PALATAL PHENOMENA IN SPANISH PHONOLOGY

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2004

ACKNOWLEDGMENTS

I would like to thank my committee members for their support and patience in this long process. I particularly thank Dr. David Pharies, not only for his vast knowledge of the history of the Spanish language but also for the considerable patience he has shown in entertaining my sometimes wild ideas concerning the phonological patterns reflected (or not) therein. I equally acknowledge an enormous debt to Caroline Wiltshire, whose quiet brilliance and (again) patience with my lurching progress in the field has been a source of real inspiration. Drs. Jean Casagrande, Gillian Lord, and Ratree Wayland have provided invaluable feedback on this work. I particularly thank Ratree Wayland for opening her lab to me on campus and for being available for my sudden, intrusive consults. Beyond the committee, *über*-linguist D. Gary Miller provided many insights into the historical processes examined here, as well as, with Judy Miller, the parties that substituted nobly for a social life during these last 5 years. I also thank Andrew Lynch and Joaquim Camps for generously sharing their statistical expertise, not to mention humor, support, and confidence in my abilities.

I would also like to express gratitude to my fellow graduate students in both Romance Languages and Linguistics. In particular, I thank Sonia Ramírez Wohlmuth for endless and incisive conversation and analysis of Spanish (and English) linguistics, and of course politics at every level. Mohamed “mighty Mo” Al-Khairy contributed untold amounts to this work, both as a technical consultant with Praat (and all other things cybernetic) and as a phonetician in his own right. I express thanks also to Sang-Hee Yeon

for frequent phonetic feedback, as well as loads of practical information about deadlines and such. Finally, Sarah Kraemer's ready smile and good cheer have helped keep me in good spirits throughout the program.

And, of course, I give special heart-felt thanks to my parents for their unconditional support and encouragement.

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of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

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August, 2004

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This dissertation proposes an analysis of the class of palatal segments in Spanish that sheds light on their phonological behavior. This class, which includes the 'ñ' of *baño* 'bathroom', the 'll' of *caballo* 'horse', and the 'ch' of *chico* 'boy', represents a series of innovations in Romance, the products of rather remarkable sound changes that took place in the evolution of the language from Latin, which, significantly, had no palatal consonants. The exceptional distributional limits of these sounds and the influence they exert on stress placement suggest a structure unlike that of other consonants in Spanish.

I explore the nature of the putative complex structure of these segments, reconciling it with previous models of articulatory features as well as with more recent frameworks founded in hard phonetic detail. I propose that the palatals have a complex articulatory structure that includes a degree of tongue dorsum activity typically reserved for vowels. Such a structure explains the relative rareness of the palatals and suggests an articulatory and acoustic basis for their behavior in Spanish stress assignment: the high

degree of coarticulatory influence they exert on preceding vowels may trigger vowel lengthening, or at least its percept.

I trace the historical origins of these sounds as the results of sometimes conflicting drives toward both articulatory and communicative efficiency. This account also speaks to the relative instability of these sounds in Spanish, which undergo significant weakening across dialects and indeed across Romance languages: parallel developments are identified in the history of French, Italian, and particularly Portuguese. The dissertation concludes with an acoustic analysis of the segments in Castilian Spanish. The results identify significant coarticulatory effects that provide tentative evidence of vowel lengthening in prepalatal environments.

CHAPTER 1
INTRODUCTION

1.1 Palatals of Spanish

Spanish has a series of palatal segments /ʎ ɲ tʃ/ that have garnered attention for their phonological behavior both diachronically and synchronically (e.g. Carreira 1988, Roca 1988, Lipski 1989). In the history of the language, these segments have demonstrated a considerable degree of instability, arising through rather complicated sound changes from largely non-palatal segments in Latin. In synchronic terms they similarly show an ongoing propensity for variation and also extreme distributional limitations. Finally, they seem to enjoy an exceptional role in Spanish stress-assignment. These aspects are shared to greater and lesser degrees across various Romance languages and dialects, particularly in Western Romance. The phonological nature of the palatal segments thus warrants further investigation, particularly in terms of the acoustic underpinnings of their behavior. It is the goal of this dissertation to explore the nature of these segments and to verify what acoustic properties account for their singular phonological status. I show that a complex phonological structure underlies palatal instability and phonotactic limitations, and furthermore that a geminate (moraic) analysis of palatals accounts for their role in stress assignment. I trace and motivate the historical reflexes that result in the segments' posited complex structure and moraic status, and I isolate acoustic evidence to underpin such structure. The following sections discuss in greater detail the particulars of palatalization and the properties mentioned above.

1.1.1 Palatal Instability

As both the products of diachronic sound changes from Latin consonant clusters and consonant+vocoid groups and as the starting points of ongoing variation in modern dialects, the palatals have shown a high degree of instability. The palatal lateral /ʎ/ provides the most obvious example. From its origins in Latin geminate /ll/ and clusters /fl pl kl/, the palatal lateral has undergone widespread loss in modern times through coalescence with the palatal glide /j/ in Spanish (a process known as *yeísmo*) and is now increasingly rare in Spanish dialects. Loss of the palatal lateral here mirrors a similar loss of the segment in the history of French, where it too weakened to a palatal glide: Mid. French /fœʎə/ > Mod. French /fœ**j**/ *feuille* 'leaf' (Pope 1934). Recasens (1991a) also documents widespread *yeísmo* (Cat. *ieisme*) in dialects of Catalan. Indeed, even where the segment remains articulatorily distinct from the glide in Spanish dialects (as in Andean regions), the lateral is often strengthened to an alveopalatal fricative [ʒ] or [ʃ], or affricate [dʒ].[1]

The palatal nasal /ɲ/ similarly evolved from Latin geminate /nn/ and cluster /mn/ (as well as /nj/), and while it generally seems much more resistant to such sound change as Spanish *yeísmo*, Lipski (1989) identifies a process of /ɲ/-gliding by which this segment loses its coronal stricture to become a nasalized glide /j̃/ in rapid Spanish registers. This phenomenon parallels similar loss of coronal features in *yeísmo* and is furthermore documented in dialects of Brazilian Portuguese. Elsewhere in Romance languages, loss of the palatal nasal has been reported in dialects of French (Casagrande 1984:112; Tranel 1987:127; Walter 1988:243): *magnifique* /ma**ɲ**ifik/ > [ma**n**ifik]. Moreover, spontaneous

reanalyses in Catalan (Recasens *et al*. 1995; see below) also suggest that /ɲ/ is an unstable sound. Finally, the affricate /tʃ/ often loses its occlusive element to become voiceless alveopalatal fricative /ʃ/ in Andalusian, Mexican, and Caribbean dialects of Spanish, following a similar process in Old French: OF *chier* [**tʃ**ier] > Mod. Fr. [**ʃ**ie] 'to shit' (Pope 1934:93). There is also evidence that dialects of norther Spain are fronting and, in essence, depalatalizing the affricate to produce a dental variant: *chico* [tsiko].

1.1.2 Distributional Anomalies

Distributional data from Spanish underscore the apparent markedness of the palatals: word-initial /ɲ/ is extremely limited in Spanish and where attested is often due to indigenous borrowing (*ñame* 'yam') or to onomatopoeic processes (*ñoño* 'namby-pamby; whiny'; cf. Fr. *gnagnan* 'whiny').[2] The segment is not found syllable- or word-finally, nor does it participate in consonant clusters (Carreira 1988). In brief, the nasal segment is virtually limited to intervocalic position. The palatal lateral is similarly unattested in codas and clusters in Spanish, as is the affricate (though it should be pointed out that, as an obstruent, the affricate would constitute a highly marked coda in Spanish phonology regardless of its place of articulation). The affricate diverges somewhat, however, from the other two in appearing word- and syllable-initially after sonorants /l r n/: *colcha* 'bedspread', *marcha* 'march', *mancha* 'stain'; cf. **marlla*, **malña*.

1.1.3 Palatals as Heavy Onsets

A third characteristic shared by the palatal series in Spanish that sets them apart from other sounds in the inventory is their apparent role in stress assignment. These segments seem to act as heavy or weight-bearing onsets, influencing the assignment of

stress in Spanish even though they are barred from coda (hence, weight-bearing) position in Spanish syllable structure. Harris (1983) shows convincingly that a heavy penult limits the normally three-syllable stress 'window' of Spanish to two syllables; that is, antepenultimate stress cannot be assigned in Spanish to a word with a heavy penultimate syllable. Strikingly, antepenultimate stress also seems to be forbidden when a palatal sound is present as the onset of the final syllable: **cá.ba.ña*, **cá.ba.llo*, but *cá.ba.la* 'cabala', *cá.li.do* 'warm' (Roca 1988). This characteristic is shared by the palatal glide /j/ (**cá.ba.yo*), the alveopalatal affricate /tʃ/ (**cá.ba.tʃo*), and the (alveolar) geminate /r/ (**cá.ba.ro*).[3] These facts further suggest that the palatals are subject to a different analysis from that of other Spanish consonants. As noted in section 1.1 above, I take the unique status of these segments to be a function of their complex structure. I view the palatals as complex both in terms of their articulatory demands (as described in features or gestures; see section 1.4) and in terms of their metrical weight as quasi-geminates (moraic segments; see 1.2.3 below) that retain the weight of the Latin geminates and clusters that gave rise to them. Note that I use "quasi-geminate" to reflect the fact that these segments are not long consonants *per se* in that they do not contrast with featurally identical singleton versions of themselves as do typical geminates. Furthermore, for expository clarity, I hereafter distinguish articulatory complexity from moraicity, reserving *complex* to refer to the former and *moraic* (or *geminate*) *structure* to refer to the latter. I see a link between the two, however; in my view, the posited complex structure of the palatals provides the acoustic underpinnings of their putative geminate function in Spanish prosody. Both takes on these segments are evident in previous analyses of the Spanish palatals, to which I now turn.

1.2 Previous Analyses

1.2.1 Bisegmental Model

Carreira (1988) presents considerable distributional evidence calling for a special analysis of the palatals and posits a bisegmental model that consists of a coronal consonant followed by a palatal glide. In her view, surface [ʎ ɲ tʃ] consist underlyingly of alveolars /l n t/, respectively, followed by /j/, with a palatalization rule accounting for the surface forms.[4] In this way, the coronal portion is syllabified into the preceding coda, with the glide furnishing a following onset: *caba**ñ**a* [ka.ˈba**n**.**j**a]. Since a coda consonant parsed into the penult renders that syllable heavy, antepenultimate stress is duly blocked. Additionally, given the identical underlying representation of orthographic *ñ* and *ni*, Carreira draws a parallel with the fact that prevocalic glides also disallow antepenultimate stress when in the final syllable of a word: **bé.go.**ñ**a*, **pé.tu.n**i**a*.

Carreira's account requires extrinsic rule-ordering and repair strategies to avoid infelicitous stress assignment, as well as the special lexical marking of the high front vocoid in a sizeable group of words in order to avoid the palatalization of /n + j/ sequences that do not palatalize (cf. *nieta* 'granddaughter' [nje.ta], *[ɲe.ta]). Also, as Carreira herself points out, the bisegmental model does not cleanly account for the presence of palatals at the beginning of words in absolute initial position; the first segment, as a coda, should have nowhere to go. Carreira invokes extraprosodicity here, explaining that many languages permit a larger inventory of segments word-initially than syllable-initially. Finally, Carreira's analysis does not further our understanding of the diachronic changes described above.

1.2.2 Palatals as Complex Segments

Lipski (1989) makes similar distributional observations and proposes an analysis characterizing the palatal sonorants /ʎ ɲ/ as articulatorily complex. Citing palatographic findings (Navarro Tomás 1967) and more recent x-ray evidence (Keating 1988), Lipski suggests that the complexity of the segments is due to simultaneous involvement of both coronal and dorsal articulators; that is, both the tongue dorsum and the tongue blade/tip are (independently) involved in their production. He uses a feature geometry model (Figure 1-1) to show that these segments are attached to both coronal and dorsal nodes. Lipski explains both *yeísmo* and /ɲ/-gliding as the result of the delinking of the coronal (COR) node, which results in the loss of alveolar closure. This apparent loss of articulator constriction suggests a lenition process, consistent with the frequency of the phenomenon in rapid or casual speech.[5] The model also accounts for 'depalatalization' of the palatals in rhymes, as in v. *desde**ñ**ar* 'to disdain' ~ n. *desdé**n*** 'disdain'; here, delinking of the dorsal node occurs, resulting in a 'simple' alveolar articulation.

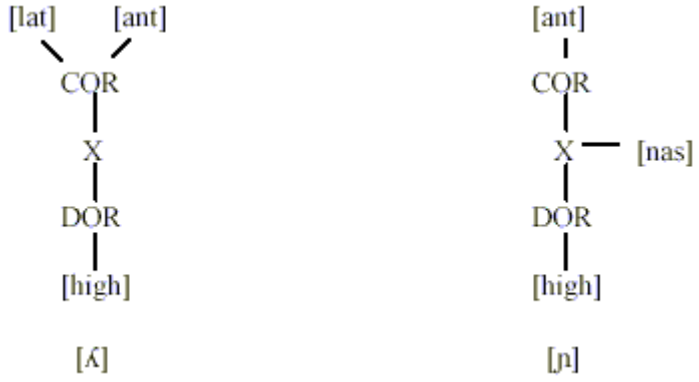


Figure 1-1. Feature geometry models of complex palatals /ʎ ɲ/ (Lipski 1989:217, fig.2-3).

Lipski's model, however, does not explain the stress effects of these segments; unlike Carreira, he does not posit more than a single timing slot for the segments in

question and so cannot suggest a heterosyllabic parse that would make for a heavy penult when the segments are the onsets of ultimae. Instead, he suggests that the absence of proparoxitonic words with palatal onsets in the final syllable is an historical artifact reflecting Latin phonotactics. Nor does he firmly account for the distributional limitations of the segments, aside from suggesting that phonotactic restrictions on consonant sequences might be based on number of articulator nodes rather than timing slots.[6]

1.2.3 Moraic Model

Subsequent works refine the model of the palatals as complex segments while also incorporating Carreira's intuition that they should be parsed heterosyllabically. Basing his ideas on observations of Brazilian Portuguese that are virtually identical to those made for Spanish, Giangola (1995) analyzes the palatal sonorants /ʎ ɲ/ as geminates, thus assigning a heterosyllabic parse of the segments that provides both a coda to a preceding syllable and an onset to the following one. Figure 1-2b shows the syllable structure commonly assigned to geminates in the moraic model (Hayes 1989) as contrasted with singleton segments (Figure 1-2a). Figure 1-2c shows that structure as here applied to the palatal sonorant /ʎ/ (which would be structurally identical for /ɲ/).

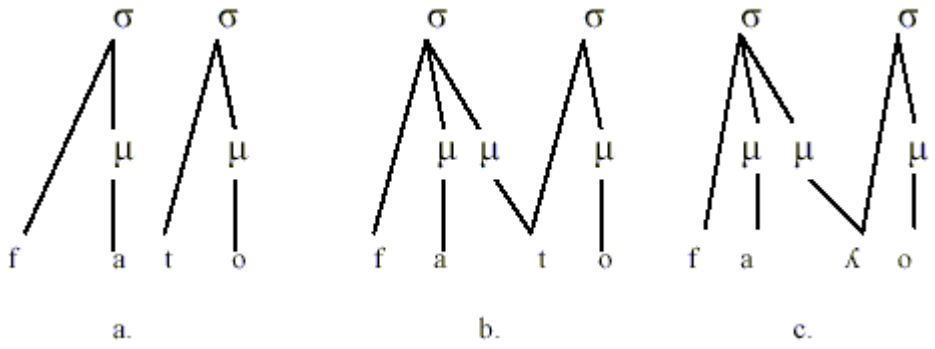


Figure 1-2. Moraic models. a) It. *fato* 'fate', singleton /t/. b) It. *fatto* 'fact', geminate /tt/. c) Sp. *fallo* 'error', proposed quasi-geminate /ʎ/.

Giangola proposes the structure of 1-2c to account for several idiosyncrasies of these segments in Brazilian Portuguese. First, they are typically limited to intervocalic contexts. Rare occurrences in word-initial position often trigger a prothetic vowel. An example is Brazilian Port. *lhama* [**i**ʎama] (< Sp. *llama* 'llama' [ʎama]); the prothetic [i] constitutes a repair strategy where an unparsable coda would otherwise be left floating. Furthermore, the presence of these segments in the onsets of ultimae block antepenultimate stress, again an expected result where the coda portion of the complex segment renders the penult heavy (cf. Carreira's analysis above). As with Lipski's analysis of *yeísmo* and /ɲ/-gliding, Giangola views /ʎ > j/ and /ɲ > j̃ /—the latter far more widespread in Brazilian Portuguese than in Spanish—as natural simplifications of a complex articulation.

Wetzels (1997) focuses primarily on the palatal nasal in Brazilian Portuguese and takes a position very similar to Giangola's. He notes the same distributional limitations of /ɲ/ and its role in blocking antepenultimate stress assignment. He examines its role in vowel nasalization, as does Giangola, pointing out a significant difference between the palatal segment and the alveolar /n/: the palatal nasal triggers nasalization of a preceding vowel where the alveolar does not. He explains this as an effect of the geminate structure of the palatal; the coda provided by the geminate to the preceding vowel bears a nasal mora and serves to nasalize the vowel. Wetzel's model retains the timing slots of feature geometry, positing a secondary vocalic articulation on the consonant. He suggests, as does Carreira, that the segment is susceptible to spontaneous reanalysis by speakers as a sequence of a consonantal articulation followed by a vocalic one, realized respectively on

each of the two timing slots. Like Lipski's, his model accounts for /ɲ/-gliding as a delinking of the coronal (consonantal) node.

Davis (1999) looks at palatals in Italian and shows that they are always long (i.e. geminate) in Italian except in phrase-initial position, thus paralleling the behavior of consonants that show distinctive length word-internally but not word-initially (Figure 1-2). In other words, palatals in Italian are always geminate but like other Italian geminates surface as short in phrase-initial position. This is consistent with a model positing a geminate structure for these segments, where the coda is unparsable in absolute initial position. Rather than assuming a timing-slot model, however, Davis provides evidence from Italian to support the moraic model (Figure 1-2), in which the segment is underlyingly moraic. This underlying moraicity apparently conditions the allomorphy of the masculine singular definite article *il*, which in Davis' view surfaces as *l(o)* when the following segment is moraic (i.e. vowel or geminate): cf. ***il*** *padre* 'the father' ~ ***l'****osso* 'the bone' ~ ***lo*** *gnomo* 'the gnome' [lo**ɲ**omo].

1.3 Present Analysis: Palatals as (Quasi-)Geminates

I assume the quasi-geminate analysis and moraic model of palatal segments offered by Davis (1999). Davis' model neatly accounts for the distributional and prosodic data observed. However, I also follow Wetzels' (1997) conception of a complex segment involving both a consonantal and a vocalic element. This approach reflects the complex, dual articulation that apparently characterizes the palatals. As noted above, the dual coronal-dorsal articulatory profile, as seen in the models offered by Wetzels (1997) and Lipski (1989), effectively predicts the allophony observed in Spanish and Portuguese

dialects. My study aims to extend these analyses by providing solid articulatory and acoustic evidence that serves to ground the abstract phonological models in phonetics.

In terms of the syllable model itself, moras are preferred here to timing slots based on persuasive arguments put forth by Hayes (1989), Blevins (1995), and others. A primary failure of a syllable model incorporating timing slots is that it does not reflect the fact that onsets virtually never influence syllable weight, despite their being represented with the same timing slot as other segments in the model. As my goal is to explain the apparently aberrant behavior of palatals that do seem to contribute to syllable weight (albeit that of a preceding syllable), we require a model that allows us to show specifically how weight is distributed within the syllable. The moraic model accomplishes this, reflecting the weightlessness of onsets (that is, non-moraic segments attached directly to the syllable node) while showing the weight contributed by other segments that are attached to a mora (vowels and coda consonants). The moraic model has nevertheless been challenged by some authors (see Blevins 1995), who criticize it for not recognizing the traditional constituents of the syllable, particularly the rime (nucleus + coda). This necessitates stipulatory measures at times that encumber a theory initially embraced for its elegant simplicity. In the following sections, the use of the moraic model is briefly discussed and defended.

1.3.1 Moraic Model of The Syllable

1.3.1.1 Background

The mora as a unit of syllabic weight is not a recent theoretical construct. Trubetzkoy, for example, described the Latin stress system in terms of moras as early as 1939 (Trubetzkoy 1939). It was only, however, in the latter part of the twentieth century that moras were decisively integrated into models of syllable structure to formalize

concepts of quantity in phonological theory. They were first used primarily to explain suprasegmental phenomena (accent, stress, tone) on the basis of interplay between heavy and light syllables (Newman 1972). Hyman (1985) and Hock (1986) both added the mora to the timing-slot model of the syllable current at the time. On the intuition that historical and morphophonological processes are dependent not on number of segments but rather on their weight, Hayes (1989) and McCarthy & Prince (1986, 1995) completely replaced the skeletal tier with the mora, advocating the syllable model seen in Figure 1-2 above.

In moraic theory, vowels are assumed to carry an underlying unit of weight universally. Thus, a short vowel bears one mora, while a long vowel bears two. In this way, long vowels are universally heavy with respect to short vowels. Onset consonants, by contrast, are either attached directly to the syllable node (as here; see Figure 1-2), or alternately to the mora of the following vowel. Either way, as non-moraic or as mora-sharers dependent on the vowel, onsets are represented as incapable of bearing an autonomous mora. The model thus captures the near-universal fact that onsets do not contribute weight to syllables or trigger such processes as compensatory lengthening (Steriade 1988, Hayes 1989). This represents a strong advantage of the moraic approach over that of timing slots, which assigns a timing unit to every segment of the word, including onset consonants.

To illustrate, consider the formal simplicity of the moraic approach in terms of word formation and syllable size limits. Reference to moras as units of weight attached exclusively to syllable rime elements helps to reveal patterns. Spanish, like many languages, has a basic two-mora size limit on syllables. The falling diphthong in the first syllable of *jaula* ‘cage’ [x**aw**.la] constitues a bimoraic, ‘heavy’ syllable (moraic segments

in bold). We therefore do not find words in which such a diphthong is followed by a coda consonant (e.g. **jaurda*) or a geminate /rr/ (**jaurra*), nor by one of the palatal geminates (**jaulla*, **jauña*). Under my proposal, the latter examples are due to the geminate structure of these segments, by which their associated mora would make up part of the preceding rime and therefore make it illicitly 'superheavy' or trimoraic. Figure 1-3 illustrates. The trimoraic syllable of Figure 1-3b is simply illicit and barred from the language, a fact captured in terms of a two-mora limit in languages (see discussion of a cross-linguistic constraint to this effect in section 1.3.3.2).

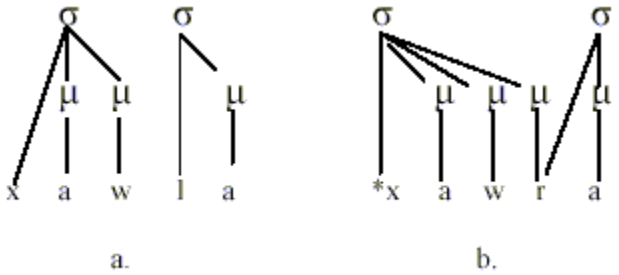


Figure 1-3. Moraic models. a) Sp. *jaula* 'cage' b) **jaurra.*

On the other hand, the timing-slot model retains reference to onset-nucleus-coda and presents a much more complicated model of syllable structure:

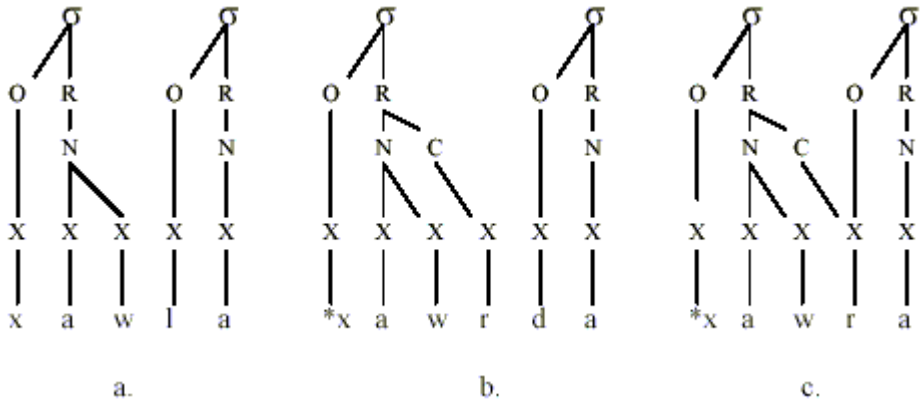


Figure 1-4. Timing-slot models. a) *jaula*. b) **jaurda*. c) **jaurra*.

Here we must specify that the R node may not dominate more than two timing slots (or 'no branching rime *and* nucleus'), while there is no transparent reason why the slots dominated by the onset do not count in the process. The moraic model is a simpler and more elegant expression of weight dynamics within the syllable.

In terms of codas, languages vary on whether a syllable-final consonant is counted as carrying weight (that is, whether it bears a mora). That is, some languages see both CVV and CVC syllables as heavy, while others count only the former. To address this, Hayes (1989) posited the Weight-by-Position parameter (now conceived in Optimality Theory as a violable constraint). Weight-by-Position (WBYP, henceforth) stipulates that consonants in post-vocalic position within the syllable are assigned a mora. When WBYP is not active, syllable-final consonants do not contribute to syllable weight. In this way, moraic theory accounts for languages with three-way weight distinctions. Since the moraic model does not recognize the traditional rime (nucleus-coda) constituent—which timing-slot models could represent by various configurations involving (non)branchingness within the rime (see Blevins 1995:214-5)—theorists were forced to add machinery such as WBYP. While Blevins sees the need to stipulate WBYP as a weakness of the theory, Broselow (1995) points out that it in fact justifies the theory. She reasons that, without such a condition, moraic structure would be (redundantly) derivable from syllable structure. Additional features such as recognition of strong~weak mora distinctions also contribute, in Blevins' view, to a weakening of the theory. However, inasmuch as Spanish is a rather straightforward weight-by-position language with none of the complex prosodic features (three-way weight distinctions, phonemic long vowels,

etc.) that have necessitated these further refinements, it seems justifiable to take advantage of the moraic model as originally conceived.

1.3.1.2 More evidence in Spanish supporting the moraic analysis

Aside from the primarily synchronic evidence presented thus far, it is also worth noting that diachronic data support the geminate analysis. Both /ʎ ɲ/ and the alveolar trill evolved in part from Latin geminates, in part (along with /tʃ/) from heterosyllabic consonant clusters:

a. L. CABALLU 'horse' [ka.ˈbal.lu]	>	*caballo* [ka.ˈba.ʎo]
b. L. ANNU 'year' [ˈan.nu]	>	*año* [ˈa.ɲo]
c. L. HORRIBILIS 'horrible' [ho.ˈri.bi.lis]	>	*horrible* [o.ˈri.βle]
d. L. LACTE 'milk' [lak.te]	>	*leche* [le.tʃe]

Figure 1-5. Latin geminate and cluster origins of modern Spanish /ʎ ɲ r tʃ/

Since moraic theory assigns a geminate to both a syllable-final and a (following) syllable-initial consonant, and since syllable-final consonants had moraic weight in Latin, these geminates and clusters carried syllable weight. Compensatory lengthening both diachronically and synchronically suggests that speakers often retain the moraic value of segments in sound change. The weight, therefore, of the segments discussed here might well reflect the retention of the weight they carried in Latin.

Pope (1934) provides further diachronic evidence. Lengthening of tonic vowels in open syllables (i.e. before single consonants) is well attested in early Gallo-Romance, setting up the conditions for subsequent diphthongization or raising: L. P**Ĕ**DEM > G.Rom. p**ɛ:**dɛ (> Mod. French ***pied*** 'foot'); L. **Ā**LA > G.Rom. **e**.lə. The process was blocked, however, when the vowel was in a closed syllable due to a following coda consonant, a geminate, or, notably, a palatal (Pope 1934:95-6): L. AUR**Ĭ**CULA > Old

French [ɔr**e**ʎə] (> Mod. French *oreille* [ɔʀ**e**jə] ‘ear’); L. *MONTĀNEA > G.Rom. mũn.t**ã**ɲə.(> Mod. French *montagne* [mõtaɲᵊ]). As Pope observes, palatals /ɲ ʎ/ block the process. This would be the result of the palatal’s geminate structure closing the preceding syllable, just as geminates also did. The moraic dynamic of geminate structure is further implicit in processes conditioned by /rr/: when geminate /rr/ was simplified in late Middle French, the preceding vowels in the now-open syllables lengthened in compensation: L. T**Ĕ**RRA > Mid. French [t**ɛ:**rə] (Pope 1934:147).[7]

Frequent reanalysis of these segments in Romance languages both diachronically and synchronically also suggests a geminate makeup. Jones (1988) recognizes the marginal status of /ɲ/ in Sardinian but notes that where it does occur, largely in loanwords from Italian, it is commonly changed to [ndz] or [ndʒ] (see also Lausberg 1965:392).[8] These clusters would certainly be parsed heterosyllabically, with the second segment assigned to an onset. The fortition reflected in the affricate realizations suggests that the segment has been reanalyzed as biphonemic /nj/. As noted above, similar reanalyses of /ɲ/ are current in French (Tranel 1987:127) and Catalan, where a number of variants are attested: [jn jŋ ɟɲ], as well as simple [j] and [n] (Recasens *et al*. 1995:270, 274). A similar process occurs in Basque, as well, where the palatal nasal is susceptible to analysis as /jn/ (Trask 1996:62).

Additionally, compensatory lengthening after deletion of segments has been observed in dialects of Spanish. This is most easily seen in dialects in which liquids are prone to deletion. In Caribbean dialects of Spanish, such as in Cuban and in the well-

known Dominican dialect of Cibao, liquids may be deleted with compensatory lengthening of the preceding vowel or with gemination of a following consonant:

a. *no**r**te* ‘north’	[no:te]
b. *ce**r**ca* ‘near’	[sek:a]
c. *zu**r**do* ‘left-handed’	[sud:o]
d. *pu**l**po* ‘octopus’	[pu:po]
e. *a**l**go* ‘something’	[ag:o]

Figure 1-6. Liquid deletion with compensatory lengthening in Spanish (Quilis 1999:326-7, 357)[9].

Such compensatory lengthening constitutes evidence of a quantity-sensitive (hence, mora-based) prosodic system.

Finally, there is evidence from morphological templates that indicate that Spanish is a mora-counting language in which prosodic structure is determined by weight criteria. Such templates are posited by McCarthy & Prince (1986, 1995) to explain apparent limits on word structure in various morphological processes such as reduplication and hypocoristics cross-linguistically: languages may set limits on the outputs of such processes that can only be properly understood as a function of weight and prosodic structure. Word minima reflect similar weight limits. In English, for example, monomoraic words are illicit. Compare the ill-formed *[strɪ], *[splɪ], or *[θɹɪ], in which the single, short /ɪ/ is insufficient to support the word without a second moraic element (coda or vocoid) to bolster it: cf. *strip* [strɪ**p**], *split* [splɪ**t**], and *three* [θɹɪ**j**] or *thrill* [θɹɪ**l**]. Consider too that onsetless *is* [ɪz] or *ill* [ɪl] are equally acceptable; clearly, number of segments is irrelevant to the process. Similarly, Spanish hypocoristics reduce names to shorter (typically trochaic) familiar forms but never go beneath a two-mora limit: *José-María* > *Chema*, **Che*; *María-Jesús* > *Chus*, **Chu*; *Eloy* > *Loy* (see Piñeros 2000).

Where *María-Teresa* can give *Maite*, /te/ can reduplicate to *Tete*, or, importantly, be retained in the presence of a reduced *María*: *Mari-Te*.[10]

In light of the evidence adduced above, it seems clear that Spanish is a weight-sensitive, mora- (not timing-slot-) counting language.

1.3.2 Acoustic/phonetic motivations

An analysis therefore of the palatals as articulatorily complex segments that also have the geminate structure described in Figure 1-2c seems well-founded, neatly accounting for the facts. The phonology, then, of the distributional and metrical phenomena detailed above is not in question. The challenge of this paper is to further investigate the palatal effect with a view to reconciling the phonology with the phonetics. The phonology/phonetics interface is an increasingly active area of research; works such as the *Phonetics and Phonology* series (Anderson & Keating, eds.) and *Phonology and Phonetic Evidence* (Connell & Arvaniti, eds.) attest to the dynamism of the field. The interest is perhaps particularly acute now, given the prevalence of Optimality Theory (OT; see below) as a theoretical framework in phonology. That is, the emphasis placed in OT on constraints that reflect universal processes demands reconciliation of phonological effects with the hard phonetic facts; being able to ground a proposed constraint in articulatory or perceptual terms greatly contributes to its viability as a universal tendency (Archangeli & Pulleyblank 1994; Hayes 1997; Flemming 1995, 2002). To illustrate, the universal applicability of ONSET, a constraint requiring consonants at the left syllable margin, can be viewed as a function of perception: a vowel is better perceived—and probably articulated—when preceded by a consonant rather than another vowel. Similarly, NOCODA, militating against coda consonants, responds to the fact that most consonants are far less effectively perceived at the right syllable margin; obstruents in

this position, for example, tend to be unreleased and thus deprived of highly salient burst characteristics (Ohala 1990).

If we are to claim that palatals have a geminate structure, we need to be able to detail what aspects of their makeup account for it. That is, what aspects of their articulation or acoustic profile underpin this apparent geminate nature? I claim that it is the complex structure of these segments that provides the articulatory/acoustic foundation for their continuing function as moraic geminates in the language. For example, we have seen in Lipski's (1989) autosegmental analysis that both *yeísmo* and /ɲ/-gliding (as well as the shift of /tʃ/ to [ʃ] and, arguably, Central American retroflex variants of geminate /r/) reflect 'delinking' of the coronal feature to leave only the dorsal. Likewise, certain morphological processes reflect the inverse: loss of the dorsal feature in /ɲ/ leaves [n] in the substantive form of *desde**ñ**ar* > *desdé**n*** 'disdain'. Historical sound change parallels this process with /ʎ/ > [l] occurring where apocope left this segment in word-final position: V.L. MILLE /miʎe/ > */miʎ/ > [mil] (Sp. *mil* 'thousand'). We therefore have a well-documented mechanism and pattern. It seems insufficient to simply claim that these segments simplify because their posited geminate structure makes word-final position untenable. Speakers are unlikely to tailor language behavior on the basis of abstract structure. Geminate structure and moraic weight must be represented phonetically in the acoustic signal. We would like to know, therefore, what articulatory or acoustic features compel such delinking. Such questions seem naturally linked to the phonotactic and distributional limits observed on palatals. Similarly, what is the phonetic basis of the

stress effects attributed to the palatals as heavy onsets? To such ends, I investigate the articulatory and acoustic nature of palatals.

In addition to this synchronically-oriented approach, I look at the complicated historical changes that produced the palatal segments of the modern Spanish inventory. I apply phonetic (articulatory and acoustic) details to the historical data in the interest of a better understanding of these sweeping changes. The identification of the forces behind the historical changes and their reconciliation with our current view of the palatals as articulatorily complex, geminate-type segments provides for one unified approach to both the diachronic and synchronic reflexes. The framework within which I provide such a unifed analysis is that of Optimality Theory. In the following sections, the key concepts of this theory are laid out and explained.

1.3.3 Optimality Theory

1.3.3.1 Brief description: constraints and ranking

Above and beyond any models employed in this work, the analytical framework will be that of Optimality Theory (Prince & Smolensky 1993). Optimality Theory (OT hereafter) is a generative theory of phonology that posits rankings of violable constraints to explain different linguistic reflexes in different languages. Since constraints are derived from the observed behavior of sounds across languages, the theory is naturally typological; different rankings of constraints—posited to be universal and thus present in every language—account for different grammars and thus allow a high degree of predictive power to the theory. Inversely, the validity of constraints can be tested against rerankings; if reranking a given constraint set generates attested languages, the constraints are much more likely to be valid. OT thus lends itself to the analysis of palatalization processes in Romance; apparent parallels in the distribution and behavior

of palatals in Western Romance, for example, as well as divergent reflexes, should be predictable in terms of different applications of the same basic drives in language, formalized as constraints.

Constraints should also be motivated in terms of phonetic facts, whether articulatory (that is, production-oriented) or auditory (perception-oriented). Recall ONSET from the previous section. This apparently universal constraint, requiring syllables to have onsets, is predicated upon the perceptual advantage of having a consonant precede a vowel. Arguably, too, in terms of production, concatenation of syllables is facilitated by a regular pattern of oral stricture (as in consonants) followed by aperture (vowels). Another example is the relative ban on high nasal vowels, which might be formulated as *[nasal][+high]. Such a constraint is rooted perceptually in the fact that, in nasalized vowels, acoustic coupling between the oral and nasal cavities, the pharynx, and the atmosphere creates a profusion of spectral prominences and crowds the acoustic signal. That is, oral and nasal formants and antiformants at lower frequencies tend to merge perceptually and thence widen the effective bandwith of the first formant (F1), the acoustic correlate of tongue height (see Johnson 1997:157-60). This serves to lower the perceived height of these vowels. Physiologically, the lowering of the velum necessary for nasalization might also contribute to inadvertent tongue-body lowering, as well.

Consider as a third example the ban on adjacent identical segments, formulated by Goldsmith (1976) as the Obligatory Contour Principle (OCP). The fact that the OCP is widely attested in a wide variety of languages suggests that this constraint could represent a universal tendency. Further underscoring the validity of the OCP as a constraint are logical perceptual issues: two identical segments back to back are less easily perceived as

discrete units than two minimally dissimilar units. Indeed, the OCP is behind a general ban in Spanish on sequences of (tautomorphemic) *ji, *ij, *wu, *uw. Since we posit the high vowels/glides to be two facets of a common high vocoid, the OCP would naturally disfavor their cooccurrence; they would not be readily distinguishable. Similar arguments explain cooccurrence restrictions barring the palatal segments from contact with the high front vocoid, dealt with in Chapter 3.

1.3.3.2 Tableaux and constraint interaction

Constraints are formally ranked in tableaux, which serve quite simply as two-dimensional representations of a grammar (a posited ranking of constraints). The theory posits that the generator (the human brain, for all intents and purposes) supplies an infinite number of potential outputs in its drive to supply an optimal candidate (i.e. one that best satisfies the constraint ranking). Note that, though intimidating, the word 'infinite' here may be vastly reduced in practice due to the limited nature of any given language's inventory and the natural limitations of the human vocal mechanism; the point is that human ingenuity—or laziness, or style—will try anything it can to satisfy both the constraint ranking of its grammar and itself at the same time. These potential outputs are arrayed vertically to the left and 'fed into' the tableau for evaluation of optimality.

To illustrate, let us return to the Obligatory Contour example from the previous section. Formulated as a constraint, we can rank the OCP above some Faith constraint. Faith here refers to the drive in language to maintain underlying contrasts posited to reside in the speaker's mental lexicon; Faith, in other words, oversees the maintenance of contrasts in language. By ranking the OCP above this Faith constraint, we formalize the fact that a particular language will alter an underlying segment rather than violate the Obligatory Contour Principle. In general, then, (adult) speakers acquire a full array of the

meaningful phonological contrasts in their language, contrasts which will surface fully whenever there is no higher-ranked markedness (or well-formedness) constraint that prohibits a contrast in a given position.

Now, general Faith is broken down into more specific constraint families targeting specific, Faith-defying processes such as deletion or epenthesis. Such division is necessary since some languages will epenthesize, for example, rather than delete to address an illicit surface situation, or vice versa. The constraint that bans segment deletion is formalized as MAX(IMALITY)-IO (C or V), interpretable as 'keep the maximum number of segments (either consonant or vowel) from Input to Output'. Where the OCP dominates MAX-IO (V), deletion of a vowel is permissible in order to prevent a violation of the OCP. For example, to avoid the illicit combination of a high vowel and a high glide noted above for Spanish, we see deletion of a high vocoid in the Spanish word *riendo* 'laughing' (cf. Sp *cayendo* 'falling' < {ka-} 'fall' root + {-jendo} pres.part.):

{ri-} + {-jendo}	OCP	MAX-IO(V)
a) rijendo	*!	
☞ b) riendo		*

Figure 1-7. Sp. *riendo* 'laughing' (Tableau 1).

Asterisks ("*") mark constraint violations. Violations of a higher-ranked (i.e. formalized in the tableau as more leftward) constraint occasion fatal violations, marked with the exclamation point ("!"). For example, candidate 1a (i.e. **rijendo*; NB: for expository economy, candidates in tableaux are referred to by the tableau's number and candidates letter) violates the higher-ranked OCP where 1b does not; this violation is therefore fatal. Upon a fatal violation, lower-ranked constraints are shaded for a candidate to reflect their irrelevance. Finally, note that the winning candidate, marked with the

pointing hand ("☞"), violates the lower constraint, which is therefore not fatal, since this constraint is less highly valued in the grammar.

Consider another possibility. Some other, hypothetical language might leave MAX undominated and down-rank DEP(ENDENCY)-IO(C), which militates against epenthetic segments. Such a grammar would favor a candidate that resolves the OCP violation with some inserted consonant. This is seen in Figure 1-8.

{ri-} + {-jendo}	OCP	MAX-IO(V)	DEP-IO(C)
rijendo	*!		
riendo		*!	
☞ riΔjendo			*

Figure 1-8. Unattested **riΔendo* (Δ = epenthetic consonant) in Spanish (Tableau 2).

One significant advantage of OT is that constraints are never turned on or off in a language, as parameters were in earlier generative theories. Rather, a constraint is always present in a language but only exerts influence if it is ranked higher than a competing constraint. Thus, high-ranked morpheme faithfulness constraints in Spanish outrank and thus thwart the OCP to allow for the surface realization of [ji] sequences that are banned tautomorphemically: *rayito* 'little bolt' < {ray-} 'bolt' + {-ito} diminutive. Constraints are violable: the OCP here is violated conditionally but is not at all turned off, as its influence morpheme-internally is clearly observed elsewhere.

The same feature would allow us to posit, for example, that onglides are moraic provided that they do not create a superheavy syllable. The ban on such a syllable, formulated as the prosodic markedness constraint *3μ in Kager (1999:268), would force violation of the Faith constraint that requires that the vocoid's mora be parsed. Assuming that we find some phonetic underpinning for our posture that palatals have a geminate structure, a similar type ranking might allow for the nonparsing of a palatal segment's

mora when in initial position. Indeed, it is the main thrust of this work to uncover phonetic motivations for constraints and rankings that prove valid not only for synchronic and diachronic processes in Romance but also for language change in general. This underscores the naturalness and predictive power of the Optimality approach.

I now briefly describe the concepts of Articulatory Phonology, which provides a lexicon for treating the complex articulatory effects associated with the Spanish palatals.

1.4 Articulatory Phonology

While much reference is made in this work to the features of segments and to feature-based models to capture the processes dealt with herein (see Chapter 2), another, more recent phonological model is also relevant to the discussion. This model, that of Articulatory Phonology (Browman & Goldstein 1986, 1988, 1989, 1992), is generally compatible with a featural approach, though it has both advantages and disadvantages (see Steriade 1990).

Articulatory Phonology (AP in the following discussion) posits that *gestures* are the basic units of phonological contrast. Gestures are defined as representations of the articulatory events that, orchestrated in the human speech process as *constellations*, make up utterances. Such events include constriction at various points in the voice tract (velic, tongue body, tongue tip, lips) and of varying magnitude or degree. Timing, both of a gesture's intrinsic duration and of its coincidence with other gestures, constitutes another important facet of this approach, one not envisaged in featural analyses. For example, /n/ comprises two gestures: full tongue tip constriction at the alveolar ridge and and velic lowering or aperture. The velic gesture coordinates with the tongue tip gesture differently according to the place of the nasal in the word: in word-initial position, velic gesture offset is more or less synchronous with offset of nasal constriction; while in word-final

position, velic offset coincides with the onset (beginning) of the constriction. This mistiming causes the nasalization of velum-lowering to effectively precede the stop occlusion and thus accounts for nasalization of a preceding, tautosyllabic vowel (see Krakow 1989).

AP provides another means of conceiving of the palatalization process: gestures are reorganized and coordinated with the gestures of preceding segments in what Browman & Goldstein call *gestural overlap*. For example, the tongue body raising that constitutes the gesture for the high vocoid /I/ is timed to coincide with the gestures for a preceding /l/ or /n/, thus accounting for the historical shift in the history of Spanish of L. ARANEA > **aranja* > Sp. *araña* [araɲa] 'spider'.

AP also provides an intuitive analysis of palatal blocking in V-to-V coarticulatory processes (see discussion in section 3.3.2), as well as the palatalization of velars before front vowels:

> In the case where consonants and vowels share the same [tongue body] tract variables…, the consonant and vowel gestures cannot both simultaneously achieve their target, since they are attempting to move exactly the same structures to different positions. As a result, the location (but not degree) of constriction achieved for the consonant will vary as a function of the overlapping vowel. (Browman & Goldstein 1992:165, citing Saltzman & Munhall 1989)

Since I posit that the palatal resonants of Spanish involve a vocalic element (see section 2.2.2.2), such untenable demands on articulators are predicted in situations of contiguous vowels and palatals. Coarticulatory blocking is the expected result.

Under an AP analysis, the weakening by approximantization of intervocalic obstruents would suggest that the degree of constriction of the consonant has lessened in the vicinity of vowels, which naturally display a lesser degree of constriction than

consonants (Browman & Goldstein 1992:164). We simply view this as assimilation in much the same way as it would be seen as a spreading of [+continuant] in feature-based theories. Similarly, the voicing of intervocalic voiceless stops—which traditional feature-based approaches would show as spreading of [+voice] to a voiceless intervocalic obstruent—is accounted for in the gestural approach with the spread of the glottal gesture of the stop to that of the vowels.

There is therefore a great deal of similarity between gestures and the more traditional features. As Steriade (1990) points out, many gestures match up closely and on a one-to-one basis with features. Indeed, for expository transparency, the feature-based approach is highlighted in Chapter 2. However, I include the AP model here to preface future reference to gestures in the analyses to follow. The inclusion of both models reflects the recognition of the advantages that each system brings to an adequate description of the processes under discussion. An important example of this is duration. Duration is better modeled in terms of Browman & Goldstein's gestures, which encompass both magnitude and internal duration. As we will see below, duration is a key distinguishing feature in the sound changes analyzed here. However, AP fails to allow separation of point of articulation from manner, which occupy separate nodes in most feature-based models (Steriade 1990). This means that AP predicts that all assimilations will necessarily involve both place and manner characteristics, which is not the case, as Steriade, citing Sagey (1986), points out (Steriade 1990:383). This is clear in homorganic nasal place assimilation: nasals readily assimilate in place to following fricatives but do not fricativize (as stop segments): Eng. *anthem* [an̪θəm]; Sp *encima* 'on top of' [en̪θima].

This said, I follow Lavoie (2002) and Kirchner (1998, 2002)—both of whom make reference to features and gestures—in not explicitly advocating one model over another. That is, I reserve access to both traditional features and gestures in my discussion and analysis of the phenomena in question. This approach is in essence licensed by the fact that I use the two models for descriptive, expository purposes only; the burden of proof in my analyses does not depend on any highly elaborated model. That responsibility falls rather to the Optimality framework, as discussed above.

1.5 Structure of the Dissertation

The dissertation is organized as follows. Chapter 2 develops further the theoretical assumptions underlying much of the following investigation. It provides articulatory and acoustic details of the segments under discussion and works them into the feature geometry model. This model is adopted to facilitate our discussion of the articulatory aspects of the palatals and their complex structure; note that where the moraic model has much to say about purely phonological processes, it fails to address phonetic processes due to a lack of consensus on what the precise auditory correlates of moraicity are. This chapter will show that a simplified feature geometry model along the lines of Padgett (1997), driven by constraints from the Optimality Theory framework, adequately describes the palatals and various aspects of their phonological behavior in terms of their articulatory complexity.

Chapters 3 and 4 trace the historical origins of the palatals. Chapter 3 takes advantage of the model of their structure established in Chapter 2 to inform our understanding of the rather extreme changes reflected in the evolution of these segments from Latin clusters. The sound changes are reconciled with the concepts of coarticulation and coproduction strategies, as well as with lenition, which is shown here to be rather

elusive in terms of hard, fast criteria. These observations motivate a new constraint (CONDENSE) to formalize the sort of assimilations posited to be responsible for diachronic palatalization processes.

In Chapter 4, the historical chain shift behind widespread degemination, voicing and spirantization in Western Romance is explained with recourse to acoustic data in the terms of Flemming's (2002) Dispersion Theory of Contrast. I show that the drive to lenite the Latin stop system conflicted with systemic demands to maintain meaningful and salient contrasts, resulting in loss of geminate stops in favor of singleton stops and approximants. The lateral and nasal geminates of Latin evolve under the pressure of similar conflicts, further mediated by the drive to condense the geminates. This leads to the innovation of a new palatal order in Spanish. I show that different outcomes in Portuguese reflect different resolutions of the same basic drives in the OT framework.

Chapter 5 addresses the concept of the palatals as geminate-type segments and explores their acoustic effects with an eye toward finding quantifiable phonetic evidence to underpin the posited geminate structure. It presents the results of a spectrographic analysis of these sounds in context, focusing primarily on their effects on preceding vowels. While measurements of vocoid durations across syllable types (light, heavy) are not helpful in support of the geminate analysis, consistent vowel lengthening effects are observed in vowels preceding the palatal segments in question. Additionally, an approach centered on coarticulatory F2 effects provides a means of explaining how these segments function as heterosyllabic clusters, hence quasi-geminates. Chapter 5 also advances the notion that the palatal glide might be susceptible to a similar analysis due to its own coarticulatory transition effects.

Finally, Chapter 6 provides conclusions and discussion of possibilities for future research. I suggest further empirical testing of the role of the palatals in native perception of licit stress assignment, and research into the behavior of palatal resonants /ɲ ʎ/ across Spanish dialects. I also point to recent work in phonetics-driven phonological models that underscores the validity of this work's claims.

1.6 Notes

1-This fortition process is also seen, interestingly, in Porteño dialects where coalescence has already taken place. That is, both segments, underlyingly /j/, are realized in onset position as alveopalatal fricatives. It may well be that the palatal glide patterns with the other palatal segments under consideration; see below. Chapter Six offers an OT analysis of this fortition process.

2-Casagrande notes the same for this segment in French (Casagrande 1984:106).

3–The geminate analysis of /r/ in Spanish was proposed by Harris (1983).

4-Casagrande (1984:111) posits a similar rule for underlying /ni/ in French; he derives [ɲ] from underlying /ni/ to explain the segment's absence word-initially, the fact that it does not nasalize preceding vowels, and other distributional anomalies.

5–Lenition is also held responsible for many of the extreme changes undergone in the history of these segments. However, varying concepts of lenition underscore the inadequacy of such an approach as vague or even simplistic. Fast-speech is in itself effortful, a fact any effort-based view of lenition (e.g. Kirchner 2001) must address. If features are simply deleted, then lenition (as a compensatory strategy to offset the effort of rapid transitions) might well be indicated. However, in situations where features are retained but condensed or adapted to faster speech/transitions, effort-based lenition does not adequately explain the changes. See Chapter 3 for detailed discussion.

6-While the feature geometry model is discussed below and in Chapter 2, the intuitive appeal of Lipski's model here perhaps warrants pointing out other theoretical flaws with feature-spreading type approaches as a means of controlling and predicting such changes. As Kirchner (2001:12-13) points outs, the model must employ two disparate devices to account for changes: both feature-spreading (for assimilations) and deletion of association lines (to account for loss). Moreover, when dealing with lenition processes, at least, the model alone seems to predict that lenition-oriented features (such as [voice] or [cont]) can spread almost indiscriminately between any two adjacent segments, which is certainly not the case. For these reasons, I primarily use feature geometry representations for descriptive purposes. Note, however, that

Lipski's (and Keating's) notion of the palatals as complex segments is well taken here and indeed will be significantly developed in the following chapters.

7 - It is important to point out that this effect was not seen in the evolution of Spanish, where diphthongization took place regardless of coda constituency: cf. Sp. ***tie**rra*. However, distributional evidence in modern Spanish largely supports the geminate analysis: strings involving heavy syllables (tautosyllabic vowel-glide and vowel-consonant sequences) are not found preceding a palatal sonorant onset: **-aiñ-, *-auñ-, *-eill-, *-eull-, *-anll-*, etc. As for the onglide of words like *tierra*, *cierro*, *criollo*, see discussion of speaker accommodation below.

8- Anecdotally, Spanish pop singer Rosa spontaneously reanalyzes *soñar* 'to dream' as [so**n**.**dʒ**aɾ] on a live recording from *Operación Triunfo*.

9-Quilis rather inexplicably differentiates here between lengthened consonants and geminate realizations. I abstract away from any (hypersubtle or imagined) distinctions between the two, considering a geminate and long consonants to be equivalent.

10- Thanks to Sonia Ramírez Wohlmuth for this observation. See Piñeros (2000) for further examples of weight-sensitive processes in Spanish truncation.

CHAPTER 2
THEORETICAL PRELIMINARIES

2.1 Introduction

In this chapter I propose and defend a representation of the palatals. As the complex nature of the segments in question, i.e. their feature makeup, is of prime importance to the analyses of their phonological behavior as geminates, a model illustrating that complex structure is an indispensable tool for our discussion. I therefore make much reference in this and following chapters to accepted models of segments, from which I borrow heavily to inform my own representation. I make particular use of the feature geometry model of the constituency and organization of the segment in order to illustrate the various processes. Additionally, some reference is made to gestures in the sense of Browman & Goldstein's (1986, 1988, 1989, 1992, *inter alia*) Articulatory Phonology, as discussed in Chapter 1. It is to be understood that these approaches serve primarily a descriptive function in the work and are not meant to provide an absolute means of testing the validity of the assumptions under consideration; the burden of proof here rests upon the Optimality framework. Note, however, that the role of models in generative phonology goes beyond mere description; the model, if correctly conceived, should inform the theoretical apparatus employed, be it rule- or constraint-oriented. Note, too, that the focus here is the articulatory complexity of the segments under discussion, posited to be the phonetic basis of the moraic structure described in Chapter 1. Thus, any reference to structural complexity in the following discussions is meant to apply to the articulatory and acoustic nature of the palatals and not to their quality as quasi-geminates.

In the following sections, then, I first provide a more detailed description of the relevant segments (/ɲ ʎ tʃ/), with an eye toward better situating them in the overall inventory of Spanish. Both articulatory and acoustic features are described, as both are key to an understanding of these segments' phonological behavior. A feature structure of the segments is then proposed. To this end, the feature geometry model utilized here is presented and defended, and the feature makeup of the palatals reconciled with the model. I show how the proposed model allows for a straightforward account of vowel harmony and, importantly, the blocking effect of palatal segments in those same processes. Finally, the OT framework is further elaborated upon to show how constraints bound and inform our model.

2.2 Characterizing the Palatals of Spanish

2.2.1 The Articulatory and Acoustic Nature of the Palatal Segments

2.2.1.1 The palatal nasal

Recasens (1990) provides copious detail on the articulation of both /ɲ/ and /ʎ/.[1] For the nasal, he notes that there is "complete contact" simultaneously at postalveolar and prepalatal zones, which might be taken to reflect the very large zone of contact of palatals in general. Keating (1991), in fact, emphasizes the raised, fronted tongue body generally required for palatal stops, noting the "extensive side-to-side and front-to-back lateral contact as for [j]" (Keating 1991:37-38). She observes that in palatals the tongue is both higher and more fronted than for [i], the tongue blade and front forming a very long stricture. Hence, we see a clear distinction between the vocalic nature of /i/ and the consonantal stricture of consonants involving the raised tongue body. Recasens (1991) cites multiple sources showing that the lingual contact involves the predorsal rather than

laminal (blade) portion of the tongue, which in his view is limited to the area including and just behind the tongue tip. Under this view, the tongue body must be seen as being fully engaged in the production of the segment. The tongue tip is lowered, tucked behind the lower teeth (Recasens 1991:271). Naturally, the velum is lowered to account for the nasality of the segment.

In terms of the acoustic characteristics of the /ɲ/, Recasens (1991) notes for Catalan that the nasal murmur (the damped effect caused by the open nasal passages of nasal sounds) shows a low F1 of about 250Hz, and high F2 and F3 components of between 2000 and 3000Hz. Quilis (1981) gives a significantly lower F2 for Spanish /ɲ/, just over 1600, though still notably higher than that of /n/. Importantly, however, and irrespective of actual frequency values, Recasens' (1991) data make clear that the F2 and F3 transitions for /ɲ/ are highly similar to those of palatals /ʎ j/, which are themselves similar to those of the vowel /i/: F1 250-300Hz, F2 2000-2300Hz, F3 2500-3000Hz. Stated more directly, there are striking similarities in the acoustic signatures of /ɲ ʎ j/, particularly as regards transitional effects on contiguous vowels.

