UNIVERSITY OF CALIFORNIA, SAN DIEGO

A Crosslinguistic Investigation of Palatalization

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy

in

Linguistics

by

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The Dissertation of Nicoleta Bateman is approved, and it is acceptable in quality and form for publication on microfilm:

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Chair

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2007

I dedicate this dissertation to my family.

Această teză este dedicată familiei mele.

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CHART OF SYMBOLS

Source symbol	Source description	IPA symbol	IPA description
ś ɕ	Prepalatal fricative (voiceless)	ɕ	Alveolo-palatal fricative (voiceless)
ź ʑ	Prepalatal fricative (voiced)	ʑ	Alveolo-palatal fricative (voiced)
ć tɕ	Prepalatal affricate (voiceless)	tɕ	Alveolo-palatal affricate (voiceless)
ʒ́ dź dʑ	Prepalatal affricate (voiced)	dʑ	Alveolo-palatal affricate (voiced)
ń ɲ	Prepalatal nasal	ɲ	Palatal nasal (alveolo-palatal nasal)
š	Post-alveolar fricative (voiceless)	ʃ	Post-alveolar fricative/Palato-alveolar fricative (voiceless)
ž	Post-alveolar fricative (voiced)	ʒ	Post-alveolar fricative/Palato-alveolar fricative (voiced)
č c tš	Post-alveolar affricate (voiceless)	tʃ	Post-alveolar affricate/Palato-alveolar affricate (voiceless)
ǰ ǧ dž	Post-alveolar affricate (voiced)	dʒ	Post-alveolar affricate/Palato-alveolar affricate (voiced)
c	Dental affricate (voiceless)	ts	Dental affricate (voiceless)
dz	Dental affricate (voiced)	dz	Dental affricate (voiced)
C’	Palatalized consonant	C^j	Palatalized consonant
t’	tense *t* (Korean)	t’	tense *t* (Korean)
s’	tense *s* (Korean)	s’	tense *s* (Korean)
C’ Cˀ		C’	Glottalized consonant (ejective)
x̯	centro-domal fricative		?? no known symbol
f	voiceless bilabial fricative	ɸ	voiceless bilabial fricative
		i̧ u̧	superclosed high vowels (in Bantu)
ɩ	semi-close high vowel		

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ABSTRACT OF THE DISSERTATION

A Crosslinguistic Investigation of Palatalization

by

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Professor Sharon Rose, Chair

This dissertation presents both a descriptive and a formal account of palatalization patterns as identified in a balanced sample of 117 languages. I distinguish between two palatalization types, one involving a primary place of articulation change (*full palatalization*, e.g. t→ tʃ), the other involving the acquisition of a secondary palatal articulation (*secondary palatalization*, e.g. t→ t^j). The focus is on similarities/differences in palatalization patterns due to the place of articulation of target consonants, and on palatalization triggers. I develop a formal analysis which uses Articulatory Phonology (AP) and Optimality Theory (OT), making crucial

reference to the oral articulators (lips, tongue) that produce the sounds involved in palatalization and their interaction during speech production.

Two main patterns are identified regarding palatalization triggers: (i) if lower front vowels are triggers, so are higher front vowels; (ii) if high back vowels are triggers, so are high front vowels. Regarding palatalization targets, I identify a striking dependency of labial palatalization on the palatalization of coronal and dorsal consonants: while coronal and dorsal palatalization can be independent or co-occurring in a given language, labial palatalization is always dependent on the palatalization of coronals and dorsals. Furthermore, labials do not undergo full palatalization. The few cases where this appears attested are explained via diachronic changes which did not involve palatalization of the labial itself. Historical evidence indicates that a palatal glide following the labial hardened to a palatal consonant, and that the labial ultimately deleted.

The proposed account explains the occurrence of palatalization, as well as the general palatalization patterns and labial palatalization. Paltalization is viewed as the result of temporal overlap of articulatory gestures produced with the two major articulators, tongue and lips. Full palatalization results from great overlap of tongue gestures, and secondary palatalization results from minimal overlap of tongue/tongue or lips/tongue gestures. The formal OT implementation relies on constraints that have an articulatory motivation and also capture the dependency of labial palatalization on the palatalization of coronal and dorsal consonants. The results of the crosslinguistic study and the formal analysis demonstrate that phonetic articulation must be incorporated in the explanation of phonological patterns.

