_] fuego	c[õ] fuego	'with fire'
	ca[_]so	c[ã]so	'I tire'
	i[_]humano	[_]umano	'inhuman'

The incidence of nasal velarization in different phonetic positions suggests that the original conditioning context was word-final, prepausal position. Researchers agree that the process is in a stage of generalization in which the velar nasal has spread first to word-final prevocalic position and only recently is beginning to occur before consonants, both across word boundaries and word-internally (Cedergren & Sankoff 1975: 72). Also affected are forms derived through prefixation with stem final nasals. The proposed path of positional spread of this phenomenon is summarized as follows:

(5) VN → Vn / _(# // → # V → + V → # C → $ C)

Presumably, nasal velarization occurs before the general rule of spoken Spanish that links together words in an utterance, erasing word boundaries and reconstituting syllable divisions. Thus, prevocalic forms such as u[ ] hijo and i[_]umano show velar nasals even though they end up in syllable initial position in the speech chain, while nasals originally occurring in the syllabic onset are never affected, e.g., se[n]ado 'senate' and never *se[_]ado. Nasal velarization reaches preconsonantal position only as a final stage of development because this environment triggers the pervasive contact assimilation rule formulated in (2) which presents a type of barrier that disfavors velarization. This barrier was bridged in word-final position where speakers generalized from prevocalic to preconsonantal position to reduce allomorphy.

Wherever nasal velarization is heard, nasal effacement also occurs but always to a much lesser degree (Lipski 1986: 148). It is thus presumed that the variation observed in the velarization and elimination of syllable-final nasals in Spanish is the synchronic manifestation of a sound change in progress, commonly stated as movement along a phonological weakening chain as seen in (6).

(6) VN > V_ > V

There are two serious problems with the analysis thus far presented, one theoretical and one methodological. First, the positional spread of nasal effacement is nearly the opposite of what has been shown to be the case for nasal velarization in (5). That is, nasal loss is much more frequent before consonants, particularly fricatives, than before vowels or a pause in speaking. It seems curious that nasal velarization and effacement would respond to different constraints if one succeeded the other as a developmental step towards a common goal. Perhaps even more disturbing is a sense of indeterminacy that field workers have felt in the tabulation of spoken materials (Bjarkman 1987; Lipski 1986; Guitart 1982(a); López Morales 1980). The distinction between a velarized nasal and a purely nasalized vowel is not an easy one to make (some have described the task as "impossible" and "pure guesswork"), yet rarely have researchers backed up their intuitions with instrumental analysis. Questionable data do not inspire confidence in the theoretical claims that result from them.

Not surprisingly, attempts to explain how and why this sound change began have not yielded satisfactory results. The most common explanations posit that nasal velarization reflects a production tendency in Spanish to weaken all consonants at the end of syllables, since it occurs in the same regions where other syllable-final processes, such as s-aspiration and liquid leveling, are also common. For example, Guitart suggests a universal tendency to retract all syllable-final sounds to the back of the mouth in these speech varieties (1982(b): 141). Bjarkman disagrees and asserts that the real goal of speakers is to reduce syllable structure by eliminating nonessential phonic material in coda position through assimilation to the preceding vowel (1986: 4). Both explanations appeal to the teological notion of articulatory ease, a concept that is poorly understood and difficult to support in any empirical way. These solutions are also inconsistent with the observation that velar [_], unlike s- aspiration, began before pauses and vowels, contexts where articulation is usually strengthened, and only later spread to preconsonantal position.

One strategy for making sense of phonological phenomena that apparently don't fit well with general phonetic principles is to override these with higher-order mechanisms. For example, Goldsmith claims that nasal velarization and effacement result from manipulation of autosegmental features in facilitating the orchestration of articulatory events needed to produce an efficient output (Goldsmith 1981: 7). Harris motivates velar [_] through psychological constraints on syllabic structure and language organization (1983: 46). In spite of their appeal, these abstractions only divert our attention from the more natural causal forces to be found in the phonetic domain if we will but dig a little deeper. I propose that a closer look at the physical details surrounding the production and perception of nasal sounds will clarify the research questions raised above and reformulated in (7).