2.2.1.2 The palatal lateral

Recasens (1990:271-2) describes the place of (lingual) articulation of /ʎ/ as "highly similar" to that of the nasal as described above. The main difference, he adds, has to do with degree of mediopalatal and postpalatal contact, with the lateral showing less such contact than the nasal. That is, the lateral /ʎ/ shows overall less posterior contact than /ɲ/, which may well be due, as Recasens notes, to the need to provide for the lateral passage of air for /ʎ/. Recasens (1991:317) also suggests that this lesser dorsal contact on the part

of the lateral may underlie its greater vulnerability to coarticulatory phenomena (see discussion in following chapter).[2] Despite this difference, it is clear that the acoustic similarities given in the preceding section stem from the extensive linguopalatal contact common to both segments. Both low F1, as a function of tongue height, and high F2, a function of tongue frontness/backness, are the expected acoustic results of the raised and fronted tongue body required for the linguopalatal contact of these segments. Formants are discussed in more detail below and in Chapter 4.

2.2.1.3 The palatal vocoid

The high front vocoid merits some additional commentary here, due to the important role it plays in the historical origins of the segments under discussion (see Chapter 3 for in-depth treatment). This segment was susceptible in Vulgar Latin to either a syllabic (vocalic) or non-syllabic (consonantal) realization depending upon the phonotactic context. For example, in L. IANUARIUS 'January', the initial segment would have been pronounced as an approximant [j] in Vulgar Latin and likely, through fortition, as a fricative [ʝ] or even an affricated [dʒ] (Penny 1991:53).[3] Similarly, any number of studies have posited that [i j] should be taken to be surface variants of a single underlying high vocoid cross-linguistically (e.g. Craddock 1980, Steriade 1984, Roca 1997, Chitoran 2001). Moreover, distributional evidence in Spanish suggests that the fricative [ʝ] can be included among the allophones of this phoneme. I therefore assume that the vowel [i], the glide [j] (shown to form part of the moraic 'nucleus' of a syllable; see Harris 1983; Hualde 1991), and the fricative [ʝ] stem from a common underlying segment, which I style /I/ here.[4] Along these lines, then, the palatal non-nuclear vocoid (called *yod* in Hispanic linguistics) shares all the features of the high front vowel /i/,

which I simply describe here as [+high], [-low], [+front], [+voice], [-consonantal]. The fricative, a product of positional fortition, shows greater stricture as a result of a more raised and fronted tongue gesture, in line with observations made by Keating (1991:37). In a cross-linguistic study, Recasens (1990:275) calls the segment a front palatal and provides more specific articulatory detail: [j] is articulated with the front of the tongue dorsum (body), and the tongue tip is always down. Constriction loci can vary from the front to the middle of the hard palate. The acoustic characteristics of /I/ were noted above in 2.2.1.1 and are clearly in parallel with those of /ɲ ʎ/.

2.2.1.4 The palato-alveolar affricate /tʃ/

Unlike its more limited congeners above, the affricate /tʃ/ is a relatively common sound in the world's languages (Ladefoged & Maddieson 1996:90). In Spanish, the affricate constitutes a phoneme (e.g. ***ch**ico*, *ma**ch**o*), the product of extensive historical sound changes that are dealt with in the following chapter. Note that its voiced congener [dʒ] arises only as an allophone of underlying /ʎ/ and /I/; the allophonic variation is posited to be the result of fortition processes that obtain in perceptually salient prosodic positions, in line with Beckman (1999), Fougeron & Keating (1997), Keating *et al*. (n.d.). /tʃ/ is particularly relevant to the diachronic aspect of the current study, as its historical origins seem to be part of a massive wave of related phenomena generally grouped together under the term 'palatalization' and dealt with in Chapter 3. As pointed out in Chapter 1, the affricate shares the distributional and phonotactic limitations of the other segments in question. Moreover, it figures with the others as well in the cohort of segments that seem to act as heavy onsets in the language.

Articulatorily, however, the affricate resists easy identification. In general terms, affricates fuse the characteristics of both stops and fricatives. Though represented as /tʃ/, the point of occlusion is posterior to the (dental) stop of Spanish, hence Ladefoged & Maddieson's palato-alveolar designation (cf. Recasen's 1990 postalveolar). The place of articulation of the fricative portion of the affricate is that of the fricative /ʃ/, again being postalveolar according to Recasens (1990). The degree of linguopalatal contact seems to vary among sources, as Recasens (1990:270) recognizes. /tʃ/ has a somewhat less extensive zone of contact than /ɲ ʎ/, not extending into the postpalatal zone, and tongue dorsum raising seems more variable. The lingual constriction is formed primarily with the blade, "with some possible involvement of the predorsum when the constriction extends into the prepalate" (Recasen 1990:270).[5] In effect, this segment is less purely palatal than the others, which may well account for its greater frequency in the world's languages.[6] The tongue tip is passive.

Acoustically, too, the affricate stands out. This is perhaps less due to its point of articulation than its manner: the affricate is an obstruent rather than a sonorant and as such does not show the formant structure common to vowels and sonorants such as laterals and nasals. However, as with all occlusives, formant transitions are in evidence prior to and following occlusion as the consonant is concatenated with preceding and following vowels. Quilis (1981:263) clearly states that the loci of transitions of /tʃ/ are the same as those of other palatals in Spanish. This accords with data in Recasens (1990) concerning the parity of the transitions of /ʃ/ with those of the other palatals.

2.2.2 The Palatals as a Class Apart

2.2.2.1 Palatals as complex segments

The anomalous behavior of palatals, as well as their relative markedness in language inventories, might be taken to indicate that they should be differentiated in some basic way from 'ordinary' segments. Indeed, Keating (1988) proposes that palatals should be considered complex segments on the basis of x-ray evidence, and Keating & Lahiri (1993) further argue that since both tongue blade and tongue body gestures are involved in the articulation of segments such as /ɲ/ and /ʎ/, they should be considered phonologically complex in the sense of Sagey (1986; cf. Clements & Hume 1995:253). Sagey argues that any segment requiring movements of two or more independent articulators should be considered complex; thus, since both the tongue blade and tongue body may be considered independent articulators employed separately for the production of other segments, the palatals are phonologically complex segments. Tuttle concurs: he asserts that Italian palatals are prone to simplification (loss of closure, nasality, laterality, or palatality) as a function of their complexity, being " composite articulations [affricates] and complex feature bundles [palatal sonorants]" (Tuttle 1997:28).

Recasens (1990), however, counters that independent control of all the tongue regions relevant to the (very large) area of possible palatal constriction is questionable and that collateral or incidental contact in other areas is perhaps inevitable in the production of (alveolo)palatals. That is, the raising of the tongue blade and the front dorsum should necessarily effect the raising of the entire tongue body. He also stresses that the blade is not actively involved in production of /ɲ ʎ/ and therefore should not be considered an active articulator.[7] Furthermore, Recasens & Romero (1997) cite

electromagnetic data that compares timing of gestures between known complex segments (Russian palatalized alveolar /nʲ/ clusters) and the alveolopalatal /ɲ/ of Catalan. They find that the timelag between the coordinated tongue blade occlusion and tongue body raising of /ɲ/ is considerably shorter than that of the Russian segment and infer from this that the alveolopalatal is not complex.[8]

This argument could well seem a primarily taxonomic one and not crucial to the present analysis. Standard geminates such as /tt pp/ do not involve independent articulators, nor do the partial geminates of homorganic nasal+C clusters; phonological complexity and moraicity are apparently not linked. I nevertheless follow Keating and Tuttle here in assuming the complexity of the palatals in question. Indeed, I ascribe the instability of palatals mentioned by Tuttle above to their very palatality, the monolithic nature of the tongue gesture required for their articulation. In a departure from Sagey (1986), however, I view the broad palatal contact over multiple regions of the tongue as being in and of itself key to palatal phonology, irrespective of the issue of independent control. It may well prove that the structural complexity of these segments—whether geminate (moraic) or not—is our best means of understanding their apparently anomalous phonological behavior (see below and Chapter 4).

2.2.2.2 The vocalic characteristics of palatals

Whatever the stance one takes on the structural representation of these segments, one common point to be taken from all of the studies and observations made of the segments in question is that they comprise movement of the entire tongue body (dorsum). Phonologically complex or not, it seems clear that the palatal segments represent a fusion of both consonantal and vocalic characteristics. Recasens (1990) asserts as much with

reference to the role of palatals in coarticulatory effects; he cites the well-attested coarticulatory 'distance' effects seen between vowels in VCV sequences in the work of Öhman (1966). Öhman finds that in V_1CV_2 utterances in English and Swedish, the articulators begin moving toward configurations appropriate for V_2 toward the acoustic end of V_1 before the consonant occlusion is achieved.[9] Importantly, Ohman does not find similar effects in Russian and theorizes that this weak V_1-to-V_2 effect is due to the well-known Russian contrast of palatalized and non-palatalized consonants; since tongue body position is crucial in distinguishing these two sets of consonants, Russian speakers are simply not free to let tongue body be influenced by V_2 before the intervening consonant has had 'its turn' with this articulator. Choi & Keating (1991) find corroborative evidence to this position; that is, their studies show very limited V_1-to-V_2 effects in Russian, as well as in Polish and Bulgarian, two other Slavic languages with palatal-nonpalatal contrasts.

In the same vein, then, Recasens (1990) notes the blocking effect palatals exert over similar coarticulatory influences in Catalan. To explain this more explicitly, he cites Perkells' (1969) distinction between the extrinsic muscles governing vowel gestures (and hence vowel harmony) and the intrinsic muscles that govern the consonantal constriction. He conjectures that the palatal gestures may well involve the former, external muscles, hence their blocking effect on VCV coarticulation, and concludes that "the case of the [palatal] consonants analyzed here may prove that the distinction between vocalic gestures and consonantal gestures is especially true for a subset of consonants only" (Recasens 1990:278). Byrd (1996:233) also notes the resistance of tongue body gestures

to ‘overlapping’ by tongue tip articulations, while tongue tip articulations are themselves readily overlapped by those involving the tongue body.

Further evidence of palatal blocking is found in Korean vowel harmony (Davis 1994:39). In Korean, a process of umlaut fronts V_1 in V_1CV_2 sequences when V_2 is a high front vowel, but not when a palatal consonant intervenes:

	/ak + -i (nominalizer)/	> ægi ‘baby’
BUT	/kac^h + -i (nom)/	> kac^{h}i (*kæc^{h}i) ‘value’

Figure 2-1. Korean umlaut and palatal blocking

Davis goes on to point out that both geminates and long vowels also block umlaut in Korean and formulates the generalization that umlaut only applies if the target vowel is in a monomoraic syllable. He does not refer to the palatal consonant effect again in his discussion, however, nor does he make plain (in phonetic terms) why it should pattern here with geminates. Though I too argue that palatals exhibit geminate structure, it is not clear how that structure is instantiated phonetically. At this point, then, I would simply point out—as Davis, citing Hume (1990), does as well—that palatals display behavior that reflects a vowel-like component, sufficient to occasion blocking of vowel harmony processes. While Davis adduces Hume’s (1990) concept of the palatal’s being specified for a V(owel)-place [coronal] feature, I prefer to view this vocalic element as, quite simply, the tongue body raising gesture that accompanies the palatal segments, as formalized in my model under the VP node (see section 2.3.1 below). Given that palatal /c/ blocks Korean umlaut where alveolar /t l n/ do not (Davis 1994:39), tongue body involvement seems clearly implicated.

In a very real sense, the variability of the high vocoid noted above—evident in its phonotactically dictated triple role as syllable nucleus (vowel), marginal element (glide),

and onset (consonant)—predicts that the palatals might well demonstrate both consonantal and vocalic traits. Indeed, the cross-linguistic markedness of palatals in general, and particularly of lower-sonority palatal obstruents (excepting affricates; recall discussion in note 6), seems to confirm their singular status. We may thus speculate that palatals could be cross-linguistically dispreferred for two reasons. As 'monolithic' gestures blocking the assimilatory process of V-to-V coarticulation, the palatals hobble the sort of articulatory streamlining that metaphony effects represent. Additionally, sonority sequencing that militates for optimally steep gradients between lower-sonority consonants and high-sonority vowels in CV sequences might be undermined by the quasi-vocalic features of the palatal segments. This second point will be explored more fully in the following chapters. At present, though, I focus on the model of palatals to be adopted for our discussion of palatal behavior. The framework and model proposed below provides the means of formalizing the articulatory characteristics of the palatals discussed above.

2.3 Feature Geometry

2.3.1 Previous Models

Feature geometry (Clements 1985; Hume 1992; Clements & Hume 1995) refers to a model of segmental content that allows change to be analyzed with reference to particular features of the segment rather than to the entire segment. Feature geometry grew out of work in autosegmental phonology (Goldsmith 1976), which had first posited a three-dimensional model in which features are active in tiers that may act independently of each other. For example, in homorganic nasal place assimilation (cf. Eng. *anthem* [a**n̪**θm̩] ~ *ankle* [a**ŋ**k̩]), the nasal assimilates to a following consonant, but only in place

of articulation; neither voice nor nasality is affected. By conceiving of these features as lying on different tiers that act autonomously of each other (hence, features as autosegments), autosegmental phonology actually predicts that nasal place assimilation should occur. Feature geometry expands upon the autosegmental approach by organizing the tiers in a hierarchical system of nodes that serves to further predict and constrain how segments may interact through assimilation. For example, by assuming a hierarchy, feature geometry claims that changes involving a major node (see model below) will necessarily involve the adoption of any dependent nodes as well. These dependent nodes, however, may locate features that are free to spread to neighboring segments without entailing any alteration in higher structure in the model. Moreover, by locating certain features at a common node, one formalizes the fact that particular features often pattern together in their phonological behavior; neutralization, for example, of the laryngeal features of voicing and aspiration—as in word-final position in some languages—supports the assignment of these features to a Laryngeal (non-oral) node in feature geometry models (see Clements & Hume 1995 for further discussion). The model predicts then that some processes will entail whole groups of features—as organized under a major node—or only a particular feature located under a minor, dependent node. The intuition that features pattern together almost like natural classes (or "higher-level functional units" in Clements & Hume's 1995 terms) in some phonological processes was implied early on by Trubetzkoy (1939); feature geometry expands strongly upon that intuition with its hierarchical approach. In effect, only those features that form a constituent under a common node are expected to participate together in phonological

processes such as assimilation. Figure 2-2 illustrates one commonly accepted feature geometry model.

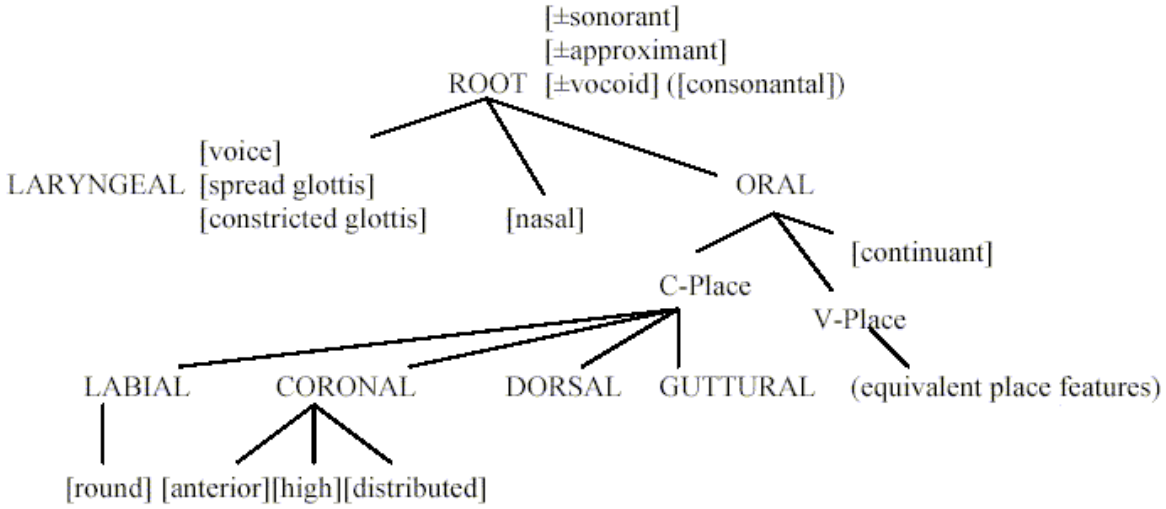


Figure 2-2. Partial feature geometry model (adapted from Clements & Hume 1995:292, fig. 62)

The placement of major place features (LABIAL, CORONAL, etc.) at terminal nodes in this model predicts the possibility of place assimilation without any entailed assimilation at higher nodes. The feature geometry model thus represents the homorganic place assimilation mentioned above. We see the depiction of nasal place assimilation in the figure below. Note that the [nasal] feature is not shown here, as we focus only on oral effects.

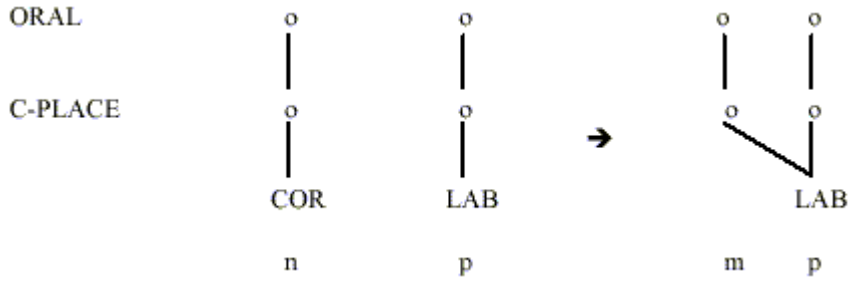


Figure 2-3. Nasal place assimilation (adapted from Spencer 1996:157, fig. 5.6)[10]

We see then that the spread of place features within the Oral node allows for homorganic nasal place assimilation without concomitant nasal or voicing effects. This is straightforwardly explained due to the lack of activity at the 'sister' node where [nasal] is located (its own node in this model) and Laryngeal (dominating [voice]).[11]

In this work, I will use a modified, indeed simplified version of this model, primarily following Padgett (1995). Padgett focuses on oral stricture, and his model does away with the Oral node in favor of the Place-dominated articulator group. Importantly, he assigns the feature [continuant], which we see above in Figure 2-2 under the Oral node, to the individual articulator nodes, making [cont] a dependent feature of each place of articulation:

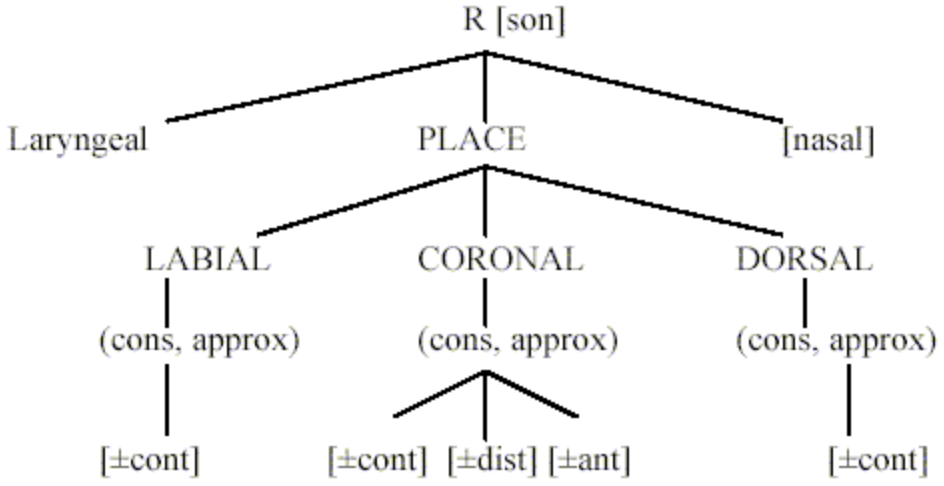


Figure 2-4. Feature geometry model (adapted from Padgett 1995:17, fig. 15)

Note that Padgett's model also moves [consonantal] and [approximant] from the former Root node and bundles them beneath each individual articulator (shown parenthetically in the model). Bundling these features together formalizes the fact that they do not act independently in phonological processes. Moreover, the move of [cont] to an end node beneath each articulator is based on facts of vocal tract physiology: the features [cont],

[cons], and [approx] are implemented by the oral articulators; for example, the intrusive stops that commonly arise in such words as *prince* [prin**t**s] and *hamster* [ham**p**ster] share place, [cont], [cons], and [approx] features with the preceding nasal (Padgett 1995:15-6). Perhaps most importantly, linking [cont] directly to place nodes eliminates a certain discrepancy between the phonological and phonetic representation by locating oral stricture with the articulators. In this way, the model resolves a major difference between feature geometry models and the gestural score of Brownman & Goldstein (e.g. 1989), whose model fuses oral stricture location and degree directly in the model, as discussed in section 1.4 of Chapter 1.

Padgett presents other arguments for including [cont] under the individual Articulators. Following observations made by Steriade (1993) on data from Venda and Rwanda, he points out that 1) there is never a distinction made between nasal-fricative and nasal-affricate clusters (cf. English *answer* [an**s**əɹ] ~ [an**ts**əɹ]), and 2) fricative ~ affricate distinctions are lost under nasal place assimilation (cf. English *mansion* [mæn**ʃ**ən] ~ [mæn**tʃ**ən]. He concludes, as had Steriade (1993), that an accurate representation should therefore not distinguish nasal-fricative from nasal-affricate clusters. His model, seen in Figure 2-5a below, accomplishes this. Viewing such clusters (e.g. /nz/ or /mv/) as tantamount to affricates ([ndz], [mbv]), the Padgett model accurately models (and thereby predicts) their lack of distinction, differently from standard models that put [cont] on a different node in the model (Padgett 1995:52-4). The more standard model that makes manner features ([cont] here) a sister node to Place would predict a distinction between nasal-fricative and nasal-affricate clusters by permitting both [-cont] and [+cont] to be appended to the Root node, thereby percolating throughout the

segment. However, nasal continuants are generally ill-formed in languages, as modeled in Figure 2-4b.[12]

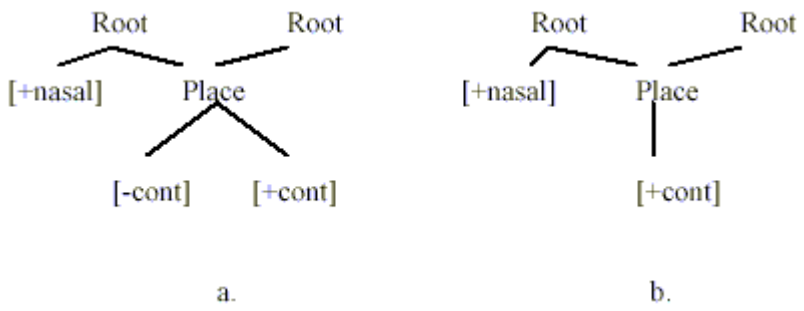


Figure 2-5. Nasal-fricative/nasal-affricate representation. a) Licit nasal affricate. b) Illicit nasal continuant (Padgett 1995:54, fig. 52).

Now, by discarding the C-place and V-Place nodes of earlier models, Padgett's model also seems to assume that vowels and consonants arise as products of the same articulators and features. This alteration has an intuitive appeal in that clearly all human sounds emerge as products of the same general apparatus. However, by assuming that the same articulators account for vowels and consonants, one misses an important distinction between the two classes of sounds: vowels are not products of oral stricture *per se*, but are rather the results of modifications to the shape of the phonating cavities (oral, pharyngeal, laryngeal) as resonating tubes. This concept of vowel production has been formalized as the source-filter theory (Fant 1960; see Ladefoged 1996:103-5 for a brief discussion). Hence, where oral stricture at specific places of articulation accounts for the wide range of consonants in human language, vowels are more general, less place-specific than consonants, and intuitively we would prefer to see the model reflect these fundamental differences in vowel/consonant production.[13] Moreover, coproduction models of coarticulation (e.g. Fowler 1980, Fowler & Rosenblum 1989; see also Öhman 1966) associate consonants and vowels with independent, indeed autonomous articulatory

strategies that overlap over time (Fletcher & Harrington 1999:169; see the following chapter for a fuller account of coarticulation and coproduction strategies). Our model should address this basic difference. Finally, the fact that secondary articulations (commonly from glided high vocoids /j w/) are available in many languages suggests that there must be some means of describing a natural class of vowels and consonants with vowel-like components. Such consonants include the palatal class, or at least the palatal sonorants that are treated here (see fuller discussion in Chapter 3).

I therefore turn to work by Lahiri & Evers (1991). Specifically addressing palatalization processes, Lahiri & Evers (1991) seek to improve upon earlier feature geometry models (Clements 1985, 1989; Sagey 1986; Hume 1990). The trick was to offer a model that allows for common features (thence spreading) among high vocoids and (alveo)palatal consonants in order to account for the feature spreading that characterizes the various palatalization processes, while also grouping those features in such a way as to accurately predict which groups of sounds should act as natural classes in other phonological processes. Lahiri & Evers' (1991) model attempts to avoid the redundancy of having the same features twice displayed under different nodes (C-Place and V-Place; see Figure 2-2 above) of Clement's (1989) work by positing a single Articulator node under which both vocoids and consonants could be represented by a unitary set of features. This involves maintaining a [coronal] specification for both coronal consonants and front vowels (though not on separate tiers, importantly). Further, they supplement the model with a separate Tongue Position (TP) node that allows for the delimiting of the natural class of segments that participate in the palatalization processes, including both (alveo)palatal consonants and high vocoids. That is, coronal consonants, front vowels,

and yod are all grouped under the same Coronal node, while keeping the traditional [high] and [low] features on the separate TP node. The model used by Hume (1990), similar to that seen in Figure 2-2 above, separated a Consonant from a Vowel Place node, creating the kind of formal redundancy that Lahiri & Evers here try to resolve. That is, while Hume (1990) posits a [coronal] feature for both C-place and V-place, here the model assumes it to be the same feature under the same Articulator node, with other features determining whether it forms part of a consonantal or a vocalic segment.

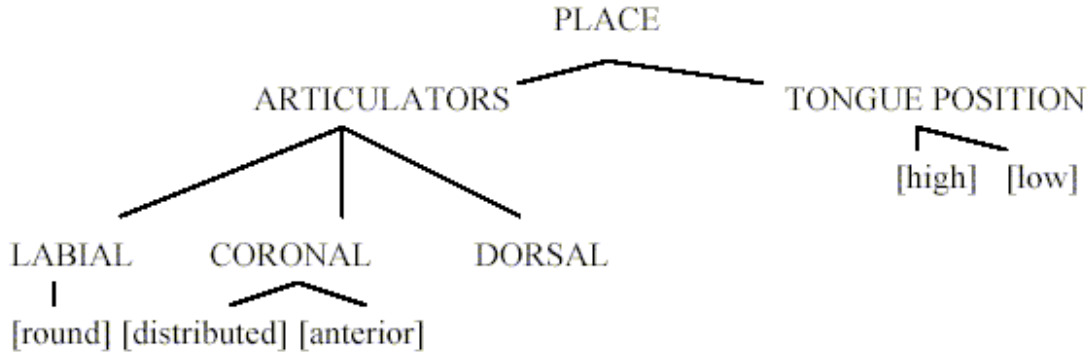


Figure 2-6. Lahiri & Evers' (1991:87, fig. 8) feature geometry model (PLACE node only)

With Lahiri & Evers' model, a change such as /n + j > ɲ/ (as observed in the history of Spanish: L. HISPA**NI**A > Sp. *Espa**ñ**a*) can be represented as the spreading of [-anterior] under the Coronal node to the preceding nasal, which as an alveolar would be [+anterior]. This is illustrated in Figure 2-7 below. The result is a complex nasal segment with a [-anterior] coronal (i.e. palatal) place of articulation and the vocalic "[j]-like off-glide" associated with palatalized consonants (Lahiri & Evers 1991:94; also Recasens & Romero 1997:58). This account accords with other treatments of the nasal and lateral palatals (Keating & Lahiri 1993, Wireback 1997). For instance, Recasens (1990) categorizes these segments as alveolopalatals, with predorsal contact in both the

postalveolar and prepalatal zones. Note that the palatal lateral would be similarly analyzed in this model.

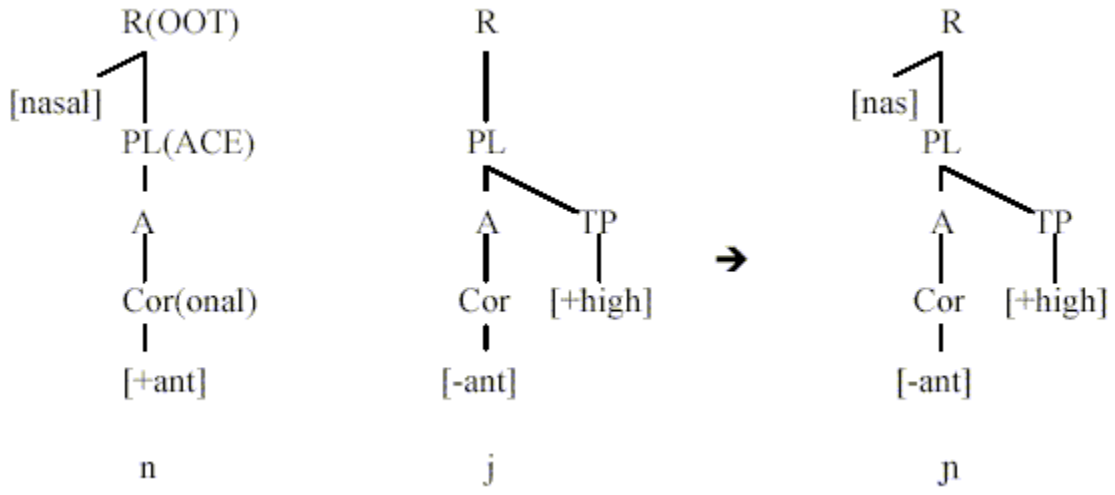


Figure 2-7. Palatalization of /n + j/ sequences

Hume (1994) however, challenges this approach, claiming that the use of [high] as the trigger for palatalization seen in Figure 2-7 is ill conceived. Her own approach focuses on [coronal] as the trigger. Hume sees coronalization as the process responsible for change in place of articulation of consonants under the influence of a front vowel. In Hume's account, both Palatalization (the addition of a palatal component to a 'base' consonant, as in many Slavic languages) and Coronalization (as in velar fronting) are characterized by the spread of [coronal], and like Lahiri & Evers, she posits [coronal] as a feature common to both coronal consonants and front vowels. Her view conceives of palatalization as the spread of the [coronal] feature from the vocoidal trigger to the preceding consonant, with the features [coronal, -anterior] "retain[ing] their original vocalic status by linking to interpolated vocalic structure on the target [consonant]" (Hume 1994:140). On the other hand, in Coronalization (such as k > tʃ / __ j) these same features undergo a shift from vocoidal to consonantal, occasioning the change of the

target's main articulator to [coronal, -anterior] (i.e. velar > coronal alveopalatal affricate). The latter action requires that a parameter controlling constriction status be switched on, and indeed, Hume points out (p.143) that her proposed Coronalization process is a marked one in light of its complexity, in least in comparison to Palatalization; that is, the change of vocoidal features to consonantal in Coronalization, as well as the fact that it involves two operations—spreading and delinking—makes Coronalization a more complex and thus more marked event than palatalization.[14] Note, too, that Hume distinguishes between palatal consonants and palatalized consonants: in her approach, palatal consonants have no vocalic specification; that is, they are [+coronal, -anterior] segments with no [high] attached.

In fact, Hume's objection to Lahiri & Evers' approach is not entirely well taken. These researchers clearly provide for the two processes that Hume dubs Coronalization and Palatalization, which Lahiri & Evers simply consider two different aspects of the palatalization phenomena.[15] Her main objection has to do with the default specification for glides, which Lahiri & Evers suggest is [coronal] and which she submits may well be [high]. I avoid delving deeply into these arguments, as I ultimately reject the notion that front vowels should be considered [coronal] at all. On the other hand, Hume's arguments concerning the sole use of [high] as the triggering feature are convincing; cases where non-high vowels trigger palatalization (her Coronalization) reveal the problem.

In one point, however, both analyses may be at a disadvantage, and this proves relevant to the issue of the use of [high]. Hume's Coronalization refers primarily to the fronting of velars cross-linguistically, a process which typically produces coronal affricates. Lahiri & Evers' clearly describe how this mechanism reflects spread of

[coronal] and [-anterior], similarly to Hume's approach. However, if we consider data from Old French, we identify a problem. A word like L. CENTUM [ken.tum] gave Old French *cent* [**ts**ẽnt] (Pope 1934). Under the view that palatal affricates—modeled as [COR, -ant]—derive from the spread of [coronal] and [-anterior], we could only expect the alveopalatal /tʃ/ rather than the dental affricate here obtained. The problem then is with the [-anterior] specification, since Old French data clearly have the velar shifting forward to dental affricates, which would require the [+anterior] specification. Yet both Hume and Lahiri & Evers suggest that the coronal node spreads along with the dominated [-anterior] specification, accounting for alveopalatal affricate /tʃ/.

The preceding discussion should make it clear that no real consensus has been reached concerning the means of representing the consonant-vowel interactions at hand. In fact, this debate underscores a general problem with phonological models: abstracted, static structure is imposed on naturally plastic and gradient phonetic effects that might more easily and intuitively be captured without recourse to an elaborate model. This does not prove problematic for the present analysis, however, for two principle reasons. First, as has been mentioned, the burden of analysis and proof in this work lies with Optimality Theory. Constraints and constraint interaction are posited to drive the palatalization processes and will be invoked to supplement and inform the model employed. Second, and related to the first, one main goal of this dissertation is the integration of hard phonetic data—both articulatory and acoustic—with the phonological analysis. One advantage of such an approach, it is hoped, is a relatively practical bent that aims to provide clear ('real time') motivations, whether production- or perception-oriented, to the sound changes in question. As such, the work seeks to further the phonetics-phonology

interface with a view to providing readily comprehensible and practical explanations for what have traditionally been intractable (or intractably abstracted) phenomena. OT, with its emphasis on constraints grounded in cross-linguistically and phonetically motivated facts, is well-suited for such work.

2.3.2 The Current Model

2.3.2.1 Incorporating the Tongue Position Node

With the preceding debate in mind, I adopt a model that benefits from all of the above discussed, while also stripping down the model somewhat in order that it be of greater functionality for expository purposes. In this I follow Flemming (2002), who suggests that Hume's assignment (and Lahiri & Evers', for that matter) of a [coronal] feature to front vowels is counterintuitive and forced in light of relatively clear articulatory facts: front vowels are not coronal, nor are they the products of coronal stricture.[16] He instead points to more indirect physiological facts to explain the palatalization process, stressing the articulatory linkage that requires (quite simply) that the tongue blade follow the tongue tip; that is, coronal stricture gestures require the tongue to be somewhat fronted, such that a [-distributed] (i.e. apical) coronal consonant must necessarily pull the tongue blade along behind it. Very matter of factly, then, Flemming accounts for the patterning of coronals with front vowels in some processes, yet without assigning coronal stricture features to vocalic segments.

In terms of the model, then, I return to Padgett (1995), as above, but with the adoption of the TP node of Lahiri & Evers. However, I adapt the TP node to govern all vocalic features and thus rename it the Vowel Position (VP) node in order to allow for labial effects.[17] In this way, Hume's Vowel-Place node reappears but without an identical

complement of consonantal features and without being dependent on the Consonantal node. This reflects the fact that vowels are products of different articulatory strategies.

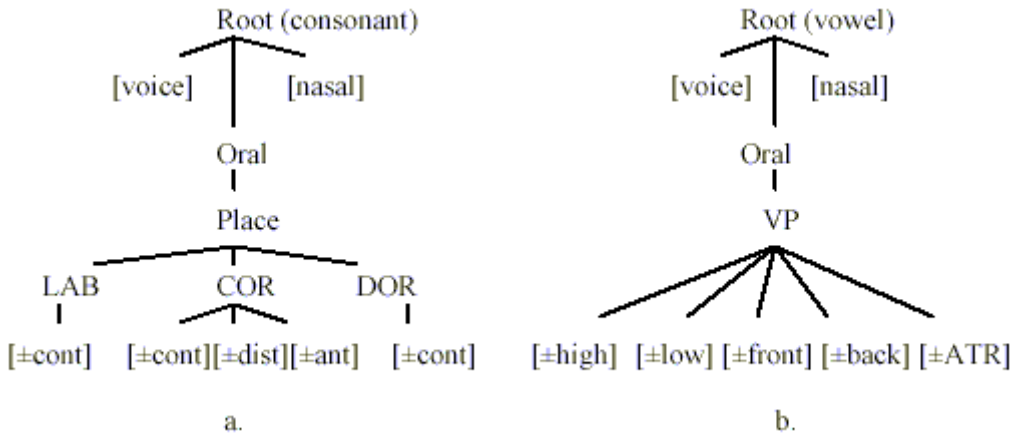


Figure 2-8. Amended feature geometry model with VP node. a) Consonantal features. b) Vocalic features.

While it is true that this model may well predict processes that are unattested, I stress again that I have abandoned the idea of a highly elaborated model; that is, given the above debate, I have opted to rely on the model for descriptive, expository value while leaving the licensing of exceptional procedures to the Optimality Theory framework. This does not seem any more problematic than invoking parametrization or rules to supplement earlier models; indeed, rules have always been used as an intrinsic part of the feature geometry platform.

This model is equipped to offer straightforward descriptions of all vowels and palatal segments in question:

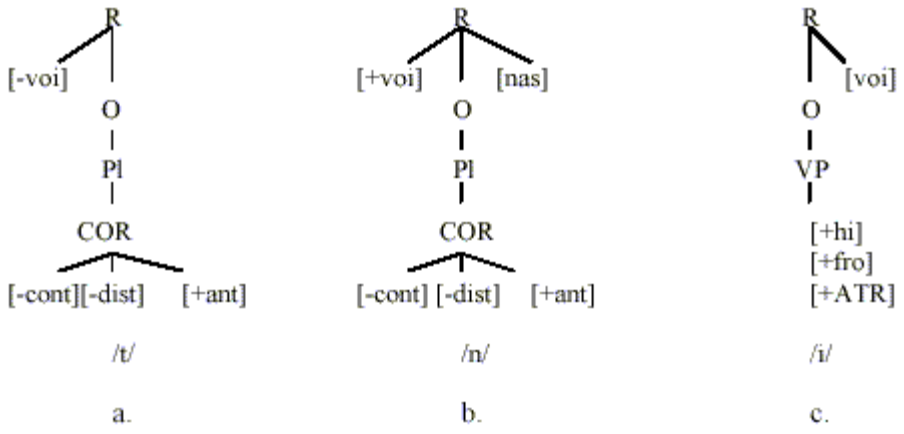


Figure 2-9. Feature representations. a) Coronal /t/. b) Nasal coronal /n/. c) Palatal vocoid.

In order to represent Hume's Palatalization, then, we see that the VP node of the vowel spreads to form part of the preceding consonant. Thus, Figure 2-9b above links with (c) (to produce Figure 2-10c below) in what seems a 'classic' feature geometry operation. Note, though, that this requires a wholesale shift of [+ant] to [-ant]:

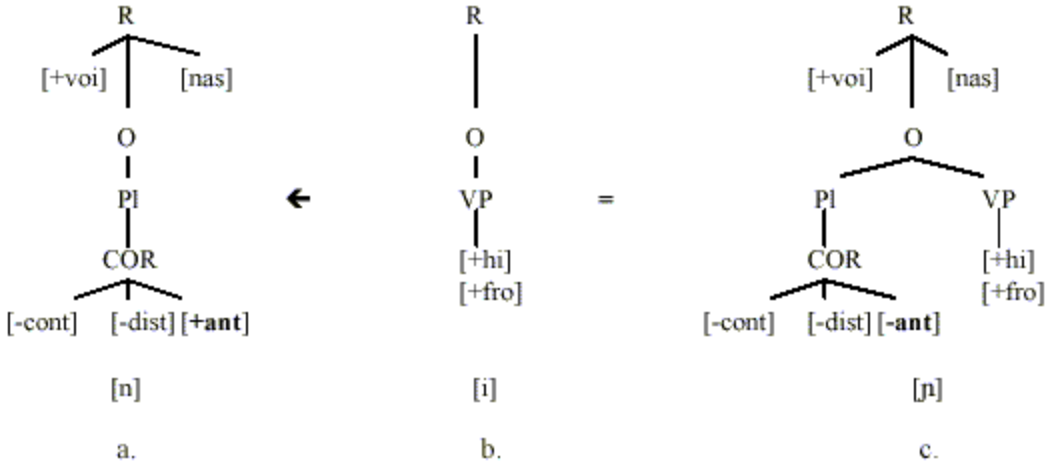


Figure 2-10. Palatalization of /n + j/. a) Structure of /n/. b) Structure of /I/. c) Structure of palatal nasal /ʎ/.

The result is a segment with both consonantal Place features and vocalic features under the Oral node. The [+anterior] specification becomes [-anterior] under a constraint barring vocoids from being [+anterior], justifiable in physiological terms since vowels are

not produced at or before the alveolar ridge. Note that if we assume that the VP node represents an independent articulator in its own right, then this segment is indeed complex in the sense of Sagey (1986), in line with our previous discussion.[18] This issue is discussed more fully further below. Now, however, I present evidence of the usefulness of providing a separate VP node in which palatal segments also take part.

2.3.2.2 The VP Node and vowel harmony

A model providing for a wholly independent vocalic node allows for a straightforward (and intuitive) treatment of vowel harmony processes. More importantly, as we see below, the treatment also explains the role that palatals can play in such processes, where they often act to block them. I illustrate this in the following sections, beginning with Montañés vowel harmony (Penny 1969; McCarthy 1984).

Montañés vowel harmony. Certain dialects of the north-central region of Spain (Santander province) demonstrate intriguing vowel harmony processes. Penny (1969) provides evidence of two distinct phenomena in the *Pasiego* (from the Montes de Pas) speech. The first involves the harmonizing of all vowels in certain words to laxer, more centralized variants that seem to make up a distinct, alternate vowel system alongside the more widely attested 'standard' one, which is virtually identical to the five-vowel system of Castilian. The dual systems are shown below. Note that I follow McCarthy's (1984) convention of using capital letters to represent the centralized, laxer vowels. Approximate IPA values are included parenthetically.

i		u	I (ɪ)		U (ʊ)
e		o	e		O (ɵ)
	a (ɐ)			A (ɜ)	

Figure 2-11. Pasiego vowel systems. a) Standard five-vowel inventory. b) Alternate lax vowel system.

The IPA equivalents given in the top tier of Figure 2-11b are in complete accord with Penny's descriptions (p.149). In the second tier, the use of [ɵ]—a rounded schwa, in essence—for 'O', generalizes somewhat. Penny describes a sound similar to French /ø œ/ (front rounded mid vowels), but without lip protrusion; here I assume that description to approximate [ɵ]. The low vowel is described as fronted and raised, 'almost [ɛ]', which very nearly matches the [ɜ] used above; the more central [ɜ] jibes with this alternative cohort's description as 'centralized' variants. Note too that /e/ retains its value in both systems, a fact that I return to below.[19] Examples of alternations illustrating the alternate systems follow:

tense	lax
a) soldáus 'soldiers'	sOldÁU 'soldier'
b) kastáɲus 'chestnut trees'	kAstÁɲU 'chestnut tree'
c) puʎúkus 'young chickens'	pUʎÚkU 'young chicken'
d) pustíya 'scab'	pUstÍyU 'little scab'
e) trípa 'belly'	trÍpU '(child's) belly'
f) gulundrína 'swallow (fem.)'	gUlUdrÍnU 'swallow (masc.)'

Figure 2-12. Pasiego tense/lax vowel contrasts (from McCarthy 1984:293-4).

The data in Figure 2-12 show that the lax variants only surface in singular masculine nouns (and masculine-marked adjectives). McCarthy (1984) analyzes the [-tense] feature as a morpheme unto itself, marking the singular of masculine 'count' (as opposed to 'mass') nouns (Figure 20a-c), and the masculine (and often diminutive) of certain feminine nouns (Figure 20d-f). The [-tense] characteristic, localized to the final, gender-marking theme vowel of nouns, spreads without exception to all other vowels in the word (McCarthy 1984:316). Note that the morphological nature of this vowel harmony is irrelevant to our purposes here, however; we are more concerned with the mechanics of vowel harmony itself, irrespective of its grammatical motivation.

A second vowel harmony process is seen in height harmony between tonic and atonic vowels in words. This process occurs far more widely than that seen above (but is not without exceptions; see below). In general, all (non-final) atonic vowels agree with the tonic vowel in its specification of the feature [high].[20] Thus, in Figure 2-13a below we see that all vowels harmonize to the [+high] specification of the tonic /i/, while in Figure 2-13b the initial (back) vowel shows similar harmony. Note that the /a/ does not respond to the process and is effectively neutral, neither creating harmony domains nor harmonizing itself.[21] This is understandable under an analysis of /a/ as [-high, +low]: since the harmony here is conceived as the spread of [high] only and since a segment cannot be both *[+high, +low], harmony of /a/ to high vowels is barred. Also, any harmony between [-high] mid vowels is satisfied vacuously, given the low vowel's specification. Finally, in Figure 2-13c, we see that mid vowel harmony is also attested.

a) bindiθír 'to bless' (cf. Sp. *bendecir*)
b) kumída 'lunch' (cf. Sp. *comida*)
c) belorta 'hay-rake' (Sp. *vilorta*)

Figure 2-13. Pasiego vowel height harmony.

In sum, then, we see two vowel harmony processes in Pasiego dialects that reflect the spread of two different features: [tense] (in McCarthy's (1984) analysis) and [high]. It is clear from the attested data that consonants are in general transparent to the process, once again making manifest that vowels and consonants should be treated as operating on separate tiers in our model. We see the featural spread of these processes then as an assimilatory process whereby consecutive vowels line up with respect to particular features that reflect tongue body posture. This clearly facilitates the concatenation of segments in the stream of speech: a string such as Pasiego *kuʃirín* 'cow-bell collar'

(Penny 1969:151) must be viewed as articulatorily facilitated vis-à-vis the Spanish homonym *collarín* 'orthopedic collar'; tongue height remains constant throughout the first word, while it must undergo adjustments in the second.

Now, McCarthy's (1984) analysis was based on the feature [tense]. Here I adopt the Advanced Tongue Root' feature ([ATR]) here in lieu of [tense]—an option that McCarthy himself recognizes as feasible—since it more clearly targets lingual posture. [ATR] allows the differentiation of such vowels as Eng. /i ~ ɪ/ and /e ~ ɛ/; the first member of each pair is [+ATR], reflecting the advanced, tensed positioning of the tongue required for each, while [-ATR] characterized the laxer second members. Again, then, harmony along the lines of [ATR] must positively impact articulatory coordination, as the tongue root is not required to shift back and forth during the production of the word.[22] Such feature-spreading is clearly predicted by a model that posits a separate vocalic node as is here put forth.[23] It also informs our assignment of features to this node. To account for the present data, we must minimally have VP dominate the features [ATR] and [high] ~ [low]. In both processes, feature-spreading takes place through the transparent consonants (parenthetically isolated) in a straightforward manner. ">>>" denotes "assimilates to", as such featural spread must be viewed as an assimilatory process. Both processes are shown below in Figure 2-14. Note again that I do not seek here to account for all the minutiae of the phonological processes discussed through the model; that is, the model as adopted here cannot (and is not expected to) predict or delimit all possible interactions. I rely on OT as the framework that ultimately motivates the processes illustrated by the geometry above. This allows a simpler model to be put forth here and

recognizes the limitations of an articulator- and (importantly) feature-based model to explain processes that may also be the result of acoustic and perceptual phenomena.

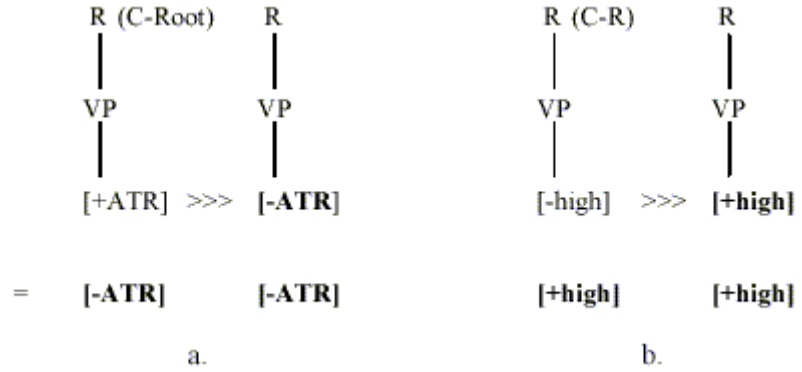


Figure 2-14. Pasiego vowel harmony processes. a) Laxing harmony. b) Height harmony.

Palatal influences in Montañés vowel harmony. In contrast to most consonants, however, palatal consonants do apparently impact the vowel harmony processes. Penny (1969:153) notes that mid vowels /e o/ do not generally appear before palatal consonants /tʃ ɲ ʎ/, just as they fail to appear before *yod* and *wau* (the names in Hispanic linguistics for the front and back high glides, respectively, as non-nuclear vocoidal elements). In fact, Penny points out that words with glides and palatal consonants may exhibit otherwise unexpected mixing of mid and high vowels. This is observed in Figure 2-15, where the stressed mid vowels do not spread their height features to preceding vowels. Rather, the affected vowels show harmony with the height of the intervening palatal.

a) **li**tʃón 'suckling pig' (cf. **lé**tʃe 'milk')
b) rem**u**ɲwélu 'coarse meal' (cf. rem**o**ywélu 'coarse meal')
c) bi**ʎ**óta 'acorn' (cf. Sp. *be**ll**ota*)
d) m**u**ljénda 'act of grinding' (cf. m**o**lér 'to grind')

Figure 2-15. Height harmony as triggered by palatals and glides (Penny 1969:154).

Again, then, our model seems to be supported: the VP node representing the vocalic element posited to be a part of palatals (see section 2.2.2.2) intervenes in the harmony

process, imposing a [+high] feature just as do the high vocoids. This is shown in Figure 2-16 below. Note that I only show essential features here. Thus, the palatal lateral is here presented as a complex non-anterior coronal sound with the VP node. The consonantal features are of course invisible to the harmony process and thus do not block it. However, the vocalic element of the palatal exerts a raising influence on the preceding vowel, despite the non-harmonic presence of the mid back /o/ in tonic position. Since no other consonant is posited to have this vocalic element, the present model predicts that palatals alone should play such a role in vowel harmony processes.

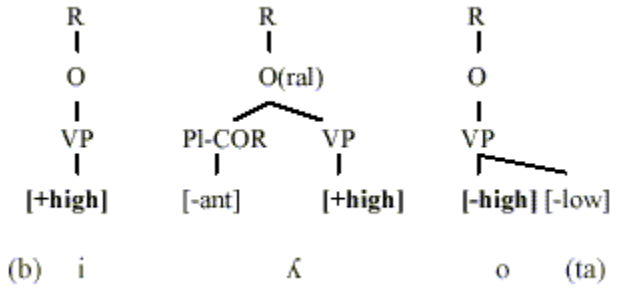


Figure 2-16. Height harmony under palatal influence (Pas. *biʎóta*).

Some qualification is nevertheless in order. As McCarthy observes (1984:302), notable exceptions to palatal influences appear: *seɲór* ‘sir’ (cf. Sp. *señor*), as well as *létʃe* in Figure 2-15a above, in both of which the mid-vowel /e/ should raise. Indeed, McCarthy seems to assume that the palatal influence, if at all valid, is likely a historical residue. Given the historical origins of palatals from consonants under the influence of high front glides (see Chapter 3), one could well posit a diachronically oriented analysis that assumes the vowel raising to be a vestige of effects once obtained phonologically in the presence of the glides that often precede palatalization. Still, under the view that historical change represents a series of synchronic phases partially overlapping through time, we would still wish to be able to account for this lingering effect. Also, as the vowel

system of Pasiego seems so mutable (consider the many contemporary variants that Penny (1969) lists of certain words), it does not seem convincing to assume that such raised variants would have withstood such a lengthy test of time (several centuries), especially under the additional normativizing influence of Castilian. In fact, one might well adduce such external pressures here to explain the exceptions: Castilian influences could serve to 'fix' certain tonic vowels, as Penny suggests (1969:162).[24]

Pasiego dialects therefore provide strong supporting evidence of the clear explanatory value of an isolated VP node in our model, as well as our model of the palatal segments in question.

Vowel harmony in Turkish and palatal blocking. The arguments presented above may also be supplemented by evidence from other languages; palatal effects in vowel harmony are by no means limited to Montañés dialects of Spain. Another, and genetically unrelated, language in which vowel harmony is (famously) attested is Turkish. In Turkish, all vowels in a word agree in frontness/backness. Additionally, high vowels agree in [round]. (NB: I keep the source's spelling conventions here; 'ü' = [y], 'u' = [u], 'i' = [i], 'ı' = [ɯ], 'a' = [ɑ].) Note in the data in Figure 2-17 below how the base morpheme sets up a harmony domain in which other vowels harmonize.

a. {kol-} 'arm' + {-umuz} (1pl) + {-un} (genitive) 'belonging to our arm'
b. {kol-} + {-lar} (pl) + {-imiz} (1pl) + {-in} (gen) 'belonging to our arms'
c. {bülbül-} 'nightingale' + {-ümüz} (1pl) + {-ün} (gen) 'belonging to our nightingale'
d. {bülbül-} + {-ler} (pl) + {-imiz} (1pl) + {-in} (gen) 'belonging to our nightingales'

Figure 2-17. Turkish vowel harmony (data from Kornfilt 1987).

Figure 2-17a,c show backing and rounding harmony in the first person plural and genitive markers; in Figure 2-17b,d, we see that the plural marker, with an underlying nonhigh vowel, harmonizes in back/front but fails to harmonize in [round] in keeping with the

limits set on rounding harmony to high vowels. Note, too, that the plural marker, having resisted rounding harmony, then establishes its own harmony domain: following vowels subsequently fail to round, a point I return to below.

The front/back harmony is easily illustrated with our current model. In the absence of any central vowels in the Turkish inventory, I use only [back] in Figure 2-18 below. In 2-18a, the front rounded vowel of the base morpheme fronts the vowel of the plural marker. In 2-18b, the back vowel causes this morpheme to surface with a back vowel.

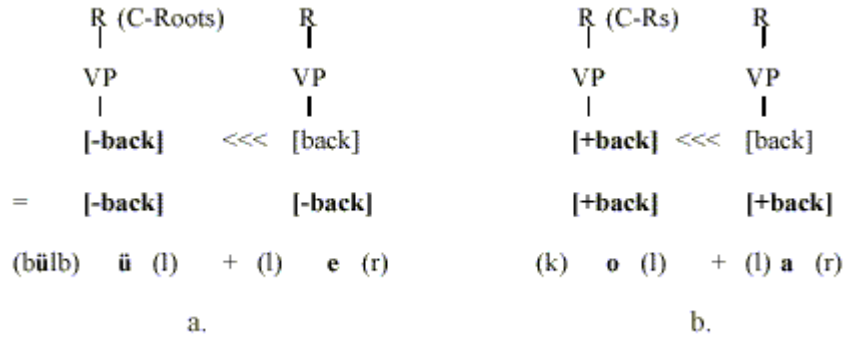


Figure 2-18. Turkish front/back harmony. a) Fronting harmony. b) Backing harmony.

The data show that we must also include [round] under our VP node. In the data in Figure 2-19, the roundness of the vowel in the base morpheme causes the following vowel to round, regardless of whether it is front (2-19a) or back (2-19b).

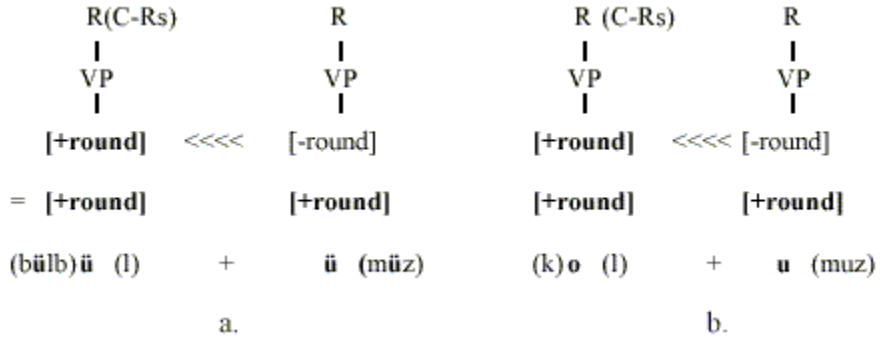


Figure 2-19. Turkish rounding harmony

Palatal consonants also play a role in these changes. A palatal following a back vowel that would normally trigger back harmony in the following vowel fails to do so. Instead, that vowel harmonizes to the palatal in frontness. In Figure 2-20, the accusative marker should have backed in harmony with the preceding /o/ but does not, fronting rather to the palatal. Note, too, that the rounding harmony is unimpeded by the palatal.

{petroʎ-} 'petrol, gas' + {-V^{high}} (accusative) > petroʎü [petroʎy] (*petroʎu)

Figure 2-20. Turkish fronting harmony to palatals

We can represent the harmony seen in Figure 2-20 as in Figure 2-21 below.