CHAPTER 1

SETTING THE STAGE

1.1 Introduction

Palatalization is a familiar notion in phonology, though many different processes are often included under this cover term. The motivation for such inclusion stems from the fact that these processes result mainly from the interaction of consonants with front vowels, high vowels, and the palatal glide *j*. These processes have been referred to by many names: *palatalization* (a consonant acquires secondary palatal articulation *t*→ t^j, Hume 1994), *coronalization* or *fronting* and simultaneous *spirantization* (a velar stop becomes a coronal affricate *k*→ *tʃ*, Hume 1994, and Bhat 1978, respectively), *raising* (an apical consonant is raised *t*→ *tʃ*, Bhat 1978), *spirantization* (a consonant is spirantized in a palatalizing environment *r*→ *s*, Bhat 1978), or *assibilation* (a dental stop *t* becomes *ts* before a front vowel *i*, Telfer 2006, Kim 2001). Various of the above-mentioned processes have been addressed in the literature at different times (see, among many others, Hume 1994 on coronalization, Telfer 2006 on assibilation as coronalization, Bhat 1978 on fronting, raising and spirantization), yet a comprehensive study of all of these processes has not been put forth.

Bhat's (1978) typological survey of palatalization remains the largest scale survey of this process to date, covering 120 instances of palatalization, but it only provides basic generalizations and line statements with references about what happens in a given language (i.e. "In CAYUVAVA, *h* becomes *š* before *i*, *e* in rapid speech (Key 1961)", p. 65). He does not provide any data, and his main goal is to argue for the existence of three distinct processes in palatalization: tongue fronting, tongue raising, and spirantization. In addition, Bhat is concerned primarily with one type of palatalization, which I call *full palatalization* below, and also includes cases of spirantization in his study, which I do not consider palatalization. Nevertheless, Bhat does provide valuable insights into palatalization, and I provide more details about these insights in section 1.4.2 of this chapter.

Others who studied palatalization have been concerned with different aspects thereof (i.e. Kochetov 2002 with contrasts between plain and (secondarily) palatalized stops in Slavic languages, Hall 2000 with secondary palatalization of rhotics), therefore a unified account of palatalization is still lacking.

This dissertation is concerned with an investigation of palatalization which covers a majority of the above-mentioned processes. I will refer to two types of palatalization: in one case the consonant shifts its primary place and often its manner of articulation while moving toward the palatal region of the vocal tract, as in (1), and in the other it is co-articulated with a following palatal offglide, as in (2)[1].

(1) Full Palatalization

k, t → tʃ

/dont ju/ → [dontʃju] 'don't you' (English)

[1] By primary place of articulation I mean the most specific place, i.e. alveolar vs. palato-alveolar. A major place change would involve a change from dorsal to coronal, for example.

(2) Secondary palatalization

t, d → t^j, d^j

/yamati/ → [yamat^{j}i] 'a person' (Watjarri, W. Pama Nyungan; Douglas 1981)

Cases of palatalization as that in (1) are analogous to Bhat's (1978) *fronting* and *spirantization*, and to Hume's (1994) *coronalization* in the case of velars. Cases as that in (2) are analogous to Hume's *palatalization*, and Bhat's *tongue raising*. In this dissertation I use the term *full palatalization* to refer to cases as that in (1) and *secondary palatalization* to refer to cases as that in (2), while using *palatalization* as a cover term for both. Instances of *assibilation* (where the resulting sound is *not* shifting toward the palatal region of the vocal tract) are also noted for individual languages, but will not be included in the general analysis. In establishing palatalization generalizations I rely on data collected from grammars of 117 genetically and geographically diverse languages, as well as on previous research on palatalization (Chen 1973, Bhat 1978, Lahiri and Evers 1991, Hume 1994, Hall 2000, Kochetov 2002, among others).

1.2 Goals and organization

The aim of this dissertation is twofold. The first goal is descriptive typology, namely to identify the patterns of palatalization in a wide variety of languages. The second goal is to develop theoretical principles to account for the patterns of palatalization observed, particularly concerning full and secondary palatalization. To these ends I conduct a comprehensive cross-linguistic survey and document the cases of palatalization. Chapter 2 provides a detailed description of the languages in the survey along with the palatalization patterns found. A file entry for each of the languages with palatalization is included as the final appendix to this thesis. Theoretical accounts for the patterns uncovered are explored in chapters 3, 4 and 5.

The dissertation is structured as follows. In the remaining sections of this chapter I provide my operational definition of palatalization and present finer grained distinctions to be made when analyzing the palatalization findings. I also review previous surveys of palatalization (Chen 1973, Bhat 1978, and Hall 2000), as well as some of the previous analyses of palatalization. Chapter 2 describes the language sample and details the patterns of palatalization emerging thereof, comparing my own findings with those in previous literature. I show that my generalizations are compatible with some of the previous findings (Bhat 1978, Hall 2000), but that they also challenge Chen's (1973) implicational hierarchy of full palatalization, as well as Hume's (1994) and Clements and Hume's (1995), and Lahiri and Evers' (1991) analyses of palatalization.