(7) a. Why does VN > V_ primarily before pauses and vowels?

b. Why is there a tenuous relationship between V_ and V?

c. Why should nasal effacement be more common before fricatives?

2. Phonetic antecedents of nasals, velars, and fricatives

A satisfactory analysis of the phonetic parameters governing speech phenomena must consider the way spoken language gets encoded and subsequently decoded. Too frequently, all eyes (and ears) are focused on the speaker with little or no regard for the role the listener plays in communication. Through careful inspection, it is not difficult for the linguist to detect a wide range of speaker variation for any given phonological sequence. This is natural and to be expected. However, many linguists make the implicit assumption that the listener passively takes in what the speaker says and is therefore a silent spectator in the game of sound change. This is not natural and quite contrary to what we know about how speakers and listeners interact while communicating.

According to prevailing views in speech perception (Liberman et al. 1967; Liberman & Mattingly 1985), listeners essentially unravel the highly variable input signal that speakers offer them. They do this through a process of normalization in which they apply reconstructive rules to weed out low-level distortions to arrive at the linguistic intent of speakers. What may seem like a demanding task becomes automated for native listeners with many years of experience (Werker 1989). Their successful efforts make listeners key players in effectively circumventing what might otherwise result in a change in pronunciation. Listeners of course are not infallible, and when this cognitive process breaks down, the potential for change exists if a faulty perception subsequently goes uncorrected in their own speech.

The perceptual indeterminacy that researchers profess to suffer in classifying taped material as a velar nasal or a nasalized vowel suggests that this phenomenon has, at least in part, an auditory basis. Before considering why listeners might misperceive the nasal patterns given in (7), we must first review the pertinent articulatory facts involving nasals, velars, and fricatives. The claim that these production features lay the foundation for potential misparsing errors under normal listening conditions implies that these nasal patterns should not be restricted to Spanish, since the physical forces that induce them equally constrain speakers and listeners of all language systems. The prediction is that similar nasal variation may be manifested cross-linguistically, but only in terms of an increased probability of occurrence and not as an obligatory feature of any given language. Data from sound change records, phonological typology, and language acquisition (Ohala 1975; Greenlee & Ohala 1980) support this prediction and will be cited where appropriate.

Nasal consonants are produced by lowering the velum while an occlusion of the oral tract forces the sound wave produced by the vibrating vocal cords to resonate out the nasal cavity. The primary acoustic cue of nasals is a strong nasal murmur, similar to vocalic formants, at the lower frequencies. The velar movement is not fully synchronized with the corresponding oral closure and thus gives rise to nasalization effects leading into and lagging out of adjacent vowels by about 100 ms (Pickett 1980: 125). Partially nasalized vowels show a slightly higher F1 and an overall broadening of the bandwidth and reduction in intensity of the other vocalic harmonics. The auditory characteristics of primary nasalization and secondary effects on neighboring vowels offer stable and salient cues to the perception of these sounds as a class.

Velar sounds require the slow moving tongue back to be raised and retracted towards the soft palate. The sluggishness of the articulator makes transitions into and out of neighboring sounds particularly protracted. The principal acoustic cue for the velar place of articulation is the rather lengthy vocalic transitions that these sounds exhibit at the margins vis-à-vis consonants produced at other points of articulation. In particular, F2 and F3 of the preceding vowel tend to converge in a dramatic fashion (Ladefoged 1993: 200).

Fricatives are produced through a fairly precise movement of articulators in order to create a narrowing of the oral tract such that the outflowing current of air becomes excited, thus causing the turbulent, aperiodic noise typical of these sounds. The frication is usually sustained and occurs at a frequency range inversely proportionate to the size of the oral chamber forward of the constriction that effectively serves as a noise filter. High airflow requirements for fricatives result in glottal widening usually anticipatory of the pending oral constriction. The acoustic effect on vowel margins adjacent to fricatives is a dampening and broadening of formants not unlike the consequences of nasalization.

3. Phonetic motivation for nasal variation in Spanish

This very brief overview of the production characteristics of nasals, velars, and fricatives offers a glimpse into the types of coarticulatory effects that might lead to the nasal variation seen in Spanish. Additional details will be given as we consider individually the patterns given in (7).