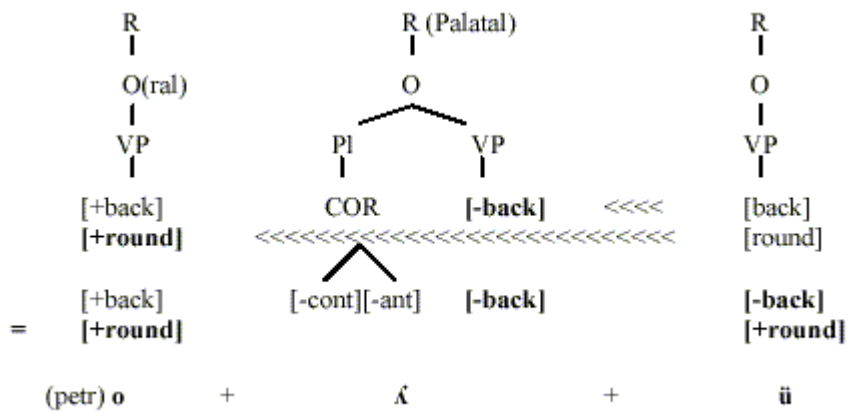


Figure 2-21. Palatal effects and noneffects in Turkish.

I assume that the palatal lateral here has no specification for rounding; indeed, labial configuration would not seem to have much to do with the lingual activity of the palatal. Consequently, rounding harmony is free to 'take' across the palatal where backing is not, since the palatal is a segment produced with a fronted tongue body.[25]

The harmony seen in Figure 2-21 above must be viewed as an assimilation driven by articulatory efficiency or economy. Front/back is here determined by tongue body position, much as [ATR] was seen to do in Montañés dialects above. By spreading the front/back feature, tongue shifting to and fro is avoided. Similarly, by maintaining the lip

rounding gesture into subsequent high vowels, speakers are not required to switch them back and forth. Indeed, Boyce (1990) found that speakers of Turkish exhibited a plateau effect (that is, a constant degree over time) in lip-rounding, while English-speakers exhibited troughs, or repeated rounding gestures; she attributes this to different articulatory strategies. Consider too the concept of harmony domains. The fact that interrupting vowel segments establish their own domain underscores the idea of economy; by assimilating to the closer vowel, the following vowel again avoids the need to switch articulator positions back and forth along some axis. Note that it would not be unthinkable, given ideas of paradigm uniformity, for the vowel to revert to the rounding specification of the original governing vowel, but it would certainly not be (articulatorily) economical.

2.3.2.3 The model of complex and contour segments

I take the above discussion to support my use of a separate VP node to describe vocalic behavior, both that between vowels as well as that exhibited in the presence of palatals, here modeled as complex segments with vocalic components under an appended VP node. A special mention must be made of the affricate /tʃ/. Its dual structure is not posited to be exactly equivalent to that of /ʎ ɲ/: its occlusive-fricative elements and more anterior point of articulation suggest a somewhat different makeup. I follow the arguments cited by Clements & Hume (1995; see also Steriade 1991) in assuming that the affricate is a two-root contour segment, viewed as composed of two separate roots linked to a single timing slot. In contrast, /ɲ ʎ/ show single roots involving two independent articulators (as formulated by Sagey 1986). This is not to say, however, that the affricate is not a complex segment; as discussed above, /tʃ/ also encompasses the tongue-body

raising and relatively extensive zone of linguopalatal contact common to the other members of the palatal cohort. I propose therefore to integrate the VP node element posited here with the structure advocated by Clements & Hume (1995). The vocalic element is appended to the alveopalatal fricative component of the segment. As such, it exerts the same influence in vowel height harmony shown in Figure 2-16 above (as evidenced by *lichón*; see Figure 2-15a). Models of all relevant palatal segments follow.

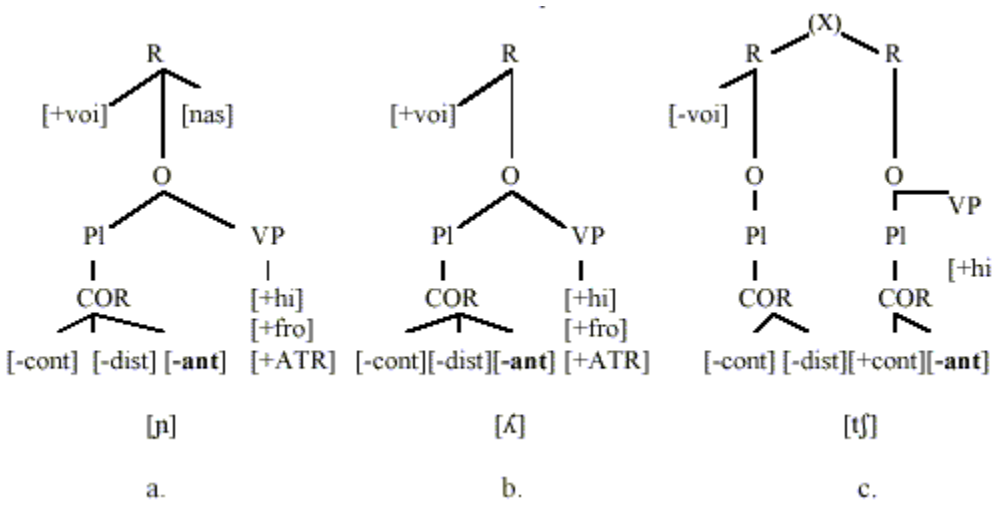


Figure 2-22. Posited feature models of the palatal consonants of Spanish. a) Palatal nasal /ɲ/. b) Palatal lateral /ʎ/. c) Alveopalatal affricate /tʃ/.

It should be immediately obvious that these models only capture the differences among the segments in broad strokes. For example, the palatal nasal (Figure 2-22a) is only distinguished from the lateral (Figure 2-22b) by the [nasal] feature; the above-mentioned differences in degree of lingual contact (greater in the nasal), as well as the more posterior stricture of the nasal, are not represented. Finer details of articulatory and acoustic distinctions among segments only figure in analyses when relevant and again are not expected to fall out from highly articulated models but rather to be formalized in the Optimality framework. I show how OT informs our models in the following sections.

2.3.3 Optimality Theory: Constraining the Model

We have already seen in the preceding chapter how Optimality Theory posits language-specific rankings of constraints to account for variant reflexes across languages. In this section I illustrate how constraints in the OT framework serve to control intersegmental interactions and resultant change in our feature model. While Hume (1994) shows that a highly elaborated model can in and of itself be constrained through rules on what types of structures can and cannot trigger featural spreading and/or delinking (e.g. features on different tiers may not interact, those on parallel tiers—sometimes situated under higher nodes that are not—may), she must still invoke occasional parameters to account for some phenomena. Indeed, one might take issue with the twofold notion of feature spreading and delinking itself, which could be potentially viewed as discrete phenomena that as such do not contribute to an intuitive view of sound change. However, if we accept that rules or constraints have a place in this approach—and accept in exchange a more relaxed, less articulated model—while also acknowledging the benefits of Optimality over earlier rule-governed generative approaches, then we have a viable system that fully partakes of the natural (as in phonetically grounded) and typological advantages that OT offers while maintaining the expository value of feature geometry as canonized by Clements (1985), Hume (1994), and Clements & Hume (1995). To illustrate, I show in the following sections how well-accepted constraints inform our understanding of segment interaction, going beyond the limitations of the model. I begin with variant parsing of the high palatal vocoid.

2.3.3.1 The high front vocoid /I/ and gliding

As discussed above, /I/ surfaces in Spanish and many other languages as either a (nuclear) vowel [i] or a so-called glide [j]. Evidence adduced in Harris (1983) and Hualde

(1991) shows that the latter is a nuclear element; that is, it is not a part of a complex (or secondarily articulated) onset consonant but is rather a peripheral element in the syllable nucleus. Rosenthall (1997) and Zec (1995) further demonstrate that in phonological terms, this glide element cannot possess its own mora or weight unit but rather must share a mora with the following, fully nuclear vowel (see Chapter 5 for phonetic evidence that this is so). Nevertheless, the featural structure of both segments is identical; for all intents and purposes, they are the same segment. Rubach (2002), though dealing with subsegmental glides, similarly shows identical structure for high vowels and glides (excepting the mora that marks the nuclear segment, which is irrelevant since this refers to the surface realizations; I take all vocoids to be moraic underlyingly).

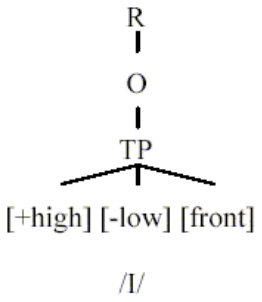


Figure 2-23. Structure of the high palatal vocoid.

What differentiates the two, then, must be constraint-governed. Consider the change from Classical Latin to Vulgar (Late Spoken) Latin, whereby hiatus between a high vowel and a following vowel was no longer tolerated:

L. FILIUS ‘son’ [fi.li.us] ~ VL. FILIUS [fi.ljus]

Figure 2-24. FILIUS from Classic to Late Latin

We may view such a change as being driven by the cross-linguistically attested drive to ensure that every syllable have an onset, formalized in the Optimality framework as ONSET. Ranked above a Faith constraint demanding that a vocoid retain its underlying

moraic weight (MAX-IO$_{[\mu]}$), we drive loss of the underlying mora of the vocoid in the interest of providing an onset to the following vowel:

/filius/	ONSET	MAX-IO$_{[\mu]}$
a) fi.li.us	*!	
☞ b) fi.ljus		*

Figure 2-25. Late Latin FILIUS 'son' (Tableau 3).

(3a) is less harmonic because we see that it violates more highly ranked ONSET. This ranking represents a change from Classical Latin, in which the drive to parse the higher vocoid with its moraic value intact was evidently greater than the need to provide an onset for the last syllable of the word. In Late Spoken Latin, then Markedness had come to outrank Faith.

We see therefore that constraint interaction serves to illuminate processes that would not otherwise be readily explicable merely from scanning the featural structure of the segments in question. This is of course an obvious instantiation of the higher-level effects of prosody over simple segments, but it does effectively illustrate the need for a framework that goes beyond the model.

We may extend this example somewhat to further underscore the point. Lahiri & Evers' (1991) model posits a separate TP node that only governs height features for vowels, formalizing the fact that, generally speaking, only high vowels trigger palatalization effects. Though I put all relevant vocalic features under the VP node in my model, palatalization can still be limited to high vowels through appeal to our understanding of sonority sequencing. That is, [+high] vowels are generally accepted to have a lower sonority than mid and low vowels and are thus 'weaker' or slightly less vowel-like than their [-high] congeners. By invoking well-attested facts of sonority

sequencing, we can illuminate the resistance in most languages to palatalization and gliding effects in [-high] vowels. Consider L. FOLIA. The Late Spoken Latin word would have likely shown the structure given for FILIUS in Figure 2-25b above, at least for a time (see further discussion in the following chapter): [fo.lja]. Now, as pointed out above, Rosenthall (1997) shows that onglides such as that in FOLIA [fo.l**ja**] must share a mora with the following vowel in order not to create a sort of fluctuating sonority profile within the nucleus of the syllable; that is, in line with observations made by Zec (1995), he posits that the nucleus must show a (consistently) falling sonority cline. Were the high vocoid awarded its own mora, it would effectively constitute a separate, perhaps the principal, nuclear element of the syllable, and this (complex?) nucleus would consequently create a sonority cline that rises from the (lower-sonority) high vowel to the stronger following vowel, only to fall again in the coda (if present) and the following syllable's onset. Such a scenario runs counter to long-accepted beliefs about syllable dynamics, the concept that the sharp contrast between (low-sonority) onset elements and (high sonority) nuclear ones is a key to the perception and subsequent prosodic organization of speech as parsed by listeners. Nor are equally sonorous vowels permissible in a common nucleus, as they do not permit falling sonority. This is illustrated below.

Using Rosenthall's (1997) SONFALL constraint, which demands a falling sonority cline in the syllable nucleus as discussed above, we can work these observations into our tableaux with an eye toward constraining certain palatalization effects. For example, gliding of non-high vowels (of equal sonority) such that they are made tautosyllabic with a following non-high vowel would simply violate SONFALL. This is illustrated in Figure

2-26 below. To show that two vowels are tautosyllabic, I here employ the tie bar that is more commonly used to mark double consonantal articulations.

/neon/	SONFALL	ONSET	MAX-IO$_{[\mu]}$
☞ a) ne.on		*	
b) ne͡on	*!		

Figure 2-26. Sp. *neón* 'neon' (Tableau 4).

Candidate (4b) violates sonority sequencing, since it forces an illicit sonority profile within the nucleus of the proposed word. (4a) satisfies SONFALL at the cost of an onset-less syllable, violating ONSET. This constraint interaction helps to explain why our model—in which the VP node dominates other height features that structurally might be expected to trigger gliding—predicts a phenomenon that does not generally occur.

Note, though, that in fast-speech or informal registers of Spanish, mid vowels may also trigger gliding effects, as in a realization of *peor* as [pjor] (see Barrutia & Schwegler 1994 for comparable examples). To account for such, we must formalize the fact that the language, in the interest of satisfying both SONFALL and ONSET, has allowed for some featural changes to the affected segment, violating featural Faith. Faith is here represented by IDENT(ITY)-IO (McCarthy & Prince 1995a), calling for identical values of a particular feature in both input and output. Thus, we see down-ranking of this feature-specific Faith constraint, which would otherwise prevent such large-scale changes from being visited upon the vowel.

/neon/	SONFALL	ONSET	IDENT-IO$_{(high)}$	MAX-IO$_{[\mu]}$
a) ne.on		*!		
b) ne͡on	*!			
☞ c) njon			*(e > j)	*

Figure 2-27. Informal, rapid register Sp. *neón* (Tableau 5).

In this speech register, then, the IDENT constraint barring alteration to the [high] specification of input vowels is ranked below SONFALL and ONSET, thus allowing the vowel to be raised in the interest of avoiding both sonority profile anomalies and onset-less syllables. A similar downranking must have allowed for such changes in Late Spoken Latin, as indicated by Lloyd: cf L. HABEAT ~ VL. ABIAT (Lloyd 1987:132).

2.3.3.2 Palatal condensing

Finally, I address the basic issue of an important aspect of palatalization. As we will see in greater detail in the following chapter, consonants in contact with high front vocoids often undergo a historical process by which they are featurally altered, becoming complex palatal segments. This can be seen in Catalan *muller* 'woman' [muʎer] (< L. MULIER). Here, the historical /l + j/ cluster has been condensed into a single segment /ʎ/. Note, importantly, that in a gestural sense no real content has been lost; the palatal lateral conserves the acoustic signature of the high vocoid (recall the discussion in the previous section) while maintaining the laterality of the /l/. The same can be said of the process whereby /n + j/ becomes /ɲ/.

In order to motivate such a process, we require another constraint. First, however, it is important to recognize that a previously cited constraint such as ONSET is insufficient to drive palatalization, since gliding alone would be sufficient to satisfy this constraint without the more drastic featural Faith adjustments (backing from [+ant] to [-ant], for example) required to generate /ʎ/. Therefore, some other process must be at work.

Comparing the /l + j/ string to palatal /ʎ/, what is most obviously different is the fact that an apparently single segment has replaced two. Given that the palatal is here

considered a complex segment that demonstrates both consonantal and vocalic characteristics, it is not readily apparently that anything has been saved in terms of articulatory effort by fusing the two discrete segments into a single (complex) one. In this light, we might consider that somehow the timing of the features has been affected; that is, as a single (and singly timed) segment, the palatal coordinates and represents all the relevant features in question (laterality, high F2 of the vocoid) in a more reduced temporal space than the previous string. We might furthermore see this as desirable from the point of view of economy, since providing acoustic cues faster in the stream of speech could be seen as a more economical communicative ploy than a piecemeal presentation of simple segments one after the other.[26] This effect may be further motivated by syllable structure; given that an idealized concatenation of segments in speech is exemplified as CV.CV, the 'crunching' of meaningful features into discrete (albeit complex) units may serve to more closely approximate such a string. I do not pursue this further at present, since it is not immediately apparent why a complex (and arguably moraic) complex onset would be preferable to a complex nucleus (that is, a glide-vowel nucleus in which a single mora is being shared). At this point, then, I simply formalize such a drive as CONDENSE:

CONDENSE compress articulatory features in the speech chain

Figure 28. The constraint CONDENSE

Note that CONDENSE does not balk at creating unwieldy structures, as we will see in the following chapter. Nor is it concerned with addressing overall effort; it is thus not a lenition constraint *per se*. It seeks simply to provide a maximal array of meaningful features in as tightly timed a fashion as possible. This constraint is explored more fully in

the following chapter, and the issue of CONDENSE's relationship to general lenition and ideas of articulatory efficiency and effort more fully developed.

In order to rein in such a process, such that any combination of consonant and vowel cannot indiscriminately fuse into some more complex segment, there must be some blocking constraint active in languages. In this case, a straightforward markedness constraint banning palatal consonants fits the bill: *PALATALCONSONANT. Such a constraint is in fact well motivated. Maddieson's (1984) survey provides evidence that palatals are highly marked cross-linguistically. Furthermore, there are solid articulatory underpinnings for this constraint, as palatals require what is arguably a highly effortful stricture with the hard palate, involving a very large contact area. Keating (1991) states that the palatal contact zone is the largest of all points of articulation save that of pharyngeals, which, it bears pointing out, are also extremely marked segments. Straka (1965) moreover directly relates the large contact zone of palatals and the tongue-raising they reflect with their inherent articulatory energy: "le degré d'élévation de la langue et les dimensions de la surface de la voûte touchée par celle-ci… sont en rapport direct avec l'énergie articulatoire" (Straka 1965:120). This tongue-raising is also subject to analysis under Kirchner's (2001) 'mass spring' model of effort, in which vertical articulator movement serves as a metric for articulatory effort (see further discussion in 3.4.1).

These observations justify a constraint barring palatal articulations. In Figure 2-29, this constraint quite directly bars /l + j/ clusters from palatalizing in some languages:[27]

/l + j/	*PALCON	CONDENSE
☞ a) lj		*
b) ʎ	*!	

Figure 2-29. Gliding versus palatalization (Tableau 6).

The historical reflex seen in Catalan *muller* from L. MULIER can then be motivated rather simply (and perhaps simplistically, since we are compressing a diachronic process into a single operation) by the tableau in Figure 2-30 below. CONDENSE here only compares surface candidates and as such is akin to a Well-formedness constraint; thus, it scans all three candidates and assigns violations to all but the most harmonic candidate (7c).

/mulier/	CONDENSE	ONSET	*PALCON
a) mu.li.er	*!	*	
b) mu.ljer	*!		
☞ c) mu.ʎer			*

Figure 2-30. Cat. *muller* 'woman' (Tableau 7).

Note that without CONDENSE, (7b) would be at least equally harmonic to (7c), and more harmonic if we take the general markedness of palatals into account, as formalized by *PALCON.

/mulier/	ONSET	*PALCON
a) mu.li.er	*!	
☞ b) mu.ljer		
c) mu.ʎer		*!

Figure 2-31. Catalan *muller* 'woman' without CONDENSE (Tableau 8)

(8b) is most harmonic since it is a less marked structure than the palatal alternative (8c) and provides an onset where (8a) does not. The role of CONDENSE as a key constraint in the palatalization processes so widely attested in Romance is developed further in the following chapter.

2.4 Conclusion

In addition to their rather anomalous distributional and metrical behavior, we have seen in this chapter that the palatal segments also pattern together in certain vowel

harmony processes. This is taken here to be the direct result of the significant articulatory and acoustic similarities they share: specifically, an apparent vowel-like element that stems from a high, fronted tongue body posture. As segments that involve both consonantal and vocalic features, the palatals are assumed to be complex, in line with previous accounts (e.g. Keating 1988). A modified version of the feature geometry model has been proposed which provides a degree of descriptive and explanatory power to this view of the palatals as complex segments. While the simplified model rather straightforwardly accounts for some aspects of palatal behavior—for example, its role as a blocker in some vowel harmony processes—it has been shown that an adequate theoretical framework is needed to satisfactorily control the sorts of operations that the model might otherwise predict. OT seems to provide just this sort of oversight, allowing us to curb indiscriminate featural spread by appealing to prosodic, extrasegmental factors formalized in the theory as rankable constraints (e.g. ONSET, SONFALL). Thus, the model adopted here is not meant to undermine the validity of extensive work already presented in the field (e.g. Hume 1994, Clements & Hume 1995, Padgett 1995) but is rather adopted with an eye on placing the greater burden of motivating and constraining the data under analysis here in the Optimality Theory framework.

2.5 Notes

1-Recasens (1990) deals exclusively with Catalan. The wealth of phonetic detail, however, makes it an invaluable resource for this study. Given that any number of studies deal with palatal consonants as generalized across widely divergent languages, I do not feel it is misleading to cite Recasens' data here. Moreover, the very high degree of Spanish-Catalan bilingualism in Catalunya seems likely to ensure a significant degree of isomorphy in the two palatal inventories.

2-The greater degree of instability of this segment could also be affected by this, though the acoustic motivations for *yeísmo* (i.e. the shift of /ʎ/ > /j/) cannot be overlooked, given the highly similar F2 profile of these segments.

3-Affrication may be taken here as a clear case of fortition: affricates demonstrate the burst characteristics of stops—recognized as a chief means of their identification (Kent & Read 1992:129-30)—plus frication noise. This serves to strengthen the segment (approximant > obstruent; see Lavoie 2001:52) and provides for a more perceptibly felicitous sonority gradient with a following vowel.

4-Fortition processes can account for all the consonantal phones arising from the vocoid, i.e. [j̩ ʒ dʒ]. See Baker & Wiltshire (2003).

5-Note, though, that Recasens notes that some tongue dorsum raising occurs automatically as a result of the laminal constriction and cites data from Josselyn (1907) and elsewhere showing occlusion as far back as the mediopalatal zone. This is an important clue to our understanding of the velarization of earlier alveopalatal fricatives in the history of Spanish (see Baker 2003; also Pensado Ruiz 1996).

6-Palato-alveolar affricates are commonly attested as 'alternative' stops in languages whose inventories already have stops at the three 'canonical' places of articulation (labial, velar, and dental/alveolar), as observed by Maddieson (1984). As observed in note 3 above, affricates have plainly perceptible burst characteristics that qualify them as stops, yet with distinctive frication noise. This frication noise is itself distinctive from that of 'plain' fricatives. The frication interval of affricates is situated between that of plain stops (in which such frication is vestigial) and that of fricatives in duration; that is, the fricative portion of affricates is of lesser duration than that of 'pure' fricatives, while being plainly greater than that of a /t/ (Kent & Read 1992:129-30). This, plus the more rapid *rise time* (the time in which maximum amplitude is reached) clearly distinguish affricates from fricatives. Note, too, that Flemming (2002) considers the affrication of palatalized velars to be a means of increasing their acoustic saliency and hence contrast with other places of articulation. The affricate then is a highly viable segment in perceptual terms.

7-Recasens (1990) makes the case that the passivity of the tongue blade in the production of /ɲ/ makes it difficult to view this segment as complex. He does admit, however, that the back of the blade is engaged during the articulation of the segment, making contact with the posterior portion of the alveolar zone. I submit that this contact is vital to produce the "ñ effect" so well known in Romance; the [j]-like off-glide is the result of the sequenced release from front-to-back (Keating & Lahiri 1993:83) of the segment. Without such a delayed, ordered release of the sizeable stricture effected by palatals in general, we are left with something like the segment represented by the palatal allophone of /n/ cited in Spanish phonology texts as occurring in such words as *ancho* [aNtʃo]. Quilis is explicit in differentiating this phone from /ɲ/: he emphasizes the lack of prepalatal contact in the former, which he characterizes as 'postalveolar' and thus 'totalmente diferente' from /ɲ/ (Quilis 1999:229-30; see also Quilis 1981:213).

8-Keating (1991:39) citing Bhat (1978), suggests that the Russian process of secondary articulation—applicable to virtually every consonant in its inventory—is not precisely the same animal as the change of primary place of articulation more typically referred to by the term *palatalization*. Though I also account here for such secondary articulation, I largely abstract away from the timing differences attested by Recasens, assuming they have more to do with interlingual differences than with basic structural ones related to the segments themselves.

9-This finding underscores the need to posit a node for vowel production that is isolated from that governing consonant production in our model.

10- Spencer's model uses the older SUPRALARYNGEAL node, which I have replaced here with the ORAL node to reflect Clements & Hume's (1995) alterations of Clement's (1985) model. The Oral node is not a simple taxonomic change, however, and arguments may be made both for and against the exclusion of the Supralaryngeal node in the model (see Clements & Hume 1995:293). I abstract away from this debate here, as it is not crucial to the changes under consideration.

11-One argument for the isolation of [nasal] in this model under the Root node might be found in the common general nasal quality of many American English regional dialects and idiolects. That is, [nasal] is free to spread in an almost unbounded fashion without concomitant effects on any other feature, whether Laryngeal or Oral.

12-A constraint to this effect (*[nasal][+cont]) has important consequences for the analysis of the evolution of nasal geminates in Spanish (see section 4.3.1).

13-In fact, Padgett does not directly address vowels or vowel-consonant interaction in his model, acknowledging the unresolved nature of "even basic questions" of vowel modeling in feature geometry (1995:12). Moreover, in later work (Ní Chiosáin & Padgett 1997), he basically gives up on the model. This seems to support my use of his simplified model for primarily illustrative purposes rather than a more elaborate, exhaustively predictive one (such as Hume 1994 or Clements & Hume 1995) as a means of motivating the processes under discussion. Note, however, that I will adapt his model to strengthen the case of the current treatment of palatals and their effects.

14-Indeed, this is the kind of situation that Kirchner (2001:12-3) seems to find objectionable in autosegmental approaches to lenition; the twofold (and formally distinct) spreading and delinking operations undermine unified analysis. Note, though, that coronalization could well be a more complex process than palatalization, in line with Hume's observation.

15-Her objections seem in part due to taxonomic issues: one argument suggests that Japanese data cited by Lahiri & Evers in support of their use of [high] as a trigger of affrication of /t/ is really 'coronalization' rather than palatalization and is thus irrelevant to Lahiri & Evers' discussion of 'palatalization'. She seems to miss the point that /i/ exerts a *palatalizing* influence such that /t/ > /tj/ > /tʃ/, the subsequent

affrication being a widely attested and wholly predictable (in articulatory terms; see Flemming 2002:104 for discussion as well as the following chapter) phenomenon. Clearly this should be subsumed under our ideas of palatal effects. Hume also criticizes what amount to *ad hoc* procedures in Lahiri & Evers' model, yet in the same discussion introduces 'on or off' parameters to supplement her own model. Moreover, she allows for interpolated vocalic structure to facilitate some processes. While this may be defensible given her situating the Vocalic node under the Consonantal node—such that any Consonantal configuration may have an implicit V node potential—we do not see just any consonant taking on the vocalic features of just any vowel; some sort of extra-model rule or constraint must be introduced to govern this sort of structural interpolation. Consequently, inasmuch as a truly straightforward falling out of the facts from the model remains elusive, it is not entirely clear that her approach is substantively superior to others.

16-Hume suggests that the fortition of palatal glides in Spanish proves that these sounds share common articulatory features. I would submit that acoustic rather than articulatory felicities (high F2 components) license such fortition, which involves not only stricture but also significant lingual adaptations: the tongue front engaged for /i/ passes to a tongue blade or even apical articulation, plus central 'grooving' necessary to provide for the stridency of Argentinian variants [ʃ ʒ] and the multidialectal affricate [dʒ].

17-In fact, Lahiri & Evers hint at such an approach themselves, suggesting that acoustic formant information could be used to enhance the usefulness of their TP node. Since F1/F2 information is sufficient to describe the entire vocalic inventory of many if not most languages, the TP node thus effectively becomes the vocalic node, as I use it here. Note that labialization—which, importantly, involves no stricture as it does for labial stops and fricatives—is a strategy that lowers formant values and thus enhances vowel contrasts. As such, it too could be easily captured by reference to formant values. For the sake of consistency, however, I retain the traditional articulator-based features for my model.

18-Note that the lateral palatal possibly presents particular structural complexity, if we accept that 'plain' laterals are themselves complex segments (Walsh-Dickey 1997). This position would make the palatal lateral extra-complex, which could well motivate its far greater instability in Spanish vis-à-vis the nasal. I abstract away from this point at present, but see Holt (2002) for various historical and synchronic applications of this approach in Spanish.

19-However, given Penny's description of the fronted, raised A seen above, any laxing and centralizing of /e/ vowel may well have undermined any lexical distinctions between the two vowels. In support of this notion, the low vowel enjoys a wider distribution in the lax subsystem than the mid vowel (Penny 1969:150), which might serve to make the preservation of a distinct contrast more important than the drive to relax the /e/.

20-Final vowels in *pasiego* undergo a separate process of 'relaxation' (Penny 1969: 149), reducing the vowel inventory in this position to a three-segment system. Penny shows that these variants are best considered weakened variants of the 'standard' (tense) vowel inventory, and suggests that reduction has taken place here for the sake of economy (p.165). Consider, too, that perception-based theories such as those pursued in Beckman (2000) underscore such a view; given the lesser importance of word-final syllables for lexeme identification (vis-à-vis initial and tonic syllables), weakening in this position is trivial. As Penny points out, however, citing Trubetzkoy (1949), where neutralization takes place (as in reducing a five-vowel system to three word-finally), more 'extreme' sounds tend to remain behind; thus, the more peripheral vocalic triangle of /i a u/ remains rather than /e a o/ in order to guarantee the "widest possible margin of security between vowels of different aperture" (p.165). Thus, despite the general reduction of the inventory in a perceptually non-salient position, perceptual interests are still represented in the election of a more harmonically spaced (albeit reduced) vowel triangle. In OT terms, this recalls an 'emergence of the unmarked scenario', whereby a lower-ranked component of the grammar (as a constraint militating for optimal acoustic contrasts) still makes itself felt when higher-ranked constraints (such as one driving reduction of contrasts in non-salient positions) have been satisfied. For the purposes of the present analysis, however, I abstract away from final vowel weakening.

21-Note, though, that where the low vowel is tonic, mid and high vowels still do not co-occur in words (Penny 1969:151). In a sense, this provides support for the analysis of vowel harmony as effort-reduction developed below; were harmony an incidental process, we would not expect to find it where the trigger (here, the tonic vowel) fails to provide the necessary input. See further discussion below.

22-It is worth mentioning that vowel harmony may often reflect perceptual enhancements as well, as it leaves a particular feature multiply represented in the stream of speech. This is particularly true here only of the tense/lax distinction under McCarthy's analysis of [tense] (or [ATR] as here assumed) as a morpheme marking a masculine category. The height harmony seems more clearly motivated by articulatory efficiency, particular in light of the fact that it is the perceptually non-salient nature of atonic syllables in general that seems to license the height harmony to (perceptually important) stressed vowels.

23-On the other hand, this data could present problems for a model that links front vowels to coronal consonants, as does Hume (1994). Her approach makes both front vowels and coronal consonants share a common [coronal] feature that replaces the [-back] feature of vowels (Hume 1994:92-3). As Flemming (2002) observes, however, this predicts that coronal consonants as well as vowels should condition front/back vowel harmony such as that seen in Turkish, something which is unattested. Note, though, that palatals do indeed impact such harmony processes (Kornfilt 1987:627; Flemming 2002:112), underscoring our model here, which represents the apparent 'vocalic' component of palatal consonants in general.

24-The question of 'tonic vowel tenacity' may also explain the resistance of *leche* to palatal raising, though Penny (1969) makes no stipulation for such vowels. Another issue that should also be addressed here has to do with the apparent influence of coronal consonants in the system. This is important given the stance here that coronal consonants and front vowels should not share a common [coronal] feature, as proposed and extensively defended by Hume (1994). Yet Penny notes that variant pronunciations undermining vowel harmony are attested in (atonic) front vowels in contact with /s n r/:

(I) Exceptional vowel height in vowels in contact with coronals
a. **a**skína ~ **e**skína ~ **i**skína 'corner' (cf. Sp. *esquina*)
b. **a**skúra ~ **e**skúra ~ **i**skúra 'dark (fem. sg.)' (cf. Sp. *oscura*)
c. **a**mbutʃár ~ **e**mbutʃár ~ **i**mbutʃár 'to save money'
d. **a**nθína ~ **e**nθína ~ **i**nθína 'evergreen oak'
e. rr**e**bUltUsU ~ rr**I**bUltUsU 'disobedient' (cf. Sp. *revoltoso*)
f. rr**e**ndír ~ rr**i**ndír 'to give in' (cf. Sp. *rendir*)

A naïve observation of such data might suggest that coronals exert an influence similar to that of palatals as seen above. However, important differences may be distinguished. First, vowel harmony in each of the words given in (I) shows the predictable vowel to be the high variant; therefore, the coronals seem to be exerting a lowering effect, quite the opposite of that shown above for palatals. Second, readily available articulatory and acoustic facts provide a far better explanation than one that might be advanced, for example, by an amended feature geometry model granting coronals some vowel-like feature *à la* Hume (1994). Flemming (2002:111-15) argues along similar lines, providing counter-arguments for the common [coronal] feature of both coronal consonants and front vowels proposed by Hume. Here, the influence of the coronal consonants on contiguous vowels may be best explained by rather mechanical physiological facts and acoustic effects that have little to do with highly elaborated feature models. Thus, the various lowering effects observed before /s/ in (Ia-b) could well be the result of incompatible demands made on the tongue by the high front vowel, involving a high tongue blade, and an immediately following *apical* /s/ (standard throughout the north of the Peninsula), requiring tongue tip stricture in the alveolar region and a (necessarily) lowered blade. Along the same lines, vowel-lowering of the high vowels before (tautosyllabic) nasals as in (Ic-d) could well be an acoustic effect of nasalization: nasalized vowels are perceptually lowered due to a nasal antiformant that readily merges with F1 (the correlate of tongue height) in the ears of listeners and raises it; since high vowels have lower F1 values, the antiformants serve to dampen or lower their perceived height by perceptually raising their F1 (see Johnson 1997:19-60; also Padgett 1997 for incisive discussion). Additionally, physiological factors may come into play: Moll (1962) shows that low vowels may tend to be nasalized due to incidental opening of the velum concomitant with the palatoglossus muscle activity in tongue lowering; the reverse would therefore not seem a stretch, whereby velum opening could entail incidental tongue lowering. The historical lowering of nasalized vowels in French seems to support these views (Casagrande 1984:72, 120; see Maeda 1993 for detailed discussion). Finally, incompatibility between the highly tense, apical rhotic

trill—requiring apical stricture with a lowered blade to allow for the forceful airstream necessary to produce the trill—and the tongue blade (with lowered tip) of the high vowel /i/ could well occasion variable vowel height, as in (Ie-f).

25-The fact that rounding harmony does not obtain in non-high vowels in Turkish must be seen here to reflect a general markedness constraint barring them. Given that full rounding contrast is seen in both high and nonhigh vowels in this language in word-initial position, we may again posit that positional faith in word-initial position licenses full contrast in this position, whereas non-initial position reduces the possible inventory by two segments, the rounded nonhigh vowels. This may make sense in terms of vowel space: if we take the mid vowels to have lower F2 (as a function of F2 – F1) than high vowels, and factor in the fact that lip rounding tends to lower all formants, lip-rounding in nonhigh vowels could act to compromise the distinctive formant values of the low vowel in acoustic space.

26-Note that such featural condensation may well require faster transitions in articulatory terms to coordinate the lateral gestures with those of the high vocoid. That is, the articulators must transition in less time from the configuration for the lateral portion to the positioning for the palatal portion. Following Kirchner (2002), we might view such speedy transitions as being more effortful than the earlier concatenation. I take up the issue of increased overall effort in the interest of communicative (and articulatory) efficiency in greater detail in the following chapter.

27-It is likely that in many languages, this constraint would have to be exploded into ordered, constituent subconstraints targeting classes of segments (*PALATALOBSTRUENTS >> *PALATALSONORANTS) or even specific segments (*ʎ, etc) to allow for the fact that languages may allow palatal liquids or nasals but not palatal stops (as in Spanish).

Note that English behavior is not entirely clear. In general, English would seem to resist both gliding and palatalization (NB: to bar the palatal, I simply posit *ʎ here):

(II) Eng. *alien*

/ejlien/	*ʎ	MAX-IO$_{[\mu]}$	ONSET
☞ a) eʲ.li.ən			*
b) eʲ.ljən		*!	
c) eʲ.ʎən	*!		

This approach assumes that apparent palatal sonorants in words such as *million* and *minion* (which incidentally might seem to form a minimal pair) are in fact glided variants: cf. [mɪl.jən], [mɪn.jən] in dictionary transcriptions, not *[mɪʎən] or * [mɪɲən]. Such a distinction may fall back on subtle timing differences that are not taken up here.

CHAPTER 3
HISTORICAL ORIGINS

3.1 Introduction

In this chapter (and in the following one) I offer a more detailed account of the historical sound changes that led to the segments in question, with a view toward reconciling their synchronic reality as posited here with the diachronic facts. Work in both phonetics (e.g. Ohala 1993a, 1993b) and sociolinguistics (e.g. Labov 1972) suggests that historical sound change can be viewed as a succession of overlapping synchronic 'snapshots' that reflect shifting language parameters. In Optimality Theory, such change would straightforwardly reflect rerankings of constraints over time, with possible intervals of tied rankings that allow for the multiple competing variants posited in Labov's mechanism of sound change (as in Gess 1996, Holt 1996). I show that different rankings of the posited constraints can account not only for diachronic change in Spanish but also for variant reflexes elsewhere in Western Romance.

I begin by sketching the changes undergone from Late Latin through Proto-Romance and into Old Spanish, showing how the palatal class arose from consonant + *yod* ('C+yod'hereafter) combinations, consonant clusters, and geminates. Following discussion of concepts and terminology relevant to the analysis—the palatalization process itself, lenition, and coarticulation—I focus specifically on the changes observed in Latin clusters and C+yod groups. I propose an account of these events in the OT framework, showing how constraints reflecting cross-linguistically attested linguistic tendencies drive the changes, with different rankings and rerankings over time modeling

the relevant changes in the history of Spanish and elsewhere in Romance. I show how palatalization of former Latin clusters arises under the twin drives to lenite (LAZY) and to condense the acoustic signal (CONDENSE). It is this compression of the segments that is posited to underlie their complex structure, which I claim is the real time (phonetic) basis of their proposed (phonological) geminate structure. As discussed in Chapter 2, the feature geometry model posited by Padgett (1995; for further historical applications of this model see also Holt 2002), along with modifications following Lahiri & Evers (1991), serves to supplement the account, providing graphic illustration and some conditioning of the constraint interaction behind the sound changes. Note that, though I present all the relevant historical data together in this chapter for the sake of coherence, I reserve my treatment of Latin geminate reflexes in Spanish for the following chapter, as they involve systemic factors that do not arise in the analysis of clusters and are chronologically ordered after all but one of the changes discussed in this chapter. Following my account, previous treatments of the sound changes are discussed, and data from articulatory and acoustic phonetics are adduced that underscores the relevance of the current analysis.

3.2 The Sound Changes in Question

From Late Latin to Old Spanish, a variety of palatal effects are observed. These effects generally involve the high front vocoid /I/, whether as a full vowel or the glided yod, that through assimilation or featural condensing gives rise to different palatal segments. In the sections that follow, I describe these processes in rougly chronological order, with the caveat that though relative chronologies are generally viable, it is difficult to affirm precise dates for changes that take place over time and overlap with other ongoing processes.

3.2.1 Fronting and Yod Effects in Clusters

Palatals arose from a variety of sources: /tʃ ʃ dʒ ɲ ʎ ʒ/ were all the results of sound changes in C+yod and consonant clusters. For example, under the influence of front vowels /i e/, /k/ was fronted in Late Latin, such that its point of articulation drew closer to the palatal zone of production of the conditioning vowels. This fronting led to an affricate /tʃ/ that later depalatalized to /ts/ (3-1a below), occasioning merger with the results of /t+yod/ (3-1b) as well as those of /k+yod/ (3-1c). What this meant was that the dental affricate /ts/ could appear before any vowel and was thus reanalysed as a phoneme in its own right (Penny 1991:56-7). In intervocalic position, these dental affricates were subject to voicing to /dz/. The data in the following figures comes primarily from Lathrop (1984), Lloyd (1987), and Penny (1991). Note that in the figures below, parenthetically adjoined V, C, and # show a conditioning vowel, consonant, or pause, respectively.

	changes	Latin to Old Sp. (spelling)	Transciption
a)	(V) k(e/i) > tʃ > ts > dz	L. VICINU > OSp. *vezino*	[be.**dz**i.no] 'neighbor'
b)	(V) t + j > ts > dz	L. PUTEU > OSp. *pozo*	[po.**dz**o] 'well'
c)	(V) k + j > tʃ > ts > dz	L. FACIE > OSp. *façe*	[fa.**dz**e] 'face'

Figure 3-1. Fronting to dental affricates from Late Latin to Old Spanish.

In contact with a following yod, geminate clusters, as well as consonant clusters that had assimilated to geminate clusters, also fronted to dental affricates:

	changes	Latin to Old Sp. (spelling)	Transciption
a)	(V) k(e/i) > tʃ > ts > dz	L. VICINU > OSp. *vezino*	[be.**dz**i.no] 'neighbor'
b)	(V) t + j > ts > dz	L. PUTEU > OSp. *pozo*	[po.**dz**o] 'well'
c)	(V) k + j > tʃ > ts > dz	L. FACIE > OSp. *façe*	[fa.**dz**e] 'face'

Figure 3-2. Fronting of clusters to dental affricates.

Perhaps more transparent is the palatalization of /n l/ under the influence of a following yod. The subsequent shift of the lateral palatal to the alveopalatal fricative (3-4a) is a fortition process observed today in Porteño dialects of Argentina and Uruguay (see Harris & Kaisse 1999, Baker & Wiltshire 2003). This probably took place some time after the initial palatalization, prior to or perhaps contemporaneously with the changes in the geminate system dealt with in the following chapter (see Penny 1991:96-7).

changes	Latin to Old Sp. (spelling)	Transciption
a) l + j > ʎ (> ʒ)	L. FOLIA > OSp. *foja*	[foʒa] 'leaf' (cf. It. [foʎ.ʎa])
b) n + j > ɲ	L. SENIORE > OSp. *señor*	[se.ɲor] 'sir'

Figure 3-3. Palatalization of sonorants /n l/ before yod.

3.2.2 Vocalization to Yod with Subsequent Palatal Effects

While the changes above were taking place, other sound changes were preparing the conditions for ongoing palatal reflexes. In particular, the widespread weakening of syllable-final velars is observed very early in the history of Spanish; indeed, the process was likely underway before the changes described in Figure 3-3 were completed. Here, the velar stop becomes a fricative , then subsequently vocalizes to yod. The vocoid in turn influences the following consonant following a supposed metathesis.

changes	Latin to Old Sp. (spelling)	Transciption
a) (V)kl > (xl > jl > ʎ) > ʒ	L. OCULUM > OSp. *ojo* 'eye'	[oʒo]
b) (V)gl > (xl > jl > ʎ) > ʒ	L. TEGULA > OSp. *teja* 'tile'	[teʒa]
c) ks(V) > (js > sj) > ʃ	L. AXE > OSp. *exe* 'axis'	[e.ʃe]
d) gn > jn > nj > ɲ	L. PUGNU > OSp. *puño* 'fist'	[pu.ɲo]
e) (#)pl/kl/fl > ʎ	L. CLAMARE > OSp. *llamar* 'call'	[ʎa.mar]

Figure 3-4. Palatalization of consonant clusters into Old Spanish

Figure 3-4d reprises the change seen above in 3-3b, with the fortition of 3-4a-b also reflecting that of 3-3a. The alveopalatal fricative of 3-4c recalls the alveopalatal affricate

stage of the former K+front vocoid groups of 3-1a,c. Lack of occlusion would be due to the fricative nature of the /s/. Finally, 3-4e shows the palatalization of initial clusters. Note that this change is much later than the others, probably due to its complex nature, and indeed follows the geminate reflexes covered in the Chapter 4. I include it here for expository convenience.

The affricate /tʃ/ is a result of similar changes in clusters. Recall that the affricate patterns with the palatal sonorants, too, in its effect as a heavy onset in Modern Spanish.

changes	Latin to Old Sp. (spelling)	Transciption
a) kt > xt > jt > tj > tʃ	L. NOCTE > Sp. *noche* 'night'	[no.**tʃ**e]
b) (u)lt > łt > jt > tj > tʃ	L. MULTU > Sp. *mucho* 'much'	[mu.**tʃ**o]
c) (C)pl/kl/fl > tʃ	L. AMPLU > Sp. *ancho* 'wide'	[an.**tʃ**o]

Figure 3-5. Palatalization of clusters to affricate /tʃ/

Finally, palatals arise as reflexes of former Latin geminate sonorants /nn ll/. Note again that this change took place after all of the changes detailed above save those seen in Figure 3-4e. I deal specifically with these changes in Chapter 4 but present them here for the sake of completeness.

changes	Latin to Old Sp. (spelling)	Transciption
a) kt > xt > jt > tj > tʃ	L. NOCTE > Sp. *noche* 'night'	[no.**tʃ**e]
b) (u)lt > łt > jt > tj > tʃ	L. MULTU > Sp. *mucho* 'much'	[mu.**tʃ**o]
c) (C)pl/kl/fl > tʃ	L. AMPLU > Sp. *ancho* 'wide'	[an.**tʃ**o]

Figure 3-6. Geminate sonorant reflexes in Spanish

3.2.3 Lenition in Palatalization

Taking stock then of the changes seen above, we see that the presence of palatal /j/, whether inherited directly from the Latin high vocoid or as residue from previous sound change had a profound impact on the evolution of the Spanish phonemic inventory. We

saw in the previous chapter that the palatal vocoid shares important articulatory (high front tongue body) and acoustic features (formant structure) with the palatal sonorants of Spanish, and that these similarities help to illustrate the mechanisms that made such apparently extreme changes possible. In this chapter I follow up these observations by addressing the forces that drive such changes and are thus responsible for the emergence of the palatals from clusters and C+yod groups. These forces, formalized as constraints in OT and ranked appropriately, help to shed light on palatalization processes.

It is important to note that, with the exception of the reflexes seen in 3-4e, these changes took place in word-medial position, often in clusters broken up by syllable boundaries: L. MUL.TUS > Sp *mucho*. This is arguably the case even for Figure 3-4a-b (Harris-Northall 1990:91-2, n46; but see Wireback 1997a). The remaining cases involve clusters or /C+yod/ combinations in word-medial onset position, that is, in intervocalic position. Given that intervocalic position has long been seen as a weakening environment (from Hooper 1976 to Lavoie 2000)—indeed, perhaps the canonical weakening environment (Kirchner 2001:22)—we must accept that lenition is a major force at work in many of the above cases. Indeed, it is commonly recognized in the literature that lenition drives the geminate stop reflexes that I deal with in Chapter 4 (Harris-Northall 1990, Walsh 1991, Penny 1991). The changes discussed heretofore, however, are less easily resolved. While lenition clearly motivates the vocalization of syllable-final velars, the shift of [s+yod] and [t+yod] groups to /ʃ tʃ/, respectively, only seems rather vaguely (and conveniently) described as lenition. Features—perhaps better viewed here as coordinated gestures—have not been lost; temporal compression has rather taken place, as seen as well in the palatal results of /n, l + yod/ > /ɲ ʎ/. Clearly, too, the change of /ʎ/

to alveopalatal fricative /ʃ/ is not a lenition process, though I do not see this as directly related to the processes under scrutiny here. It is the goal of this chapter and the next to provide a more perspicuous account of the changes exemplified above and the subsequent restructuring of the phonemic inventory that these changes occasioned.

3.3 Preliminary Discussion: Terms and Concepts

To understand the mechanisms behind the sound changes here, it is important to make plain a number of concepts. Palatalization as a widely recognized process throughout Romance is first clearly defined. Secondly, the role of coarticulation as an important production-driven process in human speech is identified as playing a part in the historical changes described above. Finally, palatalization's role vis-à-vis the important (yet perhaps ill-defined) concept of lenition is made explicit. I address these issues in the following sections.

3.3.1 Palatalization and the Role of Yod in Palatal Effects

Ladefoged & Maddieson (1996) define palatalization as "the superimposition of a raising of the front of the tongue toward a position similar to that for **i** on a primary gesture" (Ladefoged & Maddieson 1996: 363). In other words, the tongue body is raised and fronted in tandem with the gestures related to the segment under palatalization. A similar conception leads Carreira (1988) to posit underlying /nj/ and /lj/ for the palatal nasal and lateral, respectively, reflecting just such a synthesis of primary features and those of the superimposed high vocoid.[1] In this light, as Ladefoged & Maddieson point out, we may consider palatalized articulations to be "the summation of two movements" (1996:365). This underscores Keating's (1988) view of palatals as complex segments, as

discussed previously, a view accepted here as congruent with the adopted model and the attested behavior of palatals as marked, often unstable segments.

Historically, Penny (1991:53-64) makes clear that the high front palatal vocoid in its non-syllabic variation—Ladefoged & Maddieson's '**i** gesture' above, called 'yod' by many linguists—is crucial to the advent of the new palatals in Old Spanish. Indeed, palatalization by yod is here seen to have a major impact on the evolution of various segments in the history of the language, including that of the palatal geminates and affricates. Thus, in addition to the secondary articulation described above (recall Hume's (1994) distinction between Palatalization and Coronalization, discussed in Chapter 2), palatalization also refers to the assimilatory influence that this palatal /j/ has over a preceding consonant: the articulation of the adjacent consonant is drawn toward that of the following palatal and often leads to the fusion of the two segments into one.

/k/ + [j] > [tʃ] (> [ts]) L. CALCEA 'stocking' > OSp *calça* [kal.**tʃ**a] (> [kal.**ts**a])

Figure 3-7. Palatalization of velar stops from Vulgar Latin to Old Spanish

Note here that the end result is a (non-palatal) dental affricate, though an earlier stage of palatal affrication had obtained. Palatalization is used here to refer not only to the nature of the product of the process but also the articulatory assimilatory effect that a palatal exerts on a neighboring sound, whether the result is fully palatal or not. It is also important to recognize that the affricate effect, involving assibilation and the introduction of stridency to the segment, is best seen as fortition effected on an earlier /palatal obstruent + yod/ sequence, say /c^{j}/; in this way, the distinctiveness of such a segment from a plain /t/, for example, is enhanced. Assibilation then is not specifically part of the palatalization process but rather a side-effect of it (Flemming 2002:104; see discussion in

section 4.1.3). This hints already at an important issue in this chapter: the role of lenition in palatalization. If the affricate is taken here to be a strong segment (in sonority terms, being tantamount to a stop with strong frication components to boot), then we must ask ourselves to what extent lenition satisfactorily explains the palatalization process. Articulatorily, the original velar stop of L. CALCEA above was moved forward to facilitate the transition to the following front vowel; yet a highly marked palatal stop (/c/) must have been a (transitory) result of this process, followed by a phase in which this segment was further palatalized as /c^{j}/, only to front to an alveopalatal realization /tʃ/ before becoming the dental affricate /ts/. These issues are taken up fully below; for now, I simply suggest that the processes are complicated and can only be superficially glossed as cases of straightforward lenition.

Now, though complex, such changes are not rare. As seen in Figures 3-1 and 3-2 above, mergers were widespread in C+yod clusters at this point in the history of Spanish, producing (reducing to) a variety of alveopalatal fricatives and affricates in addition to dental /ts dz/. Similar reflexes occur synchronically in rapid, informal English, where word-final /t d/ commonly interact with a following /j/ to form affricates /tʃ dʒ/: *I bet you* [aj.bɛ.**tʃ**u^{w}]; *I kid you (not)* [aj.kɪ.**dʒ**u^{w}]. The alveopalatal result reflects the featural compromise that has taken place: the change represents assimilation in that featural content from both original sounds is present in the result. That is, the affricate is a coronal occlusive like the original /t/, yet with the more back, palatal point of articulation and raised tongue body of the approximant /j/.[2]

3.3.2 Coarticulation

We cannot discuss such assimilations as those seen above without some mention of the phenomenon of coarticulation. Manuel (1999) defines coarticulation as "patterns of coordination between the articulatory gestures of neighbouring segments, which result in the vocal tract responding at any one time to commands for more than one segment". The concept is not a new one, however; coarticulation has been observed and studied since at least the mid nineteenth century (Brücke 1856, Bell 1867). The term was coined by Menzerath & Lacerda (1933), referring quite simply to the effect that sounds have on the articulation of adjacent or nearby neighboring sounds. A typical example from English deals with differences in the realization of /k/ in the words *key* vs. *kook*. Not only is the point of constriction different for the initial consonant, but lip-rounding varies according to the following vowel: the /k/ of *kook* is produced with anticipatory lip-rounding for the following /u/, while lip-spreading marks the /k/ of *key* in anticipation of the following /i/. Coarticulation is the obvious result of a single vocal tract's being required to fluidly produce a highly varied string of speech sounds. As Kühnert & Nolan (1999:8-9) point out, the human vocal tract is not a typewriter; a single mechanism must concatenate the sounds, moving from one vocal configuration to the next such that neighboring sounds inevitably influence each other. This influence and phenomena such as the overlap of articulatory gestures and variant (mis)timings that Browman & Goldstein's (1986, 1988, 1989, 1992; see section 1.4 of Chapter 1) Articulatory Phonology discusses may well be responsible for the bulk of assimilations, lenitions, and deletions that make up so much of the phonologist's work.

It is important, however, not to view coarticulatory processes as a degradation of the speech signal; indeed, coarticulation may possibly offer some advantages to

communication. By anticipating upcoming articulatory features, human speech may in fact make perceptual cues available longer, along a greater stretch of the speech flow (Kühnert & Nolan 1999). This concept underscores both the spatial and temporal aspects of coarticulatory phenomena: general targets of articulation (such as that for the velar occlusive /k/) are subject to modification in the spatial sense; while the anticipation of /u/ for *kook* implies feature-spreading along a temporal axis. Browman & Goldstein's concepts of gestures varying in both magnitude and duration reflect this dichotomy.

An important aspect of coarticulation for the present investigation has to do with coarticulatory resistance, a term advanced by Bladon & Al-Bamerni (1976). Looking at varying degrees of resistance in allophones of /l/ in British Received Pronunciation, they concluded that each allophone must be stored by speakers with a specific CR (coarticulatory resistance) value, itself determined by a variety of factors, including universal as well as language-, context-, and speaker-specific. While their proposal was ultimately not accepted due to the imprecision of the CR value and the factors putatively underlying it, Recasens (1984, 1989) uses electropalotography and acoustic analysis to investigate the phenomenon from a more phonetic perspective. His model of Lingual Coarticulation proposes that resistance to coarticulation is a function of tongue dorsum elevation; that is, the higher the tongue body in the articulation of a sound, the greater that sound's resistance to and impedance of coarticulatory influences. Put yet another way, "the larger the contact between the tongue and the palate, the less the coarticulatory modifications" (Kühnert & Nolan 1999:19). In the same vein, Farnetani (1990) suggests that the sounds most resistant to coarticulation are themselves the sounds that most influence others. Further, Kiritani & Sawashima (1987) show that in V_1CV_2

coarticulation, a V_1 /i/ not only retards the V_2-to-V_1 coarticulation but also itself affects the following vowel.

The above discussion is highly relevant to the current investigation inasmuch as the palatalization process is intimately related to the high vocoid /I/. The vocoid has exerted an enormous influence on adjacent segments in the history of Western Romance, both through the palatalization of contiguous consonants as well as through the metaphony effects observed in neighboring vowels. We now see that this is to be expected: the very high tongue body position of the vocoid, present not only in the yod itself but also in the palatal class of Spanish consonants under discussion, suggests that this segment should naturally wield such influence. Furthermore, the more recent instability of the sounds as evinced in *yeísmo* and ñ-gliding in both Spanish and Portuguese dialects may be a function of these sounds' resistance to coarticulatory effects. Assuming that in addition to the perceptual advantages adduced above, coarticulation may represent articulatory streamlining, then sounds that serve to block this process should be dispreferred. That is, consonants whose articulation represents an obstacle in the stream of speech might naturally be 'eroded' over time, leading to loss of those features most problematic to speech. Thus, the tongue tip contact of the palatal lateral /ʎ/ is widely lost in Spanish *yeísmo*, leaving only the raised tongue body gesture of /j/ or /j̊/; while similar loss of the tongue tip gesture of /ɲ/ along with retention of the velic opening for nasalization leaves the nasalized glide of *ñ*-gliding. The fact that the dorsal raising is maintained in these two processes perhaps suggests that the glide is not in and of itself problematic, that it is the combination of dorsal contact with consonantal constriction that represents the troublesome articulation. In support of this, consider the high cross-linguistic markedness

of palatal obstruents in Maddieson's (1984) survey. By contrast, the vocoid itself is vastly widespread, a staple of most of the world's vowel systems.[3]

My contention here, then, is that coarticulatory processes underlie many of the sound changes seen in Figures 3-1 through 3-5 above. Note that I am assuming that assimilation is basically just an effect of coarticulation, the blending or wholesale changing of features of speech sounds to enable a more fluid articulation through easier transitions between otherwise discrete sounds. Ohala (1993c) seems to support this view. Wood (1996), on the other hand, disagrees; he defines assimilation as contexually dependent and language-specific, with coarticulation affecting all local segments at all times. Nevertheless, his definition does not seem particularly incompatible with approaches that view assimilation and coarticulation as (respectively) the "phonological and motor aspects of a common phenomenon", as he himself cites them (Wood 1996:139).