In Chapter 3 I discuss full labial palatalization in detail and demonstrate that full labial palatalization does not occur in the same sense it does as full palatalization with coronal and dorsal consonants. I discuss the cases of labial palatalization in the Moldavian dialect of Romanian (Romance, Romania) and in Tswana (Southern Bantu, Botswana), the two languages in my sample where full labial palatalization is attested, and I demonstrate that in these two languages, as well as in their respective immediate language families, labial consonants do not themselves palatalize. Instead, the observed synchronic alternations between labial and palatal sounds can be traced back to historical developments involving the hardening of a palatal glide which followed the labial, and subsequent deletion or absorption of the labial.

In chapter 4 I provide a brief background on Articulatory Phonology (AP) (Browman and Goldstein 1986 et seq., Byrd 1996a, b, Gafos 1999, 2002, Kochetov 2002, Davidson 2004) and Optimality Theory (OT) (Prince and Smolensky 1993), followed by an analysis of the general patterns of palatalization targets using gesturally-based constraints. I propose that the best way to capture the patterns of palatalization observed is to employ a gesturally-based optimality theoretic account that takes as the basis for palatalization the gestures produced during speech and the ways in which they interact. Chapter 5 presents a similar analysis for palatalization triggers, and chapter 6 provides conclusions and discusses issues for further research.

1.3 Dimensions of palatalization

Given the nature of the first goal of this dissertation, descriptive typology, my approach to the cross-linguistic survey relied on the following operational definition of palatalization (not taking into account any formal theoretical analysis):

(3) *Operational definition of palatalization*

- Any instance where a consonant changes its place features to palatal-like, regardless of the nature of the trigger.
- Any instance of a consonant acquiring a secondary palatal articulation.

The term “palatal” in the first bullet point above is defined as the region from the corner behind the alveolar ridge (marked as ‘corner’ in figure 1.1) to the end of the hard palate of the vocal tract (between hard palate and soft palate). This region includes the alveo-palatal and palatal places of articulation. In addition, alveolo-palatal has also been identified for sounds that are prepalatal (closer to the palatal region than to the corner behind the alveolar ridge).

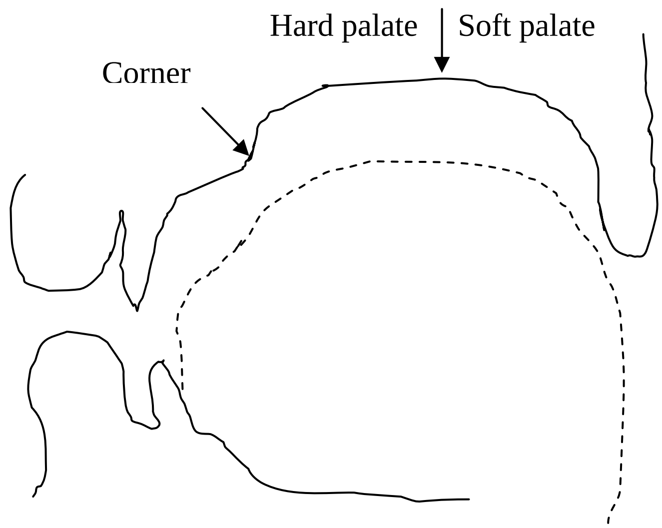
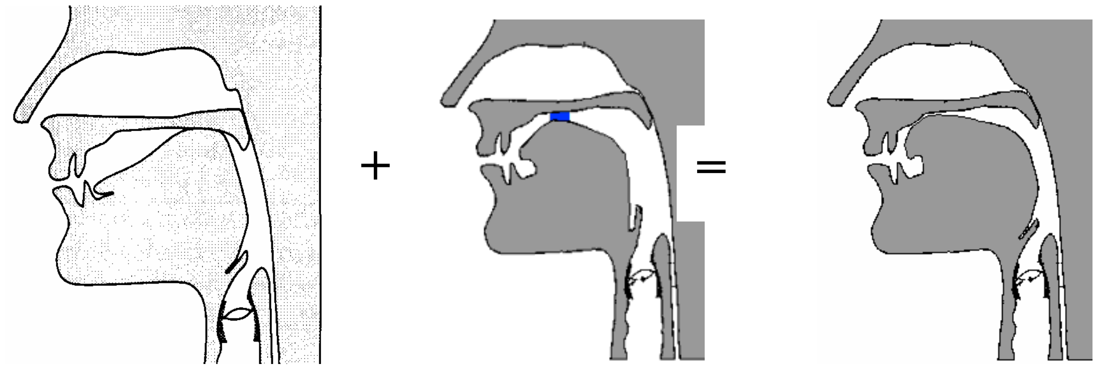


Figure 1.1 Palatal region of the vocal tract. Adapted from Keating (1991:32).