3.1. Nasal velarization before pause and lengthy vowels

Research into the effects of speaking rate on the quality of information we produce indicates a general pattern near the end of utterances when articulation becomes particularly clear. This effect, known as prepausal wind down, is a type of discourse strategy that tells the listener that our turn is coming to an end and that it will soon become acceptable for some other speaker to step in. Towards the end of an utterance, as with many forms of physical exertion, we slow down our movements and effectively lengthen our production routine. The articulatory gestures are less compressed and the speech signal more clear as we dedicate more time to each segment.

When nasals are in prepausal position the vocalic transitions that lead into the final nasal will naturally be quite protracted. The lengthy margins preceding the nasal may approximate those characteristic of velar sounds, even though this represents an unintentional effect. Of course, listeners are aware of context sensitive adjustments in speech and will normally discount such embellishments of the signal and hear the sound in its proper form. However, if listeners fail to associate the automatic transitional lengthening with a speaker's articulatory wind down, the modified nasal may be interpreted at face value as a velar sound.

When nasals are word-final, but followed by another vowel sound rather than a pause, the intervocalic nasal may still be somewhat lengthened because the corresponding occlusion bridges adjacent opening gestures that require precise gestural coordination. This effect may be more obvious when compared to cases in which the nasal abbuts a following consonant and the adjacent obstruction tends to abbreviate the nasal articulation. The intervocalic nasal will show especially lengthy vocalic transitions when the preceding syllable center contains a palatal glide or palatal vowel with extensive tongue displacement as illustrated by the items in (8).

(8)	bie[_]	nacio[_]	i[_]útil
	'well'	'nation'	'useless'

There are two corresponding patterns that I believe support the claim that nasals with lengthy transitions sound like velars. The items in (9) reflect a relationship between oral velar stops and glides, while the pattern in (10) represents a similar alternation between nasal velars and palatal vowels.

(9) (Latin) SEX > seis (Spanish) 'six'
(Latin) NOCTE > noite (Ibero Romance) 'night'
(St. Span.) afectar > afeitar (Non-St. Span.) 'affect'

(10)	St. English		Non-St. English
	smili[_]	>	smili[n]
	raci[_]		raci[n]

The arguments motivating perceptual misapprehension of lengthy vowel transitions for velars are identical to those presented above, but the process resulting in the patterns seen in (9) and (10) is basically the reverse of that proposed for the case of velar nasals in Spanish. Whereas listeners' failure to correct for context-dependent distortions motivates nasal velarization in Spanish, the patterns in (9) and (10) likely result from listeners' overextending their knowledge of coarticulatory effects. For example, listeners hear the lengthy vocalic transitions that accompany a well-articulated velar sound and presume this is not an intended effect, but rather a consequence of the lingual displacement of the preceding vowel. They therefore over generalize and falsely attribute the cues for velarization as conditioned rather than independent and develarize what was originally a velar by design.

3.2. Auditory uncertainty between velar nasals and nasalized vowels

While nasals are auditorily quite prominent as a class of sounds, the distinction between different nasal members is less salient. The production feature that signals nasal place of articulation is the sealed oral resonating chamber that represents a kind of acoustic backwash that muffles the primary nasal murmur according to the geometry of this secondary tube. The frequencies of the attenuated nasal noise as determined by anti-resonances created in the dead-end oral airway dampen the nasal harmonics and are inversely related to the length of the chamber. This is the primary cue for place of articulation for nasals.

The frequency effects are quite evident on bilabial [m] and alveolar [n] because they are manifested in the lower auditory range that we normally attune to when listening for nasal cues. In the case of the velar nasal [_], the chamber that produces anti-resonance is so short that the dampening effect occurs at much higher frequencies, well outside of the range where the nasal murmur is realized. Given the negligible effect the tiny secondary chamber exherts on the velar nasal, the auditory impression is that of a sound wave enhanced by a single resonating cavity, much like that of a vowel. In other words, a sequence of a vowel, automatically nasalized at the margins, followed by the velar nasal [_] sounds quite like a simple nasalized vowel. This observation certainly corresponds with researchers' impression that [_], and not any other nasal, is rather difficult to discern from a nasalized vowel.