Focusing on the phonological is instructive. Coarticulation is probably ubiquitous in human speech production, yet it only occasionally becomes phonologically relevant. When it does become phonologically relevant—that is to say, when it marks some feature that takes on contrastive significance in the language—is when we then speak of assimilation. We are thus treading a fine line between coarticulation as a vehicle for the creation of contrasts and the distinct possibility that coarticulation can serve to weaken or nullify contrasts. Recall Flemming's (2002) position, mentioned in the previous section, that assibilation serves to enhance contrasts in the language. Articulatorily, assibilating an obstruent with a palatal place of articulation may be a highly predictable effect of concatenating the consonant with a high vowel (Flemming 2002:104) and is thus a rather

evident coproduction strategy. Yet clearly, coproduction could just as easily threaten contrasts. Indeed, Manuel (1999) recognizes that "patterns of [coarticulatory] overlap are affected by speakers' efforts to maintain distinctions among segments," and she posits output constraints to "set limits on how much the articulatory-acoustic patterns of a segment are allowed to deviate from an ideally distinctive pattern" (Manuel 1999:180). This is clearly in line with the OT concept of constraints: coarticulation challenges Faithfulness to the underlying segments in the lexicon, and we might well expect speakers to limit the degree of coarticulation in order to maintain a sufficient degree of Faithfulness to ensure that contrast is not lost.

Let us consider Spanish post-nasal hardening. Spanish approximants are hardened or occlusivized after nasal segments, as in *dado* 'given' [ˈda.**ð**o] (cf. *dando* 'giving' [daṉ.**d**o]). Coproduction strategies seek to drive the spread of [-cont] from a nasal to a following obstruent, and we would expect to see hardening anywhere the conditions obtain and where no overriding factor prevents it. Clearly, the latter caveat refers to bans on loss of contrastiveness; for a language to be viable as a tool of communication, some level of contrastiveness must be maintained, a dynamic long recognized (from Saussure 1916 on; also Martinet 1952) and formalized in OT in recent times by Flemming's (1995, 2002) MAINTAIN CONTRAST constraint family (see below), as well as in Manuel's (1987, 1990; also 1999) output constraints. Positing the underlying voiced obstruents of Spanish to be approximants, we see that these segments harden because no contrast is threatened by their occlusivization. On the other hand, the voiceless fricatives resist occlusivization: *ansia* 'anxiety' [ˈaṉ.**s**ja], *[ˈaṉ.**t**ja]. A change of /s/ > [t] (or /f/ > [p] or /x/ > [k]) would

undermine phonemic distinctions with the voiceless stops. In other words, coarticulatory influences may be reined in to preserve distinctiveness between segments.[4]

In the changes seen in Figure 3-3a-b above, then, we see straightforward cases of coarticulatory influences. As modeled in the previous chapter, the change of /n +j/ > /ɲ/ shows the effects of coproduction strategy:

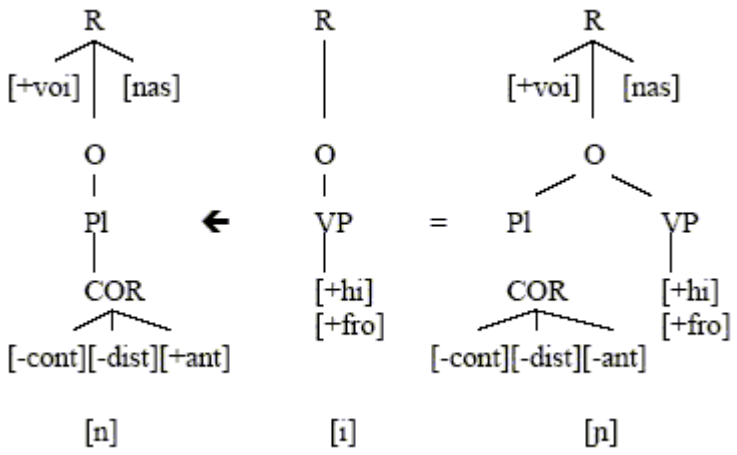


Figure 3-8. Palatalization of /n + j/

I view this type of operation as coarticulatory—and therefore assimilatory—in nature: two segments are merged into a single complex one, conserving features common to both. The retained features provide necessary perceptual cues to listeners while the timing transitions between the disparate articulatory configurations of the nasal and the palatal gestures are reduced. This is not lenition. Since faster transitions between articulatory gestures may be viewed as more effortful (see Kirchner 2001:33-4), we could actually view the drive to condense the speech signal as competing with the drive to lessen effort. Such a stance helps explain the markedness of the segments produced by the changes under discussion. That is, the palatals, as relatively uncommon segments in world language inventories, might not in and of themselves constitute articulatorily 'easy'

sounds, especially given our discussion above of the monolithic tongue body gesture they comprise.

There is, however, another way in which to view these phenomena in terms of efficiency. Byrd (1996) discusses the concept of communicative efficiency as a function of transmission speed. She posits that gestural or articulatory overlap between segments positively impacts transmission speed, "whereby information about several linguistic units is transmitted simultaneously in tandem" (Byrd 1996:235; see also works cited there). Under this view, the palatalization of Figure 3-8 reflects greater communicative efficency in that it compresses the salient perceptual features of two adjacent segments into one, thus making for a 'cleaner' syllable profile: CV over CGV (recall comments above concerning the timing differences between palatal sonorants as opposed to /l^{j}/ or /n^{j}/ combinations). Note, too, that Rosenthall (1997) demonstrates that onglides must share a moraic unit of weight with the following vowel in the nucleus.[5] This suggests two possibilities for the analysis: first, mora-sharing requires a branching structure which may itself constitute a marked structure that some languages could disprefer (Rosenthall indeed posits a 'no branching mora' type constraint); second, mora-sharing here implies mora loss, as the originally fully syllabic vocoid of Latin has lost its own mora to share with the main vowel. The posited geminate structure of the palatal sonorants under discussion here would address this, since these segments are themselves posited to be moraic; the palatal sonorants thus preserve the unit of weight. This is discussed below in the OT analysis.

We see therefore that the role of lenition is unclear here. The shift in Figure 3-8 reflects the anticipation of the [+high] tongue gesture imposed on the preceding

consonant; tongue-raising occurs during production of the nasal, which retracts its point of articulation towards that of the palatal. One might argue that this adaptation spares the speaker a shift backwards from alveolar /n/ to palatal /I/, thus reducing articulatory effort. This would be in line with Kirchner (2001), in which weakening of segments is viewed as a function of the articulatory displacement they entail in certain contexts. However, the apical manner of the original nasal does not seem particularly incompatible with the tongue body (i.e. non-blade) gesture of /I/, while the markedness of the complex palatal nasal vis-à-vis /n/ is unquestioned. Consequently, viewing this operation as a case of lenition and reduction of articulatory effort does not seem entirely satisfying. These arguments are fleshed out more fully in the following section.

3.3.3 Lenition

Lenition has long been recognized as one of the most pervasive elements of our understanding of phonological sound change, and indeed, many of the sound changes under discussion here are commonly attributed to lenition effects (Lloyd 1987, Penny 1991, Wireback 1997, Holt 1997). As noted above, Penny (1991) asserts that all of the intervocalic changes to single segments noted from Latin to Old Spanish can be attributed to weakening, and certainly intervocalic position stands as a premier weakening environment in the literature (Hooper 1976, Lavoie 2001, Kirchner 2001). Yet Penny vacillates in the case of the palatal reflexes of Latin geminate /ll nn/, claiming first that the modern palatals are the products of lenition (1991:62), then suggesting they are not (1991:70-1). In fact, lenition remains an ill-defined phenomenon in the sense that so many different definitions are applied to it, as is to be expected perhaps in something so apparently ubiquitous. Given this lack of hard and fast criteria, the role of lenition in

palatalization phenomenon is by no means clear when we take a good look at it. A discussion of lenition therefore seems warranted.

The various approaches to lenition include: lenition as a loss of structure and/or a step toward deletion (Hyman 1975, Hock 1991); lenition as an increase in sonority (Hankamer & Aissen 1974, Hooper 1976); and lenition as a decrease in neuromuscular effort (Kirchner 1998, 2001). Lenition as loss of structure is illustrated by vocalization, i.e. when a consonant loses consonantal stricture to become a simple vocoid, typically high, as in some varieties of Caribbean Spanish:

a. *carta* 'letter' [kajta] (cf. standard [karta])
b. *papel* 'paper' [papej] (cf. standard [papel])
c. *algo* 'something' [ajgo] (cf. standard [algo])

Figure 3-9. Liquid gliding in Cibaeño Spanish (Harris 1983:47)

Vocalization here typically occurs in syllable- and word-final position and seems clearly motivated by lenition.

Lenition as a sonority effect springs from the Sonority Hierarchy construct, a proposed scale ranking the sonority of individual segments (see e.g. Selkirk 1984). The sonority approach has spawned numerous hierarchies of consonant strength to encompass and predict scales of weakening and strengthening; in general, such hierarchies represent strength as being inversely correlated with sonority.[6] Kirchner (2001:14-17) argues persuasively that such scales do not allow for any unified treatment of lenition, as observed lenition processes do not systematically 'bump' segments stepwise down the attested sonority ladder, as it were. That is, such scales make invalid predictions concerning lenition processes. Note, though, that there are more and less elaborate scales (see Lavoie 2001:16-20 for a review), and Lavoie (2001) finds that the weakening scale

does indeed capture a great many of the phonetic facts of lenition, even if its predictive value is uncertain. For expository purposes here, then, I here make use of Vennemann's (1988) hierarchy:

stronger	voiceless plosives	*lower sonority*
	voiced plosives	
↓	voiceless fricatives	↑
	voiced fricatives	
	nasals	
	lateral liquids	
	central liquids	
↓	high vowels	↑
	mid vowels	
weaker	low vowels	*higher sonority*

Figure 3-10. Strength/sonority hierarchy

This hierarchy would explain the Liquid-Gliding above as a sonority effect, since vowels are clearly more sonorous and weaker than consonants.

Lenition as a function of effort suggests that segments weaken in order to facilitate articulation, that is, that segments weaken to less effortful articulatory configurations. We might thus say that the vowel of Liquid-Gliding, showing no oral stricture versus the consonantal occlusion of the liquid, is easier and less effortful than its predecessor.

To the extent that all three approaches seem to dovetail (with respect to the Cibaeño data), there may not seem to be a problem, though we would like to be able to synthesize all approaches into one unified treatment of lenition. Attempting to sort through these different approaches, Lavoie (2001) conducts an in-depth acoustic analysis of variant consonantal weakening reflexes in American English and Mexican Spanish dialects and concludes that each of various theories explains some facts very well. She refers concretely to lenition as an increase in sonority (as per our hierarchy above), as a decrease in effort—in line with Kirchner's (1998, 2001) work—and as a decrease in duration and magnitude of gestures. Interestingly, she sees this last as best predicting the

behavior of intervocalic stops in Spanish, and we will see below that her observations are vital to an analysis of the evolution of the intervocalic series.

I nevertheless take the view that the effort-based approach of Kirchner (2001) is the most fitting here, assuming, reasonably, that a decrease in the duration and magnitude of gestures is a means of lessening effort. Lenition then is claimed here whenever we can make the case that effort has been reduced through clear loss of stricture or featural content in the target segment(s). I do not, importantly, embrace the notion that merely lessening transitions between segments automatically lessens effort, since the resultant segment is so often marked and effortful.

The problem then for the palatals under discussion here has to do with their markedness and with the degree of transition-based effortfulness that they entail. The markedness of segments is often a function of the articulatory effort they require. As an example, I return to the case of voiced fricatives, particularly voiced stridents. As per Maddieson's (1984) survey, these segments are highly marked, present in only a small subset of the languages that have their voiceless counterparts. Yet Penny (1991:65) clearly accepts intervocalic voicing of voiceless fricatives in the history of Spanish as lenition. Note that I do not question the status of intervocalic position as a prime weakening environment; Lavoie (2001) demonstrates that stops readily approximantize in this position. Fricatives, however, by their nature, do not seem ready candidates for such a process, either as input or output. Fricatives require a controlled, precise degree of articulator control for their production; indeed, fricatives tolerate less variance from articulatory targets than stops and moreover seem to require that that precise articulatory configuration be maintained for a longer period of time than in stops (Ladefoged &

Maddieson 1996:137). Furthermore, voiced stridents /z ʒ/ may be considered highly marked segments both in terms of production and perception. First, they are highly effortful segments, requiring significant expiratory force to produce both glottal vibration for voicing and the oral airstream necessary to generate frication at the point of stricture, not to mention the force required to produce the strident noise component in the sibilants. Moreover, perception of frication noise may be undermined by the low-frequency sounds inherent to voicing (Ladefoged & Maddieson 1996:176-8; see also Balise & Diehl 1994 for acoustic arguments). It is difficult therefore to qualify the intervocalic voicing of /s ʃ/, as in the history of Spanish, as a clear-cut case of lenition. Indeed, these variants—as part of the 'sibilant turmoil' of the fifteen and sixteenth centuries in the history of the Spanish language—did not last long and readily underwent systematic devoicing (see Baker 2003 for an acoustic approach to sibilant resolution).

I see the palatals /ʎ ɲ/ as similarly marked. These segments arise in Spanish as the products of /l, n + yod/ strings, either directly (Figure 3-3a-b above) or as the results of lenited or reanalyzed former consonants (Figures 3-4 and-3-6). If we consider transitional effects, we see that the production of /ʎ/ requires that articulators transition in less time between laterality and the palatal lingual gesture than in the far more common /l + j/ combination. Recall that Recasens & Romero (1997) find that palatalized segments in Russian evince greater lagtime in this transitioning than do speakers of Catalan in producing their /ʎ/. Moving rapidly from one configuation to another is clearly more effortful than a slow, leisurely transition, as Kirchner recognizes (Kircher 2001:33-4). So

the palatalization of /l n/ in contact with palatal vocoids does not readily respond to notions of lenition, if indeed lenition has anything to do with effort.

In addition, these palatals arise as reflexes of former Latin geminates (see Figure 3-6 above). Whereas notions of geminate inalterability and integrity (see Schein & Steriade 1986, Kirchner 1999) dictate that geminates do not weaken unless they become singletons, we have seen in Chapter 1 that the palatal sonorants of Spanish seem to retain the moraicity (and thence geminate structure) of their predecessors. We must therefore see these palatals as reanalyzed geminates and therefore not simplified, weakened segments, in line with Penny's (1991) reticence about lumping these reflexes in with other, more obviously simplified reflexes. Moreover, we will see below that these segments surface in prosodically strong positions, as well, adding to our feeling that they should not be viewed as weakened segments.[7]

What this discussion shows is that lenition is too broad and ill-defined a term for some of the processes to which it is applied. I submit that this is the case for the palatals, or for the palatal sonorants at the very least. The palatalization process that gave rise to /ʎ ɲ/ in Spanish serves to fuse laterals and nasals with palatal vocoids in a way that challenges our view of what lenition does. As for the affricate /tʃ/, its occlusion, lingual tension, degree of linguopalatal contact, and its perceptual saliency similarly belie a general understanding of what weakening does to a segment. These observations will be important below in our formalization of the constraint interaction that accounts for palatalization in an OT treatment.

3.4 An Optimality Theoretic Treatment

In the following section, I detail the constraints that are relevant in my account of the historical reflexes described in section 1 of this chapter. I begin with further discussion of palatalization and lenition, distinguishing between straightforward lenition—formalized here by Kirchner's LAZY constraint—and palatalization as represented by CONDENSE, mentioned in the preceding chapter and here given a fuller description.

3.4.1 Lenition and LAZY

In general terms, we would like to motivate the various palatalization processes detailed by the researchers cited above with ranking permutations of the same constraints. This capitalizes on the inherently typological nature of OT as well as on its formal advantage of capturing the general forces that drive apparently disparate sound changes. Clearly, the various processes of degemination, assimilation, metathesis, deletion and vowel harmony constitute responses to cross-linguistic drives toward greater articulatory and/or communicative efficiency in speech. Vowel harmony, as we have seen, reduces the degree of lingual activity throughout the word, while we may view degemination of stops as reducing the duration of the stop gesture. These reflexes clearly enhance ease of articulation. Similarly, when an intervocalic stop (but not fricative) is voiced, the effort of stopping and restarting voicing is removed. We can thus conceive of a single, lenition-oriented constraint driving many of these processes.

Kirchner (1998, 2001, *inter alia*) has styled a constraint he calls LAZY to account for the drive toward less effort in language performance.

LAZY minimize articulatory effort (Kirchner 2001:30)

Figure 3-11. The constraint LAZY

Kirchner sees effort as neuromuscular, the action of nerves electrochemically stimulating muscular activity. He assumes that speakers develop as part of their linguistic (phonological) competence the ability to estimate the well-formedness vis-à-vis effort of articulatory gestures (Kirchner 2001:30). Given the current inability to measure all muscular activity involved in articulatory gestures, however, Kirchner takes a biomechanical tack. His work conceives of a 'mass-spring' model that allows for the quantification of effort by taking into account the degree of vertical displacement involved in the production of a sound, as well as that displacement over time. Here, vertical displacement refers concretely to the raising of an active articulator (the tongue) towards a passive articulator (the palate) to form some degree of obstruction. His model derives a single value with which to rank the effortfulness of sounds with the goal of motivating weakening phenomena in a wide variety of languages.

I use LAZY in the following analyses to formalize the drive to reduce articulatory effort in any case in which there is clear-cut loss of stricture, featural content, or duration. As per our discussion above, however, LAZY, as the drive to reduce effort, does not always seem to clearly address palatalization. Kirchner acknowledges that his model, based on up-and-down motion, greatly simplifies the extremely complex instrument which is the human vocal mechanism and should to be taken only as a first step toward the quantification of lenition phenomena (2001:38-9). He points out, for example, that the model does not address phenomena involving horizontal displacement, as is the case, for example, in the palatalization of velar segments (2001:42). I take these observations to further substantiate the need for another constraint, beyond the reasons detailed in the

preceding section. This new constraint is CONDENSE, introduced in Chapter 2 and discussed more fully in the following section.

3.4.2 CONDENSE

As seen in section 3.3.3, while widely attested throughout much of Romance, palatalization (like the intervocalic voicing of fricatives) is only partially motivated by Kirchner's LAZY constraint. This is because the results of this process are so often marked and effortful segments in their own right. To avoid this ambiguity, I therefore posit a constraint here that targets purely transitional effects without making larger claims about actual effort. This constraint drives the sort of featural compression seen in the changes under discussion, thereby formalizing the implicit distinction drawn by Penny (1991) between the intervocalic lenition phenomena and the palatalization processes. As mentioned in Chapter 2, I call my constraint CONDENSE.

CONDENSE compress articulatory features in the speech chain

Figure 3-12. The constraint CONDENSE

CONDENSE is posited as a constraint that seeks to provide faster transitions between segments with the goal of enhancing the communicative efficiency of the speech stream; it accomplishes this by compressing the articulatory features of discrete segments into one, typically complex segment, yet with no loss of structure, which would clearly be a sort of weakening. Under CONDENSE, cases of the evolution of highly marked palatal segments from /stop + vocoid/ and /stop + liquid/ clusters are viewed less as lenition *tout court* than as strategies to enhance the communicative efficiency of the speech stream. These sound changes speed articulatory transitions by providing for faster featural concatenation, thus belying the notion of a reduction of overall effort. [8]

We should not fail to address the apparent similarities between this constraint and LAZY. To the extent that CONDENSE targets intersegmental transitions irrespective of the dimension (vertical or horizontal), one may well be tempted to consider it simply a more phonologized macroconstraint of LAZY. As such, it would target all speech sound concatenation, driving articulatory overlap. Yet, as we see in the palatalization processes above, it does this irrespective of the markedness of the results and, importantly, gestures are never lost or left unrepresented under the constraint. Thus, CONDENSE as posited here produces segments that are themselves marked and articulatorily effortful, in which all the articulatory gestures of the sounds affected remain represented. In this way, it may indeed clash with the drive toward less effort, i.e. LAZY. For example, CONDENSE is posited here to militate for compression of /l+j/ sequences, yielding the palatal lateral /ʎ/. While this sequence indeed generates /ʎ/ in the history of much of Romance, we do not see this taking place in all languages, presumably due to markedness: either the markedness of palatal articulations in general or that of the posited geminate structure of the segments under discussion here. Assuming that markedness is at least in part determined by articulatory efficiency, LAZY—or a subconstraint that it comprises, such as *ʎ—must outrank CONDENSE in cases where condensing does not take place in the apparent interest of less effortful articulations. CONDENSE then could be constrained itself by higher ranked markedness constraints and is necessarily distinct from them.

It is therefore clearly not the intent to replace LAZY with CONDENSE. Recall Byrd's (1996) observations concerning communicative efficiency in Chapter 2. CONDENSE may well produce a more complex segment which itself involves a more difficult articulatory configuration. As just noted, the relative markedness of the palatal lateral is likely a

function of its articulatory complexity, yet we posit it as the result of a process involving two extremely common segments. CONDENSE therefore represents not lenition but rather the drive to 'hit' all the segments in the stream of speech in as concentrated manner as possible, thus improving communicative efficiency as a function of speed rather than ease (i.e. 'get it all out there as fast as possible'). If this is so, then, even though the two could well operate in concert, CONDENSE could conceivably compete with LAZY, which might act to temper such condensing in the interest of overall expenditure of effort. This plays into OT's basic architecture which posits constraints formalizing the separate and often antagonistic forces at work in language. Note that instances of 'tongue-tying' in fast speech registers could reflect the two drives at work; haste to blurt out the message can trigger unlikely sound overlap that is ultimately unpronounceable (and thus highly effortful).[9] Forner *et al*. (1992:87-88) also illustrate parallels between historical palatalization and modern synchronic fast-speech phenomenon. They cite the Russian palatal series, which arose as phonemes from what had been allophonic reflexes in Proto-Slavic, and point out the markedness of palatalized segments vis-à-vis their non-palatal correspondents. The implication is that featural/gestural condensing—here the province of CONDENSE—may be responsible for creating segments which are, on a piecemeal basis, at least as effortful as their predecessors.

Other studies provide support for the present stance. Straka (1965) analyzes the complex palatalization processes in the history of French and concludes that palatals arise as products of a general tendency towards *fermeté* or articulatory tension. He posits that depalatalization occurs as a lenition reflex, a function of the high cost in muscular energy that palatals require. Moreover, Pagliuca & Mowrey (1987) also seem to corroborate the

notion of a CONDENSE type drive in language. Discussing the palatalization of /s/ > [ʃ] before /i/ in Japanese, these investigators emphasize that on a gesture-based account of this process, it is difficult to view the change as a loss. That is, a feature-based approach implies that some feature of /s/ has changed, when in fact we may better view the process as one in which articulatory gestures have been coordinated differently: the transitions between the gestural arrays of the two segments have been reduced such that the two gestures are overlapped and simultaneous for at least part of their articulation. No feature has been lost or even changed. As discussed in Bybee (2001:71), once we divorce ourselves from the notion of discrete segments acting autonomously, we may see that it is not that /s/ has simply assimilated to a static /i/, but rather that a whole gestural array encompassing both the consonant and conditioning vowel has undergone restructuring in the stream of speech. As such, there has been no substantive loss of articulatory gestures but rather a temporal reduction in the coordination of the same. I take these findings to underscore my view of palatalization as a process that cannot be insightfully motivated as lenition. On the contrary, the compression of articulatory gestures in the stream of speech may well involve more costly gestural coordination, though one which provides a more efficient transmission of linguistic information.

3.4.3 Implementing LAZY and CONDENSE

Now, if LAZY or CONDENSE had their way, speech might be reduced to a single sound, *aaaaaaaa* or *tβʎ*^{h}, totally weakened or else compressed into unpronounceable meaninglessness. However, they are countered by the need to maintain contrasts so that language remains meaningful. This guarantees that when a sound is weakened or condensed, its features remain sufficiently represented in the speech signal to prevent loss

of meaningfulness. Of course, where no loss of meaning results, or where sound change creates redundancies, total deletion is a possibility, as we will see below.[10] Faith constraints, such as those described in Chapter 2, serve to formalize the drive to maintain contrasts.

To illustrate, consider the evolution of Spanish *noche* 'night'. Vocalization of syllable-final velars took place in the Late Latin phase. The resultant yod is then instrumental in triggering ongoing change in the contiguous consonant. As discussed above, the series of changes from /kt/ to modern /tʃ/ shows progressive featural alterations of the original syllable-final /k/ in L. NOCTE to modern Spanish *noche*:

nok.te > *nox.te > *noj.te > *no.tje > notʃe

Figure 3-13. From L. NOCTE to Sp. *noche* 'night'

The velar weakens, as evidenced by the loss of consonantal stricture, to a vocoid, passing through an intermediate velar fricative /x/ stage. The fricative thus represents partial loss of velar obstruction, maintaining a degree of lingering consonantal stricture. The ongoing rise of LAZY eventually favors loss of consonantal stricture, outranking IDENT$_{[cons]}$. Loss of obstruction results in a raised tongue body that accounts for the vocoid (cf. Modern Portuguese *noite* 'night' [n**oj**.tʃi] as evidence of this stage). LAZY is clearly at work here, weakening the coda and bringing the tongue forward toward the following alveolar /t/. The evolution of the palatal affricate is the final step, with the /tj/ cluster showing gestural compression under CONDENSE such that the dorsum gesture overlays that of the coronal stop. Note that the mechanism of gestural overlay, with the large tongue body gesture timed with the consonantal stricture of the consonant, accounts for the historical metathesis. If the release of the palatal gesture lags behind that of the /t/,

the percept is that of a /t/ with a palatal release. Moreover, the fact that both a preceding and a following yod could bring about palatalization follows naturally from the concept of gestural overlay.

Along these same lines, I view the final affrication stage as an outgrowth of the new palatal articulation. Flemming (2002), discussing the fronting of velars to alveopalatal /tʃ/, sees the affrication as "a by-product of enhancing contrasts in vowel F2 with a secondary difference in loudness of frication" (Flemming 2002:104). That is, the palatalization of /k > c/ before front vowels initially enhances F2 transitions to following vowels such that vowel contrasts along the front-back dimension are enhanced in consonantal contexts, as in [ku ~ ci]. But palatal stops are inherently somewhat affricated due to the slow contact and release brought on by their large contact zone. The affrication enhances the palatal segment with assibilation, adding a salient noise component. The alveopalatal articulation in turn represents an accommodation to maximize the noise component. In this way, then, according to Flemming, the alveopalatal place of articulation is incidental to the assibilation.

Here, then, the point of stricture of /tj/ is drawn back to the alveopalatal in deference to the overlaid palatal gesture. Stridency is then anatomically indicated by the slope of the palate down to the alveolar ridge. In a sense, we get enhancement for free. That is, we get greater perceptual value for an outcome that is almost inevitable given the articulation of the segment. In gestural terms, features have not been lost; apical stricture is still present along with the high tongue body of the former palatal gesture. Indeed, if anything, the affrication may be viewed as fortition along perceptual lines, making the former /tj/ more audibly salient.

In terms of basic OT, the drive to weaken or condense the string outranks feature faithfulness at successive historical stage. I again use the IDENT (McCarthy & Prince 1995a) constraint seen in Chapter 2 to represent faithfulness to underlying forms. Recall that IDENT is a family of constraints requiring that input values for particular features be identical with corresponding features in output.

IDENT-IO$_{(F)}$ Input-output values of a feature F are identical

Figure 3-14. The constraint IDENT-IO$_{(F)}$

Such constraints allow us to account for the progressive, diachronic loss of stricture features seen in Figure 3-13. Note that in the following tableaux both LAZY and CONDENSE are given categorical, all-or-nothing evaluations. Moreover, only the remaining viable candidates are evaluated and only relative to each other.[11] The √ thus indicates better constraint satisfaction relative to rivals.

/nok.te/	IDENT-IO$_{[consonant]}$	IDENT-IO$_{[velar]}$	LAZY	IDENT-IO$_{[cont]}$
a) nok.te			*!	
b) ☞ nox.te			√	*
c) noj.te	*!			

Figure 3-15. Lenition of Late Latin NOCTE 'night' (Tableau 9)

Here then we see a formalized account of the first easing of effort permitted under the influence of LAZY: the loss of velar occlusion. At this point, a fully non-consonantal realization as (9c) would have been too big a jump from the underlying representation. CONDENSE does not figure here; at this historic phase it is inactive. Indeed, all that it could presumably do with this input is try to force a stop-stop affricate *[k͡t], which I assume is blocked by high-ranked sonority restrictions in the language.

Note that some scholars posit a further intermediate stage of palatal constriction (*noçte*) between the velar fricative and the vocoid (Menéndez-Pidal 1940, Lausberg 1965). This would be accounted for by downranking IDENT-IO$_{[velar]}$ below LAZY. The palatal fricative surfaces, as it provides an easier transition to the /t/ than the velar /x/.[12]

/nok.te/	IDENT-IO$_{[consonant]}$	LAZY	IDENT-IO$_{[velar]}$	IDENT-IO$_{[cont]}$
a) nok.te		*!		*
b) nox.te		*!		
c) ☞ noç.te		√	*	
d) noj.te	*!		*	

Figure 3-16. Late Latin NOCTE, later fricative representation (Tableau 10)

Notably, despite its high markedness (Ladefoged & Maddieson 1996:165), a palatal fricative does arise as an allophone of the velar fricative /x/ in some modern Spanish dialects. Dialects of Chile, for example (see Lipski 1994:224), produce [ç] in words in which a front vowel follows the /x/: *mujer* 'woman' [mu.**ç**er], *[mu.xer].

Another possibility in OT is that of a tie, which models a situation in which various candidates might arise. In such a scenario, the velar and palatal fricatives (and, on the account in 3-17 below, the velar stop) may have each arisen as a viable competing candidate in these intermediate stages. We assume that LAZY and IDENT-IO$_{[velar]}$ are tied and follow Boersma's Stochastic OT (see Boersma & Hayes 2001, for example), whereby strict rerankings of tied constraints may favor alternating candidates. Thus, each variant could have surfaced in a sort of Labovian scenario in which several variables competed for primacy, a not improbable scenario given the chaotic tenor of the time.

/nok.te/	IDENT-IO[consonant]	LAZY	IDENT-IO[velar]	IDENT-IO[cont]
a) ☞ nok.te		*		
b) ☞ nox.te		*		*
c) ☞ noç.te		√	*	*
d) noj.te	*!		*	*

Figure 3-17. Late Latin NOCTE with competing fricative outputs (Tableau 11)

Subsequent historical changes reflect ongoing shifts in constraint ranking. In succeeding stages, all oral stricture is lost, giving the *noite* of modern Portuguese and an intermediate phase in the evolution of Spanish. This ongoing lenition is modelled in the rise of LAZY above the constraint requiring a consonantal articulation.[13] Recall that in modern Spanish dialects, this is observed by vocalization of syllable-final liquids in Cibao (see Figure 1-6).

/nok.te/	LAZY	IDENT-IO[consonant]	IDENT-IO[velar]	IDENT-IO[cont]
a) nok.te	*!			
b) nox.te	*!			*
c) noç.te	*!		*	*
d) ☞ noj.te	√	*	*	*

Figure 3-18. Loss of consonantal stricture in L. NOCTE (Tableau 12)

Here, then, (12d) provides the most harmonic candidate, dispensing with the coda consonants altogether to favor what would be the lasting reflex in Portuguese.[14]

To account for the final phase of affrication to /tʃ/, I will assume that at this point speakers are no longer aware of any underlying consonant and thus have /nojte/ as their representation of this word. With the advent of the yod, CONDENSE has material to work with and drives compression of the palatal gesture and the contiguous consonant.

/nojte/	IDENT-IO[palatal]	CONDENSE	LAZY
a) noj.te		*!	*
b) no.tje		*!	*
c) ☞ no.tʃe		√	*
d) no.te	*!		√

Figure 3-19. Affrication in L. NOCTE (Tableau 13)

The affricate of (13c) maintains the palatal gesture required by the top-ranked IDENT-IO constraint, as do (13a,b). However, it better satisfies CONDENSE, integrating the occlusive /t/ more completely with the high, fronted tongue gesture of /j/ for faster transmission. Arguably, too, the affricate better matches the high F2 of the vocoid in its transitions than the alveolar /t/ of other candidates (see Flemming 2002:58). (13d) shows that the fully LAZY candidate, in which the vocoid has simply been deleted, violates the need to retain some acoustic cue to the palatal. I would also claim that LAZY must be ranked below CONDENSE in order to prevent either /tj/ or /jt/ from surfacing; this is due to the inherently greater effortfulness of the compressed gestures of the affricate.

In fact, we can apply CONDENSE to all of the cases where clear-cut weakening of coda consonants (under LAZY) is at work. For example, the /ks/ cluster became alveopalatal fricative /ʃ/ in Old Spanish, later posteriorizing in modern Spanish to /x/: L. AXE > OSp. *exe* > Sp. *eje* 'axis'.[15] We account for this by vocalization of the weakened coda velar under LAZY, formalized in Figure 3-20, with the following sibilant in turn ultimately palatalizing according to CONDENSE, in Figure 3-21.

/ak.se/	LAZY	IDENT-IO[consonant]	IDENT-IO[place]	IDENT-IO[cont]
a) ak.se	*!			
b) ax.se	*!			*
c) aç.se	*!		*	*
d) ☞ aj.se	√	*	*	*

Figure 3-20. Vocalization in L. AXE (Tableau 14)

/aj.se/	CONDENSE	LAZY	IDENT-IO$_{[place]}$
a) aj.se	*!		
b) ☞ aj.ʃe	√		*

Figure 3-21. Palatalization in L. AXE into Old Spanish (Tableau 15)

CONDENSE favors the palatalized sibilant, (15b), which enhances the transition between that segment and the palatal vocoid by spreading the high tongue body gesture over both segments. The tableau is incomplete, however. I have left LAZY unevaluated at this point, as it is not immediately clear whether the /s > ʃ/ change should be considered weakening or strengthening; the alveopalatal /ʃ/ requires greater dorsal contact (hence, in my view, greater lingual movement) than the alveolar /s/ and is considerably more marked cross-linguistically than /s/. It may be that here CONDENSE does not occasion an out and out violation of LAZY. Moreover, the posited output of this process maintains the yod in addition to the palatalized variant (cf. [aiʃe], *[aʃe]), which in my view should encompass both. Consequently, it is necessary to integrate the vowel reflexes evident in the initial /e/ of both OSp. *exe* and Modern Spanish *eje*, as clearly the vowel-raising also involves the high vocoid.

I view vowel-raising as an effect of LAZY: the low vowel raises to accommodate the high tongue body of the palatal sibilant but retains the [-high] feature of the absorbed low vowel. Note that faith to the [+high] gesture of the yod is satisfied by the alveopalatal /ʃ/ due to the high tongue body gesture it encompasses. In terms of faith, then, the only feature retained in the attested outcome is the [-high] of the /a/. [+low] is lost to LAZY. In the tableau below, I use IDENT-IO$_{[-high]}$ to represent this aspect of faithfulness, following

McCarthy & Prince (1999), who extend IDENTITY to target specific features with specific values. This demands input/output isomorphy for the specified feature:

IDENT-IO(±F) for an input value of F(eature), there is one output F (and vice versa)

Figure 3-22. The constraint IDENT-IO(±F)

/aj.se/	IDENT-IO$_{[-high]}$	CONDENSE	LAZY	IDENT-IO$_{[place]}$
a) aj.se		*!		
b) aj.ʃe			*!	*
c) i.ʃe	*!			*
d) a.ʃe			*!	*
e) ☞ e.ʃe				*

Figure 3-23. L. AXE to OSp. *exe* with vowel-raising (Tableau 16)

IDENT-IO$_{[-high]}$ does not interact with CONDENSE; they have different targets. Only the low vowel of the input is contemplated by the former, and by its nature CONDENSE does not affect vowel sequences. This is in keeping with our model of compressed segments: vocoidal characteristics may be compressed onto consonantal structure, but sequences of VP nodes can only be concatenated as long vowels or diphthongs; a featural structure or gestural score cannot be both [+low] and [+high], with tongue fronted and backed, simultaneously. Vowels therefore are unaffected by CONDENSE. For this reason, I rank IDENT constraint alongside CONDENSE without ranking them.

In Figure 3-23, we see that the uncondensed (16a) and (16c), with the maximally raised vowel (and deleted low vowel), violate CONDENSE and IDENT-IO$_{[-high]}$, respectively. Of the remaining candidates, (16b,d,e) all satisfy the top-ranked IDENT constraint and all show a compressed alveopalatal, but (16b) and (16d) are eliminated under LAZY, as the first fails to simplify the /aj/ group and the second fails to raise the vowel as does the optimal (16e). This tableau provides a more coherent and satisfying account of L. AXE, as it does not imply intermediate outputs that fail to square with the

concept of compression of gestures. Moreover, inasmuch as the sound changes in question never raise vowels fully to /i/—indeed, high vowels are often lowered (cf. L. CISTA > Sp *cesta* 'basket')—the ranking here seems correct.[16]

To summarize, I am positing a relatively straightforward mechanism behind much of the palatalization seen in section 1: LAZY in essence sets up the conditions under which CONDENSE applies. That is, weakening of consonants (largely in coda position) eventually reduces these segments to vocoids, which may then overlap with contiguous segments under the influence of CONDENSE to produce complex, featurally dense segments. In a synchronic, rule-oriented generative analysis, this would constitute a feeding situation, the output of one rule feeding into the next in an ordered relation. Here, we may view CONDENSE as opportunistic, blocked by higher ranked constraints (markedness, contrast maintenance) until it finds suitable material with which to work, such as a high vocoid that is readily adaptable to consonantal articulations. The fact that we do not see spontaneous synchronic palatalization (including affrication) of stop clusters or stop + liquid clusters—whereas affrication of alveolar or dental consonants + /I/ is common, as in English—could be taken as supporting evidence that CONDENSE generally feeds off the effects of prior lenition. Generally, then, we see that in many of the cases here, codas weaken to vowels (vocalization) under LAZY and subsequently condense to complex segments. This relation is explored further in terms of the data from section 1 in the following sections.

3.5 Other Clusters from Latin to Spanish

3.5.1 /GN/

We next look at the Latin /gn/ cluster. Here again we have a heterosyllabic cluster, with weakening affecting the coda. There is some disagreement as to the phonetic value

of the G graph in Latin. The traditional position is that Latin GN represents precisely that, [gn], and that the velar weakened predictably, bringing a palatal vocoid into play that palatalized the nasal. Under such an analysis, a word such as L. PUGNU would become Sp. *puño* in much the same way as L. AXE > Sp *eje* above, with CONDENSE driving palatalization of the nasal.

Many scholars, however, are convinced that the segment represented a velar nasal /ŋ/ (Millardet 1923, Bourciez 1946, Vincent 1988). In this case, a word such as L. PUGNU 'fist' would have been [puŋ.nu]. Then, according to Millardet (1923), there was a mutual assimilation that brought the velar nasal forward and the alveolar back, leaving a geminate palatal alveolar. Wireback (1997) adduces evidence suggesting that /ŋn/ cannot be assumed for all of Romance, citing Southern Italian words such as *ainu* 'lamb' from L. AGNUS, where the off-glide suggests a former (oral) velar stop that vocalized in the familiar weak coda position. Wireback (1997) does assume, however, that the velar nasal obtained in Iberian Romance. He argues that GN never passed through a yod phase since data from Western Ibero-Romance do not show any evidence of a yod in Portuguese words, in which off-glides are regularly retained before other palatal sounds: *deixar* [dej.ʃar], *leite* [lej.tʃi], *beijo* [bei.ʒo]. He suggests that no particular quality of the palatal nasal would favor absorption of the vocoid over its retention with these palatal sounds ([ʃ ʒ tʃ]).

This account seriously ignores some important phonetic facts, however: the nasal /ɲ/ is a fully palatal sound with high F2, whereas the others are alveopalatals with strong fricative (and strident noise) cues to distinguish them from a vocoid. Thus there are

indeed reasons to think that /ɲ/ would absorb preceding yods where the others do not. This is pursued further in the following section, but for now I accept the traditional view that the velar vocalized under LAZY and was forthwith condensed to the palatal nasal in line with the tableaux above.[17]

3.5.2 /KL/ and /GL/

We next examine the palatalization of /kl gl/ clusters, which as seen above (see Figure 3-6) palatalized not only in word-medial but also in word-initial position. I begin with the word-medial changes.

3.5.2.1 In word-medial position

Lloyd (1987) assumes—as do most traditional scholars (Menéndez-Pidal 1940; Harris-Northall 1990)—that word-medial /kl gl/ followed /KT/ and /GN/ in weakening the velars, which he sees as emerging from syncope processes as syllable codas: L. TEG(U)LA > VL TEG.LA. If so, they would then follow the palatalization process seen above: VL teg.la > tej.la > teʎa, whence [teʒa], with devoicing to [teʃa] (Lloyd 1987:253). Wireback (1997), on the other hand, posits that an off-glide /j/ never arose in the evolution of clusters /kʎ gʎ gn/. He bases this on the fact that /a/ is never raised in the process that produced the palatal results of these clusters:

L. NOVACULA > Sp. *navaja* (OSp. [na.βa.ʒa]) 'pen knife'
vs.L. FACTU > Sp. *hecho* (p. part. of *hacer* 'to do, make')

Figure 3-24. Absence of /a/-raising in Sp. *navaja* and *hecho*

The traditional theories, in contrast, assume that upon palatalization of sonorants /l n/, the yod was rapidly absorbed, leaving the /a/ unaffected. Harris-Northall (1990), for example, assumes vocalization of syllable-final velars in all clusters (/kt ks kʎ gʎ gn/)

with subsequent “bifurcation” of effects as the off-glide yods were absorbed by following sonorants but persisted with obstruents; he points to medieval documents that show that /l/ had already been palatalized and delateralized (ʎ > j) by the advent of written Castilian, while palatalization of /kt ks/ was still incomplete.

As adduced above, phonetic evidence can help to explain these variant reflexes. As we have seen elsewhere, palatalization of the sonorants leaves a glide-like element which we may attribute to the slower release of the tongue-body raising gesture involved in the palatalization process (Recasens & Romero 1997:58). Given the high F2 component of palatals /ɲ ʎ/, any preceding high vocoid resulting from vocalization of a former velar could easily be parsed by the listener as part of the palatal segment; that is, with little F2 transition from the yod to the following palatal, it seems likely that the listener will not parse it as separate. Consider as an example the common ‘intrusive’ glide inserted between a low vowel and a following palatal, as in realizations of [ˈkaʲ.ʝe] for *calle* ‘street’. This glide, a transitional effect, is present but not represented underlyingly. Any underlying off-glide might just as easily be ‘underparsed’ as such a transitional effect; the listener hears the offglide and assumes it to be an articulatory artifact and fails to parse it (cf. Ohala’s 1993 concepts of hyper- and hypocorrection). By contrast, in the case of the results of the palatalization of /kt ks/ clusters (alveopalatal affricate /tʃ/ and strident /ʃ/, respectively), perceptually salient acoustic features—stridency and, for the affricate, burst characteristics—would have served to mark a boundary between the yod and the following palatal reflex (cf. Port *caixa* [kaj.ʃa]). This may well have allowed the yod to persist (as a parsable item) long enough to raise the vowel. Recall that Wireback (1997)

points out that in Luso-Romance, the only elimination of offglide /j/ is through the palatal sonorants.

We might be able to have it both ways. If Wireback, who follows Repetti & Tuttle (1987) in their observations of /kʎ/ clusters in both Italian and Portuguese diachrony, is correct and Hispano-Romance passed through such a phase, there does not seem to be any reason why vocalization of the /k/ could not have still taken place. Such a cluster is unwieldy to begin with, and it is likely that the velar was already weakened before the syncope that left it adjacent to the liquid (L. TEGULUM). Resolution of such a cluster is likely, as Wireback points out (1997:288) and would naturally either reduce the velar or the lateral. In (standard) Italian, the lateral simplified to an approximant in a process similar to *yeísmo*: L. CLAMARE > *kʎamara > k**j**amare *chiamare* 'to call'. In Hispano-Romance, the velar, if already weakened to an approximant, likely vocalized and was absorbed by the following palatal due to the F2 similarities just discussed. Note that there is also Mozarabic data suggesting a vocalization phase: though palatalization of clusters /kl gl gn/ (> ʎ) was the rule in Mozarabic, where it did not take place in some toponyms, an off-glide residue is present:

a) VALIUS + ENUS > Bailén
b) LUCANIUS + ENA > Lucainena (from Wireback 1997a)

Figure 3-25. Absence of palatalization in toponyms

Wireback presents this evidence in defense of his own ideas, suggesting that these forms occurred as alternatives to palatalization. That is, the vocoids here were insufficient to trigger palatalization, which did not take place "for whatever reason" (Wireback 1997:278). He therefore assumes that the palatalization process for the above clusters did

not involve a vocalization phase. It does not seem like a leap, however, to suggest that these forms indeed indirectly support a vocalization phase for Western Romance. The fact that they persist in these topynyms is precisely due to the fact that palatalization did not 'take' in these words.[18] That is, had palatalization occurred, it would have absorbed the preceding vocoid; since it did not, the vocoids were left intact. Note that what is clearly seen here is the metathetic migration of the high vocoid through a consonant; the palatal glide fails to palatalize the preceding sonorant but is anticipated to a position before it. This reflects the temporal and spatial coordination of the rather monolithic tongue raising gesture of the palatal with the gestures involved in articulating the sonorants. We therefore see such metathesis in both directions—evidencing variant speaker coordination (see Cho 1998; also Bradley 2002, for gestural timing resolution)—in Spanish and Portuguese: cf. Sp. *noche* (see Figure 3-17 above and following discussion) with *Bailén* here. We may thus view the metathesis as having occurred in lieu of (full) palatalization, as does Wireback, but without assuming that this proves that vocalization is somehow a process unrelated and apart. In sum, then, I follow the traditional view that word-medial /kl gl/ clusters were heterosyllabic and weakened along the same lines as /kt ks gn/ (due to LAZY), involving a stage of vocalization of the syllable-final velars with subsequent palatalization under the influence of CONDENSE.

3.5.2.2 Word-initial /KL PL FL/

Word-initial clusters are another matter, as they must have been tautosyllabic. Lloyd (1987:225) cites evidence from Italian and Rumanian that suggests that the initial change was indeed palatalization of the lateral in /kl/ > [kʎ] (also Repetti & Tuttle 1987, Wireback 1997). Lloyd suggests that this change may be viewed as an assimilation of the

lateral to the dorsovelar articulation of /k/. Raising of the ‘back of the tongue’ for velar constriction causes the tongue tip to be retracted towards the palatal zone. Then, citing Tuttle (1975), he assumes that the other word-initial /C+lateral/ clusters followed suit in an act of “allophonic unification”, shifting to /pʎ fʎ/, as seen above in Figure 3-6e. Lloyd points out that [kʎ] is still heard in highly conservative Aragonese dialects. Generally, however, the articulatory ‘heaviness’ of these new clusters begged for simplification and in Rumanian, Italo-Romance, and central and western Ibero-Romance, initial segments were soon dropped, leaving the palatal lateral as the sole initial segment. As Lloyd notes, this is similar to the loss of stop segments in word-initial clusters /gl bl/: L. GLATTIRE ‘to yip’ > Sp *latir* ‘to beat’; BLAT(T)A ‘light-shunning insect’ > Sp *ladilla* ‘crab louse’ (< {lad-} + dim. {-illa}; cf. Fr *blatte* ‘cockroach’).

To explain this behavior, we need to address the issue of why it was the apparent head element in the onset, the supposedly stronger (in sonority terms) obstruents /k p f/ which were lost. The examples cited above, e.g. the reflex of L. GLATTIRE, suggests that initial obstruents—especially velars, but quite possibly labials as well (Penny 1972:466)—were likely not particularly salient in clusters. Still, this does not explain the behavior of the labial /pl fl/ clusters and their parallel behavior, especially as regards the palatalization of the lateral.

Like Lloyd, I follow Tuttle (1975) here to explain these events, couching his observations in the terms of an OT approach based on CONDENSE and articulatory and communicative efficiency. This approach takes for granted that all of the clusters in question ultimately underwent the shift of the coronal lateral element to a palatal lateral in most of Romance. Indeed, Tuttle cites a number of sources to confirm the palatal

nature of the liquid in all these clusters: Bec 1970; Cavaliere 1972; Tekavčić 1972. Since the outcome is not in question, then, we must focus on the motivation; that is, why would all of the clusters have undergone similar alterations?

Tuttle recognizes the unlikelihood of 'organic' motivations (viz. articulatory motivations) for shifting /pl fl/ to [pʎ fʎ] and points instead to a systemic explanation. He suggests that speakers generalized the palatal lateral to all of the clusters to reduce the allophony of the lateral, preferring to maintain a one-to-one phoneme-allophone ratio (1975:408). In support of this, he presents the much greater frequency of /kl/ over /pl fl/ in Latin as the factor that favored the generalization of the palatal lateral in the clusters. Indeed, he points to the frequency of /kl/ both in lexical terms and in the morphology, where /kl/ was highly productive in diminutive suffixes: e.g. {–aculu} in L. NOVAC(U)LA 'little knife' (cf. Figure 3-24 above). Tuttle seems to imply that clusters may be seen as virtual phonemes in their own right, and that a following liquid acts as a feature distinguishing the cluster from single segments: e.g. Eng. *pay ~ play, fey ~ flay, Kaye ~ clay*, etc. In cases where articulatory influences such as condensing alter the nature of the secondary segment, as with /kl/ > [kʎ], the distinguishing 'feature' loses regularity and risks becoming a wholly arbitrary characteristic. Thus, Tuttle sees the generalization of the palatal lateral as a systemic response to the threat of loss of the "functional importance" (Tuttle 1975:409) of the lateral 'feature' in these clusters.[19] It was furthermore the palatal lateral that was generalized to the labial clusters because it was far more strongly represented in the language.

This quasi-phonemic view of the clusters plays into the next posited phase, in which Tuttle imagines a wholesale "reinterpretation of these clusters as a set of unit

phonemes analyzed by speakers as an occlusion or obstruency followed by a palatal lateral release" (Tuttle 1975:409). Evidence from child acquisition studies suggests that such (re)analysis may well be a natural component of language transmission. O'Connor (2001) finds that such a position best explains the anomalous results of a number of speakers in a study on acquisition of stop+liquid and fricative+liquid clusters; in some cases, the first were successfully acquired as /Cl/, despite the absense of singleton /l/ (or /r/) in their production, while the fricative-liquid clusters were reduced to simple fricatives. She explains this as due to an analysis of the stop+liquid clusters as complex segments, affricates with a lateral release; she notes that Ladefoged & Maddieson (1996: 204-9) discuss numerous cases of similar affricates in the world's languages. O'Connor also cites Barton, Miller, & Macken (1980), whose study indicates that children may initially represent some or all clusters as complex segments. Finally, Holt (2001), following Walsh-Dickey (1997), suggests that coronal laterals should themselves be considered complex segments, involving coronal (apical) closure as well as a degree of ([+cont]) dorsal obstruency accounting for the lateral passage of air. Under such an analysis, clusters involving stop closure plus laterals would constitute articulatorily complicated arrays of features and as such could be ripe for some reanalysis.

Assuming such reanalysis took place with the clusters in question, we arrive at a set of phonemic units that could be characterized as /$k^{\wedge}$ $p^{\wedge}$ $f^{\wedge}$/, comparable to languages with series of phonemically distinctive palatalized consonants, as in Russian. I claim that such sound change falls under the purview of CONDENSE as here put forth: gestural timing has been altered such that features are condensed into a single segment. Consider Recasens & Romero's (1997) findings on the relative timing of palatalized segments in Russian

versus that of palatal segments /ʎ ɲ/ in Catalan: the former show greater time lag between the coronal components and the palatal tongue body gesture than the latter. Now, taking into account evidence that Spanish onglides are nuclear elements rather than being part of complex onsets (Harris 1983; Hualde 1991; see also Rosenthall 1997), we may assume that relative timing between an onset consonant and a following (nuclear) onglide will show less overlap than would obtain if no intrasyllabic boundary were present. This suggests a phonetically justified timing hierarchy of overlap effects:

1		2		3
lj	>	l^j	>	ʎ
nj	>	n^j	>	ɲ

less ➔ *more*

Figure 3-26. Hierarchy of timing overlap

That is, the segments under 1 are separated by an intrasyllabic boundary (see Chapter 2, section 2.3.3.1) and presumably are the least overlapped in terms of timing (e.g. Sp *lion*); the segments under 2 are segmental, as in Russian, and have a greater time lag than the fully palatal segments under 3, as shown by Recasens & Romero (1997). We may therefore assume that each of these segments shows progressively greater condensing:

	CONDENSE
a) lj	*!*
b) l^j	*!
☞ c) ʎ	

Figure 3-27. Overlap as featural condensing under CONDENSE (Tableau 17)

In the palatalization of the lateral with the velar stop (/kl), given that the palatal lateral at once shows a more back articulation than the coronal such that the transition from a velar obstruent to a following lateral is lessened, LAZY might be indicated.

However, CONDENSE produces a single segment with a palatal lateral off-glide, a more complex, effortful segment. This process /kl > kʎ/ is shown in Figure 3-28 below. Moreover, the phonemicization of the latter to a segment involving occlusion with a "palatal lateral release", as Tuttle describes it, would show an additional degree of featural condensing in a spatio-temporal sense.

	CONDENSE
a) kl	*!*
b) kʎ	*!
☞ c) kʎ	

Figure 3-28. Complex segments as effects of CONDENSE (Tableau 18)

Such segments would have been extremely ponderous articulatorily, however, as Tuttle notes, and ripe for some simplification. Here again then we see that CONDENSE may conflict with general lenition processes as represented here by LAZY; featural condensing may serve to create segments that ultimately are too effortful to be viable. Now, recall that 'standard' Italian dialects simplified such clusters as Figure (18c) by losing laterality in a process similar to Spanish *yeísmo*: the palatal lateral becomes a palatal glide or approximant, as in It. *chiave* [kja.ve] (cf. Fr. *clé* [kle], Sp. *llave* [ʎa.βe] or [ja̯.βe] 'key'). Another option was to alter the initial obstruent element, which is what took place in Ibero-Romance as well as in many southern and central Italian dialects, the very dialects in which widespread weakening of obstruents is observed. Indeed, Tuttle links the palatal outcome of these clusters in southern and central Italian dialects to their propensity for obstruent weakening. Since even initial segments weakened in these dialects, a ready means of simplifying /kʎ pʎ fʎ/ was available: the obstruents were simply deleted. However, such an approach is not completely convincing for the Spanish reflexes, since

word-initial segments show much more resistance to weakening in Spanish than in southern and central Italian dialects (see discussion of positional faithfulness below): cf. Sp. *gallina* 'chicken' ~ It. (Lazio dialect) *la a[ʎ]ina* (Tuttle 1975:413). We must thus take other facts into account.

As it turns out, rather than being problematic, positional faithfulness and position-specific fortition may well help us to explain the Spanish reflexes. While the initial segments of the articulatorily challenging clusters simply weakened away in the Italian dialects noted above, the drive to strengthen those same clusters in Spanish may have served to drive simplification in its own right in Spanish. If we allow that velars are the obstruents most subject to weakening—evident for Italian in Tuttle (1975:417) and noted by Lavoie (2001: 211) in general—and consider that the labial fricative /f/ was also unstable in much of Romance and subject to ready debuccalization to [h] (Penny 1972: 466; Lloyd 1987: 214-5), we understand that the fortition of the clusters would have naturally focused on the palatal portion rather than the initial obstruent.[20] Taking into consideration, too, that the geminate sonorants were undergoing palatalization to /ʎ ɲ/, the palatal lateral as a strong initial variant seems consistent (see further discussion of phrase- and word-initial fortition below). This approach assumes as well that retention of all of the present features in the initial clusters/complex segments was barred by the sheer articulatory weight of the resulting fortified segment.

The following tableaux show the various changes undergone diachronically. As discussed above, CONDENSE is held to drive both the initial palatalization of the lateral in /kl/ clusters as well as subsequent condensing of the other clusters to complex segments with palatal release. Note that the systemic pressure to regularize the palatal lateral to

other consonant + lateral clusters is taken for granted and not formalized here; rather, see the discussion of Dispersion Theory in the following sections for a framework in which to motivate such effects. To drive the simplification of the resultant complex segments, a markedness constraint banning consonant clusters with palatals is posited here:

$*CC^{Pal}$ no consonant + palatal consonant clusters[21]

Figure 3-29. The constraint $*CC^{Pal}$

The constraint calling for maximally strong onsets is posited here as HONSET (Baker & Wiltshire 2003). HONSET, modeled after HNUC from Prince & Smolensky (1993), calls for maximally harmonic onsets, where harmonic refers to maximal perceptual salience as a function of sonority contouring with following vowels. Hence, the constraint seeks to provide maximal contrastiveness with a following vowel; thus, a voiceless stop is more harmonic than a voiced stop or fricative, since voicelessness allows for more salient burst cues leading into the vowel. We can set up an implicational hierarchy of HONSET constraints based on findings that certain prosodic positions are of greater perceptual importance than others (see Beckman 1999; see also Fougeron & Keating 1997). These positions generally reflect confluences under the prosodic hierarchy where multiple heads of different constituents align. Thus, utterance-initial position should be a point of maximal perceptual importance, followed by word-initial, foot-initial, and finally syllable-initial positions. I only focus here on word-initial position. Finally, LAZY is also invoked here to represent the wide-spread weakening effects prevalent in much of the history of Spanish at the time.