A secondarily palatalized consonant is not greatly affected by a palatalizing vocoid: the consonant maintains its primary place of articulation, whether labial, alveolar, or velar, and in addition it will have a secondary palatal articulation, with the tongue raised toward the palatal region (hard palate). On the other hand, in full palatalization from *k* or *t* to *tʃ* the shift in primary place of articulation suggests a greater effect of the palatalization trigger on the target. The configuration of the vocal tract, the speech articulators, the places of articulation of different consonants (labial, alveolar, velar) and the palatalization triggers allow us to make certain predictions about possible full palatalization outcomes. I discuss these predictions below using articulatory representations of prototypical labial, alveolar and velar consonants *p*, *t*, *k*, and the prototypical palatalizing vowel *i*. I show that while velars (dorsal) and alveolars (coronal) consonants are predicted to fully palatalize, as they are articulated with the tongue—the same articulator used to produce the vowel *i*, labial consonants are predicted *not* to fully palatalize, as they are articulated with the lips—a different articulator than that used to produce the vowel *i*.

First consider figure 1.2, representing the articulator positions for velar target *k*, trigger *i*, and the outcome of full palatalization *tʃ*. During the articulation of *k*, the velar closure is achieved by the tongue body at the velar region of the vocal tract. The articulation of the vowel *i* is achieved by a narrow constriction of the tongue body at the palatal region of the vocal tract. When the articulatory gesture of the vowel follows that of the consonant, the tongue body pulls forward toward the palatal region, resulting in the palato-alveolar *tʃ*, a case of target undershoot.[2] This appears to be a natural outcome arising out of the interaction of the articulatory gestures of the consonant and the vowel, both of which use the tongue articulator.

[2] In chapter 4 I discuss the potential reasons why full palatalization of k most often results in a palato-alveolar *tʃ* and not a palatal stop *c*. This is connected to degree of articulatory effort when producing a *c* (Lee 1999, 2000).



k ***i*** ***tʃ***

Figure 1.2 Articulator positions for velar palatalization.[3]

Next consider figure 1.3, representing the articulator positions for the alveolar target *t*, the trigger vowel *i*, and the outcome of full palatalization *tʃ*. During the articulation of *t* the alveolar closure is achieved by a tongue tip constriction at the alveolar region. The representation of the vowel *i* and that of the outcome of palatalization *tʃ* are the same as in figure 1.2. When the vowel tongue body articulatory gesture follows that of the tongue tip gesture, the tongue body pulls back, and the consonantal target is overshot, with the constriction being achieved at the palato-alveolar region—at a location between the intended target of the alveolar consonant and the palatal vowel. As is the case with full palatalization of velar *k*, the full palatalization of alveolar *t* also seems to be a natural change arising out of the interaction of the articulatory gestures of the consonant and the vowel.

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[3] These figures and the ones below are from Cipollone et al (1998) and the Language Samples Project website http://www.ic.arizona.edu/~lsp/Phonetics/ConsonantsI/Phonetics2a.html.

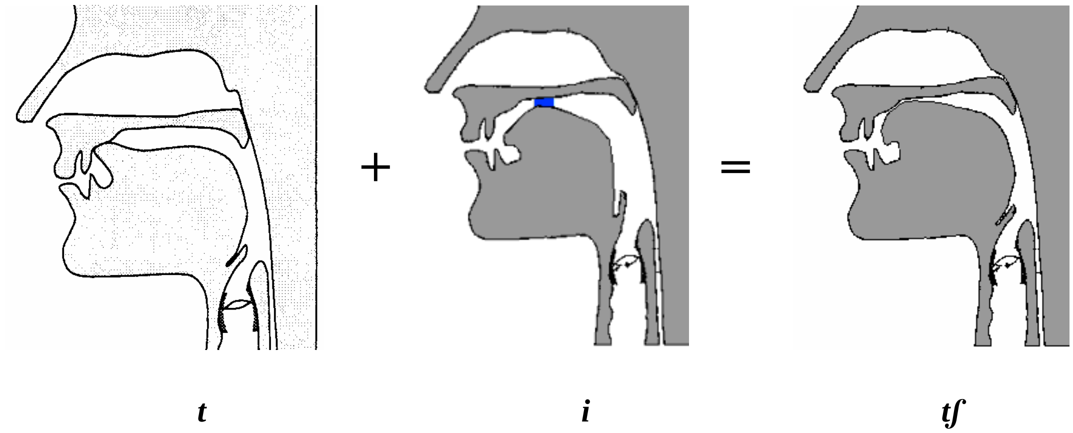

Figure 1.3 Articulator positions for alveolar palatalization.