That the velar nasal is less consonant-like and more vowel-like is evident in the relative infrequency of this sound in phonological inventories and a recurrence of the pattern seen in Spanish in many other language systems. For example, an alternation similar to the Spanish one has been found in Mandarin, French, Japanese, and in some African and North American indigenous languages (Greenlee & Ohala 1980: 288). The proposed motivation for this nasal variation is fairly commonplace since auditory indistinctness between two phonetic forms is a natural consequence of the many-to-one relationship that exists between articulation and acoustic signal (Fowler 1984).

3.3. Nasal effacement before fricatives

The final question to be addressed is why there should be a higher incidence of nasal effacement before fricative sounds. Forms often cited in reference to nasal loss include those seen in (11) which routinely involve preceding fricative sounds.

(11)	e_t[õ]seh	c[õ]forme	nar[ã]xa
	'then'	'in agreement'	'orange'

This synchronic pattern corresponds to a historical tendency in the evolution of Latin to elide /n/ much more frequently before /s/ than in the context of other, nonfricative obstruents where the nasal is actually strengthened as shown in the examples offered in (12) and (13).

(12)	Latin	Spanish	Gloss
	SPONSAE	esposa	'spouse'
	MENSA	mesa	'table'
	PENSARE	pesar	'weigh'

(13) (Latin) PALUMBA >paloma (Spanish) 'dove'

(Latin) DEMANDARE > demanar (Catalan) 'demand'

(Latin) FONTE > fuente (Spanish) 'fountain'

As previously mentioned, the primary acoustic properties of nasals and fricatives are quite dissimilar—low frequency vowel-like murmur on the one hand, high frequency random noise on the other. However, the secondary effects imposed on adjacent vowel margins are very much the same for both types of sounds—lowering of F1, broadening of harmonic bandwidth, and attenuation of noise amplitude. In other words, the unique quality associated with nasalized vowels may result in the context of fricatives, particularly /s/, as well as /n/. Perhaps this explains the appearance of spontaneous nasals where listeners insert an /n/ as a hypercorrect restitution to account for the nasal-like timbre of vowels preceding fricatives (Ohala & Busà 1995: 132). This phenomenon is illustrated in (14) and supported by percepual studies testing the degree of nasality heard on vowels in different consonantal environments.

(14) (St. Span.) mucho > mu(n)cho
(Non-St. Span.) 'a lot'
(French loan) rosse > rounçet
(Modern Breton) 'horse'
(English) half > h[œ]f
(Spanish) casado > ca(n)sado (slip of the tongue) 'married'

The reverse pattern under question, where nasal effacement occurs more frequently in the context of fricatives, represents a peculiar type of phonetic dissimilation. Listeners understand that the secondary nasalized quality of adjacent vowels is predictable in the environment of both /n/ and /s/. The robust fricative may be taken as the primary motivating condition for the nasalized vowel and may even camouflage the adjacent nasal murmur. In a sense, the nasal consonant becomes auditorily superfluous in our processing of sequences involving vowels, nasals, and fricatives and therefore expendible.

4. Conclusion

There is little doubt that the phenomenon of nasal velarization and effacement in Spanish has a phonetic basis that may be understood if one looks beyond the usual cover terms of "weakening" and "articulatory ease". In particular, the origin of these patterns derives naturally from the give and take that is characteristic of spoken communication (Kingston & Diehl 1992). I have focused on the role the listener plays in deciphering common coarticulatory effects that complicate the acoustic signal. To be sure, the speaker initiates the task, but the listener is the ultimate moderator in determining whether novel speech habits gain entry into the marketplace of sound variation and change.

I have attempted to provide sufficient argumentation for at least entertaining the idea that nasal velarization and effacement is a consquence of how language users process speech. By introducing occasional references to similar variation in other language varieties I am suggesting that the phenomenon is not unique to Spanish and therefore need not be considered an outgrowth of language internal mechanisms or a consequence of the particular socio-historical conditions of this system. If this type of nasal variation does indeed represent a general phonetic tendency, then acceptance of the proposed explanations need not rely on persuasion and logic alone, but may be supported by empirical research into the hypotheses underlying this model. Some experimental work has already been done, and these ideas are intended to pave the way for further investigation.

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