Once again, then, we see that communicative efficiency (CONDENSE), driving palatalization, and weakening (LAZY), driving articulatory efficiency, conspire to motivate the attested changes despite Faith (here, to Coronal [+ant]) and markedness.

/kl ~ pl ~ fl/	*MERGE	CONDENSE	IDENT-IO$_{(ant)}$	*CC^{Pal}
a) kl ~ pl ~ fl		*!*		
b) kʎ ~ pʎ ~ fʎ		*!	*	*
☞ c) kʲ ~ pʲ ~ fʲ			*	*
d) k ~ p ~ f	*(k)! *(p) *(f)			

Figure 3-30. The condensing of C + palatal lateral clusters to complex segments (Tableau 19)

As attested historically, then, the same process behind other palatalization reflexes in the language outranks a markedness constraint banning /consonant+palatal consonant/ clusters. Such clusters thus arise and are in time further condensed to quasi-affricates, that is, complex segments comprised of obstruence with a palatal lateral release. Note that I assume here that the markedness constraint banning the cluster implies a ban on such affricates as well, since the articulatory basis for their markedness is an issue common to both.

Word-initial fortition, however, forces some resolution of these clusters. This constraint is high-ranked in Spanish, as attested by geminate realizations of word-initial /r/: cf. *robo* 'robbery' [**r**o.βo], *[**ɾ**o.βo]. I therefore rank it high here, tied with CONDENSE. If we also assume that the markedness constraint banning such clusters, *CC^{Pal} was also rising, we arrive at an impasse that is only resolved by lower ranked LAZY (recall that LAZY is ranked below CONDENSE in Tableaux 10 and 13).

/kʲ ~ pʲ ~ fʲ/	IDENT-IO$_{[palatal]}$	CONDENSE	HONSET$\|_w$	*CC^{Pal}	LAZY
a) kʎ ~ pʎ ~ fʎ		*		*	*!
b) kʲ ~ pʲ ~ fʲ		*	*	*!	*
☞ c) $^{(k)}$ʎ $^{(k)}$ʎ $^{(k)}$ʎ			*	*	
d) k ~ p ~ f	*!	*			

Figure 3-31. Weakening (velarization) of affricate occlusive elements (Tableau 20)

While (20c) is the most harmonically condensed cohort, (20a) is the strongest, with fully realized occlusive elements and palatal laterals. All candidates violate the prohibition of occlusive-palatal consonant clusters (including the affricate of 20b). LAZY then decides which cohort is most harmonic, favoring the vestigial occlusion with fully realized palatal laterals of (20c) over the cluster of (20a) and the complex affricated segment of (20b). (20d) is included to show that the palatal quality of these sounds was tenaciously maintained, even when otherwise it might have seemed the best option to simply do away with the palatal laterals. Thus, the effects of condensing, perception-driven fortition in word-initial position, and markedness hold each other in check to be resolved by general lenition. Weakening of the occlusive element of the contour (affricate) segments merely reflects the trend toward general obstruent weakening going on in the language, particularly as regards the unstable fricative. Moreover, the apparently inherent weakness of the velar—perhaps due to the loss of tongue blade and tip activity it represents—is attested by candidate (20c); contrasting points of occlusion are lost in favor of a general "'obstruency' plus palatal lateral release" as envisioned by Tuttle (1975): the velar (involving tongue root raising) permits easier negotiation of the coronal (apical) and dorsal (lateral) features of the palatal portion of the segment.[22]

It is important to bear in mind that, in light of the difficulty of setting fixed chronologies to such processes, I only opt here for this particular ranking of the constraints in question for expository clarity. In fact, various rankings of the constraint set will give the attested results. For example, while LAZY has been ranked below CONDENSE or at best tied with it in previous tableaux, ranking it here above CONDENSE would also account for the results above, as it would were LAZY tied with CONDENSE and

the others. Only an undominated HONSET would provide variant results. I do not speculate here as to exact rankings, though I have shown that each individual constraint seems to play a role in the variants discussed above. The results in Tableau 20 seem to be almost inevitable, given that several permutations of the constraint set favor them. Given the rather tumultuous tenor of the times during the history of Spanish when these sounds changes were in evidence, it seems difficult to establish exact rankings and chronologies and indeed that is not the objective of the present work.

Finally, however, the sheer markedness of these contour segments forces further simplification. *CC^{Pal} rises above CONDENSE and favors candidate (24c):

/k^{ʎ} ~ p^{ʎ} ~ f^{ʎ}/	IDENT-IO$_{[palatal]}$	*CC^{Pal}	CONDENSE	HONSET$\|_{w}$	LAZY
a) kʎ ~ pʎ ~ fʎ		*!	*		*
b) k^{ʎ} ~ p^{ʎ} ~ f^{ʎ}		*!	*	*	*
c) $^{(k)}$ʎ $^{(k)}$ʎ $^{(k)}$ʎ		*!		*	*
☞ d) ʎ ~ ʎ ~ ʎ			*	*	
e) k ~ p ~ f	*!				

Figure 3-32. Simplification of contour segments to palatal consonants (Tableau 21)

In effect, by formalizing a common drive underlying all the changes, CONDENSE (along with LAZY) provides for a more unified analysis of the palatalization of /kl pl fl/ with the other palatal reflexes discussed above, unlike Wireback's (1997) approach that must posit two different processes. Given, too, the acknowledged synergy between condensing and lenition in general, CONDENSE allows us to formalize the role of consonant weakening in those dialects which also show wide-ranging palatalization effects. This is in line with Tuttle (1972), who notes the importance of such weakening as a concomitant factor in the process. My analysis underscores this observation, since the effects of LAZY generally complement those of CONDENSE, qualifying the effects of palatalization. Despite this, the fact that CONDENSE drives /kl/ to [kʎ]—a ponderous

cluster that must later be simplified by what is clearly a lenition process—illustrates the legitimate separate identities of this constraint and a constraint such as LAZY.

3.5.3 /L+j/ and /N+j/

This leaves us with the clusters, /l+yod/ and /n+yod/. Though one might expect these to prove the most transparent in our discussion, they present problems having to do with our concept of the palatal segments as having geminate structure. Clearly, CONDENSE predicts that these clusters should palatalize:

vinea(m)	CONDENSE
a) vi.ne.a	*!
b) vi.nja	*!
c) ☞ vi.ɲa	√

Figure 3-33. Condensing in L. VINEAM (Tableau 22)

If we accept that the /nj/ is less overlapped and thus less condensed than the palatal nasal (recall the discussion in the previous section), then we see that it fares worse than the palatal under CONDENSE. The same would hold true of L. FOLIA > *folja > *foʎa > OSp. [hoʒa] > MSp. *hoja* [oxa] 'leaf'.

The problem here is the potential for mora loss if we posit an intermediate stage of [vi.nja] in Late Spoken Latin, with gliding of the formerly syllabic high vocoid. As noted above, Rosenthall (1997) has shown that onglides cannot be fully moraic themselves lest they create unattested sonority profiles in the syllable (see Zec 1995b). An onglide would therefore share the mora of the main vowel. This is problematic, however, since it suggests that at one point syllabic weight was lost, only to be restored later in the palatal geminate /ɲ/. Recall that this segment is posited to be moraic (i.e. geminate) in Spanish, Portuguese, and Italian primarily due to phonological behavior in stress-assignment. We

must therefore assume that at all times there was present in the cohort of variants a palatalized representative that permitted the maintenance of syllable weight. In the following tableaux, the drive to maintain syllable weight is formalized as MORAFAITH, which forbids loss of moraic weight specified in the underlying representation.

VINEA(M)	ONSET	CONDENSE	MORAFAITH
a) vi.ne.a	*!		
b) vi.nja		*!	*
c) ☞ vi.ɲa		√	

Figure 3-34. Condensing and mora faithfulness in L. VINEAM (Tableau 23)

ONSET is shown here as it seems clear that the drive to resolve hiatus in Classical Latin would have driven the first changes in the vowel. Also, we do not see onsets being lost in the interest of condensing, which suggests that ONSET dominates CONDENSE. ONSET then takes care of (23a), while (23c) is more harmonic under CONDENSE than (23b). MORAFAITH is shown to underscore the idea that [vi.nja] could never have been an optimal candidate here; indeed, it may be that this constraint forces the palatal overlay and creation of a geminate structure to preserve the moraic unit otherwise lost.

3.5.4 Other Takes on Palatalization in Western Romance

Historical linguists have traditionally described the various sound changes while only diffidently advancing theoretical notions to motivate them. As noted above, most recognize that lenition drives much of the change, and others link the lenition process with other systemic changes taking place in the grammar.

Penny (1991:53), for example, gives the fortified reflexes of /i/ as the first steps in the creation of the new palatal order of consonants. As noted above, a word- or syllable-initial /i/, realized already as a glide in Spoken Latin, was strengthened to [j̩ dj̩], and even

[ʒ dʒ], in Proto-Romance, as evidenced by orthographic variation: cf. ZANUARIO for IANUARIO. When we compare the various reflexes observed in dialects of modern Spanish, we see that all of these segments are represented. The palatal fricative is the most common, while dialects of the Caribbean, Mexico, and Argentina and Uruguay all show some degree of frication and affrication in line with the reflexes above. This only attests to the phonetic naturalness of the vocoid fortition process. Penny deems the variants of /i/ to be a first step in that they reflect a growing influence of syllable structure on the surface realization of this segment; that is, the drive to provide an onset for the following vowel led to consonantization of what was underlyingly a vocalic segment.

Penny attributes the stronger role of syllable structure in Proto-Romance to the shift from a duration-based accent system to one based on stress (expiratory force). With this shift, hiatus became untenable and led to the 'sweeping up' of atonic E, I as palatal onglides (Penny 1991:34-5, 51). Note that this process affected all [-low] vowels; the higher tongue position of /i e/ naturally gave rise to palatal glides, while their back congeners /u o/ were caught up as /w/. With a notable increase in energy vested in tonic vowels, adjacent atonic vowels in hiatus were forced into the sonority cline. From there, of course, the new palatal glides were free to fuse with preceding consonants: L. ARANEA > Pr.Rom [aranja] > OSp *araña* (or *aranna*) [araɲa] 'spider'.

Penny also identifies the clear-cut assimilation that is represented by palatalization of velars. Despite the validity of Penny's observations, however, he does not provide any motivation for the lenition process beyond his valid implication that it took place largely in intervocalic contexts. The parameter shifting that he attributes to the change in accentuation also needs to be formalized in any theory-driven account of the data, as does

the systemic restructuring that took place due to the chain-shifting of the occlusive inventory in the language (dealt with in Chapter 4). Clearly, as a historical linguist working in a more philological tradition, Penny never aspired to situating the facts in a theoretical framework, and the same may be said of Lloyd (1987), whose observations concerning the systemic shifts and the wholesale weakening and assimilation taking place in the palatalization processes are no less intuitive. Still, we would like to be able to provide a satisfying theoretical account of the various reflexes.

A more theoretically driven approach is that of Wireback (1997). Wireback's approach draws heavily on the feature geometry model, motivating glide epenthesis and metathesis of /C+yod/ clusters as functions of feature-spreading. In this way, his approach is similar to this one in that he attempts to explain phonological structure and change by way of phonetics. For example, similar to the model espoused by Lahiri & Evers (1991) above, he views palatals as being both coronal (tongue blade articulated) and dorsal (tongue body articulated), though he does not separate the [+high] feature from the Dorsal node as do Lahiri & Evers, who reserve Dorsal for velar segments. Wireback uses the feature geometry model to explain a number of C+yod effects. For example, he explains the regular metathesis (with lack of palatalization) of /r s/+yod in terms of feature-spreading triggered by mistiming: in the shift of L. BASIU > * bajso > Sp *beso*, the metathesis that ultimately raised the vowel results due to lag in the first vowel's articulation along with leftward spread of the consonant's [coronal] feature as well as that of the [+high] of the yod. Here, he claims, the spread is licensed due to the coronality of the two consonants in question. In contrast, labial consonants + yod show no metathesis (L. RABIE > Sp *rabia* 'rage'; L. APIU > Sp *apio* 'celery') due to their lack

of a [coronal] feature and an adjacency restriction that requires this common featural content for spread to take place.

My approach here is at once less structured and more practical. To the abstractness of Wireback's analysis I propose a greater degree of articulatory and acoustic detail. Thus, I see the resistance of /r s/ to the palatalization that bleeds the metathesis process in /t d/ +yod strings (e.g. L. HO**D**IE > Sp *ho**y*** 'day', with which no metathesis can take place) in more straightforward articulatory terms. For example, /r s/ are apical sounds, both involving a considerable degree of lingual tension and control. The /s/ inherited from Latin required a rather effortful obstruction between the tongue tip (rather than the tongue blade, as in most dialects of English) and the alveolar ridge. The tongue tip was brought close to the angle between the alveolum and the roots of the front upper teeth to produce the sibilance. As for the rhotic, the very precise articulatory demands of this sound—involving lingual placement, tension, and aerodynamic control (see Solé 2002)—made assimilation to the tongue body gesture of the palatal virtually impossible without, of course, retraction in the place of articulation such that /ʃ/ was produced, in which case merger was threatened with Old Spanish /ʃ/. Solé also notes the similarity of the requirements of /rr/ with the articulatory demands of fricatives (Solé 2002:686). Note too that recent work on fricatives suggests that fricatives should not be considered weaker than stops; on the contrary, frication requires a precise, controlled gesture that implies potentially greater effort than simple plosives (Ladefoged & Maddieson 1996:137). This is in line with Recasens *et al*. (1993), who find resistance to coarticulatory influences to be inversely proportional to the degree of necessary articulatory control required; one example notes that the constriction shape of [s] is too critical to tolerate coarticulation.

Finally, both Hock (1991:120) and Tuttle (1997:28) also note the difficulty with which /r/ accepts palatal influences. In this light, it is the muscular tension of the tongue blade, necessarily involving a lowered tongue body, that precludes palatal assimilation, rather than the mere fact of being a coronal articulation. Metathesis, however, could obtain, reinforcing our gestural analysis. That is, it would still be possible to overlap the relatively lengthy tongue-body raising gesture such that metathesis could take place. Coarticulatory anticipation of the raised tongue body provided an off-glide to the preceding vowel, as we see in modern Portuguese *beixo* ('kiss') and in the raised vowel of Spanish *beso*. On the other hand, the lack of any lingual activity for labial consonants makes /p+yod/ and /b+yod/ sequences unproblematic, with no articulatory 'tie-up' and thus no palatalization of these segments *per se* (except in clusters); indeed, Hock deems palatalization of labials "rare and unstable" (Hock 1991:120). Still, mistimings were possible even here: cf. Sp *apio* ~ Port *aipo*; Sp *rabia* ~ Port *raiva*, though lack of vowel raising here suggests that the process occurred later (Wireback 1997:37). In any event, no stipulatory restrictions seem necessary to account for the different reflexes.

Wireback's teleological assumptions also seem to undermine what are otherwise perfectly natural phonetic processes. Following Lloyd (1987:245-6), Wireback argues that in parallel with word-medial voicing of stops, word-initial voiceless stops also voiced when following words ending with a vowel (e.g. L. ILLA TERRA [il:a.**d**er:a] 'that land'). This would have continued until phonemicization of the voiced word-medial variants created confusion with the alternating word-initial variants, which could have been interpreted as being either of two phonemes (the older voiceless or the new voiced). At this point, speakers would have opted to use only the stronger (voiceless) variant to

prevent confusion. Again, while speakers may well establish strong/weak phonological patterns, I would add some less abstract detail to his account. Word-medial, intervocalic segments naturally weaken, while word-initial position is inherently strong (Hock 1992, Beckman 1999, Lavoie 2001). Thus, sonorant strengthening—the multiple trill in Spanish and Portuguese, the palatalized nasals in dialects of Asturias and León (Quilis 1999:242) and laterals in Catalán—is a phonetically natural process in this position, a function of its increased perceptual load. To place emphasis on abstract speaker-generated strength patterns based on the behavior of the voiceless stops obfuscates widely attested phonological behavior. Moreover, to suggest that weakening occurred only to be systematically resolved by speakers to reinstate a jeopardized contrast seems counterintuitive. It seems more likely that attested cases of weakening in word-initial, intervocalic position in dialects of Italy, as well as approximantization of voiced stops in the same position in standard Spanish, are the results of the phonemicization of the approximant, with positional faithfulness (Beckman 1999), or the drive to maintain contrast with the (fortis) voiceless segments, preventing their fortition.

Finally, the use of rules seems problematic and ultimately underscores the greater perspicuity of the OT approach. Wireback posits a specific metathesis rule to account for forms such as Med Sp *terné*, *verné* < future /tenr + é, venr + é/ 'I will have, I will come'. This only underscores the limitations of rule-based accounts in general: rules fail to capture the generalizations embodied in constraints. In this case, the metathesis of forms such as *terné* < *tenré* (or *ataldes* < *atadles* 'bind them', *tomalda* < *tomadla* 'take it'; see scene 4, day 1 of *La Vida es Sueño*) can be accounted for more directly via constraints that reflect universal phonological processes. Here, the concept of syllable contact

phenomena (Vennemann 1988; see also Davis & Shin 1999) provides a more intuitive analysis: metathesis provides for a more harmonic sonority contour between coda and syllable onset. A syllable contact constraint therefore formalizes a process observed crosslinguistically and obviates the need for *ad hoc* rules targeting specific morphemes, as Wireback proposes.

3.6 Conclusion to Historical Palatal Effects in Clusters

This chapter motivates the complex sound changes undergone in the history of Spanish that gave rise to the palatal and (alveo)palatal series. It does so by recourse to a few constraints that are posited to represent fundamental drives in language. Most of these drives are cross-linguistically attested and indisputably active—lenition, faith to underlying contrasts, and positionally (perceptually) motivated fortition. However, I propose a new, relatively untested constraint to account for apparent anomalies in palatalization processes; CONDENSE attempts to reconcile heretofore unaddressed issues of markedness, effort, and sonority in what has often been dubbed simple 'lenition' effects. CONDENSE is posited as the drive to accelerate the flow of phonologically relevant features by compressing them into complex but communicatively denser structures, such as those of the palatals. This communicative efficiency comes at the price of structural complexity and effortfulness, accounting for the markedness of these segments and belying any weakened status in a lenition-based approach, such as Kirchner's (2001), that factors effort into its calculations.

Thus, I have shown that the sound changes that Late Spoken Latin forms underwent on their way to Old Spanish can be analyzed as responses to twin, sometimes conflicting drives to lessen articulatory effort and enhance communicative efficiency. Faithfulness to former segments as we know them in Classical Latin broke down under

the pressure towards well-formedness: coda consonants weakened and eventually vocalized, altering contiguous segments through palatalization; clusters likewise broke down and evolved into palatals. Ironically, perhaps, the phonemic inventory of the language increased with the addition of the palatal series.

Such palatalization nevertheless seems a likely outcome if we recognize that the preservation of phonemic distinctiveness (that is, not encroaching on other, previously filled places of articulation) is a legitimate force in language systems. Though we have not discussed heretofore the role such a drive may play in language—as the changes above deal not with the evolution of discrete segments but rather with clusters—it will be seen in our discussion of the reflexes of the Latin geminates in the following chapter that the threat of phonemic merger comes to be of the utmost importance. In the current context, we may also posit that, to accommodate the radical sound changes discussed above, Latin took advantage of a place of articulation which the classical language had never exploited. Since Latin had no palatal segments, new palatal articulations would be readily perceptible alternatives to the former clusters (and, importantly, the geminates; see Chapter 4). This accords with observations made by Maddieson (1984) that languages typically innovate new sounds in articulatory regions not previously utilized. Hence, the palatal zone would have been ripe for exploitation by speakers of Proto-Romance for the new sounds. This approach also seems congruous with concepts of adaptive dispersion (Lindblom 1986, Flemming 1995, 2002), and, perhaps, to Keating's (1984) polarization principle (Keating 1984; also see Ladefoged & Maddieson 1996:45-46). That is, by spreading the phonemic inventory over diverse points of articulation, greater perceptual

distance is achieved acoustically. I explore these concepts more fully in the next chapter in the context of the historical reflexes of Latin geminates in Spanish.

3.7 Notes

1-Phonemic distinctions between palatalized segments and fully palatal ones in Russian, for example, suggest that we cannot simply view /ɲ/and /ʎ/ as tantamount to /nj/ and /lj/, respectively. Some putative minimal pairs in Spanish (*huraño* ~ *uranio*) would also seem to attest to this (Recasens & Romero 1997:45).

2-Such backing is not automatic; consider conservative British data:

(I) a. British RP *issue* [ˈɪsʲu] (cf. American [ˈɪʃu])
b. British RP *sexual* [sɛksʲuɨ̞] (cf. American [sɛkʃuɨ̞])

British Received Pronunciation disallows the alveopalatal backing of American dialects, just as it steadfastly observes the same palatal element in the high back /u/, as in RP *tune* [tʲun] versus the [tun] of many American dialects. Consider too the fully affricated [tʃun] of some Scottish English dialects.

3-Note though that the glide also participates in the phenomenon of heavy onsets. Given this, it may be that its perseverance in *yeísmo* and ñ-gliding simply represents a Faith effect; that is, something had to be left behind to preserve the identity of the altered segment. This matter, as well as the acoustic correlates of /I/ as a quasi-geminate, is taken up in Chapter 4.

4-The converse is illustrated by the case of nasalization in English, as noted by Manuel (1999). Since English does not distinguish between oral and nasalized vowels, speakers are free to anticipate velum-lowering before nasal consonants, effectively nasalizing the preceding vowel. Note that this further informs observations made in the preceding chapter concerning the unchecked spread of the [+nasal] feature in our feature geometry model (see note 11): some speakers readily adopt 'lazy velum' in their speech, giving rise to the nasal accents of so many (idio)lects of American English.

5-This falls out from widely attested linguistic reflexes involving sonority gradients within the syllable; see Zec (1995a, 1995b).

6-Sonority itself is most often defined in terms of loudness. Blevins (1995:207) describes it as loudness relative to other sounds with the same input energy; she follows Ladefoged (1991), who similarly defines sonority as loudness relative to other sounds with the same length, stress, and pitch. Lavoie (2001) concludes that, at least for some languages, sonority is a function of intensity, while Bray (2002) studies sonority in terms of perceptibility and finds that sonority (and its role in the

perceptibility of segments) is a function of loudness, duration, and the optimization of formant frequencies. Sonority remains, like lenition, an undeniable and less-than-perfectly understood phonological phenomenon, and it is not my goal here to provide a clear definition, merely to acknowledge its place in the questions at hand.

7-Moreover, palatal behavior baffles even a sonority-based perspective: they surface as strong segments even when they should be weaker in terms of sonority, exhibiting more vocalic (formant) structure, greater intensity and hence more sonorous aspects.

8- It may also be that CONDENSE drives the historical voicing of intervocalic fricatives, since voiced fricatives and voiced stridents particularly are highly effortful segments; by maintaining voicing across the fricatives, intersegmental transitions may be enhanced at the cost of greater overall effort. This would reflect a conflict between communicative efficiency and articulatory ease. Note, though, that CONDENSE is posited here specifically to inform our understanding of the palatalization processes under scrutiny; intervocalic weakening such as that seen in (2-3) above is not generally in question. That is, I follow Lavoie's (2001) finding that the most representative kind of weakening is the voicing with approximantization of voiceless stops in intervocalic position; slackening of occlusive stricture and lessening of duration are clearly lenition effects, and where appropriate, LAZY is invoked. I moreover do not in any way aspire in this work to expand upon or amend Kirchner's mathematics- and physics-driven model with a view toward fine quantification of effort (or lack thereof) involved in the changes. CONDENSE reflects a phonologized phenomenon here; in all the cases under discussion, categorical distinctions will be sufficiently transparent to obviate the need for fine-grained computations such as those afforded by Kirchner's approach.

9-Saturday Night Live's 'Drunk Girl' character makes an art of such extreme overlap, an exercise that must be seen as highly effortful articulatorily. I would not care to launch a debate, however, on the various other types of effort that such registers may be addressing (cognitive, time-related overall effort, etc.). Indeed, we could easily be led into the question of relative effort: that of an entire sequence versus that of individual segments; i.e. condensing as a process reducing overall effort versus the more segment-oriented processes triggered by LAZY. Given that effort is such a notoriously amorphous concept in terms of measurement (as Kirchner recognizes in his work), I prefer to avoid such a distinction at this point. Here, then, LAZY is retained as the general lenition-driving constraint such as that responsible for intervocalic stop weakening, while CONDENSE is viewed as the prime mover of the palatalization processes.

10-CONDENSE (and LAZY, too) may seem to have much to do with the AGREE family of constraints, which militate for common points of articulation between adjacent segments (see Lombardi 1999). Clearly, such a constraint serves to facilitate intersegmental transitions. I am here proposing CONDENSE as something subtly different, though it could possibly be subsumed under AGREE and similar constraints; CONDENSE is meant to govern timing relationships between features or articulatory

gestures in a way that is not, strictly speaking, an assimilation process. That is, it may create unwieldy articulatory bundles that are not 'easier' to produce, as AGREE seems to do. The question of adjacency is left for future work, though CONDENSE is probably not applicable to 'distance' coarticulatory processes (i.e. limited to strictly local phenomena, as between contiguous segments) such as those between non-adjacent vowels or between vowels and a palatal consonant (see discussion below of metaphony effects and vowel-raising due to palatals as effects of LAZY). Indeed, strict locality—and rejection of feature geometry's tenet of independently adjacent tiers or nodes—has been argued for by Ní Chiosáin & Padgett (1997). Such a posture has the added attraction of jibing with Browman & Goldstein's (1989 *inter alia*) concept of gestural overlap; gestures are not lost on contiguous segments but are merely 'cloaked' by them, including between vowels and consonants. This posture seems to suggest strict locality. I prefer nevertheless to assume that vowels may interact on an independent tier, as expressed by the independent Tongue Position node assigned them in the model in Chapter 2. This is in line with much early work in coarticulation, discussed in section 2.2, and seems implicit as well in the facts of Spanish metaphony:

(II) a. sentir 'to feel' ~ sintió 'he/she felt' (< {sent-} + {-jó} 3sg pret, -ir/-er verbs)
b. erguir 'to build' ~ irguió 'he/she built'

Raising of the base vowel has taken place due to the following palatal glide, despite the presence of the partial geminate cluster /n̪t/ or the heterorganic /rg/ cluster. It seems difficult to argue that the non-coronal velar stop has been made [+high] (a vowel feature) in a strictly local characterization of these events.

11-I leave it to future research to determine whether a realistic means of quantifying gradient degrees of merger between condensed segments is feasible. Acoustic analysis may suggest a solution, although one would first have to determine which feature of a target sound is the most perceptually salient, that is, the one most responsible for segment identification. Given the considerable amount of work currently being realized in such pursuits, the task is clearly not an easy one. Moreover, it may well be that in a particular case, more than one feature seems equally salient. For example, a study in fricative identification by Jongman *et al*. (2000) found that various different cues (spectral peak, spectral 'moments', relative intensity) gave statistically significant positive results for identification. Arriving at a single value to evaluate overall identification via several viable cues seems all the more challenging.

12-I assume in Figure 3-16 that, based on the historical evidence and the fact that the speech signal is conceived of as a left-to-right chain moving through time, that coarticulatory/ assimilatory phenomena privilege the relationship of the weakening segment to the following one rather than the preceding one, at least in Spanish. Thus, the palatal fricative is considered more harmonic with respect to LAZY than the velar fricative since it shows closer proximity to the following coronal stop. One might otherwise wonder why moving the velar /k/ away from the preceding back vowel

actually eases transitions. In my view, though, the transition to the palatal /ç/ anticipates the subsequent transition to the /t/. This is well in line with attested patterns in Spanish, where assimilation is almost always anticipatory. Moreover, given the greater perceptual importance of onsets over codas, we might expect speakers to favor articulatory easing that caters to onset production over that of a vowel. That is, the language may play to the element that carries the more salient rather than a transition within the rhyme. Consider too the prosodic drive toward CV.CV strings, as well as the Onset Maximization Principle; the highly consequential relationship of the coda to a following onset seems evident.

13-This discussion brings us quite naturally to NoCoda (Prince & Smolensky 1993). This widely attested constraint militates for open syllables; codas are banned, reflecting the reality of many languages world-wide. Though often invoked for categorical distinctions (CV ≻ CVC, where '≻' denotes 'more harmonic than'), NoCoda can legitimately be exploded into an implicational hierarchy of subconstraints based on the sonority hierarchy. As demonstrated by Zec (1995a, 1995b), there is a cross-linguistically attested tendency for languages to prefer more sonorant codas (nasals, liquids) to less sonorant ones (obstruents); this is largely the case in Spanish, where liquids and nasals account for most of the attested coda consonants and where stops are subject to significant alteration or elision: *se**p**tiembre* ~ *se**Ø**tiembre* 'September'; *técnico* 'technical' [te**k**.ni.ko] ~ [te**θ**.ni.ko] (Madrid dialectal). We can therefore posit a hierarchy of NoCoda constraints based on sonority: $\text{NoCoda}_{(\text{obstruent})}$ >> $\text{NoCoda}_{(\text{sonorant})}$. Such an approach, however, would not allow us to favor one fricative over another, as between /x/ and /ç/, since they are theoretically equally strong on the sonority scale. See more discussion below.

14-We could again generate tying candidates with a NoCoda barring stops in codas: an implicational NoCoda hierarchy based on a highly detailed sonority hierarchy rating individual segments, such that stops are stronger than fricatives, would allow for such a ploy. Note that I do not here espouse such a highly detailed sonority schema, preferring to lump obstruents (stops and fricatives) together over sonorants. For argument's sake, though, I show such a tableau. Again, the Stochastic approach is invoked here; that is, strict ranking permutations of any of the tied constraints might have yielded any of the candidates.

(III) Labov-style competing variants of L.NOCTE

/nok.te/	$\text{Ident-IO}_{[cons]}$	$\text{Ident-IO}_{[cont]}$	$\text{NoCoda}_{[stop]}$	$\text{Ident-IO}_{[velar]}$	$\text{NoCoda}_{[fric]}$
a) ☞ nok.te			*		
b) ☞ nox.te		*			*
c) ☞ noç.te		*		*	*
d) ☞ noj.te	*			*	

Nevertheless, Lazy seems to permit a neater, more integrated account of gradual coda breakdown followed by vocalization. It permits a more unified approach to the

different processes here, as well, applying to intervocalic onset clusters that are beyond the purview of NOCODA.

15-Posteriorization to /x/ is clearly not an effect of condensing but rather of the drive to optimize contrasts as conceived in dispersion theories (Lindblom 1986, Flemming 2001; see also Baker 2003).

16-We might apply a similar analysis to vowel reflexes in certain dialects of English. Diphthongs in some dialects of West Coast American English reduce to mid low vowels: *sale* [sɛɫ] (< [sejɫ]); *boil* [bɔɫ] (< [bojɫ]). Two segments are synthesized into one, easing articulation in terms of duration of vocalic gestures. Here, though, in closed syllables with no following palatal onset to assimilate to, we should not expect vowel-raising but rather lowering as the tongue body is left low to produce mid-low vowels [ɛ ɔ].

(IV) Diphthong simplification

/sejɫ/	IDENT$_{[+front]}$	LAZY	IDENT$_{[-low]}$
a) sejɫ		*!	
b) seɫ		*!	
c) ☞ sɛɫ		√	*
d) saɫ	*!		*

The shorter, laxer /ɛ/ is adjudged more harmonic in terms of LAZY than the higher, tenser /e/, allowing a smoother transition to the velarized lateral while maintaining the mid-vowel's identity. Moreover, loss of /i/ seems to indicate lenition. A similar approach might also motivate a rule of vowel-lowering in closed syllables in French: *peut* 'he can' [p**ø**] ~ *peuvent* 'they can' [p**œ**v]; *espérer* 'to hope' [es.p**e**.ʁe] ~ *espère* '(I) hope' [es.p**ɛ**ʁ] (Casagrande 1984:89-90). Note, though, that LAZY could seem less than ideal from another perspective, given the effortful jaw-lowering (i.e. vertical displacement) implicit in producing the [-ATR] mid-low segments.

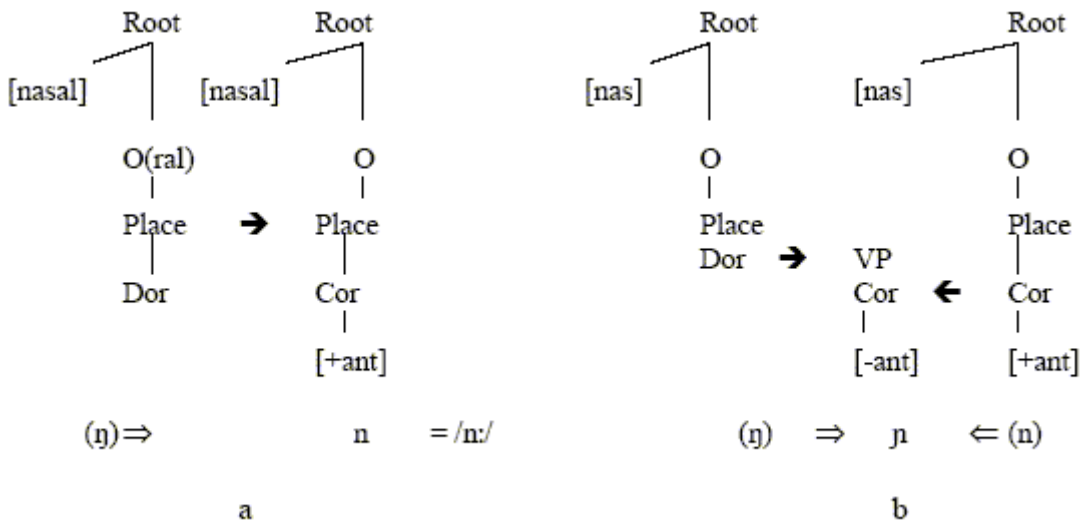
17-Note, though, that it may be immaterial for our analysis here to prove beyond all doubt what the phonetic realization of the Latin digraph GN was; our analysis will still give us /ɲ/ from L. GN and indeed more directly than the L. AXE analysis above. Assuming that LAZY might well have assimilated the two nasals so as to produce a geminate /nn/, the advent of CONDENSE would have subsequently fused them into a single, complex (and moraic) palatal segment. Such an operation hinges on our concept of a reanalysis of the spatio-temporal gesture of the geminate into a spatially enhanced geture with greater linguopalatal contact but shorter duration. For another application, see Tableau 39 below.

(V) Nasal condensing

/pun.nu/	CONDENSE	IDENT-IO$_{[place]}$
a) pun.no	*!	
b) ☞ pu.ɲo	√	*

(Vb) would be more harmonic under CONDENSE since—similar to the palatalizing effect seen above that backs dental /t/ to affricate /tʃ/—the resultant /ɲ/ is a product of the fusion of the two segments into a single, complex one (see discussion of degemination as reanalysis in Chapter 4). Recall, too, that from the discussion of the feature geometry representation of the palatal nasal that this segment is [-ant] and shows as well the Tongue Position node that dominates the tongue body gesture responsible for the high F2 offglide noted by phoneticians. To derive such a segment we must rank CONDENSE over LAZY in order to favor a feature-*changing* operation over straightforward feature-*spreading* (the feature-based equivalent to the gestural modification suggested just above):

(VI) Feature-spreading (a) and feature-changing (b) under CONDENSE



We must accept in (VIb) that the DORSAL position of the velar, which raises the tongue root toward the velum, leads to the innovation of the raised tongue body, accounting for the TP node in the resulting palatal segment; similarly, the CORONAL node of the following nasal, though retained, undergoes a feature change: [+ant] becomes [-ant]. Such operations should only be licensed in the light of observed facts. Studies of the velarization of former alveopalatal sibilant /ʃ/ in the history of Spanish point out that palatal stricture often involves a velic component as well (Kiddle 1975:74); while studies of the palatalization of velars cross-linguistically also indicate the likelihood that alveopalatal stricture necessarily engages the dorsum (see e.g. Keating & Lahiri 1993:85). In this light, the velic stricture's moving forward as a function of mediation with a following coronal nasal does not seem difficult to countenance. This is not to say that velar segments are inherently palatal and the model should not represent them as such; however, as a matter of assimilation, we view the shift forward as a feature-changing operation that is motivated by articulatory and acoustic commonalities between velar and palatal segments. Recall that Flemming (2002) takes a similar stance.

18-Toponyms in fact often display highly irregular, even capricious phonological changes that set them apart from other types of words (Trask 1996:350). Moreover, toponyms often exhibit conservative behavior, as in ancient Greek (D. Gary Miller, personal communication).

19-Invoking the ideas of such early researchers as Saussure (1916) and Trubetzkoy (1949), let us further consider the implications of this approach. If a contrast $X \sim X^Z$ exists in a language, it implies another contrast $Y \sim Y^Z$; in a sense, by generalizing a contrastive feature this way, the language gets maximal 'bang' for its 'buck', increasing the array of contrasts possible in the language (cf. Flemming's (1995, 2002) Dispersion Theory; see below). We would expect therefore—in the absence of some overpowering markedness constraint—for a contrastive feature to be found across all available segments; Korean for example employs various features to mark contrasts in the stop series: glottalization /p' t' k'/; aspiration /p^h t^h k^h/, as well as lack of aspiration /p t k/. We would not expect to find only /p t' k^h/, for example, without the generalization of the contrastive feature to other stops, as this would represent a failure to capitalize on potential contrastiveness in the language, as well as making the aspiration and glottalization features wholly arbitrary to a given segment. Economy demands that contrastive features be regularized such that the system does not demand memorization of arbitrary features (cf. Saussurean ideas of segments' meanings as dependent on their relation to other segments; this presumes *minimal* distinctive features). On the other hand, there are upper limits on the number of contrasts that languages employ. If a language permits $X \sim X^Z$ and $Y \sim Y^{Z+1}$, this again implies X^{Z+1} as well as Y^Z, and an oversaturated system of overfine contrasts might well be generated. Consequently, where k ~ kʎ obtains, we might expect other occlusives to also accept a contrastive /ʎ/ in lieu of maintaining a coronal /l/; this drives the palatalization of /l/ in the other clusters.

20-Penny 1972 points out that /f/ like /p/ was a bilabial articulation, probably in much of Romance. Given the instability and relative infrequency of /fl/ (and /pl/), we might indeed assume that an early change relaxed the labial articulations to the velar, merging the $p^ʎ$, $f^ʎ$ clusters with $k^ʎ$, resulting in Tuttle's single phoneme characterized by obstruency with a palatal lateral release mentioned above.

21-This constraint seems motivated by distributional evidence from Spanish, noted in Chapter 1 above, as well as in evidence given in Casagrande (1984:107), showing the failure of palatal /ɲ/ to occur in clusters with other consonants in French.

22-This take on velarization sees it as a sort of 'semi-debuccalization' process; all tongue blade and tip activity is 'freed up' by the posteriorization, facilitating subsequent articulations. This jibes with observations made by Lavoie (2001), as well as with widely attested 'weakening to velar' reflexes in Spanish, where many dialects weaken word-final /n/ to [ŋ], and in Catalan (and English), where syllable final laterals velarize to 'dark' [ɫ]. Note that, though complementary, this view is not wholly in

accord with Tuttle's simpler position that the velar stricture arose due to its more homorganic point of articulation with the palatal segment.

CHAPTER 4
DISPERSION, DEGEMINATION, PALATALIZATION AND THE OLD SPANISH CHAIN SHIFT

4.1 Introduction

In this chapter I focus on the historical reflexes of Latin geminates in the history of Spanish. While Latin geminate stops simplified to singletons in Spanish, alternative reflexes observed in geminate sonorants /nn ll/ gave rise to the palatal segments /ɲ ʎ/, respectively. I motivate these reflexes through recourse to phonetics-based approaches that take into account systemic pressures to maintain and optimize auditory contrasts between segments. Such an account provides solid phonetic grounds for the observed historical changes.

We will see that length contrasts between geminate and singleton stops in Latin are lost over time in favor of contrasts between voiced and voiceless singletons, which are also duration-based but prone to later reanalysis in the phonology as a voicing contrast (Lavoie 2001:165). The process of approximantization of the voiced stops is shown to represent a further evolution as the former three-way contrast in Latin becomes a two-way one in the interest of greater perceptual distinctiveness. Sonorant geminates /nn ll/ represent an alternative process, palatalizing rather than following the evolution of the stops and thus participating fully in the innovation of a new order of palatal consonants. I posit that the drive toward greater temporal compression of gestures under CONDENSE forced such an outcome. I then extend my treatment to account for variant reflexes in Portuguese, and I also look at ongoing variation in the geminate rhotic of Spanish across

modern dialects. Finally, I conclude the chapter with a discussion of earlier approaches to these historic changes and illustrate how the current analysis is preferable. In the following section, I provide description of the sound changes in question.

4.2 Geminate Reflexes in the History of Spanish

The phonemic inventory of Latin included voiced/voiceless pairs of occlusives at the three cardinal points of articulation: alveolar/dental, labial, and velar (see Maddieson 1984:32). The voiceless stops and, to a much lesser extent, the voiced ones, contrasted with geminate articulations, as did the alveolar/dental /s/. Two nasals (/m n/) and two liquids (/r l/) complete the consonant inventory and likewise had phonemically distinct geminate forms. Voiceless fricatives at these same points (assuming a loose definition of velar for aspirate /h/) were also available, though neither /f/ nor /h/ geminated. This inventory is seen in Figure 4-1 below. Note that I use a double grapheme (/CC/) to represent geminates as opposed to the IPA long consonant symbol (/C:/). I do this primarily for convenience and representional clarity.

(place)	labial		alveolar/dental		velar	
(manner)	sing.	gem.	sing.	gem	sing.	gem.
plosive	p b	pp (bb)	t d	tt (dd)	k g	kk (gg)
fricative	f		s	ss	h	
nasal	m	mm	n	nn		
liquid						
lateral			l	ll		
tap/trill			r	rr		

Figure 4-1. The consonant system of Latin.

The system underwent considerable structural changes into Old Spanish. While all of the simple (non-geminate) segments persist into Spanish (though some with altered articulations and with the exception of the aspirate /h/, lost very early on), Latin geminate

obstruents underwent degemination in the history of Spanish—as well as throughout Western Romance, reflecting what is generally considered a lenition process (Penny 1991; see also Kirchner 1999, 2001):

a. pp > p	L. CUPPA > Sp. *copa* 'cup' (cf. Fr. *chope* 'mug')
b. tt > t	L. GUTTA > Sp. *gota* 'drop' (cf. Fr. *goutte* [gutᵊ])
c. kk > k	L. BUCCA > Sp. *boca* 'mouth' (cf. Port. *boca*)
d. dd > d	L. (*IN)ADDERE > Sp. *añadir* 'to add' (cf. Port. *adicionar*)
e. ss > s	L. GROSSU > Sp. *grueso* 'thick, fat' (cf. Fr. *grosse* [grɔs])

Figure 4-2. Degemination of geminate obstruents into Old Spanish.

Recall that due to their moraic structure, geminates are typically limited to intervocalic position, where the underlying mora can form part of a preceding syllable.[1] This was the case in Latin: a three-way contrast between voiceless geminates, their singleton (non-geminate) counterparts, and voiced singletons obtained only in word-medial, intervocalic position. Consequently, the simplification of the voiceless geminate obstruents could have caused a significant loss of phonemic contrast had other changes not taken place. The degemination process, however, was in effect licensed by the previous voicing of singleton intervocalic stops (see Lloyd 1987:144), such that no loss of phonemic contrast, and hence no potential homonymic clash, resulted from their degemination. This is shown in Figure 4-3.

a. (V)p(V) > b	L. LUPU > OSp *lobo* 'wolf'
b. (V)t(V) > d	L. VITA > OSp *vida* 'life'
c. (V)k(V) > g	L. FOCU > OSp *fuego* 'fire'
d. (V)s(V) > z	L. CASA > OSp *casa* [ka.**za**] 'house'

Figure 4-3. Voicing of intervocalic (singleton) obstruents in Old Spanish.

Furthermore, the voicing seen here was itself made possible by the previous approximantization of intervocalic voiced obstruents (Harris-Northall 1990:7). This is exemplified in Figure 4-4.

a) L. SUDARE > su[ð]ar 'to sweat'
b) L. CABALLU > ca[β]allo 'horse'
c) L. AUGUSTU > a[ɣ]osto 'August'

Figure 4-4. Approximantization of intervocalic voiced Latin stops.

This process is ongoing in modern Spanish, in which intervocalic voiced stops /b d g/ are realized [β ð ɣ] in intervocalic position.[2]

Loss of phonemic distinctiveness was thus avoided all round. In effect, then, we have a chain shift, as has been recognized in the literature (Alarcos Llorach 1961, Lloyd 1987, Wireback 1996). I take these changes to constitute a drag chain, in which changes in one set of sounds leave a gap into which other sounds may move. Such a restructuring is not random but rather motivated by production- or perception-based drives. Vowel shifts have been shown to respond to perceptual drives, maintaining efficient margins of contrast (see Lindblom 1986). Here, I assume a systemic drive to weaken articulations drove the restructuring. Thus, intervocalic voiced stops became approximants, allowing the voicing of intervocalic voiceless stops, which themselves leave open the possibility of degemination of the voiceless geminate stops:

1) /b d g/ > [β ð ɣ]
↑
2) /p t k/ > [b d g]
↑
3) /pp tt kk/ > [p t k]

Figure 4-5. Intervocalic stop drag chain from Latin to Old Spanish.

In the case of the geminate voiced occlusives /bb dd gg/, the above solution was unavailable; their singleton correspondents, already being voiced, could not weaken through voicing to leave them phonemic 'room' to degeminate. Degemination here, then, certainly would have led to merger. However, the occurrence of these voiced geminates

was so rare that the resulting merger with singleton forms was trivial, and researchers have commonly paid scant attention to them (Lloyd 1987:243; see also Harris-Northall 1990:6).[3] I similarly do not focus on the fate of these segments here.

The same cannot be said, however, of the geminate sonorants /ll nn rr/; these segments were far too common in the lexicon for their loss to be considered trivial. Yet sonorants, like the voiced stops, are by definition voiced and so there was again no means of resolving potential homonymic clash by way of voicing of (also inherently voiced) singletons /l n r/. Consequently, palatalization seems to have occurred as an alternative solution in the case of /ll nn/. Geminate /rr/, on the other hand, has been preserved intact in the language (see Harris 1983 for a geminate analysis of Spanish /rr/):[4]

a) /ll/ > /ʎ/ L. CABALLU 'horse' > OSp *cavallo* [ka.βa.ʎo] 'horse'
b) /nn/ > /ɲ/ L. ANNU 'year' > OSp *anno* [aɲo] 'year'
c) /rr/ > /rr/ L. CARRU > Sp. *carro* [ka.**r**o] 'wheeled vehicle'

Figure 4-6. Reflexes of Latin geminate sonorants.

These palatal sonorants therefore constitute new phonemes in the inventory of the language. Recall that where the palatal lateral had previously arisen in earlier stages of the language (see Figure 3-3 a and 3-4a-b) fortition to /ʒ/ had already taken place. Thus, no risk of merger was occasioned by these new reflexes, and the phonemic status of the erstwhile Latin geminate /ll/ was secure. Note though that the results of the later change of word-initial clusters seen in Figure 3-4e did merge with the palatal, albeit in a different context (word-initial as opposed to word-internal).

Though the role of lenition is a clear motivator among the stop reflexes seen in Figures 4-2 to 4-4, it is again unclear that weakening is the most incisive means of accounting for the palatal reflexes of Figure 4-6. Indeed, Penny seems to flip-flop a bit,

explicitly distinguishing between the lenition of the intervocalic stop series (indeed, lenition as a systemic phemonema in the history of Spanish) and the palatalization of Latin geminate sonorants (Penny 1991:62-5, 71-2).[5] As in Chapter 3, it is the goal of this chapter to shed better light on these processes with a view toward providing a clearer and more satisfying account.

4.3 An OT Analysis of the Historical Chain-shift

The sound changes described above greatly altered the consonant inventory of Latin as it was inherited into Old Spanish. While a three-way stop contrast in intervocalic position was preserved, systematic weakening affected all the segments involved. Voiced singletons approximantized (L. NUBE > [nu**β**e]), voiceless singletons voiced (L. LUPUS > [lo**b**o]), and voiceless geminate stops simplified to voiceless singletons (L. CUPPA > [ko**p**a]). Voicing and spirantization did not affect the sonorants /nn ll rr/, however. These segments either changed in different ways or, in the case of the rhotic, did not change at all, in both cases maintaining their phonemic distinctiveness. In the following sections, after a brief excursus on the difficulty of accounting for chain shifts in OT, I investigate the nature of the changes at the articulatory and auditory levels with an eye toward motivating the changes in terms that best satisfy OT's goal of grounding constraints in phonetic facts.

4.3.1 Accounting for Chain-Shifts in Optimality Theory

Most researchers acknowledge, either directly or indirectly, that the drive to maintain phonemic contrasts in the language shaped the sound changes in question (Lloyd 1987; Penny 1991, Walsh 1991, Holt 1997). There does not seem to be any other means of accounting for the systematic nature of the weakening that took place in

Western Romance in intervocalic position. Indeed, the fact that the segments that show the fewest lexical contrasts in the language—as with low-yield /bb dd gg/—are those that do suffer merger seems to attest to this.[6] We therefore seem justified in assuming that such a drive to preserve meaningful contrasts in the language should be formalized as part of the grammar. Traditionally in OT, this function is (at least indirectly) instantiated as FAITH-IO constraints: IDENT$_{(F)}$, calling for the preservation of a given feature F in the underlying representation of a candidate, outranks the markedness constraint that would otherwise militate for its loss. Coda obstruent devoicing in Dutch, for example, shows that the constraint calling for neutralization of voicing contrasts in codas outranks the FAITH constraint (IDENT) calling for an identical surface value of an underlying feature:

/bed/	*VOICEDCODA	IDENT-IO$_{(voice)}$
a) bed	*!	
b) ☞ bet		*

Figure 4-7. Word-final devoicing (Tableau 24).

Candidate (24b) is optimal, devoicing at the expense of a voicing Identity violation. The opposite ranking, of course, allows for voicing contrast, as in English:

/bed/	IDENT-IO$_{(voice)}$	*VOICEDCODA
a) ☞ bed		*
b) bet	*!	

Figure 4-8. No word-final devoicing (Tableau 25).

This approach is problematic, however, in the face of chain shifts, series of changes in languages that show a fixed, step-wise progression, such that x > y, y > z. The degemination in Old Spanish from /tt/ > [t], the voicing of /t/ > [d], and the approximantization of /d/ > [ð] in intervocalic contexts represent such a chain shift. These changes constitute non-surface-true effects (McCarthy 1998, Kager 1999); that is,

some generalized process in the grammar apparently fails to take effect at the surface despite the necessary conditions for it. Here, intervocalic segments fail to lenite fully to approximant [β] or [Ø] despite being in the lenition context: intervocalic voiceless obstruents fail to voice (and subsequently approximantize) and intervocalic voiced obstruents fail to spirantize (approximantize) in Old Spanish.

This situation has been considered a weak point in Optimality Theory, whose surface-oriented, non-derivational approach has trouble accounting for these changes. Since constraints instantiate general forces at work in the grammars of languages, the drive to lenite should take full effect on any segment found in the proper context (NB: 👂 represents an unattested winner, ✋ the desired winner):

/lupu/	LAZY	IDENT-IO$_{(CONT)}$	IDENT-IO$_{(VOICE)}$
a) lopo	**!*		
b) ✋ lobo	**!		*
c) 👂 loβo	*	*	*

Figure 4-9. Old Spanish intervocalic lenition in L. LUPU 'wolf' (Tableau 26).

Here, candidate (26a) fails to lenite. (26c) lenites more fully than the others and thus wins despite not being the attested variant. We could rank IDENT-IO$_{(cont)}$ above LAZY to resolve this particular situation, but then 'proper' weakening via spirantization of intervocalic voiced obstruents could not take place without (illicit) reranking:

/lupu/	IDENT-IO$_{(CONT)}$	LAZY	IDENT-IO$_{(VOICE)}$
a) lopo		***!	
b) ☞ lobo		**	*
c) loβo	*!	*	*
/nube/	**IDENT-IO$_{(CONT)}$**	**LAZY**	**IDENT-IO$_{(VOICE)}$**
a) 👂 nube		*	
b) ✋ nuβe	*!		

Figure 4-10. Lenition in L. LUPU 'wolf' and L. NUBE 'cloud' (Tableau 27).

So, even though the ranking above provides the attested result in L. LUPU, the same ranking gives an unattested winner from L. NUBE.

Innovative approaches to chain shifts in OT have provided solutions at the expense of some of the core principles behind the theory. Kirchner (1996), taking a cue from Smolensky (1993), posits constraint conjunction to allow two lower-ranked constraints to be conjoined and ranked higher than either constituent constraint individually, thus instantiating the (rather defensible) intuition that languages should allow multiple violations of lesser constraints to outweigh single violations of higher-ranked ones. In this way, a conjoined IDENT-IO$_{(CONT)}$ & IDENT-IO$_{(VOICE)}$, ranked above LAZY, would prevent /p/ from weakening 'all the way' to a spirantized [β], while leaving /p/ free to voice to [b] unproblematically:

/nube/	IDENT-IO$_{(CONT)}$ & IDENT-IO$_{(VOICE)}$,	LAZY	IDENT-IO$_{(CONT)}$	IDENT-IO$_{(VOICE)}$
a) nube		**!		
b) ☞ nuβe		*	*	
/lupu/	**IDENT-IO$_{(CONT)}$ & IDENT-IO$_{(VOICE)}$,**	**LAZY**	**IDENT-IO$_{(CONT)}$**	**IDENT-IO$_{(VOICE)}$**
a) lopo		***!		
b) ☞ lobo		**		*
c) loβo	*!	*	*	

Figure 4-11. Resolving the chain shift via local conjunction (Tableau 28).

Note, though, that this approach, while effective for two-step chain shifts, does not seem able to handle the three-step situation under discussion here; we cannot account for degemination in this way.

/gutta/	IDENT-IO$_{(CONT)}$ & IDENT-IO$_{(VOICE)}$,	LAZY	IDENT-IO$_{(CONT)}$	IDENT-IO$_{(VOICE)}$
a) gutta		***!		
b) ☹ guta		**!		
c) ☺ guda		*		*

Figure 4-12. Sad tableau with local conjunction from Figure 4-11 (Tableau 29).

Moreover, even if we could, the approach is problematic in that it is not clear how to limit conjunction in such a way as to avoid wild predictions through rampant combinations of constraints (but see Moreton & Smolensky 2002 for research in this field). Also, strict domination is a crucial feature of OT architecture as conceived by Prince & Smolensky (1993), a feature undermined by the idea that any two lower ranked constraints can 'team up' to defeat a higher-ranked one.

4.3.2 Dispersion Theory

4.3.2.1 Background

To handle the historic chain shift seen in the changes from Latin to Late Spoken Latin as well as into Old Spanish, I propose an approach that permits implementation of our observation of contrast maintenance as the force responsible for the controlling of the lenition-driven changes in the language. Flemming's (1995, 2000) Dispersion Theory of Contrast provides the appropriate framework. Dispersion Theory picks up on Lindblom's (1986) work in Adaptive Dispersion in vowel systems. Lindblom shows that vowel inventories tend to develop in such a way as to maximize contrastiveness by dispersing the vowels in the auditory space. That is, the canonical five-vowel system of /i e a o u/ not only differentiates /i e/ and /o u/ in terms of frontness/ backness but also unrounded/rounded, thus maximizing contrastiveness (perceptual distinctiveness) among the segments. The concept also explains the relative markedness of front rounded vowels and unrounded back ones: the lip-rounding of front vowels such as /y ø/ would serve to lower formant frequencies, undermining crucial F2 distinctions with back vowels. Therefore the maximal distinctiveness is achieved by contrasting high-F2 unrounded front vowels with low-F2 rounded back ones.

Flemming applies these ideas to the development of language inventories, positing three conflicting drives that serve to shape inventories of contrasting segments. Flemming's theory formalizes these concepts as three basic goals that underlie the selection of phonological contrasts in languages: 1) to maximize the number of contrasts; 2) to maximize the distinctiveness of contrasts; and 3) to minimize articulatory effort.[7] The first goal enriches the communicative potential of the language, the second ensures an optimal degree of perceptibility, while the third lessens the articulatory cost of such distinctions. These goals obviously conflict: a maximal number of phonemes reduces the degree to which they can be acoustically contrastive, while articulatory effort is impacted by the required degree of refinement needed to maintain contrasts.

4.3.2.2 Constraints

Flemming (1995) proposes that the drive to maximize the number of contrasts in a language be instantiated by a series of constraints that require *x* number of contrasts for a particular dimension (D):

MAINTAIN 1D Contrast >> MAINTAIN 2D Contrasts >> MAINTAIN 3D Contrasts, *etc*.

Figure 4-13. Implicational hierarchy of MAINT constraints.