Finally, consider figure 1.4, representing the articulator positions for the bilabial target *p*, the trigger vowel *i*, and, in this case, the hypothetical full palatalization outcome *tʃ*. The bilabial closure of *p* is achieved by closing the lips. The vowel *i* and the palato-alveolar *tʃ* are articulated as before, with a tongue body narrow constriction at the palatal region, and a tongue body constriction at the palato-alveolar region, respectively. However, unlike in the case of velar and alveolar palatalization, the change from labial to palato-alveolar would not be the result of assimilation of nearby articulations. The lips and the tongue are independent articulators, and the tongue gesture of the vowel *i* is not expected to disturb the lip gesture of the bilabial *p* in the same way it did the tongue gesture of *t* and *k*. The lips and the tongue do not interact in the same way as the different parts of the tongue do (e.g. tongue tip and tongue body). On the other hand, bilabial *p* is predicted to show secondary palatalization, as this involves only the raising of the tongue body toward the palatal region. The bilabial articulation is not itself changed.

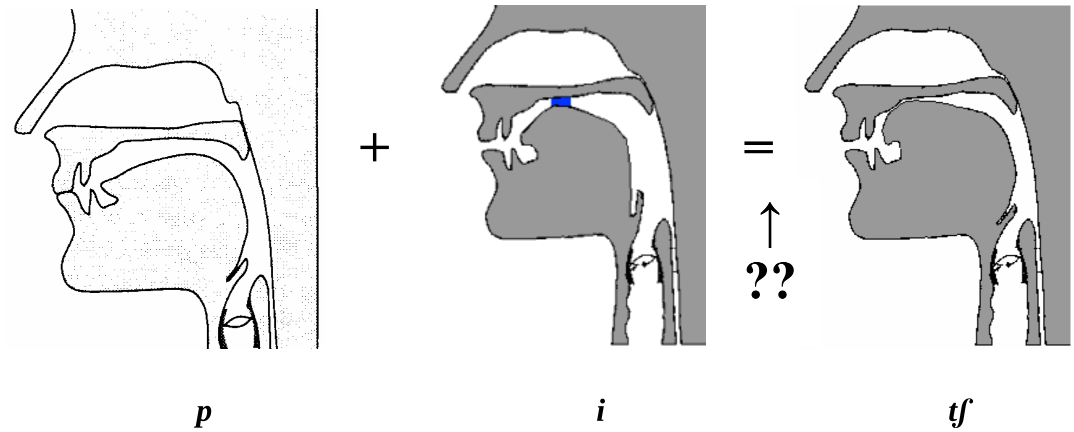

Figure 1.4 Articulator positions for labial palatalization.

As I show in chapter 2, the palatalization survey confirms these predictions. There are very few languages (two in my sample) which show full 'labial palatalization', and as stated earlier these cases can all be attributed to diachronic sound changes that did not affect the labial in the way indicated in figure 1.4. On the other hand, full palatalization of velar (dorsal) and alveolar (coronal) consonants is predicted and attested in many languages. Chapter 4 presents a formal account of these predictions using Articulatory Phonology in OT (gesturally-based constraints).

1.3.1 The finer-grained palatalizing contexts

In addition to distinguishing between full and secondary palatalization, which are the primary concern of this dissertation, it is also important to distinguish between purely phonological and morpho-phonological contexts of palatalization. In this section I clarify what I consider a purely phonological and a morpho-phonological context. Purely phonological palatalization occurs across the board in a language, which is understood as allophony. Some examples are given below.

(4) Purely phonological palatalization

(i)	/pi**t**iko/	[pi**tʃ**iko]	'small'	(Apalai, Carib)
(ii)	/ku**k**ira/	[kʊ**tʃ**ɪɹæ]	'exceed'	(Nkore-Kiga, Bantu)
	/e**g**jo/	[ɛ**dʒ**o]	'that'	
(iii)	/**g**ɛbam/	[**g**ʲɛbam]	'pound'	(Koromfe, Gur)
	/gɪram/	[**g**ʲɪram]	'judge'	
(iv)	/tiéeh́/	[**t**ʲéeh́]	'valley'	(Navajo, Athapaskan-Eyak)
(v)	[ðɪ**s j**iər] ~ [ðɪ**ʃ**jɪər]		'this year'	(English, Germanic)
	[don**t j**u] ~ [don**tʃ**ju]		'don't you'	
	[**tj**uzde] ~ [**tʃ**juzde]		'Tuesday'	

A morpho-phonological context is one where palatalization is restricted to certain morphological forms, but where it is phonologically conditioned by the presence of a common palatalizing trigger. The major types of morpho-phonological palatalization are given below.