As we see in Figure 4-13, such constraints naturally show a fixed ordering, as it would be impossible to satisfy MAINTAIN 2 Contrasts without also satisfying MAINTAIN 1 Contrast.

MAINTAIN conflicts with constraints militating for MINIMUMDISTANCE between contrasting segments for a particular acoustic dimension. These constraints are likewise fixed in an implicational hierarchy:

MINDIST (D=1) >> MINDIST (D=2) >> MINDIST (D=3), *etc*.

Figure 4-14. Implicational hierarchy of MINDIST constraints.

MAINTAIN and MINDIST constraints (as implicationally ordered series) are interleaved to reflect the conflict between maximizing both the number of contrasts and their distinctiveness: e.g. MAINT3 >> MINDIST$_{(X)}$ >> MAINT2, *etc*. Note that markedness constraints enforcing concepts of articulatory efficiency or effort are invoked as they become relevant in the analyses that follow.

Following Flemming, then, I posit that an active constraint militating for a three-way stop contrast at each place of articulation (dental, labial, velar) was in effect in Late Spoken Latin and was inherited by Old Spanish. Such a constraint therefore forces maintenance of the existing contrasts even as other constraints demand certain margins of acoustic differentiation. I flesh out this approach in the sections below.

4.3.2.3 Duration as a distinguishing acoustic feature

Much work with geminates has focused on how gemination is reflected in the acoustic properties of the utterance, and which of these properties are relevant to its perception. A good many studies, including work on Italian, have concluded that closure duration is the main, if not the only cue to a categorical distinction between singletons and geminates (Giovanardi and Di Benedetto 1998, Esposito & Di Benedetto 1999, Mattei & Di Benedetto 2000 for Italian; Cohn *et al*. 1999, for various languages of Indonesia; Arvaniti 1999, for Cypriot Greek). Moreover, Lavoie (2001) concludes that the commonplace voicing of stops intervocalically in Spanish is itself also a function of duration and as such is not true voicing but rather only its percept: “A decrease in the duration of a gesture will yield the percept of voicing of a voiceless stop or the percept of degemination” (Lavoie 2000:217).

We may thus view the Latin distinction between geminates and singleton voiceless and voiced stops as a three-way contrast based primarily on duration. That is, for each

major place of articulation, there are three stop phonemes distinguished auditorily by duration, as we can see above in Figure 4-1.[8] As discussed above, maintenance of a number of contrasts is formalized as MAINTX$_{(F)}$, calling for X number of contrasts for a feature F (duration here). These constraints naturally constitute an implicational hierarchy:

MAINTX$_{(dur)}$ >> MAINTX+1$_{(dur)}$ >> MAINTX+2$_{(dur)}$ Maintain X duration contrasts

Figure 4-15. MAINT constraints with duration.

MIN(IMUM)DIST(ANCE) constraints set limits on the required margin of contrast along some phonetic dimension. Here I assume a very basic scale of consonantal duration based on cross-linguistically attested patterns of weakening (see the survey in chapter two of Lavoie 2000). Note that the scale is wholly phonologized (hence, categorical) and thus does not take into account scalar phonetic differences in duration.

voiceless gem	>	voiceless stop	>	voiced stop	>	approx	>	Ø
4		3		2		1		0

Figure 4-16. Scale of stop weakening via duration.

Note that voiced geminates are not taken into consideration. This reflects their high degree of markedness as a function of the effort involved in their production, as detailed in Kirchner's (1998, 2001) work and taken up again more recently in Hayes & Steriade (2004). I assume a high-ranking markedness constraint that blocks their presence in the inventory. Were they present, however, they would assume a position between voiceless geminates and voiceless singletons. This follows findings by Esposito & Di Benedetto (1999:2058), who show that voiced geminates are shorter than their voiceless counterparts. Indeed, in general terms, voiceless geminates are as a class longer than voiced ones[9]. Their findings accord with results of experiments discussed in Ohala

(1990:264), in which variant closure intervals account for varying percepts of voiceless/voiced singletons and consonant clusters. That is, presented with VC.CV stimuli, participants interpret shorter closure intervals as marking singletons, with voiced singletons indicated by shorter intervals, voiceless by longer. Above a particular threshold, participants' identified consonant clusters rather than singletons. Moreover, within the range triggering percepts of a consonant cluster, a shorter interval elicited percepts of voiced clusters, with voiceless clusters perceived as an effect of longer closure.

Given the above discussion, we might more realistically assign a value of 5 to voiceless geminates, making voiced geminates—which will not surface under high-ranked constraints banning them—ranked below at 4.

t:	(d:)	t	d	ð
5	(4)	3	2	1

Figure 4-17. Coronal stop duration scale.

My assumption at this point is that listeners compensate for this 'gap' in the scale and simply expand the acceptable range under which they both produce and hear a sound as a voiceless geminate. The only absolute exigency is that geminate closure be greater than that of the singletons with which they contrast.[10]

For the approximants, see Lavoie (2001:159), who finds the main acoustic correlate of lenition to be lessening of duration; approximants then arise as the products of both a decrease in duration and in magnitude of a stop gesture (Lavoie 2001:166-7). Moreover, there is evidence that approximantized voiced stops in Spanish also show lesser duration than their occlusive counterparts (Romero 1996).

The MINDIST constraints therefore call for a set margin of distinctiveness based on duration. As with the MAINT constraints above, they fall into an implicational hierarchy:

MINDIST$_{(XDur)}$ >> MINDIST$_{(X+1Dur)}$ >> MINDIST$_{(X+2Dur)}$ Have minimal distance of X

Figure 4-18. MINIMALDISTANCE constraints for duration.

With these constraints in place, we are ready to begin our analysis of historical degemination in the history of Spanish.

4.3.2.4 Dispersion in the stop series

The constraints discussed above allow us to posit a tableau that generates the plosive inventory of Classical Latin:

	MAINT2dur	MAINT3dur	*ð	MINDIST$_{(2dur)}$
a) tt t d ☞ 4 3 2				**
b) tt d ð 4 2 1			*!	*
c) t d ð 3 2 1			*!	**
d) t ð 3 1		*!	*	

Figure 4-19. Classical Latin stop contrasts as duration contrasts (Tableau 30).

Here we see that the drive to maintain three contrasts outranks the minimum distance constraint militating for a duration differential of 2; none of the three-segment cohorts fully satisfies that constraint. (30b) satisfies it better than the winning candidate (30a), and (30c) is no less harmonic by minimum distance, but a markedness constraint blocking the approximant [ð] prevents either candidate from winning. Kirchner (2001) suggests that languages may set limits on the degree of weakening (as here in lessening of duration) they are willing to allow. I see the markedness constraint here as reflecting such a limit in Classical Latin, in which approximantization would have simply taken the

lessening of duration too far. This ban would be relaxed under pressure from the rising drive to lenite these segments in Late Spoken Latin:

	MAINT3dur	LAZY	*ð	MINDIST$_{(2dur)}$
a) tt t d 4 3 2		*(tt > ð)!		**
b) tt d ð 4 2 1		*(tt > t)!	*	*
c) t d ð ☞ 3 2 1		√	*	**
d) tt t ð 4 3 1		*(tt > d)!	*	*

Figure 4-20. Late Spoken Latin/Old Spanish three-way contrast maintenance (Tableau 31).

Here lenition is clearly implicated, as we see reduction of gestural duration with no apparent alteration or strengthening of the target segments. Recall, moreover, that intervocalic position is well-attested as a prime weakening environment. I therefore simply use LAZY. It is ranked above the ban on the approximant since at this stage of the language's development, the latter was indeed surfacing. Moreover, LAZY outranks the MINDIST2 constraint, as well, to prevent the more harmonic acoustic distancing of (31b) from surfacing.[11] Note again that I tally the effects of LAZY in a relative way, only comparing candidates among themselves. That is, (31d) is less harmonic under LAZY than (31c) because the /tt/ member of (30d)'s cohort is less lenited in terms of duration than is the /d/ of (31c)'s cohort. Similarly, the other candidates' less lenited members are indicated in the tableau.

By the time of Modern Spanish, we see that the drive to maintain three contrasts has become less important under the rise of lenition and a stricter enforcement of minimum distance:

	MAINT2dur	MINDIST$_{(2dur)}$	LAZY	*ð	MAINT3dur
a) tt d ð 4 2 1		*!	N/A	*	
b) t d ð 3 2 1		*!*	N/A	*	
c) ☞ t ð 3 1			√	*	*
d) tt d 4 2			*(tt > t), * (d > ð)!		*
e) tt ð 4 1			*(tt > t)!	*	*
f) d ð 2 1		*!	(√)	*	*

Figure 4-21. Modern Spanish stop reflexes (Tableau 32).

The drive to maintain three distinct contrasts has been down-ranked in favor of a fully harmonic satisfaction of MINDIST$_{(2dur)}$, such that two-segment cohorts with more harmonic distancing is permitted. Among the remaining candidates, LAZY favors (32c), which shows segments more fully lenited in terms of duration than (32d) and (32e). (32f) shows that MINDIST$_{(2dur)}$ has risen above, since were it still lower ranked, this candidate, with a more weakened two-segment cohort, would be optimal. Note that MAINT3DUR is shown as tied with *ð, as there is no means of establishing a ranking.

Thus far, then, we have seen how the tendency toward lenition in intervocalic contexts and the drive to increase acoustic contrast among segments conspire to drive the historical changes observed from Late Spoken Latin into Modern Spanish. The above tableaux show that widespread lenition, formalized here as LAZY, affected all of the stops in the Latin system. The weakening process, however, was constrained by systemic pressures to maintain a certain number of contrastive segments as well as a certain margin of contrast between them. These pressures are here instantiated by Flemming's (1995, 2001) MAINT and MINDIST constraints. This approach is congruent with the

observations of most philologists and historical linguists, who identify not only the lenition process but also the systemic pressures working to shape the changes undergone by the Latin system into Hispano-Romance. Note that I have not had to posit a general ban on geminates (NOGEMINATES); the weakening drive alone has sufficed to pare them down. This will be important in the analysis of the geminate Latin /r/, which has not degeminated in the standard modern language. Now, however, I apply a similar analysis as that seen above to the sonorants /nn n ll l/.

4.4 Geminate Sonorants in the History of Spanish

Latin never showed a three-way contrast, even in intervocalic position, with the sonorants. That is of course due to their inherent voicing; a voiceless-voiced contrast would constitute an extremely marked situation.[12] Indeed, as we will see below, the sonorants had relatively little leeway for change, and geminates /nn ll/ apparently persisted for centuries after the loss of the geminate occlusives (Alarcos Llorach 1961; Holt 1996). This may be taken as further evidence against positing a high-ranked NOGEMINATES constraint in the tableaux above (in a sense, we get degemination for free, via lenition). We do not therefore see any chain shift in the evolution of these segments. Still, we would like to be able to motivate the palatalization that did affect the geminates, and, ideally, in the same terms used in the analysis of the stops. I provide such motivation in the following sections.

4.4.1 Geminate Nasal Reflexes in Spanish

The nasal, as a sonorant, was far more constrained in terms of voicing and stricture options than the stops. There are clear articulatory and acoustic bases underlying these limitations. Voicing in nasals is thought to be coupled with the velum-lowering necessary for the opening of the nasal sinuses through which the brunt of airflow passes in

nasalization. That is, larynx-raising and some stretching of the vocal folds associated with the physiological act of opening the velic valve (via palatoglossus and palatopharyngeus activity; see Moll 1962) may make voicing a normal side-effect of nasalization. Ladefoged (1996:110) also states that nasals, as well as laterals (see below), "depend on pulses from the vocal folds" for their production. This supports a markedness constraint barring voiceless nasals that is high-ranked in most languages (at least outside southeast Asia; see note 12): *N̥.

Additionally, we may consider approximantization of nasals to be a marked option due to perceptual factors; as Kirchner (2001:173, 256 n96) discusses, nasal continuants are marked since formant transitions—key to place of articulation perception—are less salient in continuants than in stops, a problem compounded by the damping that nasalization entails through the production of antiresonances in the nasal sinuses (see also Ladefoged & Maddieson 1996:118). Consequently, we must assume that the lenition affecting the geminate occlusives was here stymied by the markedness of nasal approximants. To represent this, Padgett's (1995) markedness constraint barring nasal continuants is invoked here in the following tableaux, as discussed in Chapter 2. I represent a nasal approximant in tableaux as 'n^{cont}'.

With these constraints, we can explain the historical behavior of the Latin geminate nasal. Note that in the tableaux below, I use the same duration scale as that posited above; /n/ receives a 2 rating based on the possibility of a longer, voiceless nasal (rated 3), as in Burmese (see note 12), while the geminate is given the 4 of the other (albeit voiceless) geminates in the absence of any information on the presence of geminate voiceless /n̥n̥/ in language inventories. The possibility of deletion of the nasal consonant with nasalization

of a preceding vowel would represent a 0 duration, an option to be seen below in the analysis of the Portuguese inventory. We must assume for Spanish that a markedness constraint barring outright deletion of the segment with concomitant vowel nasalization was in effect (*ṽ), blocking this option (Holt 1996 posits a similar constraint). Spanish has traditionally resisted the sort of nasalization heard in French and Portuguese vowel inventories.[13]

	MAINT2dur	*ṽ	*N̥	*[+NAS, +CONT]	MAINT3dur	MINDIST(2dur)
a) ☞ nn n 4 2					*	
b) nn n̥ n 4 3 2			*!			**
c) nn n n^{cont} 4 2 1				*!		*
d) n ṽ 2 0		*!			*	

Figure 4-22. Latin and Old Spanish (coronal) nasal inventory (Tableau 33).

The various markedness constraints, however convenient they may appear to be here, simply reflect the fact that, due to the articulatory and acoustic factors mentioned above, there simply was not any place for the nasals to 'weaken to' at this point in the evolution of the language. Candidates (33b) and (33c) demonstrate that there was no means of establishing a three-way contrast for nasals as there had been for oral stops; only highly marked (and therefore banned) voiceless nasals or nasal continuants might have completed the triad. (33d) shows that degemination could have been harmonic in terms of distancing on our scale if deletion and concomitant nasalization of the preceding vowel had been available as an option, which it was not. It is important to note that we cannot simply up-rank MINDIST(2dur) above MAINT3DUR to get the same results, since we are positing that the same grammar that formed the stop inventory also generates the nasals,

and the ranking of MAINT3DUR over MINDIST$_{(2dur)}$ is necessary to get the stop inventory, as we saw in Figure 4-20 above.

4.4.2 Geminate Lateral Reflexes in Spanish

We can make similar arguments for the laterals /ll ~ l/, as laterals are susceptible to an acoustic analysis quite similar to that of nasals (Johnson 1997:153-7). Citing Fant (1960), Johnson discusses the antiformants (antiresonances or acoustic zeroes that neutralize formant energy at the same frequencies) produced in the spectra of both nasals and laterals. In the former, the sinuses set up anti-resonances that serve to nullify certain resonant frequencies, while in the latter, an air pocket atop the tongue in the production of laterals is theorized by Fant to act as a side-cavity to produce the antiformants noted in their spectra. The effect in both cases is to lower the amplitude of higher formants. Moreover, given that the lateral /l/ is already considered to be an approximant, it seems reasonable that the durational contrast seen between a voiced stop and approximant as with /d ~ð/ is simply not possible here. That is, in singleton laterals, we would expect a contrast based on weakened or shortened articulator stricture or contact—further impacting formant transitions—to be highly marked in language inventories. Also, as noted above (Ladefoged 1996), voicing is a near given in laterals, though voiceless laterals do occur (see Ladefoged & Maddieson 1996:198). These observations are formalized below in the tableau.

I assume here that the lateral approximant receives a 2 on the duration scale. Navarro Tomás (1918) measured laterals and nasals and placed them between voiceless stops and their voiced counterparts in duration, while much more recently, Lavoie (2001) found laterals and nasals to be very close to voiced approximants in duration, findings

that square in relative terms with the findings of Borzone de Manrique & Signorini (1983). The geminate is rated 4, in line with /nn/ and other geminates. A hypothetical lenited lateral approximant with distinctively less duration to traditional /l/ is assumed to rate 1.

	MAINT2dur	*L̥	*LC^{ont}	MAINT3dur	MINDIST$_{(2dur)}$
a) ll 1 ☞ 4 2				*	
b) ll l̥ 1 4 3 2		*!			**
c) l̥ 1 1^{cont} 3 2 1		*!	*		*

Figure 4-23. Old Spanish lateral inventory (Tableau 34)

The markedness constraints above are meant to formalize the observation that voiceless laterals are rather rare in languages of the world (*L̥); voicelessness, moreover, would greatly undermine the perceptual saliency of place of articulation cues in this (sonorant) segment. *LC^{ont} formalizes the observation made above that distinctive shortening—as that seen between voiced stops and voiced approximants—of the traditional approximant /l/ seems a near impossible endeavor. These markedness constraints are fatally violated by candidates (34b) and (34c). We see then that no combination of laterals other than (34a) can fulfill the contrastivity requirements of the language.

4.4.3 Palatalization of the Latin Geminate Sonorants

In Figures 4-22 and 4-23 above, we saw that the geminate sonorants persist relatively late in Spanish. This is due to the systemic pressure to maintain a particular number of contrasts as well as a certain margin of contrastiveness; moreover, lenition effects are stymied by the high markedness of alternative weakened sonorants. This creates an imbalance, however; a contrast is maintained along a dimension that is no

longer functional for other segments. As a response to increasing pressure to resolve this, the innovation of the palatal segments seems rather predictable. Given the shift from a duration-based stress system to one based on expiratory force (see Penny 1991:34-5), duration-based contrasts in general are undermined, and the drive to simplify the geminate increases. The system responds by establishing a new order of consonants at a less exploited place of articulation.[14] Here we will see the onset of CONDENSE, representing the drive that motivates the innovation of a new palatal order of segments that maintain the contrastiveness of the geminates by reanalyzing their inherent phonological (and phonetic) strength in the system.

4.4.3.1 Perceptual bases for palatalization of geminate sonorants.

Sonorants (glides, laterals, and nasals), as voiced continuant sounds, have formant structure. Moreover, as consonants, they show formant transitions present in the act of moving from the consonant articulation into that of the following vowel. Indeed, second and third formant transitions present in CV sequences provide important cues to the place of articulation of consonants. Now, as Flemming points out, while alveolars and dentals typically have a relatively invariant F2 transition, generalizations concerning formant transitions and place do not apply to consonants with strong secondary articulations such as palatalization; here, the formant transitions generally reflect the secondary articulation rather than the primary (2001:22-3). Hence, a palatalized nasal or lateral will demonstrate the very high F2 component of the palatal glide gesture involving the raised tongue body discussed above. To illustrate, Recasens (1991) points out from spectrograms that the F2 transitions of /l/ are generally negative; that is, they rise to that of a following vowel. On the other hand, the transitions of /ʎ/ are similar to those for /j/, with high F2 and thus

positive transitions that descend to that of a following vowel (Recasens 1991:306, 317). Note too that Quilis (1999:313-14) also points out the significant difference in F2 transitions between the palatal /ʎ/and the /l/, with the former showing formant transitions that are twice as long as those of /l/. For the nasals, Quilis (1999:233-4, citing Albalá 1992) similarly confirms that F2 transitions are the principal means of differentiating nasal place of articulation, and formant transitions are found to be some 50% greater for /ɲ/ than for /n/ (Quilis 1981:211-19). Finally, Ladefoged (2002:22) notes measurably higher F2 and F3 transitions in palatal /ɲ/ in Malayalam than in other nasals consonants and suggests that in this segment these frequencies distinguish it from the others. Interestingly, such frequency differences do not characterize the other nasals, which could support the notion that the formant transitions isolated here represent a means of contrast unique to the /n ~ nn/ contrast in Spanish.[15] We may therefore view palatalization as a means of enhancing a perceptual contrast between singleton /n l/ and their palatalized counterparts /ɲ ʎ/: F2 formant transitions are raised by the secondary articulation of the raised tongue body gesture.

This approach appears to be confirmed in light of other evidence. Recasens (1991) notes the similarity of F2 and F3 transitions among all the palatal segments of Catalan, which suggests that a focus on F2-based contrasts provides for a unified account of the parallel development of /nn ll/. Recasens, citing Straka (1965), moreover views the palatalization process of /nn > ɲ/ as analogue to that of /ll > ʎ/; he asserts that the considerable duration of the alveolar geminates occasioned an increase in the zone of lingual contact, thence leading to palatalization (Recasens 1991:266). Lloyd (1987:243)

suggests something reminiscent of this, as noted by Holt (1997); they subscribe to the notion that the articulatory energy involved in the geminate realization was rechanneled in the palatal articulation, which requires a large zone of contact. In a sense, energy expended temporally is viewed in this approach as being reapplied in spatial terms. Gesturally, we might see this as a shortened gesture (less duration) with greater gestural magnitude (greater degree of contact). Note finally that Keating *et al*. (n.d.), in a study of prosodic domain-conditioned fortition, find evidence of increased linguopalatal contact in initial /n/ in higher domains (i.e. utterance- or intonational phrase-initial). They conclude that "phrasal/prosodic conditioning of articulation across languages… generally affects both linguopalatal contact, which reflects overall height of the tongue, and also duration, so the total effect is on contact-over-time" (Keating *et al*. n.d., p.14). In this sense, I do not view degemination of /nn ll/ as a product of lenition but rather of communicative efficiency and featural compression under CONDENSE:

/nː ~ lː/	CONDENSE	*PALATAL
a) nː ~ lː	*!	
☞ b) ɲ ~ ʎ		**

Figure 4-24. Condensing of the geminate sonorants (Tableau 35)

Thus, duration-based distinctions give way in the grammar to contrasts on different dimensions. The drive to condense (and indirectly do away with) duration-based distinctions becomes more compelling than the general ban on marked palatal articulations. Recall too Flemming's (2002:104) idea by which the drive to maximize contrasts may well drive affrication (with its highly salient stridency) of palatalized velars. Here, we might also view a similar drive to optimize contrasts in the new opposition between the former geminates /ll nn/ and singleton /l n/. That is, we might

view the drive to increase an F2 differential between the new condensed segments as the force behind full palatalization. This articulatory shift also provides secondary contrastiveness in the longer transition durations and even longer overall segment duration that come of the large contact zone (Ladefoged 2001:144; also Keating 1991:38); see Chapter 5 for empirical evidence. We could plainly view these effects as substitutes for the loss of geminate length, in line with our concept of the palatals as quasi-geminate segments.

4.4.3.2 Implementing palatalization in dispersion.

With this in mind, we again follow Flemming (1995, 2002) in positing MINDIST constraints that formalize the requirement that there be a certain distance between contrasting segments in terms of F2 transitions. Note that these constraints operate independently of $\text{MINDIST}_{\text{dur}}$ constraints calling for duration-based differences. I posit here that the new constraints represent a separate component in the grammar, filling in where the duration-based constraints cannot decide the issue due to a lack of viable duration-based options for the sonorants.[16] Recall that this state of affairs is in a sense effected by LAZY, as seen in Figure 4-30 above. Here I will rate the palatalized /ɲ ʎ/ F2 5 in line with the value Flemming gives to the high front /i/ and other palatalized stops. Flemming assigns F2 4 to alveolars generally, which seems to be the appropriate value for /n l/. Given such a small margin of difference, this alone would seem unconvincing. However, we have already mentioned that transition duration is also enhanced by palatalization: the transition of the palatal lateral is twice as long as its alveolar counterpart, the nasal 50% longer. Flemming (2002) addresses such a situation:

> The magnitude of the distinction between two contrasting forms cannot depend solely on the magnitude of a difference along some special parameter, but must

> also depend on the duration of that difference. So the total difference between two forms is some integration of the auditory difference between them over time.
>
> (Flemming 2002:61; see also Kawasaki 1982)

Aside from using conjunction to posit constraints targeting two different features, Flemming does not develop a specific approach to integrating duration into his theory of distinctiveness. In the same vein, I will abstract away from specific phonetic gradations (as well as conjunction) and simply target overall F2 transition differences between the relevant segments. Thus, I see an F2 transition difference of 2 between /ɲ ~ n/ and /ʎ ~ l/—based on the frequency rating difference of 1 given by Flemming above—plus 1 based on the significant duration differences between the two. Further gradation does not seem necessary in light of the lack of any other viable nasal candidates (NB: previously cited markedness constraints barring nasalized vowels, nasal continuants/approximants, and voiceless nasals are assumed here to be unviolated and are not shown, nor any cohort including such segments).

Integrating the F2-oriented constraints into the tableau favors the new palatal candidate. They are unranked here, as either would select the palatal cohort. The other constraints maintain the ranking given in previous tableaux.

	MAINT2F2	MINDIST$_{(2F2trans)}$	MAINT2dur	MINDIST$_{(2dur)}$
a) nn n 4 4	*!	*(!)		
b) ɲ n ☞ 6 4			*	*

Figure 4-25. Palatalization of the geminate nasal (Tableau 36).

As there is no reason to posit that geminate /nn/ has a different F2 transition from that of singleton /n/, the cohort in (36a) satisfies neither of the constraints posited, while (36b) of course is harmonic under both. The formerly decisive constraints based on

duration differences have been down-ranked to reflect the change in the grammar whereby length-based contrasts have given way to F2 criteria.[20] Note that the duration-based constraints must be ranked below those based on F2 differences since there is no apparently significant overall segment duration-based difference between /ɲ ~ n/.[17] Data in Lavoie (2001) show that while the palatal nasal is somewhat longer (some 30%) than /n/ in various positions, in non-pre-stress medial position (e.g. *ceno* vs *baño*), the difference is minuscule. Consequently, the duration-based constraints are lowered to allow the surfacing of the /ɲ ~ n/ contrast. The same tableau would account equally for the palatalization of the lateral.

In essence, then, palatalization here is simply the shifting of contrast parameters in the grammar away from what had been duration-based to a contrast based on salient formant frequency cues. We may view this as a strategy to reconcile potential loss of meaningful contrasts in the language inventory due to loss of contrastive length. To compensate for this loss, speakers innovate a new means of marking a meaningful (phonemic) contrast. For the stops, length contrasts between geminates and singletons were lost in favor of length contrasts between singletons, phonologized later as a voicing contrast (Lavoie 2001:165). Approximantization reinforces such distinctions in the modern language through additional weakening of the magnitude of the gesture (constriction). The sonorant geminates /nn ll/ could not follow this pattern due to inherent voicing and/or approximant status. Palatalization and the subsequent innovation of a new order of consonants, remediated the potential loss of contrastiveness in the language.

4.5 Geminate Sonorants in the History of Portuguese

4.5.1 Geminate Nasal in Portuguese

Differently from Spanish, the Portuguese system did indeed reduce Latin /nn ~ n/ to a singleton /n/ contrasting with deletion and vowel nasalization:

L. ANNUM > Port *ano* 'year' [a.nu] (cf. Sp *año*, OSp *anno* [an.no], later [aɲo])
L. MANUS > Port *mão* 'hand' [mãʷ] (cf. Sp *mano*)

Figure 4-26. Nasal geminate/singleton reflexes in Portuguese

We can account for this by down-ranking the ban on nasalized vowels. From there, low-ranked LAZY—in a sort of emergence of the unmarked scenario—accounts for the more harmonic status of (33d) over (33a). Recall that in the OT framework, all constraints are always present in the grammar; only ranking varies. Here then, low-ranked LAZY decides the winner, since the higher-ranked constraints are satisfied by both candidates. I omit MAINT3dur and the other markedness constraints here; presumably they conspired to neutralize each other as we have seen above for Spanish.

		MAINT2dur	MINDIST$_{(2dur)}$	LAZY	*ṽ
a)	nn n 4 2			*(nn), *(n)!	
b) ☞	n ṽ 2 0				*

Figure 4-27. Portuguese (coronal) nasal inventory (Tableau 37).

Candidate (37b) simply shows more harmonic weakening under LAZY than (37a).

4.5.2 Geminate Lateral in Portuguese

Portuguese deleted Latin singleton /l/ in intervocalic position in much the same way it lost the nasal, in part through fusion with the preceding vowel, resulting in a labiovelar glide (Figure 4-28a-b). Note, though, that in some cases, merger ensued with

the rhotic (Figure 4-28c; NB: Spanish also undergoes interesting reflexes with this item, showing metathesis of the liquids):

a) L. CAELUM	Port *céu* 'sky' [se^{w}] (cf. Sp *cielo*)
b) L. PALUM	Port *pau* 'stick' [pa^{w}] (cf. Sp *palo*)
c) L. PERICULUM	Port *perigo* 'danger' (cf. Sp *peligro*)

Figure 4-28. Variant reflexes of Latin /l/ in Portuguese (Holt 1997)

I will assume here that cases such as (Figure 4-28c) have to do with factors that lie outside the current analysis. Aside from this merger, then, we see once again a loss of duration (in deletion of the segment *per se*) with a residue left on the preceding vowel. Hence, contrastiveness has not, in a sense, been lost.

At this point, we need to take a closer look at the Portuguese inventory. Before we can approach the evolution of the lateral in Portuguese, it is incumbent upon us to investigate the evolution of the stops in the history of the language. Portuguese, like Spanish, displayed weakening of stops in word-medial intervocalic position; geminates degeminated and voiceless stops voiced. However, differently from Spanish, Portuguese has traditionally resisted approximantization of the voiced stops in intervocalic position: *lobo* 'wolf' [lo.bo] (< L. LUPUM; cf. Sp [lo.βo]).[18] In fact, excepting the *de facto* approximant status of the lateral /l/, modern Portuguese, like French, displays no approximants in its inventory. This forced a different resolution of the former voiced stops in the history of the language. While the voiceless segments voiced, the voiced segments generally deleted (L. SEDEM > Port *sé* 'see; seat of authority'; L. SIGILLUM > Port *selo* 'stamp'), resulting in a loss of contrast. Consequently, rather than downranking our MINDIST constraints to simply allow for a narrower margin of duration-based differentiation, we can account for the general absence of approximantization by positing that a markedness constraint barring loss of obstruent stricture is in effect in

Portuguese (as well as in French).[19] Such a constraint would be perceptual in nature; Kirchner observes that "[the fact that] formant excursions are less extreme in a continuant than in a stop… makes for poorer cues to the consonant's place of articulation" (Kirchner 2001:256 n96). I motivate degemination with LAZY, given that otherwise a minimal distance between a geminate and a singleton would seem to be equally harmonic to that between the voiceless and voiced singletons.

	MAINT2dur	*ð	LAZY	MINDIST$_{(2dur)}$	MAINT3dur
a) tt t d 4 3 2			N/A	**!	
b) t d ð 3 2 1		*!		**	
c) ☞ t d 3 2			√	*	*
d) tt t 4 3			*(tt > t), *(t > d)!	*	*
e) tt d 4 2			*(tt > t)!		
f) t ð 3 1		*!			*

Figure 4-29. Portuguese stop contrasts from Latin (Tableau 38).

Here we see that the downranked MAINT3dur allows the loss of one contrast in favor of less effortful articulations (i.e. singletons over geminates). The ban on approximants, seen here simply as *ð, prevents any cohort with that segment. As opposed to the ranking in Figure 4-21 above, where LAZY outranked such a ban, permitting the Modern Spanish contrast, here the markedness constraint outranks LAZY and allows more effortful segments to be more harmonic. Consequently, LAZY selects (38c) as more harmonic than (38e), which would otherwise be the winner with a better MINDIST evaluation. LAZY also weeds out (38d), since the geminates represent highly effortful segments not found in the winner. Since I do not evaluate different numbered cohorts under LAZY, (38a) is only

eliminated under MINDIST, where its larger cohort causes two violations of distancing. (38b) and (38f) fatally violate the high-ranked ban on approximantized stops.

Having established the rankings, we have to amend Tableau 37 (Figure 4-27) from above accounting for the nasal inventory of Portugese. LAZY seems to outrank the MINDIST2dur constraint. This is not problematic, however, since the attested candidate is superior to its rival under both constraints:

	MAINT2dur	LAZY	MINDIST$_{(2dur)}$	*v̄
a) nn n 4 2		*(nn), *(n)!		
b) n v̄ ☞ 2 0				*

Figure 4-30. Portuguese nasal inventory revised (Tableau 39).

As for Portuguese laterals, at least in cases where labialization took place, loss with a compensatory vocalic reflex is straightforwardly modeled:

	MAINT2dur	LAZY	MINDIST$_{(2dur)}$
a) ll l 4 2		*(ll), *(l)!	
b) l w ☞ 2 0			

Figure 4-31. Portuguese lateral inventory (Tableau 40).

Note too that loss of a lateral contrast seems congruent with similar loss of the lateral in syllable-final position through vocalization to a labiovelar glide: cf. Sp *mal* ‘badly’ [mal] ~ Port *mal* [maw]. This change, however, is expected for reasons of articulatory efficiency that do not seem related to the pressures at work in the loss of the geminate sonorants.

4.6 The Rhotic Geminate

The /rr/ remains the only geminate in Spanish, as well as in some dialects of Portuguese. In word-medial, intervocalic position, /r/ remains phonemically distinct from the flap /ɾ/ and is distinguished primarily from it (at least phonologically) by duration as manifested in the number of apical taps it involves (see Quilis 1999:332). Thus, the solution sketched above for the other sonorants did not take in this case, and this exceptional behavior requires some mention. To account for this segment's historical resistance to the palatalization innovated for the other, degeminated sonorants, we again take into account articulatory factors.

As discussed above in 3.5.4, the rhotic, whether geminate or singleton, resists palatalization. Wireback (1997), discussing metathesis of palatal elements as alternatives to palatalization, points to evidence in Portuguese showing that where a rhotic resisted palatalization, metathesis ensued. Indeed, this is the case with both the rhotic and /s/.

In fact, we would expect these segments to resist palatalization—a tongue body gesture—given their articulatory characteristics. First, the /r s/ are apical sounds, involving a high degree of lingual tension and control. In fact, trills and sibilants are the last sounds acquired by Spanish language learners, and are not produced in the experimental babbling stage observed among infants (Solé 2002:656, citing Jiménez 1987). Recasens & Pallarès (1999, 2001) also note the high degree of tongue body resistance of the trilled rhotic to coarticulation; they show through their DAC ('degree of articulatory constraint') model that fricatives and trills /s r ʃ/ are highly constrained at both the tongue front and dorsum; that is, they resist coarticulatory and assimilatory influences from neighboring sounds. Focusing on the rhotic trill, Solé (2002) is more

explicit, emphasizing the complex array of production requirements of this segment; she notes the "critical positioning" and degree of tension required of articulators as well as rather precise aerodynamic factors. Aerodynamically, production of the multiple trill involves rather fine control over aerodynamic pressure at the sub- and supraglottal levels. A narrow pressure differential must be maintained in favor of the subglottal zone in order to initiate and sustain the multiple taps; too great a differential merely forces a fricative-like egression of air; too little, and no tap is produced (Solé 2002; see also Lewis 2004). In this light, assimilation of the rhotic geminate to the tongue body gesture of the palatal becomes virtually impossible, requiring too great a degree of articulatory control. Recall, too, that both Hock (1991:120,134) and Tuttle (1997:28) note the difficulty with which /r/ accepts palatal influences.

It must be noted, nevertheless, that this segment demonstrates ongoing instability, certainly as a result of its complex production. Indeed, we see in Hammond's (2000) survey that the trilled (geminate) rhotic seems very much the exception and not the rule. A whole array of variant reflexes are available for /r/, as is seen in Figure 4-33 below.

/r/	Assibilated	Ass./Devoiced	Pre-aspirated	Uvular	Retroflex/glide
variant	a) [ř]	b [r̥]	c) [ʰr]	d) [ʀ]	e) [ɹ]

Figure 4-32. Modern cross-dialectal reflexes of geminate /r/.

These variants must be seen by and large as reflecting simplified articulations, typically due to loss of the full occlusion that produces the multiple taps of the standard trilled variant. Thus, we see a fricativized (not approximantized) variant (Figure 4-33a), transcribed [ř] (IPA [ʒ]) in Hispanic linguistics, that must be seen as a very strong

segment but no longer geminate. This accords with Solé's (2002) observation that the production requirements of trills, while qualitatively similar to those of fricatives, are more highly constrained (Solé 2002:686).

Loss of voice is another reflex, found in Cuban Spanish ([r̥], with the taps intact), also in line with findings by Solé (2002) that the voiceless geminate tolerates a wider margin of oropharyngeal pressure variation to achieve and maintain the trill than the (standard) voiced trill. We might also view loss of voicing here as a clear case of weakening (in effort-based, not sonority-based terms): expiratory force needed for the taps is no longer undermined by glottal friction required for voicing (recall observations concerning the effortfulness of voiced fricatives).

In Central American dialects, a retroflexed, glided rhotic similar to that of English is heard (Figure 4-33e). This reflex represents a total loss of occlusion, aerodynamic requirements, and lingual tension in favor of what is essentially a vocoid, as in the glided /ɹ/ of English. Similarly, the partially aspirated or preaspirated variant (Figure 4-33c) reflects loss of all oral stricture. These variants also provide valuable evidence of the gradual nature of the lenition process: we view /hr/ as a first step toward apparent posteriorization and perhaps fricativization of this segment. That these variants occur in a dialect zone in which velarization or even uvularization (Figure 4-33d)—the [ʀ] or [χ] of Puerto Rican and some Cuban dialects—is also observed underscores this observation. What [hr] and [ʀ] suggest is a reanalysis of an intensely effortful, and (arguably) systemically marked segment by speakers. That is, the /rr ~ r/ distinction, as the last vestige of the duration-based geminate~singleton distinctions of Latin, could be ripe for some sort of reanalysis. The Caribbean dialects seem to be improvising a new sound in an

unused point of articulation. Note that Caribbean speakers with the uvular do not confuse such pairs as *Ramón~jamón* 'Ramon' (name)~ 'ham', since the latter has lost velar frication to become a simple aspirate: hence, the minimal pair *Ramón~jamón* [χa.moŋ] ~ [**h**a.moŋ]. Without calling this a drag chain, we do see that uvularization of /rr/ in these dialects is made feasible by the availability of the uvular slot. Of course, this move also addresses the vestigial geminate~singleton distinction and arguably simplifies the trill, albeit to a relatively strong fricative. Note too that Bolivian /rr/ > [z] is also attested, providing very straightforward evidence of the process of converting (effortful) geminate trills to (effortful) voiced singleton fricatives. Inasmuch as Spanish does not have voiced fricatives in its inventory, we see again that new reflexes exploit available articulatory space.) It is also worth noting that the uvularization process is observed in Brazilian Portuguese, where word-initial and post-sonorant (hence, strong-position) rhotics are pronounced [χ] (e.g. *Rio (de Janeiro)* [χi.u], *Enrique* [en.χi.ki]; cf. Sp. *río* 'river' [ri.o], *Enrique* [en.ri.ke]). Again, the stronger, trilled variant has been uvularized and consequently degeminated.

Thus, though articulatory circumstances blocked the palatalization (hence, degemination) process in the case of the trilled rhotic, ongoing sound change seems to be accomplishing it nonetheless.

4.7 Other Accounts

The chain shift dealt with in this chapter has certainly not gone unnoticed by linguists and historians of Spanish. As noted in Chapter 3, researchers have often observed the facts, though only sometimes advancing explanations beyond the apparent role of lenition in intervocalic environments. Martinet (1974) looks at the role of

language contact, for example, and suggests that the Celtic substratum, in which intervocalic consonant lenition was also present, influenced Latin. Given the systemic, internally driven focus of the present work, I abstract away from such external influences even as I allow that substratal elements may well have played some role. However, any valid synchronic analysis must be able to account for such change within its own bounds, particularly when such historical language-contact phenomena are so notoriously difficult to prove. Moreover, even were the Latin system merely reflecting Celtic intervocalic lenition, we might still ask why the Celtic consonants themselves lenited, and the influence of syllable structure and phonotactics would not be any less valid for pertaining to a different language. Finally, given ongoing intervocalic lenition as evinced in modern elision of /d/ (i.e. *he hablado* 'I have spoken' [e.a.βla**w**]) or /b/ (i.e. *fabula* 'fable' [fa**w**.la]), it does not seem especially necessary to seek motivations for intervocalic lenition outside the language.

Addressing the systemic changes in the occlusives, Alarcos (1965) suggests that the increase in geminates arising from assimilations in consonant clusters such as RS (> ss) or PT (> tt) led to an imbalance which was redressed by simplification of the geminates. This in turn would have set off the chain reaction that voiced intervocalic singleton voiceless obstruents and approximantized voiced singletons. However, such a systemic analysis—at least ordered thus—ignores the phonetic naturalness of intervocalic weakening in general; that is, intervocalic stops tend naturally to weaken, regardless of systemic pressures. The flapping of intervocalic /t d/ in American English, for example, neutralizes voicing contrasts as well as reducing occlusion of the two segments. To

suggest that a preponderance of geminates was necessary to force such weakening does not seem satisfying.

Holt (1997, 1999) addresses the historical changes in question here and provides analysis in the OT framework, following Gess (1996) in viewing diachronic change as constraint-reranking over time. Holt attempts to draw a parallel between the loss of distinctive length in the Latin vowel system and the degemination processes seen above. He posits that the drive for 'systemic parity' forced degemination, creating a better balance with the loss of phonological length among vowels. Thus, moraic consonants would have been aberrant where bimoraic vowels were banned. Holt crucially links sonority and moraicity, assuming that the more sonorous a segment, the more licensed it is to bear a mora (the unit of syllabic weight). This would follow from the universal moraicity of vowels, which are of course more sonorous than consonants, widely banned from underlying moraicity (unless geminate, in which case they are held to bear an underlying mora, following Hayes 1989). Holt then demonstrates that successive bans on moraic consonants systematically rose in the grammar, following the sonority hierarchy to ban first obstruents, then nasals and laterals, leaving moraic (geminate) /rr/ as the sole remaining geminate. He furthermore links the bans on geminate stops with the weakening of their singleton counterparts in codas, since the latter would receive moraic weight via Weight by Position and thus violate the general ban on moraic segments.[21] That is, a ban on geminate /kk/, for example, should also ban any weight-bearing /k/ in codas. Holt thus motivates the reflexes that weakened and eventually palatalized such segments.

While the notion of links between reflexes of geminates and heavy coda singletons is interesting, Holt's analysis suffers from more basic problems. The first has to do with

his assumption that there is an integral link between long vowels and long consonants. Cross-linguistically, long vowels are far more common than geminates, which are themselves relatively rare. This fact does not in itself contradict Holt's assumption: long vowels are less marked, to be expected if his idea of sonority and weight is correct, and thus obtain more often. However, we do not see that long consonants only arise in systems with long vowels, which we might also expect were both inventories subject to common constraints on phonological length contrasts. Italian, for example, has long consonants but no long vowels.

A second problem with Holt's premises has to do with the supposed relationship between geminates and sonority. There is no compelling cross-linguistic evidence that languages favor more sonorant segments for gemination. Kirchner (2001), for example, explains that voiced obstruents are far less common (and more effortful) than their voiceless counterparts, despite being theoretically more sonorous (see also Hayes & Steriade 2004). Moreover, Podesva (2000) finds typological evidence implying an inimical relationship between high sonority and gemination. His forty-language survey shows geminate nasals to be more common than liquids, themselves more common than glides, which suggests that one might explode a general ban on geminates into an implicational hierarchy of $*\text{GEM}_{\text{glide}} >> *\text{GEM}_{\text{liquid}} >> *\text{GEM}_{\text{nasal}}$, quite the contrary of any such hierarchy based directly on sonority, as Holt (1997, 1999) does. Given the shaky premises on which his analysis is based, Holt's use of general (if straightforward) bans on geminates does not seem to be the best way of explaining the historical changes. My lenition-driven analysis takes systemic function into account as well as cross-linguistically common processes of intervocalic weakening and prosodically motivated

fortition and allows us to avoid positing such general 'no geminate' bans, while also tapping detailed articulatory and acoustic data to better illuminate the historical reflexes.

4.8 Conclusions

I thus prefer to see degemination, devoicing, and approximantization as the products of a common drive to weaken segments intervocalically while maintaining viable and salient acoustic contrasts among distinctive segments. Where similar strategies were not available because of the nature of the segments in question (the geminate sonorants), no degemination took place for centuries. However, an eventual reanalysis occurred: duration-based (thus temporal) contrasts were realigned in spatial terms, as is evident in the greater degree of linguopalatal contact that resulted in the palatalization of the geminate sonorants /nn ll/. Such a view of the change hinges on the spatiotemporal nature of articulatory gestures, measured in terms of both magnitude (degree of contact) and duration. I hold that such change was favored by the tendency towards gestural compression active in the language under CONDENSE; the palatals reflect a temporally condensed makeup that still maintains the distinctiveness of the geminates vis-à-vis their singleton counterparts while providing a faster transmission of linguistic data than did their geminate forebears.

I have also shown that the same general drive to lenite intervocalic segments drove changes in the Portuguese system. Different rankings of markedness constraints, however, made for different historical results. A ban on approximants prevented the sort of acoustic dispersion seen between voiceless and voiced stops in Spanish, while low-ranked constraints barring nasalized vowels and labialization allowed for a greater degree of weakening of Latin /nn ll/.

Finally, the sole remaining geminate of Spanish (/rr/) is readily explicable in terms of its articulatory nature. A high degree of articulatory and aerodynamic control involved in the production of the trilled rhotic prevented its following the palatal reanalysis of the geminate nasal and lateral. Nevertheless, numerous strategies are observed in modern dialects of Spanish which suggest ongoing variation and simplification of this segment.

While the thrust of this and preceding chapters has been the complex articulatory and acoustic nature of the palatals as the basis for much of their phonological behavior, I now focus on the posited moraic structure of these segments. In the following chapter, I attempt to find empirical evidence that speakers do indeed treat these segments as moraic. That is, what acoustic event, if any, supports our contention that the palatals of Spanish function still as geminates in the language?

4.8 Notes

1-Initial (and non-moraic) geminates have been reported in languages such as Leti (Hume *et al*. 1997) and Malayalam (Mohanan 1989). See Davis (1999) for an alternate analysis, however; he motivates an analysis of moraic initial geminates in Trukese in line with Italian geminate structure.

2-Recall from the discussion in note 12 in Chapter 2 that the traditional idea of the spirantization—that is, fricativization—of these segments in modern Spanish has been challenged in recent times and is not adopted here. Lavoie (2000) shows through phonetic analysis that Spanish voiced stops do not weaken to fricatives but rather to approximants, while phonological evidence of this comes from Baković (1994). Importantly, recent work in fricatives suggests that this class of sounds is not well understood but should likely not be considered as weaker than stops (see Ladefoged & Maddieson 1996). Here, then, the traditional 'fricatives' [β ð ɣ] are taken to be approximants, lacking the precise, highly controlled obstruction that earmarks true fricatives. I retain the tradional symbols here, however, for expository ease.

3- Kirchner (2001) demonstrates that voiced stop geminates may be considered marked in term of their effortfulness (or, in the case of the nasal, their perceptual markedness). He cites Ohala (1983) who explains in terms of aerodynamics (involving trans-glottal air pressure differentials involved in the maintaining of voicing over a

sustained period of time) why voiced obstruent geminates require more effort than their voiceless counterparts. See also Podesva (2000) and Hayes & Steriade (2004).

4-There does not seem any convincing reason to assume that the geminate /r/ of Latin is substantively different from that of modern Spanish (Lloyd 1987:246, Holt 1997:106). Wireback (1997) suggests that a word-initial fortition process produced the modern segment, implying that the Latin forebear was in some way weaker. Inasmuch as it is commonly recognized that the Latin /r/ was an apical tap, its geminate realization seems likely to have been a multiple trill.

5-Penny plainly asserts that the palatal outcomes of former Latin geminate sonorants are the results of lenition (Penny 1991:62), and then treats them as somehow exceptional to the general lenition process (Penny 1991:71). He otherwise treats lenition and palatalization as two somewhat distinct processes, for example listing the various palatalization stages as distinct from that of lenition in his chronology. I take this uncertainty to underscore the need for a clearer approach to these sound changes, and my approach assumes that palatalization processes are simply too complicated to easily term lenition proper, at least in the absence of clearer criteria for what constitutes lenition.

6- Recall the high cross-linguistic markedness of voiced stop geminates.

7-Kirchner's (1998, 2001) basic proposal of a system in which LAZY—calling for less effort—vies with Faith and Fortition constraints is actually rather similar to Flemming's proposal. Fortition represents the drive to enhance acoustic or auditory features, while Faith seeks to minimize divergence from the underlying representation in the surface output, thus preserving contrasts.

8-I do not account for the voiced geminate stops here, which were very rare (Lloyd 1987:140). As mentioned above, the rarity of voiced geminate stops in Latin may well have been a function of their high effortfulness, hence markedness in the system.

9-Esposito & Di Benedetto's graph shows some exceptions to this rule: before front high /i/, the geminate /k:/ is only fractionally longer than geminate /d:/ and fractionally shorter than /b:/, while before high back /u/, geminate /k:/ is only fractionally longer than /d:/. While some front/back bias may be in effect here, note that in the context of central /a/, these data show clear voice-based duration distinctions. The graph is based, too, on averaged values across both speakers and repetitions, which could serve to skew results. It seems safe at this point to assume that, in general, voiceless geminates are longer than voiced geminates, a relationship that certainly holds for individual places of articulation.

10-Given that one of Lavoie's findings was that 'voiced' stops often show no real voicing and that therefore stop 'voicing' is often only a percept based on closure duration distinction, we might also assume that maintenance of such a five-way duration-

based was simply overly fine in systemic terms. Under this view, the production- and (articulatory) effort-based account is merely incidental. I do not attempt here to sort out the basis for the markedness of voiced geminate stops.

11-Note, however, that in southern and central Italian dialects where geminates have been maintained despite apparent lenition of other intervocalic stops (Walsh 1991:152), the reverse ranking—i.e MINDIST$_{(2dur)}$ >> LAZY—is evidenced:

(VII) Southern and Central dialects of modern Italian

		MAINT3dur	MINDIST$_{(2dur)}$	LAZY
a)	t: t d 4 3 2		**!	t:(***), t(**), d(*)
b) ☞	t: d ð 4 2 1		*	t:(***), d(*), ð
c)	t d ð 3 2 1		**!	t(**), d(*), ð
d)	t: t ð 4 3 1		*	t:(***), t(**!), ð
e)	t: d 4 2	*!		t:(***), d(*)
f)	t ð 3 1	*!		t(**), ð

Here then we see that certain modern dialects' inventories mediate between the drive to maintain a certain number of contrasts and minimal distance while still obeying the dictates of articulatory efficiency to the extent possible. Thus, two-segment inventories, VIIe and VIIf, fail to satisfy high-ranked MAINT3, while VIIa and VIIc each incur two violations of MINDIST$_{2dur}$. Of the two candidates who better satisfy this constraint, VIId falls to LAZY, since its members incur more violations of the drive to weaken in terms of duration than the winning VIIb.

Note that were MINDIST ranked above MAINT, a two-segment system would result. Our tableau predicts that VIIf would always be more harmonic than VIIe, since it would always do better in terms of lenition as instantiated by LAZY. VIIf, in fact, represents the modern Spanish contrast. On the other hand, by switching LAZY and MINDIST but leaving MAINT high, forcing a three-member cohort, we arrive at the medieval Spanish cohort. The tableau therefore seems valid at least in terms of its predictive power.

12-Burmese, Iaai, Tibetan, Angami, and other southeast Asian languages contrast voiceless nasals and laterals with voiced ones. Such segments are, however, rare in the world's languages. Note, nevertheless, that Ladefoged & Maddieson (1996:111) observe that at least in Burmese, the voiceless nasals are longer than their voiced counterparts and would thus fit in with our durational contrast between voiced and voiceless segments.

13-But see Lipski (1994:312) concerning Central American dialects (Nicaraguan) in which nasals are weakening in favor of nasalized vowels, evidence of a relaxing of this constraint.

14-Note that uvularization of trilled rhotics in Portuguese, as well as in French, may provide an analogous reflex; the duration-based distinction between flap and trill is shifted to one of distinct places of articulation, exploiting the unused uvular place.

15-This argument seems corroborated by the distributional facts of Spanish, where palatals do not generally occur with following high vocoids tautomorphemically: *ɲ + I, *ʎ + I. This underscores the importance of the F2 transitions: since there would be no readily perceptible transition in terms of F2 between the high F2 palatal and the high F2 vocoid, we may identify a perceptually based dispreference for such a combination. Moreover, any phonemic contrast between /ni ~ ɲi/ would similarly be undermined. Anecdotal evidence occurs in frequent pronunciation of words such as *dañino* 'harmful' as [da.**n**i.no]. The high F2 of the following high vocoid effectively masks that of the palatal nasal, such that the speaker fails to 'parse' the nasal as palatal; this is a case of what Ohala (1993) deems 'hypercorrection': a listener hears a high F2 component apparently coarticulated between two segments—the nasal and the following vocoid—and assumes a production error on the speaker's part and erroneously corrects it. Such circumstances are the likeliest reason why historical palatalization of /n + i,e/ took place to begin with (e.g. L. ARANEA > Sp *araña*); the high F2 transition following /n/ before the high F2 vowels effectively simulates the high F2 of the palatalized segment. The listener hears the coarticulated high F2 of the nasal and erroneously parses a palatal /ɲ/; here, then, we see Ohala's (1993) hypocorrection. In this light, there is little reason—beyond an intractable ranking of featural faith, for which there is little evidence in Late Spoken Romance and Proto-Hispano-Romance—not to condense articulation by overlapping and fusing the two gestures.

16-Moreover, with the progressive loss of geminates, we may also assume that the systemic pressure to degeminate had either become a drive independent of the general tendency toward lenition, such that geminate length was lost while the durational contrast between voiceless and voiced stops endured; or that we need to introduce some new machinery capable of establishing a set threshold in the grammar that limits the extent to which certain parameters can be exploited. As to the latter point, both Flemming (2002:28-29) and Kirchner (2001:148) suggest the possible need of some (rather arbitrary) bounds to be established within their respective theories.

17-This may lead one to wonder what the phonetic basis, if any, there is behind the apparent (quasi-)geminate status of the palatal sonorants, as discussed in Chapter 1. This is investigated in Chapter 5.

18-But apparent ongoing lenition of these segments is reported in modern dialects of Portugal (Parkinson 1988:139); see below.

19- Interestingly, modern Portuguese, like French, does have voiced fricatives. These segments are thought to be high-energy, rather labor-intensive in their production (Ladefoged & Maddieson 1996:176-8). Consequently, we would not see the Portuguese change of intervocalic /b/ to /v/ (L. CABULLUS > Port *cavalo* [ka.va.lu] 'horse') as a case of lenition. Rather, a high-ranked constraint—based on articulatory effort—banning voiced fricatives in Latin (which in fact had no voiced fricatives), was apparently down-shifted in the language to allow for richer contrast inventories. The rise of such a constraint in the history of Spanish accounts for the loss of voiced fricatives in the language; there are no voiced fricatives in (standard) Modern Spanish, though Old Spanish had many. Under the circumstances, /b > v/ 'phonologizes' the new segment as a voiced counterpart to /f/ that merged with the already extant /v/ that resulted from Latin /w/.

20-In addition to the widespread degemination motivated here and above, loss of such contrasts may also be observed in the loss of contrastive length in the Spanish vowel system (see Holt 1997).

21-The concept of a link between the behavior of moras of geminate-borne codas and of singleton consonants that receive weight positionally is well worth pursuing. Tranel (1991) points out, for example, that languages always seem to treat coda consonants equally, whether due to a geminate or a singleton. This calls into question the notion of underlying moraicity for geminates. The issue is beyond the scope of the current work, however, and is not addressed fully here.

CHAPTER 5
THE ACOUSTIC BASES OF PALATAL GEMINATE STRUCTURE

5.1 Introduction

In this chapter I take up the issue of phonological quantity as expressed by moraic theory and its relevance to the palatal phenomena at hand. The posited moraic structure of the palatal segments has not generally been at issue heretofore, as I have focused rather on the complex structure of the segments and also on the systemic role of contrast to explain much of their historical development. Indeed, there has been little reason to consider the role of these segments in weight-driven processes. It is therefore to such processes, particularly the apparent role of the palatals in Spanish stress-assignment, that I turn in the following chapters.

Specifically, I attempt to isolate the acoustic correlates that represent the geminate structure posited to underlie the palatal sonorants. Recall that in Chapter 3 I demonstrate that a lexical contrast between geminates/singletons in Latin has been maintained in modern Spanish. I suggest furthermore that, in the case of the former geminate sonorants /lː nː/, the nature of that contrast passed from one based purely on segment duration to one marked by enhanced formant transitions, specifically the F2 component. While the investigations of Recasens (1991, 1999b), Quilis (1999), Flemming (2002) and others cited above do not leave in question that these segments themselves comprise a high F2 component, it remains to be verified through acoustic analysis to what extent this aspect of the palatals impacts adjacent segments. Secondly, we need to determine whether there is any means of linking such cues to the perception of syllable weight that putatively

underlies the stress window effects and distributional and phonotactic limitations of the palatal segments.

Previous research by Lipski (1989) speculates that the formant transitions to a following vowel may underpin the proposed geminate status of these sounds, contributing somehow to overall geminate length. Here I focus rather on the preceding vowels. Given the consistent, measurable evidence of such F2 contrasts in the segments in question—recall the findings by Recasens (1999) reported above—it seems likely in light of previous discussion concerning the coarticulatory demands of these segments that this component has significant repercussions for neighboring sounds. Indeed, one may fully expect the high F2 component of these sounds to be marked upon the preceding syllable. This follows from the coarticulatory influences that drive anticipatory tongue dorsum raising and fronting: the enhanced F2 profiles should emerge in the acoustic signal in the formant makeup of the preceding vowel. This needs to be tested. It also needs to be demonstrated in phonetic terms that this F2 component is sufficient to distinguish the palatals from their non-palatal, singleton counterparts, in line with the phonology-driven arguments of the previous chapter. Beyond this, we would like to be able to show that the F2 contour is present in the signal well before the onset of consonantal stricture. (Recall the complex structure assumed for the palatal segments, consisting of consonantal stricture features and the separate Tongue Position node that dominates the vocalic formant cues.) Finally, any evidence that the palatals serve to close a preceding syllable would support the phonological assertion concerning the geminate structure of the palatals.

To these ends, spectrographic evidence is examined in order to 1) trace the formant structure of vowels preceding palatals as contrasted with those preceding non-palatals; 2) to find cues to the onset of stricture in the palatal consonants, to which F2 profiles are measured and compared; and 3) to analyze the acoustic makeup of vowels in open, closed, and pre-palatal positions in terms of duration and intensity with an eye toward identifying some common 'coda effect' in support of the geminate structure of the palatals. These correlations are calculated as percentage values and compared to those of singleton consonants in similar contexts via statistical analyses.

The chapter is structured as follows. In section 1, I provide further background on the moraic theory of geminate structure and phonological quantity or weight and review arguments that support the idea that the palatals should be considered to have such a geminate structure. The potential role of vowel duration and intensity as the acoustic correlates of syllable weight are also detailed. In section 2, the acoustic tests are prefaced, with further background provided on the role of formants and formant transitions in the acoustic signal. The current test is motivated through findings in lingual coarticulation and the primacy of F2 distinctions in palatal articulations. Section 3 describes the tests, with the results and discussion in section 4. Section 5 presents the conclusions and addresses the necessary inclusion of the palatal vocoid /I/ (and its various allophones) in the palatal cohort under discussion.

5.2 Moraic Structure of Geminates

As discussed in Chapter 1, I adopt the moraic theory of geminate structure as detailed in Hayes (1989), whereby a geminate consonant dominates a mora underlyingly. This underlying mora thus distinguishes a geminate from its singleton counterpart, which

has no moraic weight (unless it assumes it at the surface, as in coda position under Weight-by-Position).

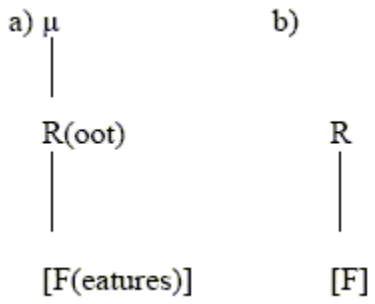


Figure 5-1. Underlying representations of geminate and singleton.

On the surface and in intervocalic position, Figure 5-1a takes on the structure seen in Figure 5-2b below, whereby the geminate provides an onset to a following vowel while retaining its moraic weight as a coda constituent of the previous syllable:

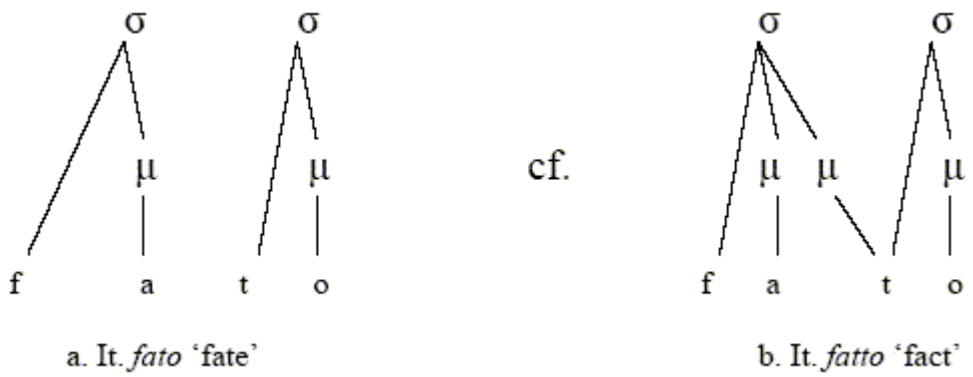


Figure 5-2. Moraic models. a) It. *fato* 'fate', singleton /t/. b) It. *fatto* 'fact', geminate /tt/.

As discussed in Chapter 1, this structure best explains the exceptional behavior of the palatals in Spanish. Distributionally, the extreme rarity of these segments as word-initial elements reflects that of word-initial geminates cross-linguistically: the inherent mora of these structures is only properly concatenated word-medially, between vowels. Additionally, the fact that these segments do not occur in clusters but rather only intervocalically again reflects the phonotactic limitations of geminate structure. Finally,

the apparent effect that these segments have when occurring as the onsets of final syllables indicates that they contribute weight to the preceding syllable, in much the same way that 'true' geminate /r/ does in Spanish, and which the full array of geminates in Italian do.

Yet, while significant evidence can be found that indicates that a level of prosodic structure exists and conditions processes such as stress assignment or compensatory lengthening (with repercussions at the melodic level), the actual phonetic correlates of syllabic and segmental weight remain poorly understood. That is, despite the phonological 'fit' of the geminate model here, it is not clear how moraic weight is represented in the acoustic signal, how it 'sounds'. Some consistent means of marking weight must be available in speech, as we cannot realistically count on native speakers' recourse to a wholly abstracted level of representation with no surface instantiation aside from the results of such weight-conditioned processes as those mentioned above. In the following subsections I describe some approaches to possible phonetic correlates of moraic weight.

6.2.1 Length as an Expression of Segmental Weight

The mora as a unit of weight has often been assumed to be a unit of length, as is only logical given the basic contrast in many languages between long vowels (as universally heavy nuclei) and short ones (universally light). Indeed, the mora emerged as a response to earlier proposals concerning segmental association with timing slots, as discussed in Chapter 1. Moreover, research has indeed shown consistent evidence that quantifiable length distinctions do in fact underpin prosodic structure.

Broselow *et al.* (1997) look at three languages with contrasting heavy syllable structure and measure vowel lengths to see to what extent variant moraic structure affects

timing patterns in vowel realization. In Hindi, coda consonants always bear a mora through Weight-by-Position and always add weight to a syllable. In Malayalam, by contrast, codas do not make a syllable heavy, while Levantine Arabic has a contextually determined process: after short vowels, a coda bears a mora but does not following a long vowel (recall the bimoraic limit that most languages impose on syllables). Assuming the moraic model adopted in this work, Broselow *et al.* assign variant structures to closed syllables in each language, allowing for mora-sharing in cases where a coda does not contribute weight to a syllable:

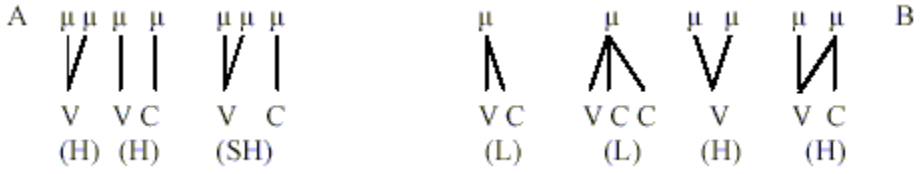


Figure 5-3. Moraic syllable structures. A) Hindi heavy (H), superheavy (SH). B) Malayalam light (L), (H) (from Broselow *et al*. 1997:49-50, fig.3,5).

Their hypothesis is that vowels engaged in mora-sharing with a following coda consonant should be consistently shorter than 'untrammeled' vowels that have their moras all to themselves. For example, the Malayalam vowel of the VCC context should be shorter than the vowel of the VC context since it must share its mora with two consonants. In fact, Broselow *et al.* posit that three- and four-way weight contrasts should manifest in such situations. That is, the longest vowel should occur in the Malayalam VV context, followed by the vowel of the VVC, also long but sharing its mora with a coda, with the single-sharing vowel of VC next and of greater duration than that of VCC which, again, shares its mora with two coda consonants. Hindi, in stark contrast, has no mora-sharing and even allows for trimoraic, 'superheavy' syllables, and thus no compensatory shortening of vowels is expected.

In fact, Broselow *et al.* (1997) find consistent evidence that mora-sharing does impact the duration of vowels. Vowels that shared moraic units with codas were shorter than 'discrete' vowels in Malayalam, and the expected scale of vowel length was borne out by the data. On the other hand, Hindi vowels—always assigned their own moras—had consistent duration across contexts. Coda consonant durations also jibed with the proposed moraic models. Moreover, in the variable contexts proposed for Levantine Arabic, in which a coda consonant is mora-sharing only when preceded by an already bimoraic long vowel, the expected results were obtained: VV was greater than the vowel of VVC (with mora-sharing), which was greater than the single-mora vowels of VC and V.

Now, this study had limited participants: 2, 3, and 1 speakers respectively for Hindi, Malayalam, and the Arabic dialect. Moreover, Gordon (1999:206-210) finds no significant correlation in rime duration between CVC 'light' (i.e. mora-sharing) and CVC 'heavy' rimes, which one might otherwise expect.[1] Nor does he find evidence of significantly shorter vowels in closed syllables in Khalkha—a language with a weight system like that of Malayalam—than in open ones (Gordon 1999:212). Oddly, in fact, two languages (Japanese and Finnish) without mora-sharing show considerably *longer* vowels in closed as opposed to open syllables. Though Gordon's results are troubling for Broselow *et al.*'s findings, it should be noted that Gordon's survey was also based on a very limited numbers of participants per language (one speaker). Until they are more firmly disconfirmed, Broselow *et al.*'s (1997) results remain intriguing. For the present, at least one acoustic correlate of moraic structure must be considered length. Whether vowel-length values hold across speakers and contexts in a given language, and whether

we can realistically expect similar ranges of durations to be maintained outside strictly local contexts remains to be verified.

Yet simply viewing the mora as a unit of length, with some close length-weight parity, is problematic. As Perlmutter (1995) points out, were a mora simply a question of some set duration in a language, one might expect to find equivalent durations between long vowels and vowel-consonant codas, as both are bimoraic. We do not find such parity, however. No fixed length can be associated with any one mora, any more than we could expect all moraic coda consonants to have (even approximately) the same duration as (inherently moraic) vowels.[2] Note, however, that this would not be expected even were there some fixed criteria for length according to moraic weight, given the vagaries of human speech production and the resultant gradient nature of phonetics. Nonetheless, Perlmutter's point is well taken: moras serve to mark *relative* contrastiveness in syllable weight in a given language. It does not matter whether some rigidly defined mora-based length difference is found between all heavy and light syllables system-wide so long as a consistent, segment-specific difference is maintained in local contrasts. This in a sense justifies the assumption from the previous chapter that the moraic weight of the Latin geminates passed intact into the modern language but with different acoustic marking. Rather than the durational distinctions that persist in modern Italian, Spanish innovated the palatal sonorants, whose complex, bimoraic structure is encoded through a different acoustic feature (e.g. the F2 component).

Hubbard (1995) also investigates the correlation of moraic structure with phonetic timing. Analyzing various Bantu languages, she shows that, on the whole, mora count in a word is systematically reflected in durational terms. Importantly, however, she does not

find evidence of a direct mora-to-segment relationship in terms of timing; indeed, a mora varies in duration according to its context. She finds instead that it is at the level of the word that mora count correlates with duration: that is, words with equivalent mora counts show comparable durations. She attributes this to “timing compensation” whereby inherent durational differences between segments are effectively neutralized in order to maintain word-level equivalence in timing. In this way, moraic weight is generally consistent in terms of length. One interesting aspect of the languages she investigates involves compensatory lengthening phenomena in Luganda and Runyambo, where vowels preceding a /nasal+consonant/ sequence typically lengthen. She attributes this to the drive to retain the mora of the nasal, which is given up when that nasal becomes part of a prenasalized stop onset. This is illustrated in Figure 5-4 below:

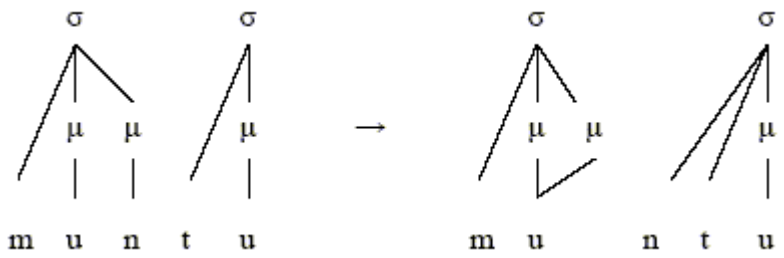


Figure 5-4. Luganda prenasalization and compensatory lengthening (adapted from Hubbard 1995:174, fig. 3).

In essence, then, the vowel lengthens to preserve the mora relinquished by the nasal when it becomes part of the (nonmoraic, non-weight-bearing) onset. Her findings suggest furthermore that in another Bantu language like Runyambo, mora-*sharing* might account for the differences found in vowel durations in pre-/nasal+consonant/ positions. This accords with the work of Broselow *et al.* (1997) discussed above, in which durational distinctions also seem to closely match moraic constituency, with mora-sharing explaining more finely cut distinctions.

For the present purposes, these findings suggest an interesting test for Spanish. Given the structure posited for the palatals, if the nasal or lateral portion of /ɲ ʎ/, respectively, is at once moraic and yet phonologically associated with the following onset, we might expect to see some compensatory lengthening of the preceding vowel, in much the same compensatory capacity as that seen in Luganda or Runyambo. That is, if listeners 'hear' the lateral or nasal quality of these palatal sonorants as part of the preceding syllable and yet know metalinguistically that it is bound up with a discrete segment, they may make durational adjustments to accommodate the contradiction.[3] This is modeled in Figure 5-5 below (NB: /ɲ/ is transcribed /nj/ for expositional clarity):

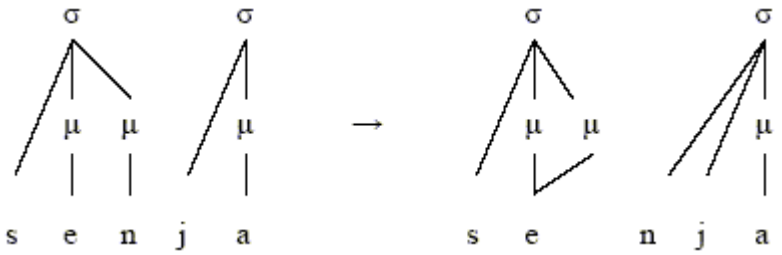


Figure 5-5. Posited compensatory lengthening of prepalatal vowel in Spanish *seña* 'sign' This is taken up and tested in section 2 below.

5.2.2 Syllable weight as intensity

I turn back to Gordon (1999, 2002) for another approach to the issue. Gordon investigates the length-as-stress issue and also takes into account the phonetic correlate of overall energy. He cites numerous studies of various languages that identify both an increase in duration and in energy or perceptual loudness as correlates of word stress (Gordon 2002:59). His findings suggest that weight assignment in languages correlates much more closely with a metric based on the total energy or intensity of the rime than on duration or other such considerations. He establishes a means of calculating that

energy which involves getting the average amplitude (RMS) in decibels for target rimes. Following previous work on loudness in tones (Warren 1970), he converts that value into perceived loudness, then multiplies the result by the duration of the rime components, the nuclear vowel and, if present, that of the coda. His findings suggest that these loudness values predict cross-linguistic weight systems much more accurately than does duration.

Following Gordon (1999, 2002), then, I look at the intensity of stressed rimes to see if any pattern emerges which might indicate that the presence of a palatal 'ramps up' the intensity of a preceding rime.

5.3 The Tests

5.3.1 Vowel length

Broselow *et al.*'s (1997) work suggests a line of inquiry for the Spanish palatals. Vowel lengths of syllables in contact with palatals versus non-palatals could be compared for patterns of lengthening or shortening. The problem with this approach for Spanish, however, is that Spanish—unlike the languages studied by Broselow *et al.* (1997)—has no long vowels and does not allow superheavy (trimoraic) or CV_1V_2C type syllables (where V_2 represents a glide; see Harris 1983:14-15). There is thus no reason to posit mora-sharing with any coda in the language and thus no apparent context in which to expect to find compensatory vowel shortening.[4]

Vowel shortening, however, might provide another viable possibility. Many languages, English included, shorten vowels in closed syllables: e.g. the vowel of *tea* is typically longer than that of *teak* (see Maddieson 1985). Such an effect is plausible as well for Spanish. I will measure the vowels of open versus closed syllables and test for significant patterning. The durations of vowels before palatals will then be compared to these findings to see how they might fit in with any discovered pattern.

5.3.2 Vowel intensity

To test vowel intensity, I look at the RMS (root-mean-square) values of vowels in varying contexts, comparing vowels in open (therefore light or monomoraic) syllables with those in closed (heavy, bimoraic) syllables. RMS, as its name indicates, finds a sort of average value of wave amplitude or variations in air pressure. RMS is calculated by squaring the amplitude value of each sample in a particular waveform, then the average of the results is found and the square root taken (see Johnson 1997:36-7 for more details). Since the loudness of a sound generally depends on the amplitude of its wave (Ladefoged 1996:80), the RMS value provides a good means of calculating a sound's perceptual loudness. Similar to the duration test above, relativized intensity values of pre-palatal vowels will be compared with those of vowels in open and closed syllables and analyzed for significant patterns.

5.3.3 Nasal length and intensity

Another test references work by Cho & Keating (1999). They look at the effects of prosodic structure on sounds in Korean. Their findings show that coronal stops (including /n/) exhibit consistent articulatory and acoustic traits depending on their position. Left-edge or domain-initial effects serve to make stops longer and stronger, with greater linguopalatal contact and greater duration. Thus, for example, an utterance initial /t t^h n/ in Korean will be longer than one in a coda, as well as being longer than one that is merely word-initial. Since the articulatory contact consistently demonstrates an acoustic correlate as duration, the duration of the palatal nasal (or at least its nasal portion) can be compared to that of a nasal in onset position. If Spanish patterns with Korean in this regard, we might expect to find a longer period of nasality in the nasal singleton—fully parsable into the onset—than in the nasal portion of the palatal nasal, part of which is

posited to make up part of the coda of the preceding syllable (see note 3). A caveat is in order: since we are dealing with two distinct segments, an alveolar nasal versus a palatal one, with different intrinsic durations, it is unclear whether it is legitimate to compare them in this way. Still, if we found that the onset nasal is indeed longer, despite being intrinsically somewhat shorter than the palatal (see Lavoie 2001:106), it could provide at least weak evidence of coda shortening.

Secondly, Cho & Keating find that nasal intensity (as nasal energy minimum) also varies according to position: the higher the domain-initial position, the lower the nasal energy minimum. They cite Fougeron (1998), who assumes that a similar effect in French is a function of muscular tension: the greater articulatory force of domain-initial stops prevents as great a degree of velic opening as in stops in coda position. This greater velic aperture effectively allows greater resonance in the nasal cavities and thence more resonant energy or intensity. Again, if Spanish patterns similarly, we expect to find greater nasal energy minima in the nasal portions of palatal nasals than in the nasals that occupy onset position.

5.3.4 F2 contours

Formants are the frequencies at which acoustic energy is concentrated in a sound, corresponding to the peaks of a sound's spectrum. Each formant makes up a component of a sound. Formant frequencies are determined by the shape of the vocal tract and directly inform sounds' identifying qualities. Vowels, for example, may typically be recognized on the basis of the first two formants alone. The first formant, F1, is generally reflective of oral aperture: the greater the aperture, the higher the F1. F2 reflects the dimension of frontness/backness: a fronted tongue, as in the production of /i/, produces the highest F2 values, while back /u/ has the lowest F2 among vowels. Both of these

vowels have low F1, due to their height. Among consonants, formant transitions are often crucial to place identification (see Delattre *et al.* 1955). As we have seen in the previous chapter, the very high F2 of the palatal segments tends to cause a very high F2 transition due to the high tongue position adopted for palatalization. However, the emphasis here is on the preceding vowel, as noted above. Recasens (1999:94-5) relates the onset of anticipatory consonant-dependent effects on vowels to the involvement of the lingual articulator in the formation of the consonantal closure or constriction. Thus, alveolopalatal /ɲ/ (as well as /ʎ/) require large anticipatory effects because they are produced with very salient lingual gestures. This accords with the findings of Recasens *et al.* (1997) and their DAC (Degree of Articulatory Constraint) model of coarticulation, which seeks to formalize and predict the coarticulatory potential of segments, both as active (influencing neighboring segments) and passive (being influenced) participants. Note that this approach ascribes a high degree of coarticulatory resistance to both /s/ and /r/ (Recasens *et al.* 1997:559, Recasens 1999:96), which, as seen in Chapter 3, proved more resistant to the historical changes that affected other segments (see section 5.3.3.3).

I posit that the large anticipatory coarticulation effects of the (alveolo)palatal sonorants impacts the rime of the preceding syllable by raising the F2 profile of the preceding vowel. The effect is temporal as well as spectral: F2 raising (and F1 lowering) should obtain in the acoustic profile of preceding vocoids earlier and to a greater degree than general formant transitions observed in rimes preceding consonants at other places (probably the canonical) of articulation. This effect is due quite simply to the significant tongue dorsum raising and fronting required in the articulation of these segments. This augmented rime profile may be interpreted by the listener as an off-glide—always moraic

in Spanish—and may serve to create a perception of duration that reflects the posited geminate structure of the palatal segments. A second possibility is that this enhanced formant profile in the rime contributes to the overall intensity and total energy of the rime, as put forth in Gordon (1999, 2002). This augmented total energy has been shown by Gordon to correlate more closely with heavy/light distinctions cross-linguistically than duration-based distinctions.

In light of the above discussion, the final test presented in this chapter looks at the results of an acoustic analysis of the vowels preceding palatal sonorants (as well as the approximant /j/). F2 is taken at regular intervals throughout the vowels to give an F2 contour. These contours are then compared with those of vowels preceding the palatals' non-palatal, singleton congeners, and differences are tested for statistical significance.

5.4 Methodology

Participants were all speakers of (northern) Iberian Spanish, all female, all between 22-45 years of age, and all possessed of post-graduate level education. They were recorded in a sound-attenuated booth on a Sony TCD-D8 DAT recorder with a professional, unidirectional Shure SM10A microphone. The recordings were digitized as WAV files, sampled at 22.050 kHz, on Kay CSL 4400 hardware. Tokens were segmented with CoolEdit software and analyzed with Praat (© 2004, Paul Boersma & David Weenink).

Participants were asked to read a series of sentences from note cards. Each card included a preparatory warm-up sentence in which the target item was used in a contextually transparent way in order to guarantee participants' comprehension of the word. Occasionally nonce words—consistent with the phonotactics of Spanish—were employed to provide for more complete control of word structure. These words often

merely evoked real words with slightly variant spelling, as in *selta* for *celta* 'Celt'. All words were presented in set-up sentences that left no doubt as to their general meaning: e.g. *Se dice que las* <u>*setas*</u> *silvestres causan locura* 'It is said that woodland mushrooms cause madness'. Following the preparatory sentence was the frame sentence: *Digo* __*(setas)*__ *para ti* 'I say X for you' in which the target item was reproduced. All words were produced three times as part of the whole series of words, including numerous distractors; that is, words were not read three times at once, but were rather included in a large set of words, which was read in its entirety three times. Target words (though not distractors) were exclusively disyllabic with stress on the initial syllable to control for prosodic context. Additionally, target words all began with /s/ for ease of segmentation purposes, and the target vowel was always /e/ to avoid any possibility of interference due to inherent vowel length differences. The second vowel was limited to /a/ with /o/ occurring occasionally. See Appendix B for a complete wordlist.

Segmentation criteria largely followed techniques found in the literature. Target vowel onset was taken to be the onset of periodicity following the cessation of noise from the preceding sibilant. V1 offset was marked at F2 offset. For C1 (always /s/), the onset of noise marked the onset. For C2, bursts in stops or, in the case of nasals and laterals, the onset of antiformants as evinced by formant discontinuities and energy changes was used. In the case of *yeísta* productions of /ʎ/ as [j], onset was taken to be the point of greatest occlusion as evidenced by F1 minima. For /ɲ/, onset was taken as the onset of nasality following V1.

5.5 Results

5.5.1 Vowel duration

The following table shows representative partial results of vowel duration measurements.

Table 1. Vowel durations in ms., both raw and relativized, for one speaker

Token	V1Dur	V2Dur	R1Dur	NormV1	W1Dur	RelWord
2seca1	0.0519	0.0558	0.0529	-0.001	0.291	0.238
2seca2	0.0452	0.056	0.0627	-0.0174	0.2872	0.225
2seca3	0.0343	0.0506	0.0436	-0.0093	0.2627	0.219
2sela1	0.0504	0.0611	0.0447	0.0058	0.2653	0.221
2sela2	0.0445	0.0652	0.0551	-0.0106	0.2627	0.208
2sela3	0.0424	0.0645	0.059	-0.0166	0.2823	0.223
2setas1	0.0593	0.0614	0.0538	0.0055	0.3393	0.286
2setas2	0.0614	0.0558	0.0484	0.013	0.3642	0.316
2setas3	0.0397	0.0638	0.0518	-0.0121	0.3358	0.284
2senos1	0.029	0.0553	0.0374	-0.0084	0.2863	0.249
2senos2	0.0649	0.0517	0.0736	-0.0087	0.359	0.285
2senos3	0.0513	0.0534	0.0586	-0.0073	0.3047	0.246
2sello1	0.0721	0.073	0.0522	0.0199	0.2736	0.221
2sello2	0.0607	0.0691	0.0583	0.0024	0.2672	0.209
2sello3	0.066	0.0633	0.0569	0.0091	0.2627	0.206
2seña1	0.0479	0.0676	0.0627	-0.0148	0.2784	0.216
2seña2	0.062	0.061	0.0434	0.0186	0.2817	0.238
2seña3	0.0663	0.0673	0.0467	0.0196	0.2796	0.233
2senda1	0.0563	0.0602	0.0361	0.0202	0.3139	0.278
2senda2	0.0695	0.0553	0.0508	0.0187	0.3045	0.254
2senda3	0.068	0.0665	0.0515	0.0164	0.3073	0.256
2seltas1	0.0369	0.0636	0.0525	-0.0156	0.3835	0.331
2seltas2	0.03	0.0522	0.0561	-0.0261	0.3642	0.308
2seltas3	0.0383	0.0524	0.0487	-0.0105	0.3892	0.341
2sesta1	0.0434	0.0434	0.0574	-0.014	0.3187	0.261
2sesta2	0.0418	0.0491	0.0565	-0.0147	0.3099	0.253
2sesta3	0.0444	0.0436	0.05	-0.0056	0.3362	0.286

The table presents the results of various words for a single speaker (#2), with each word followed by its token number (1-3). Raw duration of the target vowel (V1) and the second vowel (V2) are shown. R1 is the reference vowel used for relativizing, in this case the stressed /a/ of *para* from the frame sentence, used due to the variation in the second vowel (e.g. /o/ in *sello*). The duration of R1 was subtracted from the target vowels, given

in the 'NormV1' column. Raw overall word duration (W1Dur) is also given, with its relativized value (RelWord=WordDur-R1Dur) in the last column.

As is evident comparing V1 durations in *senda* 'path', *seltas* '(nonce)', and *sesta* '(nonce)' with closed target syllables, to those of open syllables in *seca* 'dry', *sela* '(nonce)', *setas* 'mushrooms', and *senos* 'breasts', there is little evidence of vowel shortening in closed syllables in Spanish. This was confirmed in repeated measures analysis of variance (ANOVA) and post-hoc tests: vowels in both open and closed syllables patterned as a homogeneous group (F=10.26, df =2). Prepalatal vowels, however, show significant differences from vowels in both open and closed syllables, seen in post-hoc Tukey and Scheffé tests to be longer than vowels in either of the other groups (significance $p < .000$ in both tests). I tentatively assume that something similar to what Hubbard (1995) discusses for Bantu languages is in effect here: speakers lengthen the prepalatal vowel in deference to the moraic weight of the following palatal. This is taken up below in the discussion in section 5.6.

5.5.2 Vowel intensity

The following table gives representative RMS readings for one speaker. RMS1 and RMS2 stand for the relative RMS measure of, respectively, the target vowel and the second vowel in each word. RMSN1 is the intensity of the reference vowel, the first /a/ of *para* from the frame sentence. Note that the relative intensity of the atonic second vowel (RelV2) is often greater than that of the tonic vowel (RelV1). These measurements are in Pascals, not Decibels—which more directly reflect perceptible loudness—and clearly the procedure here is far simpler than the calculations taken by Gordon (1999, 2002). Still, having seen that duration is by no means a predictable correlate of stress, it is difficult to imagine how the lower intensity values of stressed values would consistently outweigh

those of the atonic vowels. What this (limited) data suggests falls in line with observations by Quilis (1999) concerning stress in Spanish: duration and intensity are at best marginal, sporadic correlates of stress; pitch is apparently a far more consistent marker. For the present purposes, it seems clear that RMS is not relevant to the palatals in question. Moreover, one-way ANOVA testing the correlation of RMS to syllabic affiliation show no pattern (significance .239); all three groups (open, closed, and pre-palatal) form a single homogeneous group (F=1.448, df=2). Post-hoc Tukey and Scheffé tests confirm these findings.

Table 2. Vowel intensity readings in Pascals, raw and relativized, for one speaker

Token	RMS1	RMS2	RMSN1	RelV1	RelV2
1seca1	0.0078	0.0095	0.006	0.0018	0.0034
1seca2	0.0113	0.014	0.0115	-0.0002	0.0025
1seca3	0.0069	0.0092	0.0098	-0.0028	-0.0006
1sela1	0.0059	0.0074	0.0044	0.0015	0.003
1sela2	0.0104	0.0118	0.0104	0	0.0013
1sela3	0.0109	0.0117	0.0095	0.0014	0.0022
1sello1	0.0065	0.0058	0.0071	-0.0005	-0.0013
1sello2	0.0094	0.0058	0.0079	0.0015	-0.0021
1sello3	0.0094	0.0058	0.0088	0.0006	-0.003
1seña1	0.0017	0.0017	0.0028	-0.001	-0.0011
1seña2	0.0016	0.0019	0.0035	-0.0019	-0.0016
1seña3	0.0023	0.0018	0.0027	-0.0004	-0.0009
1senda1	0.0017	0.0023	0.0029	-0.0013	-0.0006
1senda2	0.0025	0.0028	0.0032	-0.0007	-0.0004
1senda3	0.0024	0.0028	0.0031	-0.0007	-0.0004
1senos1	0.0085	0.0046	0.0087	-0.0001	-0.0041
1senos2	0.0081	0.0049	0.0094	-0.0013	-0.0044
1senos3	0.0071	0.0041	0.0078	-0.0007	-0.0036
1seltas1	0.0134	0.0105	0.0063	0.0071	0.0042
1seltas2	0.0097	0.0102	0.0124	-0.0028	-0.0022
1seltas3	0.01	0.0081	0.0104	-0.0005	-0.0024
1sesta1	0.0085	0.0129	0.0098	-0.0013	0.0031
1sesta2	0.0087	0.0148	0.0111	-0.0024	0.0037
1sesta3	0.0091	0.0138	0.0095	-0.0004	0.0043
1seta1	0.0024	0.0024	0.0029	-0.0005	-0.0004
1seta2	0.0025	0.0022	0.0028	-0.0004	-0.0006
1seta3	0.0024	0.0019	0.0029	-0.0005	-0.001

5.5.3 Nasal effects

5.5.3.1 Nasal duration

Cho & Keating (1999) find that positions of prosodic prominence (utterance-initial, word-initial) have a cumulative effect on the production of consonant segments in Korean, such that utterance-initial /t/ or /n/ show both greater magnitude and duration of the closure gesture than in word-initial or, particularly, syllable- or word-final positions. Along these lines, we might therefore expect coda-bound nasals to exhibit shorter duration than their word-initial congeners. In fact, this is indeed what we find in the data: nasals in onsets (*senos*) are found to be significantly longer than nasals in codas (*sendas*). However, the nasal portions of the palatal nasal pattern with the onsets in showing significantly greater duration than the coda nasals. In a one-way ANOVA comparing duration as an effect of syllabic affiliation, nasals in *senos* and *seña* patterned as a homogeneous group ($F=21.792$, $df=2$, $p < .000$), showing greater durations than in *senda.* Post-hoc Tukey and Scheffé tests confirm these findings. Mean duration for the coda nasal was -29ms as compared to 1.7ms and 3ms for palatal and singleton nasals, respectively.[5] This might suggest that the nasal portion of /ɲ/ is indeed bound up entirely with the onset. However, given that we are comparing two different segments, the test is not ultimately conclusive. Nor do we know whether geminate structure lends itself to the same dynamics being tested for singletons by Cho & Keating (1999). In light, too, of the findings for nasal intensity (see below), we cannot draw any solid conclusions from these results. See Appendix D for comparative durations of nasals in the test words.

5.5.3.2 Minimum nasal energy

Following Cho & Keating (1999), I constructed an RMS profile of each pre-nasal vowel in order to compare the RMS 'valley' or nasal energy minima between pre-/n/ and pre-/ɲ/ vowels. The procedure was as follows. Using Praat, the nasal segment in productions of *senos*, *senda*, and *seña* was extracted (nine tokens total per participant). A Praat script then tracked in 5ms windows across each segment and took RMS measurements for each interval. Number of windows varied according to token length. Results reveal no pattern of diminished nasal energy in onset /n/ as Cho & Keating (1999) found for Korean. Indeed, more often than not, the RMS was greater both as a mean and in terms of its least value in the onset /n/ of *senos*. No evidence of lesser nasal intensity was thus found. The following table shows comparative results for two tokens, one of *seña* and one of *senos*. Though differences are less marked in other participants, where not greater, the intensity of non-onset nasals is generally equal to that of the nasals in other contexts. These findings further undermine the relevance of the findings for nasal duration above.

Table 3. Nasal intensity readings across vowels in pre-palatal (*seña*) and onset (*senos*) for one speaker

token	5ms window	RMS Pascal	Decibels		token	5ms	RMS	dB
1seña1	1	0.0011	34.787		1senos1	1	0.00344	44.719
1seña1	2	0.00117	35.314		1senos1	2	0.00378	45.535
1seña1	3	0.0012	35.535		1senos1	3	0.00399	46.008
1seña1	4	0.00124	35.816		1senos1	4	0.00425	46.541
1seña1	5	0.00125	35.89		1senos1	5	0.0039	45.799
1seña1	6	0.00134	36.501		1senos1	6	0.00385	45.695
1seña1	7	0.00129	36.208		1senos1	7	0.00381	45.595
1seña1	8	0.00124	35.843					
1seña1	9	0.00124	35.867					
1seña1	10	0.00132	36.382					

5.5.4 F2 Contours

I compared the F2 contour means of vowels in pre-resonant (pre-/n l/), pre-oclusive (pre-/t k/) and pre-palatal (pre-/ɲ ʎ j/) contexts. Tokens with CVC syllables were not considered in order to focus on the differential behavior of palatals versus singleton segments. To measure F2 contours, a Praat script tracked across each target vowel (/e/) and took F2 readings every 5ms for the vowel's duration. The resultant formant readings were calculated as percentages of change; that is, a move downward from 2500Hz to 2000Hz would represent a -20% change. For each word, a mean percentage of change was calculated, resulting in a general value reflecting net positive (F2 increase) or negative (F2 decrease) values. End effects—i.e. large sudden jumps up or down at the end of the token—were suppressed to avoid skewing. Similar 'perturbations' in mid-token—perhaps due to idiosyncratic articulations on the parts of the participants—were retained and factored into the calculations. Representative scatter plots are available in Appendix C. Note that vowel duration is not factored in at this point.

The means were tested with SPSS software. Significant results in a one-way ANOVA procedure obtained among all three groups (F=90.086, df=1), and subsequent Tukey and Scheffé post-hoc tests showed discrete grouping for all contexts. The greatest F2 means were found in pre-palatal position (mean value 1.172%). Thus, the F2 contour of the palatals reflects a positive trend upwards of about 1% per 5ms window. Note that an average 1% change is not trivial; it is important to bear in mind that average F2 values of the /e/ used as a constant here hovered consistently in the 1900-2400Hz range. A 1% shift therefore shows change of some 20Hz. Following Kewley-Port's (1982) criteria for vowel steady-state whereby changes of less than 10Hz per 5ms constitute steady state, we

see that prepalatal vowels are significantly unsteady, i.e. they tend towards an F2 rise rather than the flat frequencies that characterize ideal vowels.[6]

Pre-occlusive vowels show a mean F2 contour value of .499, roughly half that of the prepalatal vowels. Pre-resonant vowels show a negative F2 value (-.223), reflecting a tendency to lower F2 across the vowel. These findings support the idea that F2 contour, the result of the tongue-body raising required of palatalization, may well function as a principal cue to palatal/non-palatal distinctions. Moreover, such a distinction is significantly greater between the palatals and their resonant congeners: i.e. /n ~ ɲ/ and /l ~ ʎ or j/. Given that other cues—burst characteristics, for example—serve to underscore occlusive~palatal distinctions, this second finding seems the more compelling, underscoring the sort of localized contrast maintenance (i.e. that between /l~ʎ/ and /n~ɲ/) dealt with in the discussion of the historical changes in Chapter 3.

The scatter plots in Appendix C make plain that pre-palatal vowels are subject to a significant and steady F2 rise, generally from 2000Hz to approximately 2500Hz or higher. Trends differ notably in the non-palatal counterparts of /ɲ ʎ (j)/, i.e. /n l/. For pre-/n/ vowels, F2 tends to exhibit a rather flat contour or an overall decrease in F2 from 2000Hz to between 1700-1800Hz, while in the context of /l/, the vowel shows a great deal of variation (at times similar to that of pre-/ɲ/), with a fluctuating pattern or a general downturn predominating. By contrast, the vowels in palatal contexts show remarkable consistency, and this must be considered to indicate a systematic acoustic differential with the behavior of the vowels in the context of /n l/. Moreover, these figures do not take into account duration, as mentioned above (but see below). Given that the pre-/ʎ/ vowels

tend to be considerably longer, it is to be supposed that the F2-based cues would be available longer—and thus be more salient—in the signal. Consider that where the length differences are less salient (in Speaker 1, the only *lleísta* among the participants), pre-/l/ vowels show consistent downturns, with no F2 rise that could imitate that of the pre-palatal vowels. In fact, in light of the apparent lengthening observed for prepalatal vowels in the data above, as well as the significant differences shown here to involve F2 contours, it may be that the two are part of the same phenomenon. Lengthening in essence could accommodate the enhanced F2 and the tongue-fronting gesture that gives rise to it. Speakers may preserve 'steady-state' values of the underlying vowel, then, in anticipating the tongue body gesture required for the following palatal, append another vocalic segment of rising F2 that ultimately serves to lengthen the overall duration of the vowel.

In light of this discussion, it is necessary to get a better sense of the transitions in the F2 trajectories in question. To do so, I reexamined the same formant readings used above, focusing solely on prepalatal (pre-/ɲ ʎ/) versus non-prepalatal (pre-/n l/) vowels. For each vowel, I found the period of steady state, that is, when the formant frequency values show a period of acoustic stability. To determine steady state, I again used the criteria of Kewley-Port (1982), which looks for the point in the vowels formant trajectory where the freqency change falls to less than 10Hz per 5ms frame, or where within four frames (i.e. over a 20ms span) the frequency back-tracks to the same value. I expanded the latter criterion to accept back-tracking to within the 10Hz window of acceptability. After isolating the steady-state portions of each vowel, I assumed that the largest period of steady-state—there was generally only one that spanned more than a single frame—

was the F2 target for the vowel. I next located and measured spans of clear F2 transitions, defining transition as sustained, uninterrupted periods of F2 increase or decrease. Thus, series of frames showing alternating increase and decrease from frame to frame were not taken to represent transition. (Indeed, were such periods considered transition, then every vowel would simply break down to steady-state and transition, and it would not seem useful to even look at transition as anything other than non-steady-state.) For methodological consistency (and differently from above), I did not consider periods of F2 transition that were broken up by apparently anomalous F2 dips or rises, as might be the case due to articulatory 'flutter' or idiosyncratic linguistic behavior. Thus, even in cases where it seems clear that an F2 rise (the case with some prepalatal vowels) has been interrupted by a single frame of 'flutter', only the portion before or after the event is considered. This could have the effect of skewing the findings, since the transitions could conceivably be much greater; however, it is noteworthy that even with this very conservative approach, the prepalatal vowels show greater periods of F2 transition (see table below). Moreover, the prepalatal transitions are without exception F2 rises (as are the unconsidered secondary periods of F2 transition), while those of the non-prepalatal vowels are a mixed bag, more often than not showing an F2 fall, with any secondary periods of transition often being F2 rises. This is discussed more fully below.

Finally, I also found the F2 slope of each vowel considered. That is, I found the value based on a linear regression analysis of the F2 freqency changes (the y axis) as functions of time (each 5ms increment being a point on the x axis). This in effect shows the overall direction of the F2 trajectory across each vowel and is a methodologically

'cleaner' means of showing general rising/fall trends. Additionally, I did not suppress any edge effects in this analysis.

The results of this second analysis are shown in Table 4 below.

Table 4. Results of F2 analysis for the /e/ in each token (steady state) in ms, F2 transition in ms, word length in ms, normalized steady state and transitions as percentages of overall word, and the F2 target as seen in the greatest periods of steady state for each vowel.

token	st-state (in ms)	transition (in ms)	length (in ms)	normst-st (% word)	normtrans (% word)	F2target	F2 slope
1seña1	15	15	30	50	50	2346.3	3.439
1seña2	10	10	30	33.3	33.3	2332.7	2.469
1seña3	10	15	50	20.0	30.0	2196	9.873
2seña1	5	30	45	11.1	66.7	2221.5	6.326
2seña2	10	25	65	15.4	38.5	2282	4.015
2seña3	15	50	70	21.4	71.4	2351.5	6.793
3seña1	5	30	35	14.3	85.7	2156	10.41
3seña2	20	20	105	19.0	19.0	2522	3.017
3seña3	25	30	105	23.8	28.6	2661.3	6.52
4seña1	10	70	90	11.1	77.8	2670.7	8.726
4seña2	10	70	95	10.5	73.7	2192.3	8.498
4seña3	10	35	85	11.8	41.2	2297.7	8.304
5seña1	5	60	65	7.7	92.3	2016	8.638
5seña2	10	45	55	18.2	81.8	2362.3	7.043
5seña3	10	20	60	16.7	33.3	2360.7	4.137
1senos1	20	40	70	28.6	57.1	2113.3	-1.523
1senos2	15	45	70	21.4	64.3	2133.8	-3.31
1senos3	25	35	65	38.5	53.8	1962	-3.665
2senos1	5	10	25	20.0	40.0	1840	-0.998
2senos2	10	20	65	15.4	30.8	2041.3	-1.042
2senos3	25	10	50	50.0	20.0	1934.7	-1.14
3senos1	20	15	90	22.2	16.7	2206.6	-0.251
3senos2	15	25	75	20.0	33.3	2410	-0.887
3senos3	5	45	105	4.8	42.9	2358.5	2.268
4senos1	5	40	85	5.9	47.1	2229.5	3.232
4senos2	10	30	80	12.5	37.5	2180	3.078
4senos3	5	20	70	7.1	28.6	2088	2.201
5senos1	15	35	60	25.0	58.3	2101.5	-3.648
5senos2	20	30	55	36.4	54.5	1965.6	-0.126
5senos3	10	40	80	12.5	50.0	2203.3	-1.882
1sello1	5	40	60	8.3	66.7	2217	4.818
1sello2	10	15	45	22.2	33.3	2303	-1.031
1sello3	10	20	50	20.0	40.0	2306.7	5.802
2sello1	10	35	75	13.3	46.7	2017.7	5.171
2sello2	5	30	65	7.7	46.2	2102	3.829
2sello3	5	25	70	7.1	35.7	2223.5	3.725
3sello1	20	50	125	16.0	40.0	2286.8	4.135
3sello2	25	55	155	16.1	35.5	2406.2	4.876
3sello3	30	60	140	21.4	42.9	2623	3.354

Table 4. Continued

token	st-state (in ms)	transition (in ms)	length (in ms)	normst-st (% word)	normtrans (% word)	F2target	F2 slope
4sello1	15	40	95	15.8	42.1	2774	8.857
4sello2	15	80	105	14.3	76.2	2769.5	8.471
4sello3	5	50	85	5.9	58.8	2752	8.628
5sello1	10	45	95	10.5	47.4	2348.7	5.125
5sello2	20	60	105	19.0	57.1	2117.7	4.826
5sello3	20	55	85	23.5	64.7	2455.4	5.311
1sela1	5	15	65	7.7	23.1	1995.7	-1.157
1sela2	0	30	40	0.0	75.0		-5.482
1sela3	10	15	40	25.0	37.5	1928.7	-4.201
2sela1	15	20	55	27.3	36.4	1914.3	-0.986
2sela2	20	10	45	44.4	22.2	1924.4	0.255
2sela3	10	15	45	22.2	33.3	2035.7	-4.491
3sela1	10	20	85	11.8	23.5	2245	0.094
3sela2	10	20	85	11.8	23.5	2355	3.584
3sela3	10	15	90	11.1	16.7	2131.3	1.607
4sela1	15	25	70	21.4	35.7	2213	-1.163
4sela2	5	55	80	6.3	68.8	2129	2.932
4sela3	10	15	55	18.2	27.3	2190.7	3.743
5sela1	20	20	45	44.4	44.4	2080.5	-1.881
5sela2	10	30	50	20.0	60.0	2218.7	-4.596
5sela3	10	30	60	16.7	50.0	2162	1.322

As is evident in Table 4 above, F2 transitions are consistently longer before palatal segments, averaging some 52% of the overall word length as compared to 40% for vowels before /n l/. This in itself would perhaps be unimpressive were it not for the fact that the prepalatal vowels are also significantly longer than their non-prepalatal counterparts (recall discussion in 5.1 above), which therefore means that the transitions are in absolute terms much greater than those before /n l/. Also, it should be noted that for methodological consistency, only the single longest interval of either rising or falling F2 was used for the calculations. That is, a transition was only considered as such if it showed a sustained, uninterrupted increase or decrease in F2 with no steady state. Often, with the prepalatal vowels (and much less frequently with the non-prepalatal vowels), there was a second F2 rise nearly as long as that reported above, such that one could argue that the two should be considered together to give a more accurate F2 profile of the

segment. Note too that steady states are on average longer in the non-prepalatal vowels: 21.3 and 19.2% of overall word length respectively for /n l/ as opposed to 19 and 14.8% for /ɲ ʎ/. While no clear patterns emerged in the data with respect to the ordering of steady state and transitional effects in the F2 profiles for either group of segments, the lesser duration of steady state in the (overall longer) palatals suggests that transitional effects dominate in these vowels. Moreover, the prepalatal vowels were far more often marked by long transitional excursions from vowel onset than were the non-prepalatals. This seems to support the notion that F2 excursions are marked earlier and longer in prepalatal vowels than in the vowels preceding the palatals' singleton counterparts.

Secondly, the slope analysis shows significant differences in the two groups of vowels, with the prepalatal vowels showing much higher slope values than the non-prepalatals. Note moreover that negative slope values, indicating a general downward trend, are virtually never associated with prepalatal vowels (one case for *sello*), while negative values obtain more than half the time for the non-prepalatals. The average F2 slopes for vowels before /ɲ ʎ/ are 6.5 and 5.1, respectively; averages before /n l/ are -.5 and -.7, respectively. These results confirm the findings of the approach discussed above.

5.6 Discussion and Conclusions

The statistical tests discussed above suggest that significant differences in both F2 contours and vowel length occur as a function of palatal/non-palatal context. These findings seem temptingly complementary. Alongside the F2 findings, ANOVA tests also confirm that vowel length is significantly affected by palatals in the same contexts. Of the three groups tested—vowels pre-occlusive, pre-resonant, and pre-palatal—vowels before palatals were significantly longer than those in the other contexts. Post-hoc Tukey and

Scheffé tests show that pre-occlusive and pre-resonant vowels form a homogeneous group opposed to that of the pre-palatals: prepalatal vowels show much greater average lengths than those of vowels in the other group. The average length of prepalatal vowels is some 23ms as compared to pre-occlusives (10ms) and pre-resonants (2ms).[7]

In terms of vowel length in open, closed, and 'pre-palatal' syllables, the pre-palatal position was also found to be significantly greater ($p < .000$ significance in both cases) than that of vowels in both open and closed syllables. With relative means of 6.2ms and 4.7ms, respectively, vowels in open and closed syllables formed a homogeneous group with respect to that made up of the prepalatal vowels, with a relative mean of 24ms (again, relativized values). These findings suggest that the pre-palatal vowel lengthening is unrelated to word-level timing in the sense of Hubbard (1995) or indeed with syllable-timing at all, since there is no apparent mora-based reason to assume that the pre-palatal would behave differently from both the vowels in CV light and CVC heavy syllables as it does in the data. It appears instead that the effect is due to the nature of the following segment; the palatal's complex structure may exert an exceptional lengthening effect on the preceding vowel that could itself be a response to the high degree of anticipatory tongue-body raising and fronting involved in its production.

Importantly, we see that not only are the prepalatal vowels longer in overall duration but their F2 transitions are longer as well. While the consistency of these transitions—which are unfailingly rising whereas those of the prealveolar vowels are sometimes rising, sometimes falling—is totally predictable due to the articulatory demands of the following palatal segments, there is no compelling reason for speakers to lengthen the overall vowel to accommodate the lengthier articulatory transitions to the

palatals. That is, speakers could simply decrease steady state and increase the transitional elements (as they do) without actually lengthening the vowel (which they do regardless). We might explain such behavior in terms of mechanics: the tongue has further to go in transitioning to the following palatal segment. However, both the transitions and vowel length increase, despite a decrease in the steady state portion of the vowel. It is tempting to speculate that the complex structure of the palatals could trigger a sort of compensatory lengthening of the transitional elements of the preceding vowels in deference perhaps to the 'parsing paradox' that the palatals represent: the nasal and lateral antiformants these segments generate precede the linguo-palatal obstruction required for their release phase (see note 3 and further discussion below). That is, syllable dynamics naturally push for the disparate gestures to affiliate with distinct syllables, *contra* the metalinguistic knowledge of speakers. Lengthening of the F2 excursions and the overall vowel may represent means of resolving the conflict. However, we must also consider that the palatal aproximant /j/ also affects the stress window, despite the fact that it does not share the complex structure of /ʎ ɲ/. This suggests that the F2 demands alone are sufficient to engender the geminate effect, since the data above show that the *yeísta* participants' F2 profiles reflect the same enhanced degree of length and rate as compared with those in vowels in the context of non-palatal singletons.

It is necessary, however, to address another aspect of the discussion, one ultimately problematic for any such analysis of vowels in the vicinity of /j/ (or "/j/-like" elements, for that matter): the difficulty of segmentation. It must be noted that the pre-/j/ vowels may well be longer simply because it is notoriously difficult to know when the vowel proper ends and the approximant's formant transitions begin. In the absence of any

occlusion or energy shifts or such that might clearly indicate the consonant's onset, one must rely either on general values of formant frequencies to determine where the speaker likely meant to begin /j/ production, or assume that the consonant's *de facto* onset is at the point of greatest occlusion. As indicated above, I have followed the latter, finding the point of onset of an F1 minimum in the signal to mark the onset of the consonant. This effectively leaves the transitional portion of the sound as part of the preceding vowel and serves to lengthen it. In the case of the *lleísta* participant, lateral antiformants cause an energy dropoff that is much easier to segment; in this case, then, the vowels are shorter, since the transitional portion of the /ʎ/ is in essence 'chunked in' with the consonant following the lateral onset. One may therefore accuse the present study of 'stacking the deck', segmenting in such a way as to lengthen the vowels.

There are two points to consider here in response. First, I have shown above that even without considering vowel length, the F2 contours of pre-palatal vowels (as in *sello*, *seña*) show notable differences with both their non-prepalatal counterparts' (*sela*, *senos*) and with those of vowels preceding other non-palatal segments (*seca*, *seta*). These differences are furthermore statistically significant as shown by analysis of variance testing, with post-hoc tests revealing significant differences in the F2 of prepalatal vowels as compared to vowels both in open and closed syllables when followed by non-palatal sounds. The inclusion of durational data only serves to accentuate the differences.[8]

Second, the segmentation protocols employed here reflect the very premises of the current work: given that the proposal here is that the palatals contrive to render heavy a preceding syllable via their putative geminate structure, my assumption is that this weight is a function of the anticipatory coarticulation involved in the palatals' production. That

is, in transitioning from a vowel to a following /ʎɲ/, the speaker produces a vowel with a greatly enhanced (both in terms of degree of change and length; note that I have not factored in frequency) F2 component, apparent in the signal as part of the vowel. Given sonority sequencing protocols as they are understood, there is little reason to assume the listener will parse these transitional effects—already vocoidal as part of an approximant—with the lower-sonority, higher-occlusion portion of the segment. By segmenting in terms of F1 minima, I reflect what can be reasonably supposed to be the most obvious onset for the listener. The fact that release bars—closely paralleling similar acoustic effects in the presence of released stops—are often visible in the spectrogram suggests that this approach may well be valid.

On the other hand, I do not use a similar modus operandi for the segmentation of /ɲ/: rather than marking the point of minimum F1 as the perceptible onset of the sound, I use the onset of nasality as evidenced by the abrupt energy changes on the spectrogram. However, it should be noted that given the approach above I could attempt to isolate the point of perceptible onset by way of F1 or other spectral data. This would have the effect of 'parsing' the nasality of the palatal nasal with the preceding syllable in much the same way as the transitional portion of the approximant /j/ is lumped in with the preceding vowel. Indeed, it may be that listeners accomplish the same in speech. If the palatal component of these sounds may indeed be characterized by the large tongue body raising and fronting gesture as discussed in previous chapters, a gesture that is ill-coordinated with the apical gesture that effects occlusion, then it is feasible that velic opening responsible for nasality anticipates actual closure and produces a nasalization that is best parsed as a nasal coda on the preceding vowel. Note, secondly, however, that even

without this assumption, the F2 contour of the /CVɲ/ vowel shows significant differences with that of the other (non-prepalatal) vowels. We therefore see that the distinctiveness of the palatals /ɲ ʎ/ is guaranteed vis-à-vis their non-palatal counterparts in terms of their F2 components, which is itself clearly marked via anticipatory coarticulation on the preceding vowels.

Additionally, it is conceivable that the overall lengthening observed in the data here is sufficient to motivate the prosodic effects of palatals on the Spanish stress window, contributing to the perception of weight in a preceding syllable. The lengthened vowel in tandem with the very high F2 excursions (compare F2 targets in Table 4 above) may effectively simulate a diphthong effect. Such an effect is predictable for all of the segments in question (/ɲ ʎ j/), regardless of their posited structure, due to the "articulatory engagement" of the tongue dorsum involved in their production.

Ultimately, however, we have not seen irrefutable proof of the perceived weight of the affected syllables. Since no correlation was found between vowel length or loudness and its affiliation with an open or closed syllable, we have failed to find a viable measure by which to show that vowels preceding palatals take on additional weight. Even indication that vowels preceding palatals lengthen does not prove that they are parsed by listeners as heavy syllables. Consequently, it is only through empirical testing that we may be able to find acceptable evidence that speakers do indeed assign weight to such syllables. This matter is discussed more fully in the concluding chapter that follows. [9]

5.7 Notes

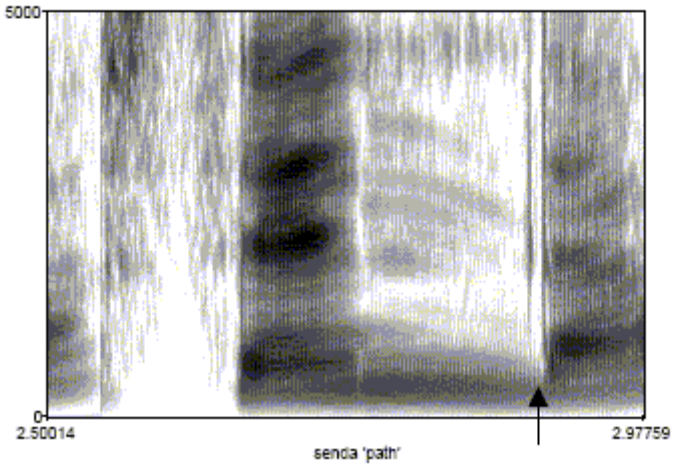
[1]-Gordon does not apparently winnow apart the vowels in the rimes measured in the greater part of his wide survey. One might therefore argue that concentrating on the entire rime and isolating coda consonants rather than nuclei is less than satisfying. Speakers may well control vowel duration when similar finessing of a consonant with its implicit oral stricture gestures might be considerably more challenging, aside from the fact that shortening closure duration of some consonants can impact the perceptual identity of the sound. Still, though, that rime durations do not seem to provide evidence of a shorter rime for mora-sharing CVC syllables than for bimoraic CVC in weight-to-stress languages does undermine the argument for simple duration as a viable universal correlate of syllable weight.