(5) Morpho-phonological palatalization:

a. Triggered by affixation: affix contains palatalizing trigger

(i)	[kā̀**z**ā]	'hen'	[kā̀**dʒ**ī]	'hens'	(Hausa, Chadic)
	[mōtā̀]	'car'	[mōtō**tʃ**ī]	'cars'	
(ii)	/fak/	[fa**k**]	'make/do (1sg.3pl.)'	(Standard Romanian, Rom.)	
	/fa**k-e**/	[fa**tʃ**e]	'make/do (3sg)'		

(iii) [**k**áɣa] 'he made it' (Dakota, Siouan)

[ni**tʃ**áɣa] 'he made it for you'

b. Either triggered by affixation with opaque trigger, or no apparent trigger but expressing morphological property:

(i) /fa**k-i**/ → [fa**tʃ**] 'make/do 2sg' (Standard Romanian)

/bra**d-i**/ → [bra**z**ʲ] 'fir tree'

(ii) oloze etu → olozjetu → oloʒetu 'but we' (Luvale, Bantu)

In chapter 2 I show that there are few differences in full and secondary palatalization with respect to these two contexts. The most significant difference regards full 'labial palatalization', which is observed only in morphological contexts. I demonstrate in chapter 3 that the alternations between labial and palatal consonants in morphological contexts have mistakenly been interpreted as full palatalization of labials[4]. The diachronic changes which can no longer be observed obscure the fact that labials did not actually themselves palatalize.

1.4 Previous surveys of palatalization

As I have already indicated, palatalization is no stranger to linguistic investigation. In this section I briefly review previous surveys of palatalization in the literature, including Chen (1973), Bhat (1978), and Hall (2000). I reserve comparisons with my own research results for the next chapter, where I present them in detail.

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[4] A diachronic analysis has been proposed before for Moldavian (Ionescu 1969, Avram 1977, inter alia). I adopt a slightly modified version of this analysis in chapter 3.

1.4.1 Chen (1973)

Chen (1973) writes about the predictive power of phonological rules, and uses full palatalization to illustrate his point (Chen 1973:176-177). The languages he relies on are a few Mandarin dialects, Russian, French, Italian and Spanish. His argument is that phonology cannot predict *if* a language will have palatalization, but it can predict when certain sounds at particular places of articulation will have palatalization. He proposes that when (full) palatalization does occur it targets the consonants from back to front, that is dorsal, then coronal, and finally labial, in an implicational fashion: if labials palatalize then so do coronals, and if coronals palatalize then so do dorsals. For example, if the labial *p* palatalizes in one language, then alveolar *t* and velar *k* should also palatalize, and if *t* palatalizes then so should *k*. Thus, we should expect to find no language in which only coronals palatalize, to the exclusion of dorsals, and no language where only labials palatalize. On the other hand, we should expect to find languages with only full palatalization of dorsals.

In addition to the implicational hierarchy of palatalization targets, Chen also establishes an implicational hierarchy for palatalization triggers. He argues that palatalization is triggered by front vowels in an implicational fashion: if lower front vowels trigger palatalization, then so will higher front vowels (Chen 1973:177). Thus if a consonant palatalizes before the lower front vowel *ɛ*, it should also palatalize before higher front vowels such as *e* and *i*. Chen also adds that the palatal glide *j* can be an even stronger trigger, and that in some languages it is the only such trigger (Chen 1973:180).

Chen formalizes the targets and triggers hierarchies in the following way. First he provides a schematic representation of consonants and vowels, as in (6), and then gives the rule in (7) as a universal constraint:

(6) Schematic representation of consonants and vowels (Chen 1973)

	p	t	k
	b	d	g
	f	s	h
	m	n	ŋ
[back] →	1	2	3

[high] ↑		
4	i	u
3	e	o
2	ɛ	ɔ
1	æ	ɑ
[back] →	1	2

(7) Palatalization rule (Chen 1973:178, rule 5)

$$\begin{bmatrix} \text{C} \\ \alpha \text{ back} \end{bmatrix} \rightarrow \text{palatalization} / \_\_\_ \begin{bmatrix} \text{V} \\ 1 \text{ back} \\ \beta \text{ high} \end{bmatrix}$$

lg-univ. constraint: $\alpha \geq m$
$\beta \geq n$

In this rule *m* and *n* are language specific values for the features [back] and [high], respectively. For example, if *m* is 3 and *n* is 1 in a given language, then in that language we should see palatalized velars when they precede **all** front vowels; if *n* is 4, then the velars should palatalize only when they precede *i* (since the height value is already specified as 1). As the rule in (7) shows, Chen predicts that we should not see any instances of full palatalization before the high back vowel *u*, since the triggering vowel's backness value is specified in the rule as {1}, which excludes all back vowels. Moreover, it predicts that full palatalization is only triggered by a *following* front vowel.

1.4.2 Bhat (1978): generalized study of palatalization

As mentioned earlier, Bhat's (1978) typological survey of palatalization is the largest to date, including about 120 languages; however, among these are languages which I do not consider to have palatalization. Bhat's definition of palatalization covers cases that meet one *or* both of the following conditions (Bhat 1978:49):

(i) The environment that induces the change must be a "palatalizing environment" (i.e. it must be a front vowel, a palatal semivowel, or a palatal or palatalized consonant)

(ii) The sound that results from the change must be palatal or must have a secondary palatal articulation.

The second condition is identical to the one in my operational definition, but the first is different, as it covers sound changes which do not result in a fully or secondarily palatalized sound (cf. Telfer 2006). Since Bhat does not always include the palatalization outcomes in his descriptions, it is difficult to estimate how many of the languages in his sample would be excluded by my definition.

Based on his findings, Bhat (1978) proposes that there are three distinct diachronic processes that, either in isolation or in combination with one another, can lead to palatalization: *tongue-fronting*, *tongue-raising*, and *spirantization*. He does not separate full from secondary palatalization, nor morpho-phonological from phonological contexts, and proposes that secondary palatalization is an areally restricted phenomenon[5]. Thus, most of his findings regard full palatalization in general. In what follows I will present his generalizations on palatalization triggers and palatalization targets.

1.4.2.1 Bhat (1978): Palatalization targets

Bhat finds that consonants at all places of articulation are targeted by palatalization, without establishing any implicational relationships among them, as his goal is to argue for the presence of the three distinct processes involved in palatalization. Tongue-raising (essentially secondary palatalization) occurs more with apical (sounds articulated with the tip of the tongue) and labial sounds and is triggered by a following high (particularly front) vowel or semivowel. Tongue-fronting occurs more with velars and is triggered by a front vowel (not necessarily high). Spirantization may occur alone with the palatal glide and the trill *r* among others (Bhat 1978:56), and it may occur in combination with tongue-fronting and –raising. Velars may be affected by fronting, raising and spirantization at the same time, resulting in *k*→ *tʃ* (Bhat 1978:51).

Bhat finds that there is a general tendency for labial consonants not to alter their primary place of articulation in palatalization, as there are few instances of this type of change (i.e. rare full labial palatalization; Bhat 1978:70). Furthermore, he finds that among labials the glide *w* (which is often labio-velar) is the most common target. Among apicals, Bhat reports that the sibilants and the nasals are targeted most

[5] He refers the reader to Bhat (1973), a paper on areal restriction on retroflex consonants. It is not clear on what he bases his argument that secondary palatalization is areally restricted.

often by palatalization. Apical stops are changed into palatal affricates, and lateral continuants or trills are changed into flaps, while non-lateral liquids are changed into laterals. Velar stops usually change into affricates, but they may also remain stops (Bhat 1978:71-72).

Finally, Bhat mentions that palatalization sometimes carries a diminutive meaning, as in Russian and Belorussian (Bhat 1978:64). It can also be a characteristic of rapid speech, and also of female and child speech as opposed to male or adult speech (Bhat 1978:64-66).

1.4.2.2 Bhat (1978): Palatalization triggers

Bhat finds that in general the best triggers are following front vowels, especially *i* and *e*, and the palatal semivowel *j*, and occasionally high back vowels. The strongest environment that triggers fronting of velars is a following front vowel, while a following yod (palatal glide) is a strong trigger for raising apical consonants. He provides examples of velar consonants not being affected by the palatal glide, and of front vowels not affectig apicals, or only optionally doing so (Bhat 1978:52-53). In addition, he finds that the height of the following vowel or semivowel is more important for palatalizing apicals, while its frontness is crucial for palatalizing velars. In contrast to this finding, Blevins (2004) states that velar palatalization is more common before front high vowels and glides than it is before non-high front vowels (Blevins 2004:138).

Bhat also reports differences in palatalization caused by vowel stress: tongue-fronting is triggered more easily by a following stressed vowel, while tongue raising by a non-stressed vowel. He does not find significant effects on a vowel's triggering ability based on whether it is round or unround (Bhat 1978:61).

Regarding the position of the palatalizing trigger, Bhat reports that in most cases this follows the target, and that there are also a few languages where it precedes the target. He does not discuss in detail cases where the trigger is maintained, and it is safe to assume this is because there is nothing interesting about such cases. He does mention cases where the trigger is deleted, and treats them as cases of "extreme palatalization" where the trigger is absorbed into the target (Bhat 1978:73-76).

1.4.3 Hall (2000): rhotics vs. non-rhotics

Hall's paper is primarily concerned with the markedness of *phonemically* secondarily palatalized rhotics vs. nonrhotics. However, as he claims that an implicational universal established for phonemic systems could potentially apply to phonological representations as well, I include this survey here as well.