[2]-Nor do all vowels have equivalent length. Gordon (1999) points out that lower vowels have intrinsically greater duration than higher vowels, despite the fact that most languages fail to discriminate between a mid-vowel mora and that of a lower vowel.

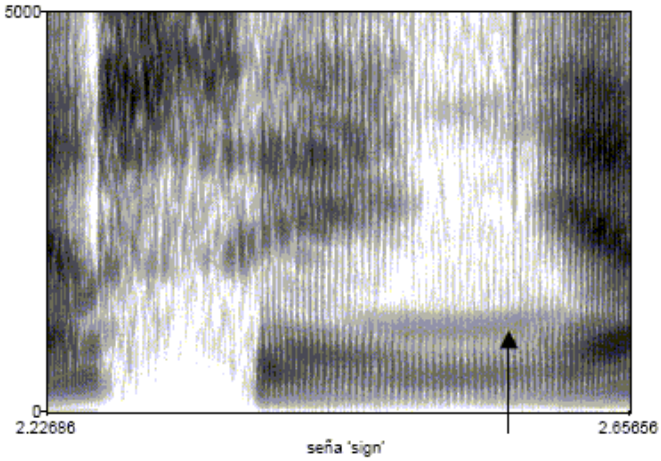
[3]-A sonority-based understanding of syllable dynamics suggests that speakers hear onsets in terms of stricture and release (see Clements 1990, Zec 1995a,b). Thus, the ideal onset is a stop, whose occlusion and subsequent burst provide clear perceptual contrast with a following vocoid. Both the universal CV syllable type and the cross-linguistic preference for voiceless plosives support this concept. It does not seem unreasonable to assume that speakers will 'parse' the onset of a palatal segment in terms of its point of greatest stricture prior to release. That is, while it is perhaps impossible to prove on purely theoretical grounds just how speakers perceive intra- and intersyllabic structure in a CVPalV sequence, positing such perception as a function of stricture and release is wholly consonant with long-held views. Recasens *et al.*'s (1997:558) observation that the anticipatory effects of /ɲ/ are presumably due to the fact that "the articulatory manifestation of the dorsal gesture is more /j/-like at consonantal release than at consonantal formation" could be taken to support this approach.

Interestingly, in spectrograms of /ɲ ʎ/ there is sometimes a pulse bar present prior to the onset of vocalic periodicity that is similar to that observed for stops. Comparative spectrograms for Sp. *senda* 'path' and *seña* 'sign' are shown below, with arrows showing the pulse bars.

(I) Spectrogram of Sp. *senda* 'path'



(II) Spectrogram of Sp. *seña* 'sign'



These bars mark acoustic events associated with the moment of stricture release, perhaps that associated with the /j/-like glide element of /ɲ/ noted by Recasens & Romero (1997). Importantly, these bars come well after the onset of nasal antiformants—visible as the lighter portions of the spectrogram—in the speech signal. It should also be noted, though, that the presence of a double bar in *senda* (the second one flush against the vowel onset and thus less visible; the arrow points to the narrow space between them) suggests a somewhat different interpretation: the bars (i.e. that of *seña* and the first one in *senda*) mark some alternate nasal event, perhaps velar closure at nasal offset, rather than the release of apical stricture related to some discrete glide portion of /ɲ/. In either case, however, the bars in both words do seem to mark (or herald) the onset of the second syllable in rather parallel ways; in *seña*, /ɲ/ is only perceptible following the pulse bar.

[4]-Mora-sharing in Spanish must be posited in the nucleus, however. Onglides as in *fuerte* 'strong' [f**w**ɾte] or *siempre* 'always' [s**j**empɾe] are considered to be part of the syllable peak (if not the head) and thus do not dominate their own mora (Appendix A shows the results of acoustic measurements of vowel duration across various contexts that confirm these observations). Following Zec (1995a,b) and Rosenthall (1997), I assume that onglides cannot surface with their moras intact due to universal sonority sequencing laws. Specifically, Zec (1995a) posits a condition on relative sonority by which the sonority of the left-most mora—i.e. the head of the syllable—must be at least equal to or greater than that of the following segment (Zec 1995a:91). In effect, such a condition prohibits a rise and fall of sonority in the syllable peak. That is, following the onset of the syllable, the sonority profile of the syllable must exhibit a downward trend (cf. Rosenthall's 1997 SONFALL constraint). Thus, if a lower sonority onglide such as /j/ precedes the 'nuclear' vowel of a word such as *bien* 'well', the glide must make up part of the syllable head and thus share the mora of the peak vowel. Otherwise, the sonority profile would exhibit a 'dip' following the onset's release before immediately rising to the higher sonority peak of the following (lower) vowel. Such a situation is infelicitous in terms of listener parsing of the syllabic make-up of the word.

[5]-Note that since negative values—arising from relativization with respect to a control vowel in each frame sentence—were involved, these figures do not reflect real-time averages.

[6]-The articulatory demands of transitioning to palatal /ɲ ʎ/ with their inherent tongue body fronting gesture, as opposed to transitions to (apical) alveolar /n l/, clearly predict rising F2 transitions in the former with less marked rises in the latter. Thus, it is not surprising and not significant in and of itself that the prepalatal vowels show such F2 rises. However, the duration of such rises may be significant. See discussion below.

[7]-The same caveat concerning relativization as seen in note 5 above applies here: these are relative values that nevertheless show that vowels tend to be lengthened in pre-palatal position.

[8]-Recall the discussion from section 4.4.3.2 in Chapter 4. Both the magnitude and duration of acoustic cues logically play a role in contrast. Given that the prepalatal vowels tend to be longer than the others, not only does their F2 component serve to differentiate them from their non-palatal counterparts but also the length of time that this auditory cue is made available to be perceived. Table 4 shows that the duration of transitions in prepalatal vowels is consistently greater than that of non-prepalatal vowels, while steady state is shorter. Clearly, the transitions are a salient feature of these vowels.

CHAPTER 6
CONCLUSIONS

6.1 Overview

This dissertation has examined the phonological nature of the palatal resonants /ɲ ʎ/ of Spanish. The goal has been to shed light on the complex changes and resultant structure of these segments with an eye toward motivating and thus better understanding their place in the Spanish inventory. I have demonstrated that an approach that assumes both a complex articulatory makeup and a geminate (moraic) structure for these segments provides a ready means of explaining various aspects of their phonological behavior. I have also shown that the same approach helps us understand reflexes elsewhere in Romance, primarily in French and Portuguese.

The segments are posited to be featurally (or gesturally) complex and moraic. Featurally, the segments comprise both consonantal and vocalic elements that have clear consequences for their production. Following findings by Recasens (1990), both extrinsic and intrinsic muscles come into play, accounting for the monolithic nature of these segments in the speech stream and explaining their impact on coarticulatory processes. That is, the resistance of these segments to coarticulatory influences—again in line with findings by Recasens & Pallarès (2001) and their DAC model—and the high degree of anticipatory coarticulation that they themselves exert helps explain the particular cooccurrence restrictions operative upon them. For example, their absence in consonant clusters is explicable in terms of the unwieldy concatenation of consonantal gestures that

would result from such a cluster. Note that the concept of palatals as complex segments is also patent in Keating (1988), Lipski (1989), and Lahiri & Evers (1991).

In terms of weight, the palatal resonants are assumed here to be quasi-geminates that encompass both a (moraic) coda and an onset in successive syllables, in line with Davis (1994) and Wetzels (1997). This approach helps explain the striking distributional limitations on these segments: they do not occur word-finally and are infrequent word-initially. This accords with attested behavior of geminates cross-linguistically: word-initial position is marked for these quasi-geminates just as it is for true geminates (Hayes 1989). The geminate structure of these segments also provides a means of accounting for the metrical effects associated with them: the three-mora stress window of Spanish is predictably impacted by these segments in precisely the same way as it is by true geminate /r/, leading to the concept of heavy onsets in the language (Roca 1988).

Chapter 2 provides a feature geometry model of the segments that follows proposals by Lahiri & Evers (1991), assigning a vocalic tongue node feature to /ɲ ʎ/ to represent the tongue body gesture—involving the large, intrinsic muscles discussed by Recasens (1990)—required for their production. I show that the complex featural composition of these segments also provides for clear analyses of other attested phenomena, including the role of palatals in vowel harmony systems in both Romance (Pasiego) and elsewhere (Turkish).

In terms of Spanish diachrony, much of the dissertation (Chapters 3 and 4) has concerned itself with illustrating how the approach adopted here contributes to our understanding of historical processes. The genesis of these segments from Latin geminates and clusters explains their complexity if we see their historical evolution in

terms of a featural ‘condensation’ or compression. To explain this compression, I have formulated a constraint CONDENSE. CONDENSE is posited to drive the sort of overlap observed in /ɲ ʎ/: features from two consecutive segments are compressed temporally to form a single unit. As such, CONDENSE is subtly different from LAZY, which encodes the drive to lessen articulatory effort. CONDENSE is posited here to be behind speech phenomena that impact the concatenation of articulatory features, producing marked (and potentially more effortful) sequences. Note, however, that CONDENSE and LAZY may work in concert: the presence of high vocalic segments, as in the evolution of GN clusters to /ɲ/, clearly reflect the effect of lenition (LAZY) in the vocalization of the former velar stop. Thus, LAZY may set up the conditions under which CONDENSE applies.

The evolution of Latin geminates and clusters in Spanish thus reflects universal drives (formulated as constraints LAZY and CONDENSE) on the one hand, and, on the other, systemic pressures, in line with ideas that stem from early work by Lindblom (1986) and currently strongly represented in the work of Flemming (2002) and Padgett (1997, 2001). These researchers approach some sound change from the perspective that processes are sometimes only explicable in terms of the whole system. Following these investigators, the tenets of Dispersion Theory are here invoked in Chapter 4 to illustrate the well-known chain shifts in Spanish history that account in part for the advent of the palatals.

My dispersion approach assumes that a system-wide drive to lenite the consonant inventory of Latin conflicted with the systemic drive to maintain important phonemic distinctions. The resolution of this conflict led to the reduction of geminate stops, geminate voiceless singletons, and geminate voiced singletons in the well-known chain-

shift discussed at length in Chapter 4. Phonetic factors—the near universal voicing of resonants, the high markedness of lateral and nasal approximants—made parallel reflexes in Latin geminates /nː lː/ untenable and set the stage for a reanalysis of these geminates as the palatal sonorants under discussion here. Spatio-temporal gestures—i.e. the amalgam of articulatory contact and duration that mark geminates—were reanalyzed in favor of the spatial component; duration was deemphasized while greater spatial contact involving the large tongue dorsum raising and fronting gesture for palatalization took on greater prominence. In this sense, then, these new palatal segments are not weakened singleton variants of former geminates but reanalyzed quasi-geminates; we may thus view these segments as compressed (along the durational dimension) versions of geminates, the results of ongoing pressure from CONDENSE. Indeed, the markedness of the palatals and their tendency to simplify (as in *yeísmo* and, to a lesser extent, in ñ-gliding) belie the notion of palatals as weakened variants. This conforms to Kirchner's (1998) findings concerning the weakening patterns of geminates whereby geminates only weaken to singletons. I also view the results of such historical processes as L.FOLIA > MSp. *foʎa* as featural condensation under CONDENSE rather than as lenition proper. The lateral takes on the palatal gesture implicit in the following high vowel and becomes complex /ʎ/.

To better illustrate, I turn to the gestural model of Browman & Goldstein (1986, 1988, 1989, 1992). Articulatory Phonology focuses on the articulatory gesture rather than on individual segments; what we conveniently label as segments are only really incidental and ultimately descriptive devices for the true nature of speech, a very complex coordination of speech gestures. In a system that questions the validity of dividing the speech stream into discrete segments and instead views the speech stream as such an

array of gestures (in the sense of Browman & Goldstein, cited above), the argument that a process such as li > ʎ constitutes weakening due to the loss of /i/ is invalid. That is, the gestures implicit in /i/ are still present but simply overlapped with the preceding lateral. Furthermore, in any system that defines lenition in terms of effort, it is difficult to imagine that a complex articulation like /ʎ/ truly represents lenition. Indeed, the coordination of various gestures could be interpreted as more effortful, with faster transitions between rapidly concatenated gestures or with articulatorily challenging simultaneous gestures. Rather than seeing such sound change as lenition, therefore, I argue that we should skirt the issue of effort altogether and view such changes more in terms of communicative efficiency, in line with ideas discussed in Byrd (1996). Speakers may well try to get all the information out as quickly as possible while creating marked articulatory configurations. I take this up in greater detail below in my discussion of recent proposals concerning usage-based phonological models (as in Bybee 2001).

Chapter 5 presents the results of acoustic analysis of the palatals and their singleton counterparts /n l/. The data confirm that the F2 component posited to be the main acoustic consequence of the reanalysis that took place historically is indeed a statistically salient and consistent characteristic of /ɲ ʎ/. Moreover, analysis of the vowels preceding these segments showed significant lengthening effects, and it is posited that this is perhaps due to the high percentage of the vowel duration dedicated to F2 transitional effects, with large stretches of upward excursions consistently marking the pre-palatal vowels. In contrast, transitional stretches in the non-palatal singleton counterparts of these segments showed far less predictable patterning, with higher percentages of steady state values. In general terms, I posit that the complex articulatory demands of palatals trigger what may

be viewed as compensatory lengthening of the preceding vowels, as speakers mediate between the coarticulatory demands of the palatals and the drive to maintain at least some steady state for the target vowel. This is discussed more fully below.

6.2 Residual Issues

In the following subsections I discuss the implications of the findings above for other segments in Spanish, particularly the palatal glide/approximant /j/ and the alveopalatal affricate /tʃ/. These segments seem to exert the same influence on the Spanish stress window as the palatal resonants, functioning as heavy onsets, and as such present challenges to the approach adopted in the present work. More specifically, /j/ cannot be argued to be a complex segment as per our model in Chapter 2. Indeed, /j/ is the common result of widespread *yeísmo* in Spanish and elsewhere in Romance (French, Catalan). Nor is /j/ particularly unstable, one of the diagnostics for complex segments cited in Chapter 1, having arisen in part as the result of simplification of complex /ʎ/. The affricate for its part is much less marked than /ɲ ʎ/ and does not present the problematic sonority issues discussed in Chapter 4 for the resonants. That is, there would seem to be no question of parsing difficulties for the affricate—with its salient burst and subsequent frication component—as an analog to the early onset of nasality and lateral antiformants prior to stricture as discussed for the resonants. These issues are discussed below.

6.2.1 Palatal Approximant /j/

Given that the /j/ does indeed figure among those segments that are claimed to function as heavy onsets in Spanish, we must find some means of reconciling the issue of its non-complex structure. Clearly, the argument that the palatals' complex structure is behind their effect on the Spanish stress window is undermined if simple segments also

exert the same structure. However, this line of reasoning itself fails if we consider not merely the fact of the complexity itself but rather those specific characteristics that constitute that complexity. Thus, we see that the vocalic element of /ɲ ʎ/ is also present in /j/. That is, the monolithic tongue body gesture that constitutes the vocalic portion of the palatal resonants is the key (and sole) articulatory characteristic of the glide/approximant. We may therefore expect that it triggers the same high degree of coarticulatory F2 activity in preceding vowels as the complex segments and that the same lengthening effect should be present. Indeed, this was seen in the data in Chapter 5, where four of the five participants were indeed *yeísta* speakers and whose data contributed in large measure to the conclusions reached in that chapter.

In a sense, then, this argument follows the reasoning alluded to above, that we must focus on specific features (or gestures) of speech sounds in order to understand their changes rather than adhering too closely to assigned categories that are ultimately limiting and counterproductive. Similar arguments are implicit in Mielke (2004). Mielke claims that our long tradition of distinctive features and natural classes has proven too limiting in light of the copious evidence of 'unnatural' classes or patternings in his survey of 561 languages. The problems of the traditional approach are all the more evident in the face of our growing understanding of phonetics and gradient phonetic detail. He looks beyond the overly rigid demands of feature assignment and seeks the common phonetic properties underlying phonological patterning. Focusing on the lateral /l/, he shows that the features assigned to this segment are highly inconsistent cross-linguistically, functioning in some languages as [-continuant] and in others as [+continuant]. He demonstrates that attempts to force this segment to fit some universal featural mold

ultimately fail to explain its variant patterning across languages. He proposes instead that we look to the phonetic properties of such sounds, since 'unnatural' (feature) classes ultimately come clean as 'natural' on the basis of shared phonetic properties. Note that Flemming's (2002) work adopts a similar strategy, looking for the acoustic bases for language processes that defy obvious featural interpretations. Thus, an approach that accepts that patterns may arise from processing variable phonetic cues in different languages better predicts the variant patterning attested cross-linguistically for ambivalent segments such as /l/. Interestingly, nasals and rhotics also figure among Mielke's ambivalent segments, patterning sometimes as continuant and sometimes as non-continuant segments across languages. It remains for future research to prove the connection between this ambivalence and the reflexes of rhotic, nasal, and lateral segments in the synchronic and diachronic systems of Spanish as dealt with in this dissertation.

In line with these ideas, then, we may similarly improve our argument here by identifying the common phonetic property shared by the segments in question. In this case, /j/ shares with both the palatal resonants the very high F2 transitions that strongly mark (and perhaps serve to lengthen) preceding vowels. This phonetic property, the acoustic result of the tongue body gesture required for the 'glide' element, may be sufficient to mark a category for speakers, the pattern emerging over time (as emergent structure) from language use. See further discussion of emergent effects below.

The concepts of Recasens & Pallarès (2001) DAC model may also play a role. Coarticulatory binding, that is, a high degree of articulatory engagement of the tongue (as the active articulator), may indeed underlie the lengthening effect seen in Chapter 5; a

high proportion of transitional movement of the tongue alongside the demands of achieving some degree of steady state (almost a Faith effect, in OT terms), may drive the longer vowels observed and account for the perception of bimoraicity in the affected syllables. It is interesting to note that the DAC model predicts that a number of the sounds which have been observed as allophones of both quasi-geminate /ʎ/ and the geminate trill /r/ figure among the sounds rated as exerting a high degree of anticipatory coarticulation: [ʃ ʒ dʒ]. That is, the strengthened variants of these geminate and quasi-geminate sounds share an important articulatory feature with the original segments, the feature deemed key here to the vowel lengthening effect observed in Chapter 5.

6.2.2 Alveopalatal Affricate /tʃ/

As noted above, the affricate is not a particularly marked segment. Nor does it present the potentially challenging parsing issues of the palatal resonants. The affricate effect is the result of a slower release than that typical of stops, allowing for a brief period of affrication following stricture release. Both the release burst and the subsequent stridency would seem to serve to mark consonantal onset quite clearly, and arguments that listeners might parse the stop portion in the preceding coda and apply the fricative segment to the onset do not seem persuasive. Moreover, this sound is quite common word-initially, seeming to be particularly productive in some dialects of Spanish (as in Mexican dialects, for example). On the other hand, the sound as a contour segment may arguably be viewed as complex and it figures among those segments that appear to function as heavy onsets.

Again, then, as with /j/ above, it is necessary to isolate some phonetic feature that allows for the membership of this sound in the class of heavy onsets in Spanish. I would

focus once more on the high degree of articulatory engagement involved in the production of this sound. The affricate as described by Recasens (1990) shares with /ɲ ʎ/ the "raising of the entire tongue dorsum and, thus, an increase of contact area over the entire palatal surface" (Recasens 1990:277). Indeed, it is by virtue of this feature of the affricate that I assigned it the VP node in Chapter 2 (see Figure 2-22). Quite in line, then, with the strengthened allophones of /ʎ r/ mentioned above ([ʃ ʒ dʒ], affricate /tʃ/ involves a high degree of articulatory binding that may well be the origin of the coda effects seen in Chapter 5 and assumed here to underpin in acoustic terms the apparent weight ascribed to preceding vowels. These effects remain to be verified empirically in the affricates and fricatives, but at this point we do seem to have a common articulatory property present in all of the segments under discussion. To the extent that the articulatory features of a sound dictate its acoustic profile and that of any coarticulated segments in its vicinity, /tʃ/ may be expected to have analogous effects on the formant excursions of preceding vowels.

6.3 Directions for Future Research

6.3.1 Ongoing Empirical Testing

As already noted above, a number of the assumptions of this work bear more extensive empirical testing. While a great deal of this dissertation has focused on the theoretical underpinnings of established historical processes, it remains to be seen to what extent the modern language continues to reflect the proposed models. Language systems change and evolve ceaselessly, and a number of reanalyses may well be in progress in Spanish. These are detailed below.

6.3.1.1 Pre-palatal vowel lengthening

Further data must be collected to determine to what extent the findings of Chapter 5 hold across a larger group of speakers and across dialects. Vowel lengthening and a higher proportion of F2 transitional excursions may not be the norm across dialects or even in the dialects of northern Spain. Moreover, vowel effects need to be measured for a wider array of stops and other consonants in Spanish. If we were to find that similar degrees of vowel lengthening were common to other singleton consonants, then the quasi-geminate theory would be weakened. Since Esposito & Di Benedetto's (1999) data shows that all geminates are longer than all singletons among Italian stops, we might well hope to find that any compensatory mechanism that substituted for geminate length in sound change is also consistently more strongly represented in former geminates than in singletons. Similarly, for former geminates /nː lː/, the spatial reanalysis that led to the raised and fronted tongue dorsum should conceivably trigger stronger F2 effects on the preceding vowel than any other singleton. Note, however, that for the purposes of contrastiveness, it is sufficient for the palatal nasal and lateral to be distinctive only in relation to their singleton counterparts.

Additionally, no real conclusions can be drawn as to /ʎ/ from the collected data, which include tokens from a single *lleísta* speaker. Fieldwork in areas of ongoing *lleísmo* can be collected to corroborate or disconfirm the current findings. It would moreover be of interest to collect data from *lleísta* speakers from widely dispersed areas (say from the Andean region and from Paraguay, as well as from northern Spain) to see to what extent patterns can be attributed to this segment.

Similarly, fieldwork remains to be done to determine to what extent ñ-gliding is spreading in the areas in which it was reported by Lipski (1989 and citations therein). Clearly, however, loss of syllable-final /n/ with resultant nasalization of the preceding vowel is reported in Nicaragua and elsewhere and seems likely to spread as it did in the history of French. Inasmuch as ñ-gliding reflects similar effects—loss of apical contact with nasalization of the resulting vocoid—we might well predict an eventual spread of the phenomenon. Furthermore, there seems to be no reason to expect the formant excursions of a nasalized approximant /j̃/ to differ from those already attested in non-nasal /j/. Whether or not this translates to a parallel vowel-lengthening effect remains a question for further field study.

6.3.1.2 The status of the heavy onsets

As discussed in Chapter 1, Spanish is traditionally a language that recognizes weight for the purposes of various morphological and phonological functions, among them the formation of hypochoristics, word minima templates, and, importantly, stress assignment. Indeed, the issue of weight is crucial to perhaps the key aspect of palatal structure: its putative moraic structure. Now, there is some question in recent literature concerning the quantity-sensitivity of Spanish (Aske 1990, Roca 1990, Alvord 2002). These researchers suggest that Spanish is not (or is no longer) quantity sensitive for the purposes of stress assignment. Alvord (2002), for example, tests the acceptability of antepenultimate stress in words in which the final syllable contains (putatively) geminate /r/ and finds evidence that these words are overwhelmingly judged acceptable by his participants. Such findings go to the very heart of this study, which has assumed that Spanish remains quantity-sensitive. Indeed, the moraic approach to the structure of the

palatal segments is nullified in a system in which syllable weight no longer has any psychological reality for native speakers.

Still, a great deal of work in the field holds to the notion of quantity sensitivity in Spanish (Harris 1983, 1992, 1995; Face 2000). Face (2000) shows that syllable weight—as a function of its structure rather than as an acoustic effect—has significant impact on the perception of stress in Spanish. He used synthesized nonce words with neutralized stress, pitch, and duration in order to test the effect of syllable structure on the perception of stress and found that the heavy-light distinction does indeed impact stress perception, even at times controverting the available acoustic evidence in manipulated tokens. Note, however, that he does not include palatal content in his list of nonce forms. Indeed, aside from Alvord (2002), there seems to be little direct testing of stress window effects with the class of heavy onsets in Spanish.

This suggests a further empirical study of potentially great importance to the claims of the present work. The ongoing influence of these segments needs to be confirmed. Native acceptability judgments on putatively aberrant forms such as **cáleyo* or **tógoña*, where palatal segments presumably render the penultimate syllable heavy and hence shrink the acceptable stress window, would provide valuable insight into speaker perception of weight patterns. As in Face (2000), careful control over other potential correlates of Spanish stress—pitch, vowel duration, and intensity—would have to be maintained in order to prevent skewing of results. Interestingly, F2 excursions could be manipulated to test their effect on the perception of weight in the absence of any other factor, including vowel length. Were speakers to respond to such cues even in the absence of any vowel lengthening such as that found in Chapter 5, we might conclude

that vowel lengthening in the tokens was indeed compensatory, speakers lengthen what they perceive to be the heavy syllable in a sort of Weight-to-Stress effect.

6.3.2 Bigger Picture

The above discussion leads naturally to questions of language acquisition and change. In the preceding section, I suggested that vowel lengthening might arise as an effect of perceived weight due to the salient F2 transitions in vowels preceding palatals (and other segments with high degrees of coarticulatory resistance). That is, the phonetic effect of rapid and lengthy F2 excursions in vowels under the influence of following palatal segments leads to the perception of vowel weight, which itself could trigger some lengthening of the same vowel in a compensatory effect not unlike that suggested in Hubbard (1995). There, Bantu speakers compensatorily lengthen vowels before pre-nasalized stops to satisfy a certain perception that the preceding syllables are made heavy in this context (see section 1.1 of Chapter 5). That is, they parse the perceived moraic weight of the nasal into the preceding vowel. With the palatals, the F2 excursions could more directly be parsable as weight-bearing and lead to compensatory lengthening. Thus, speaker confusion over the source of the apparent weight could cause reanalysis. In short, then, a phonetic effect leads to a phonological consequence. In a way, this stands traditional approaches on their head; traditionally, we view the phonology as imposing structure on otherwise uncontrolled phonetic gradience.

6.3.2.1 Emergent phonological structure

The reevaluation of the phonology-phonetics interface implicit in the section above is featured in some current approaches that focus on phonological patterning as the result of speaker usage: phonological structure is taken to be ‘emergent’ from patterns of speaker usage. These patterns may be to some extent phonetically (articulatorily and

acoustically) dictated; that is, the universal limits imposed by the human speech mechanism will favor some sounds over others, while perceptual factors such as those discussed throughout this work may well be common to all human linguistic experience. This is very much in the same vein as the ideas of Mielke (2004) cited above, where phonetic properties conspire to determine the constituency of natural classes heretofore assumed to conform to universal distinctive features.

Bybee (2001) investigates the nature of phonological patterns as products of language use. Just as Mielke (2004) suggests that natural classes arise as a function of common phonetic properties, Bybee (2001) sees language structure as emergent from language use. Thus, the sort of structure traditionally encoded in the grammar as rules (or constraints) and viewed to arise as a product of those rules is here seen as emergent, a pattern that is itself the product of recurrent speaker performance. Bybee's approach owes much to Browman & Goldstein's (1986, 1988, 1989, 1992) Articulatory Phonology; she assumes that much of emergent phonological patterning is articulatory in origin, best explained in terms of the production of concatenated speech gestures and even neuromuscular 'automation' of recurrent patterns over stretches of speech (Bybee 2001: 64-5). Indeed, the categories that we overlay on such recurrent gestural patterns give rise to segments and syllables, in this view.

This approach details a mechanism that parallels in a sense the role of CONDENSE in this work. Citing the work of Mowrey & Pagliuca (1995), which deals with reduction of articulatory gestures as the key engine behind sound change, Bybee discusses two types of reduction, substantive and temporal. Substantive reduction is reduction of the magnitude of an articulatory gesture and is tantamount to weakening as here understood.

Temporal reduction on the other hand is the result of compression of gestures into a tighter temporal space, such that 'crunching' of features results. This is very much in line with the effects of CONDENSE as here posited. Mowrey & Pagliuca (1995) point out that these reduction processes normally occur together, but may operate independently. Indeed, as Bybee observes, historic changes often first undergo temporal reduction only to be subjected later to substantive reduction: "diachronic changes may have the effect of creating more complex segments by the increased overlap of gestures and then may resolve this complexity by further loss of gestures" (Bybee 2001:82). This is precisely the nature of the changes involved in the creation of complex /ʎ/ under CONDENSE, later simplified to /j/, or in the simplification of /ɲ/ to nasalized /j̃/ in ñ-gliding.

Bybee also focuses on the role of patterns as functions of access. In her view, lexical access is impacted by frequency and usage: the more frequent a pattern, the more quickly it is accessed. Moreover, representations are in turn strengthened whenever they are accessed, such that the strong get stronger and the weak get weaker (Bybee 2001:11-12). This approach assumes that human attention to and retention of detail is far greater and more prominent than has heretofore been recognized: every detail is retained, phonetic similarities in production are impressed on the speaker's lexicon and gradually converge to form patterns. Now, while practice makes patterns on the one hand, forms showing less convergence with the main pattern are less frequent and less easily accessed, on the other; their representation may indeed be lost, as they are increasingly neglected in favor of the practiced, readily accessed 'central' patterns.

Frequency impacts productivity, as well; less frequent forms are less likely to be accessed as templates for new items (Bybee 2001:13). Hence, the highly frequent

penultimate stress pattern in Spanish—accounting for the vast majority of items in Spanish ending with vowels—shows a high degree of productivity. In contrast, the far lesser occurrence and productivity of words that contrast with that pattern, i.e. antepenultimate and final-stress words, is assured. Indeed, items may undergo alteration to better conform to more frequent, more productive patterns. For example, traditionally antepenultimate words such as *período* [pe.ˈɾi.o.ðo] very frequently surface as *periodo* [pe.ˈɾjo.ðo] and in fact spelling without the accent showing the antepenultimate stress is now widespread. Something similar, if less overt due to the lack of stress marking, occurs in some dialects of English, where the penultimate (trochee-based) accentuation pattern may shift the final stress of words such as *garage* [gə.ˈɹɐʒ]—a borrowing from French—to the preceding syllable: [ˈga.ɹɐʒ]. The type frequency of the trochaic stress pattern is so great that 'aberrant' forms are adapted to suit it.

In quantity-sensitive languages, such patterns would also take into account weight distribution in the word, such that a pattern exemplified by *sábana* '(bed)sheet' in Spanish acts as a template that licenses similar type constructions: ˈCV.CV.CV. We might therefore expect resistance in terms of acceptability judgments when virtually unrepresented patterns such as ˈCV.CV.P^{al}V. (a word with antepenultimate stress with a final palatal onset) arise, just as unrepresented sequences with final off- or onglides might well meet resistance from native speakers: ˈCV.CV.CVG or ˈCV.CV.CGV.

This approach also indicates the sort of empirical testing described above. Native speaker acceptability judgments of words reflecting different patterns would test the accessibility and hence acceptability of the different stress patterns. The working

hypothesis of such a test is that less frequently attested or indeed non-occurring stress patterns in Spanish should trigger the lowest ratings of acceptability. Moreover, another possible angle is suggested: in light of the notion of accessibility mentioned above, reaction times of participants would be quite meaningful. Less easily accessed patterns should require more time for processing than the most productive patterns as speakers 'scan' for the token type. On the other hand, in a rule-based or even constraint-based approach to stress-assignment, there should be no consistent evidence of variant reaction times: patterns either conform to licit outputs or not. Such a test could therefore provide not only evidence of the productiveness of various stress patterns in Spanish but also, on a higher level, of the viability of articulation- and usage-based approaches.

6.3.2.2 Consequences for the current analysis

Bybee's (2001) and Mielke's (2004) approaches suggest that de-emphasizing the feature geometry of the segments in question is apt. The phonetic element that seems to matter most here, the degree of coarticulatory resistance (or articulatory binding, as I have occasionally termed it) is not easily captured by feature geometry models. The flexibility needed to reflect the full range of phonetic detail and describe classes built around recurrent phonetic effects is ill captured in rigid models. For example, the fact that geminate /r/ seems to belong in a class with the palatal resonants and the palatal approximant is not readily transparent in any feature geometry model, though they apparently share a high degree of coarticulatory resistance that may well inform their effect on the Spanish stress window.

On the other hand, Bybee's ideas suggest that Optimality Theory, as a generative approach, is also disadvantaged. Consider that in usage-based approaches, humans are believed to store networks of fine phonetic detail informing every item in their lexicon.

That phonetic detail in turn informs language use, which itself continuously shapes the language structure with every utterance. Patterns arise due to frequency effects: distributionally high-frequency forms or patterns are most commonly (and most readily) judged acceptable, while uncommon forms are less readily accessed, in proportion to their distribution. Language change flows naturally from such an approach. Under social forces or language impact, or due to ceaseless internal change, one pattern attains higher distribution, reinforcing its place in the system with each utterance. In comparison, constraints get reranked over time simply because we know they do; no real mechanism is detailed in the OT architecture for constraint demotion or promotion.

Moreover, the very concept of more or less acceptable patterns contradicts the generative approach. In a rule-based system, the rules are conceived as being equally acceptable, thus disallowing any such gradient effects. Like its rule-based predecessor, OT assumes that a great deal of language performance springs directly from the grammar, such that words are shaped not by retained lexical knowledge but rather by constraint interaction. Gradient phonetic effects are incidental and only appear at the surface. Such an approach affords a certain economy to language system; speakers theoretically do not have to access fully defined phonological units. However, there is no mechanism by which lexically stored phonetic details can alter the basic architecture of the constraint ranking (except through exceptional lexical marking). OT constraints perhaps seem to provide a sort of gradiency via ranking, but there is nonetheless a static element in the very notion of a fixed ranking for particular grammars. Moreover, both generative approaches isolate the grammar—as an array of rules or ranked constraints—from the

lexicon, in which speakers apparently store only exceptional or idiosyncratic material that fails to follow established patterns.

The foregoing discussion is not meant to undermine the validity of the present work but rather to acknowledge that phonological theory is, like language, in a constant state of flux and will devise new means of approaching the data that provide for ever more nuanced understanding of the complex details of human language. Given the cognitive bent of much of the new work in the field, however, as well as the relative newness of such approaches, Optimality Theory will certainly continue to provide a straightforward, highly transparent means of describing the complex negotiation of systemic forces shaping human language. That is, despite the 'organic' appeal of usage-based approaches and their appeal to human cognition, OT's interaction of phonetically grounded constraints provides for clear modeling of the conflict between articulatory, perceptual, and communicative drives. This is particularly evident in the Dispersion Theory framework, where phonetic detail figures prominently, as discussed in Chapter 4. Indeed, while the new approaches seem to provide intuitively satisfying accounts of language use and change over time, OT seems destined to remain for some time the best framework for the description and illustration of synchronic approaches.

Moreover, the general findings of the present work are not dependent upon any particular framework. Recognition of a drive in language change that operates independently of the (perhaps over-used and under-defined) concept of lenition is valid in any approach to phonological processes. Such a drive is merely formalized in OT as the CONDENSE constraint; the concept is useful in non-OT approaches, as we have seen in the ideas of Mowrey & Pagliuca (1995), and indeed could have figured in earlier, rule-based

generative frameworks. The key concepts of dispersion theory as employed in this work are likewise independent of any particular framework: contrast maintenance and auditory salience have long been part of accounts of historical sound change (e.g. Lloyd 1987, Penny 1991) and have figured as well in synchronic accounts (e.g. Ohala 1993a, 1993b). More importantly, the articulatory and acoustic data adduced here to underpin the analysis of the Spanish palatals must be taken to be universal to human language. Given that the physiology of the human vocal mechanism is a common factor in all human speech production, as would seem to be the mechanics of human speech perception, the phonetics cited here to validate the phonological assertions of this work should transcend and outlast the limitations of the theoretical model in vogue. From such a perspective, the view espoused in this work of the palatals as complex, moraic segments provides a means of better understanding their diachronic and synchronic behavior in phonological and phonetic terms, both in Romance and beyond.

APPENDIX A
NUCLEAR VOWEL DURATION IN CV, CVC, CGV(C), AND C(G)VP[AL]
SYLLABLES IN SPANISH

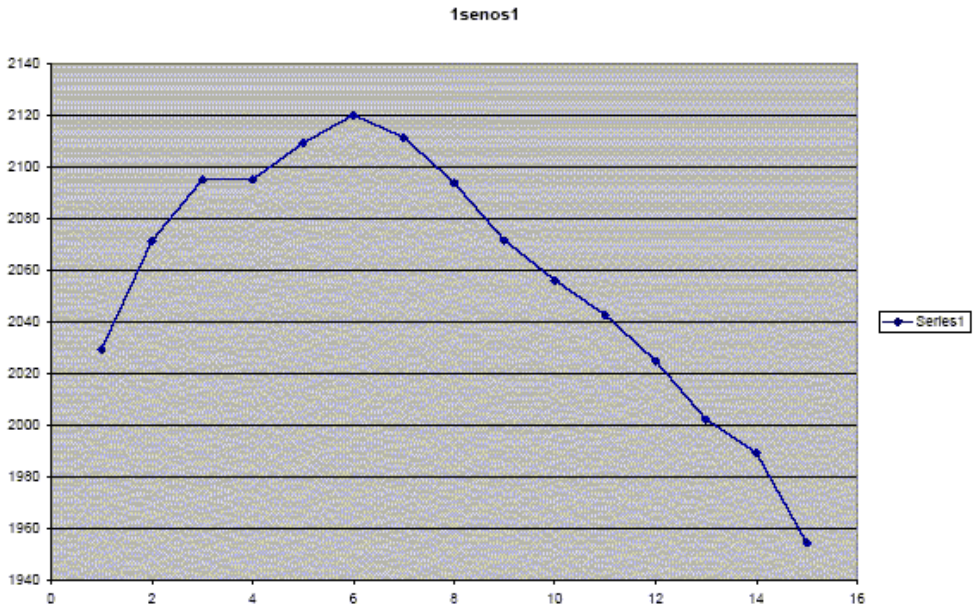
speaker	word	token #1	(%)	token #2	(%)	token #3	(%)	av.
#1 (AB)	seta CV/V	185/54	29	157/44	28	165/48	29	29
#2 (MG)	seta CV/V	165.7/59	35.5	174.5/61.4	35.2	150.7/39.7	26.3	32
#3 (PR)	seta CV/V	198/71	35.8	213/87	41	205/83.5	41	39
#1 (AB)	senda CVC/V*C*	262.7/57.6 *78.8*	22	249/44.6 *77.3*	18	243.8/58.8 *63*	24	21
#2 (MG)	senda CVC/V*C*	240/56.3 *75*	23.5	242.4/69.5 *70.5*	28.7	234.5/68 *67.5*	29	27
#3 (PR)	senda CVC/V*C*	312/64.8 *115.7*	20.8	329.5/89.8 *135*	27	339.4/94.4 *133*	27.8	25
#1 (AB)	seña CV(C)/V*C*	239.5/33 *74*	13.8	206.7/33.8 *41.6*	16	218/49.8 *48.8*	23	18
#2 (MG)	seña CV(C)/V*C*	198/48 *47*	24	204.8/54 *43.7*	26	207/63.6 *37.6*	31	27
#3 (PR)	seña CV(C)/V*C*	191.6/47 *59.6*	24.5	294/108 *77*	37	322.6/107.5 *87.7*	33	32.
#1 (AB)	suelo CGV/GV	216.5/71	33	222.7/71.2	32	218.7/64.6	29.5	31.5
#2 (MG)	suelo CGV/GV	227.6/90.6	40	226.7/91.4	40	196/69.3	35.3	38.4
#3 (PR)	suelo CGV/GV	260/99	38	268/136	51	257.5/123	48	45.6
#1 (AB)	suerte CGVC/GV*C*	231.6/58 *38*	25	223/51.4 *35.4*	23	223/47.6 *46.5*	21	23
#2 (MG)	suerte CGVC/GV*C*	208/73.6 *32.4*	35	293.5/102.8 *45*	35	237/63.6 *45.6*	27	32
#3 (PR)	suerte CGVC/GV*C*	251/83.2 *42.3*	33	308.4/120 *52*	39	330.5/134 *80.5*	40.5	37.5
#1 (AB)	sueña CGV/GV*C*	280/78.2 *45*	28	228.3/37.5 *49.5*	16	223.6/45.2 *51.3*	20	21
#2 (MG)	sueña CGV/GV*C*	242/71.6 *46.6*	29.5	286.4/107 *46*	37	249/91 *42.6*	36.5	34
#3 (PR)	sueña CGV/GV*C*	353.4/141 *85*	40	363.3/143 *91.7*	39	358.6/135 *96.5*	37.6	39
#1 (AB)	meta (CV/V)	131.7/61.8	47	110/58.7	53	127/72.5	57	52.3
#2 (MG)	meta (CV/V)	118/57	48	121/55	45.5	140.5/78.5	55.9	49.8
#3 (PR)	meta (CV/V)	137/72.7	53	172/90.5	52.6	161.6/87.5	54	53.2
#1 (AB)	mente CVC/V*C*	157.3/60.2 *41.1*	38.3	149/56.7 *38.8*	38	167.5/71.5 *35.8*	42.7	39.6
#2 (MG)	mente CVC/V*C*	181.6/55.7 *51.6*	30.7	171.6/59 *55.3*	34.4	161.7/79 *39.6*	48.8	38
#3 (PR)	mente CVC/V*C*	196/82.6 *49.9*	42	291/80.1 *121.7*	27.5	290.4/103.2 *109*	35.5	35
#1 (AB)	mecha CV(C)/V	161/79	49	126/58	46	108.7/46.5	42.8	45.9
#2 (MG)	mecha CV(C)/V	131.5/62.5	47.5	110.7/52	47	130.6 /59	45	46.5
#3 (PR)	mecha CV(C)/V	145.8/84.8	58	175.3/101.8	58	166/94.7	57	57.6
#1 (AB)	mueca CGV/GV	164.8/85.6	52	168.7/84.6	50	194/93.4	48	50
#2 (MG)	mueca CGV/GV	149/84.9	57	147/76.9	52.3	177.4/96	54	54.4
#3 (PR)	mueca CGV/GV	167.5/85	50.7	231/103.2	44.7	223.3/103	46	47
#1 (AB)	muerte CGVC/GV*C*	190.3/80.3 *33.5*	42.2	194/69.5 *30.6*	35.8	179.4/70.4 *32.1*	39.2	39
#2 (MG)	muerte CGVC/GV*C*	216/73.5 *59*	34	197.5/79.5 *48.3*	40.2	195.5/80.2 *37*	41	38.4
#3 (PR)	muerte CGVC/GV*C*	245.6/116.5 *29.6*	47.4	282.8/119 *65.3*	42	361/112.3 *109.3*	31	40.1
#1 (AB)	muelle CGV/GV	166.4/85.8	51.5	202.5/127.4	63	204.5/110	53.8	56.1
#2 (MG)	muelle CGV/GV	181.9/95.6	52.5	198.6/130.8	66	213.2/136	63.8	60.8
#3 (PR)	muelle CGV/GV	270.8/184.6	68	328/212.6	64.8	336/204.8	61	64.6

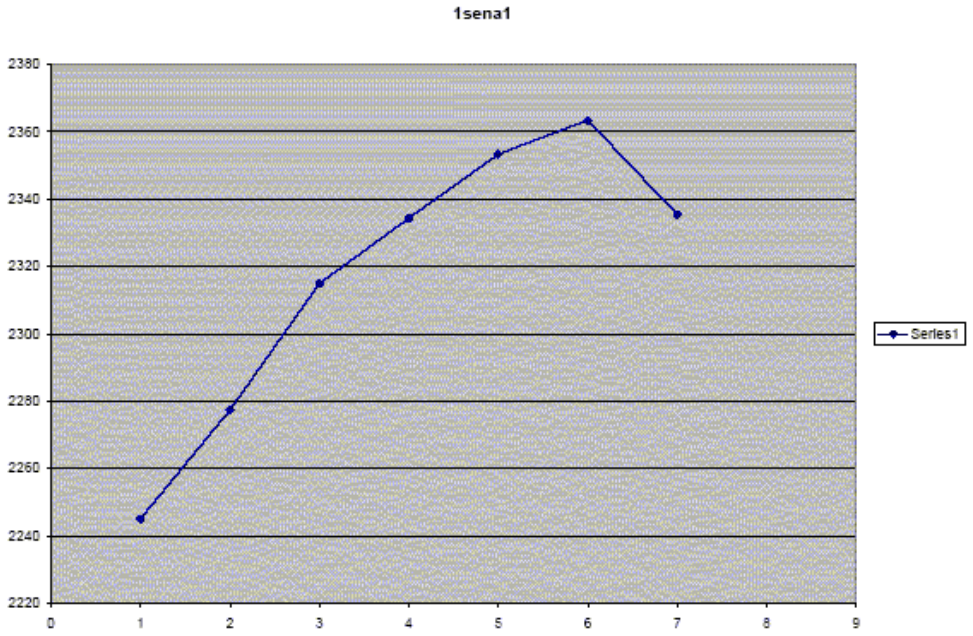
APPENDIX B
WORDLIST FOR THE ACOUSTIC TESTS

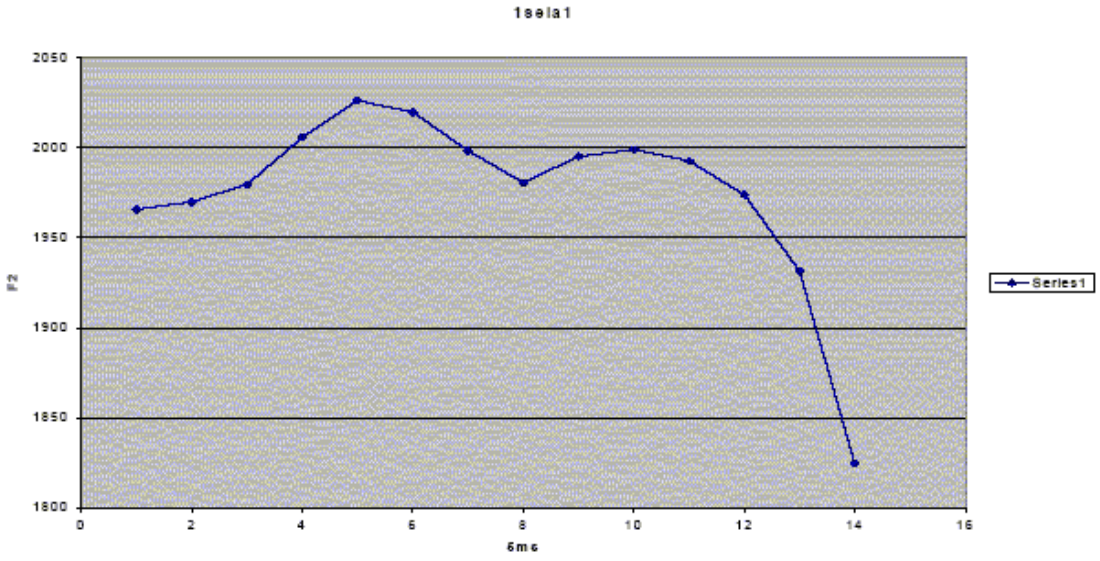
Se dice que las setas silvestres causan locura. Digo setas para ti.
Acabamos en una senda perdida en la selva. Digo senda para ti.
Tienes que dejarles una seña para que lo guarden. Digo seña para ti.
No es una cuestión de suerte sino de amiguismo. Digo suerte para ti.
Se alegró de pisar su suelo natal. Digo suelo para ti.
Su hermana sueña con socorristas australianos. Digo sueña para ti.
Los siete enanos fueron corriendo hacia la bruja. Digo siete para ti.
Una persona decente nunca haría eso. Digo decente para ti.
Sería mejor deshacerte de él. Digo deshacerte para ti.
Sin café, siento sueño. Digo siento para ti.
Nunca he esquiado en la Sierra Nevada de Andalucía. Digo sierra para ti.
La sopa quedaba fría. Digo sopa para ti.
Paco vació todo el cubo en el suelo. Digo vació para ti.
Cerraron la casita de vacación temporalmente. Digo vacación para ti.
¡Ni un dedo en el flan! Digo "dedo" para ti.
Agarren y denle la plata. Digo "denle" para ti.
La pobre vive en duelo perpétuo por su perrito. Digo "duelo" para ti.
Los payos no encuentran el duende nunca. Digo "duende" para ti.
En tres años nunca vio al dueño de su casa. Digo "dueño" para ti.
Analiza los datos de inmediato. Digo "datos" para ti.
Nunca devolvió la dote de su novia desaparecida. Digo "dote" para ti.
Pilar aprecia la danza mucho más que yo. Digo "danza" para ti.
Esa chica tiene el don de la labia. Digo "don" para ti.
Han vuelto dos de los mejores. Digo "dos" para ti.
El gran comediante murió antes de terminar el rodaje. Digo "comediante" para ti.
Chac-mul era el dios de la lluvia entre los indígenas. Digo "dios" para ti.
Hay que ponerse metas realistas en la vida. Digo "metas" para ti.
Lo que tienes en mente no se puede realizar. Digo "mente" para ti.
Hacen gracia las muecas que se ven en el gimnasio. Digo "muecas" para ti.
Se ha hecho mechas rubias en el flequillo. Digo "mechas" para ti.
No acaba de aceptar la muerte súbita de su gato. Digo "muerte" para ti.
Caminamos por el muelle principal del puerto. Digo "muelle" para ti.
Suelo tomar el té por la mañana. Digo "té" para ti.
Hay pocos tan tercos como éste. Digo "tercos" para ti.
Se anunció una tregua general. Digo "tregua" para ti.
Un cadáver tieso puede estorbar bastante. Digo "tieso" para ti.
El sol le ha estropeado la tez de su cara. Digo "tez" para ti.
En la vida he tomado el tren para ir de viaje. Digo "tren" para ti.
Hemos contado casi treinta faltas en dos días. Digo "treinta" para ti.

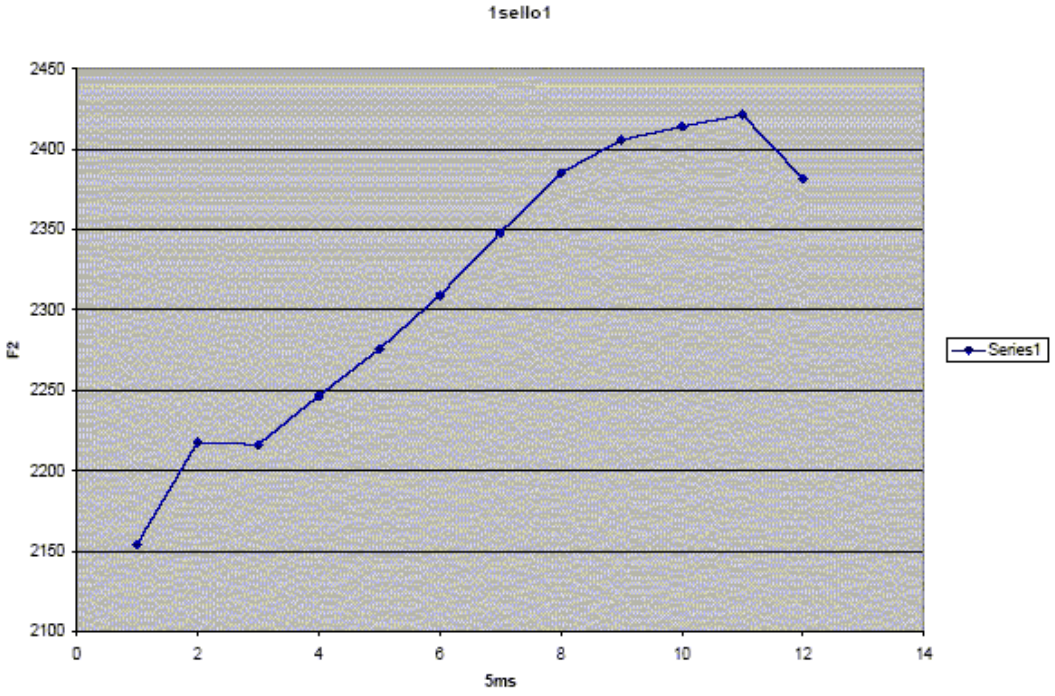
Ese cabrón se muestra lo más tierno posible con su hija. Digo “tierno” para ti.
¿Tienes tiempo para un café? Digo “tiempo” para ti.
Tuvo su máximo triunfo como director, no actor. Digo “triunfo” para ti.
Imaginemos la tierra cubierta con agua. Digo “tierra” para ti.
La típica maruja en bata desgastada ya no hace gracia. Digo “bata” para ti.
Las cosas livianas son lo único que le interesa. Digo “livianas” para ti.
Le parece bárbaro lo de Mariana. Digo “bárbaro” para ti.
Ha pasado a la banda de los exiliados. Digo “banda” para ti.
Yo creo que cambiar la naturaleza humana es de lo más inútil. Digo “cambiar” para ti.
Parece un buey por haber hecho tantas pesas. Digo “buey” para ti.
Los vientos serranos de Escocia me encantan. Digo “vientos” para ti.
Nunca devolvió la dote de su novia desaparecida. Digo dote para ti.
El pobre quedó tuerto en un tiroteo. Digo tuerto para ti.
Me dijo “verte” sin vergüenza. Digo verte para ti.
Me dijo “veinte” sin vergüenza. Digo veinte para ti.
Me dijo “vete” sin vergüenza. Digo vete para ti.
Me dijo “vente” sin vergüenza. Digo vente para ti.
Llorar en tales circunstancias no sirve para nada. Digo llorar para ti.
Ella ha pasado a la banda de los exiliados. Digo banda para ti.

APPENDIX C
SCATTERPLOTS OF COMPARATIVE F2 CONTOURS FOR *SENOS~SEÑA* AND *SELA~SELLOS*.






1sela1
2050
2000
1950
1900
1850
1800
F2
0
2
4
6
8
10
12
14
16
6ms
Series1


1sello1
2450
2400
2350
2300
2250
2200
2150
2100
F2
0
2
4
6
8
10
12
14
5ms
Series1

APPENDIX D
COMPARATIVE LENGTHS OF NASALS IN ONSET (*SENOS*), CODA (*SENDA*), AND PALATAL (*SEÑA*) IN SECONDS

Token	N1Dur	R1Dur	Norm
1seña1	0.0511	0.0389	-0.0121
1seña2	0.0348	0.0449	0.01
1seña3	0.0441	0.0446	0.0005
1senda1	0.0746	0.0546	-0.0199
1senda2	0.0685	0.0493	-0.0193
1senda3	0.0577	0.0497	-0.0081
1senos1	0.0358	0.0522	0.0164
1senos2	0.039	0.0502	0.0112
1senos3	0.0394	0.0524	0.013
2seña1	0.0439	0.0627	0.0188
2seña2	0.0285	0.0434	0.0149
2seña3	0.0345	0.0467	0.0122
2senda1	0.0725	0.0361	-0.0364
2senda2	0.0614	0.0508	-0.0106
2senda3	0.058	0.0515	-0.0065
2senos1	0.0388	0.0374	-0.0014
2senos2	0.056	0.0736	0.0177
2senos3	0.0417	0.0586	0.0169
3seña1	0.0583	0.0702	0.012
3seña2	0.0754	0.0714	-0.004
3seña3	0.086	0.0735	-0.0125
3senda1	0.0997	0.0668	-0.0329
3senda2	0.1176	0.0874	-0.0302
3senda3	0.12	0.0689	-0.0511
3senos1	0.0618	0.0747	0.0128
3senos2	0.067	0.0703	0.0033
3senos3	0.0561	0.067	0.011

Token	N1Dur	R1Dur	Norm
4seña1	0.0739	0.0641	-0.0098
4seña2	0.0571	0.0833	0.0262
4seña3	0.0603	0.0403	-0.02
4senda1	0.105	0.0482	-0.0568
4senda2	0.0849	0.0558	-0.0291
4senda3	0.1014	0.0429	-0.0585
4senos1	0.0704	0.061	-0.0094
4senos2	0.04	0.0446	0.0046
4senos3	0.0395	0.0425	0.0029
5seña1	0.0526	0.0554	0.0028
5seña2	0.0512	0.045	-0.0063
5seña3	0.0461	0.0384	-0.0076
5senda1	0.0535	0.0434	-0.0101
5senda2	0.0721	0.0347	-0.0374
5senda3	0.0656	0.0432	-0.0225
5senos1	0.0521	0.0416	-0.0104
5senos2	0.0501	0.0219	-0.0282
5senos3	0.049	0.0335	-0.0155

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BIOGRAPHICAL SKETCH

Gary Kenneth Baker completed his B.A in English and Theatre at the University of Georgia in 1984, graduating with General Honors and Special Honors. After a long vacation in Paris and preliminary coursework at Georgia State University, he began a Masters in Romance Languages (linguistics track) at UGA, focusing on French with a minor in Spanish. He taught French and Spanish for two years before moving to Madrid, where he received residency status and taught as an English professor in a private adjunct of the Complutense. He repatriated to begin his doctoral work and received a Fellowship to study at the University of Florida in the Department of Romance Languages and Literatures in 1999, focusing on Spanish with a French minor (linguistics track). He taught various levels of Spanish as part of the program and received his Ph.D. in 2004.