Hall does not consider cases of full palatalization as palatalization, but rather as nonanteriorization[6] (Hall 2000:14). He presents evidence that palatalized rhotics such as r^j are much more marked typologically than palatalized coronal nonrhotics such as t^j, d^j, n^j, l^j, basing his arguments on findings in 20 languages (which include eight languages discussed in Maddieson 1984), and on analyses of apical sounds (rhotics and nonrhotics). Hall (2000) argues that the distinction between coronal

[6] An important claim Hall makes is that rhotics are *universally immune* to nonanteriorization (full palatalization), because the output of such a process would be a postalveolar laminal rhotic, a non-existent segment (p. 15).

rhotics and nonrhotics when it comes to palatalization has articulatory origins: rhotics are apical (articulated with the tongue tip), while nonrhotics are laminal (articulated with the tongue blade). Furthermore, rhotics are [-distributed] and nonrhotics are [+distributed] (Hall 2000:16). He proposes a general ban on palatalized apical sounds, supported by the fact that even nonrhotic apical sounds, for example retroflex sounds like *ʈ* and *ɖ* or dental sounds like *t̪* and *d̪*, also resist secondary palatalization (Hall 2000:19).

The markedness of palatalized rhotics, and also of apical coronal nonrhotics, is established as follows (i) palatalized rhotics and apical nonrhotics are found less often in phonemic systems, and (ii) synchronic or diachronic phonological processes which would result in a secondarily palatalized rhotic or apical nonrhotic either do not affect these sounds, or that they change into other sounds (i.e. *r*→ *j* in Walpiri, *r*→ *ʒ* in Polish; Hall 2000:9, 19).

Hall presents his generalizations about phonemically palatalized rhotics as a typology, which I duplicate here for reference:

(8) Typology of secondarily palatalized phonemes (Hall 2000:10):

a. Languages with at least one palatalized nonrhotic and no palatalized rhotics (many languages)

b. Languages with at least one palatalized rhotic and at least one palatalized non rhotic (languages in Hall's list of 20).

c. Languages with at least one palatalized rhotic and no palatalized nonrhotics (no examples)

d. Languages with no palatalized consonants (some examples).

Hall further introduces the following implicational universal: *if a language has a palatalized rhotic, that same language will have at least one palatalized nonrhotic* (Hall 2000:10). Although this implicational universal is established for phonemic systems, evidence from synchronic and diachronic phonological rules that trigger secondary palatalization suggests that this implication could hold both at the phonemic and the phonological surface level, and it is thus a tentative absolute universal: there are languages where both rhotics and nonrhotics acquire secondary palatalization, but no languages in which only rhotics do so (Hall 2000:12). He leaves this to be (dis)confirmed by a larger study.

1.4.4 Brief comparison with current survey

The results of my own survey are generally compatible with Bhats's (1978) and Hall's (2000) findings, and partially compatible with Chen's (1973). Bhat (1978) did not aim to make any universal claims about palatalization, but his general patterns have been confirmed. Hall’s (2000) implicational universals regarding rhotics has also been confirmed, though my study is not concerned directly with the difference between rhotics and nonrhotics (or apicals vs. non-apical sounds). My findings challenge Chen’s (1973) implicational hierarchies for full palatalization. He predicts that there should be no language in which only coronals palatalize alone, and this is not true. In fact, coronals are the most common targets of palatalization. In addition, he predicts that only front vowels trigger palatalization, when in fact high back vowels can also do so, however more rarely (c.f. Bhat 1978).

1.5 Previous analyses of palatalization

In this section I review some of the previous analyses of palatalization, particularly within the framework of Feature Geometry (Sagey 1986, McCarthy 1988, Clements 1985). This is not a comprehensive review, rather a review of analyses which are in general different than the proposal in this dissertation. Palatalization has been viewed as an articulatory assimilation process in different versions of Feature Geometry. At different points in the development of this framework, the representation of palatalization has taken the shape of spreading of different features that vowels were assumed to have (i.e. Dorsal [-back]). In the following sections I briefly review some of these analyses of palatalization and point out the benefits and shortcomings they each present with respect to palatalization.

1.5.1 Sagey (1986): Spreading of Dorsal [-back] feature

Sagey (1986) proposes a set of primary articulator features to characterize all consonants: Labial, Coronal, and Dorsal, each represented on a separate tier. Each of these have a set of dependent features: [round] is a dependent of Labial, [anterior] and [distributed] are dependents of Coronal, and [high], [back] and [low] are dependents of Dorsal. Thus, all vowels are characterized as Dorsal. There are several problems with this account, which have already been pointed out in the literature. First, velar consonants and vowels as a group, both characterized by dependent features of the Dorsal Node, do not act as a natural class in any phonological process. As Clements & Hume (1995) point out, dorsal consonants interact with back vowels, whereas coronal consonants interact with front vowels. Second, palatalization is viewed as spreading of [-back]. As front vowels are [-back], a dependent feature of the Dorsal Node, they cannot interact with Coronal consonants, as spreading should not occur if segments do not share any features (Lahiri and Evers 1991). This is due to Coronal and Dorsal nodes being on separate tiers, and 'blind' to spreading of their dependent features. A representation such as that in figure 1.5 shows the Dorsal along with its dependent feature [-back] spreading to add a secondary palatal articulation to the coronal consonant.

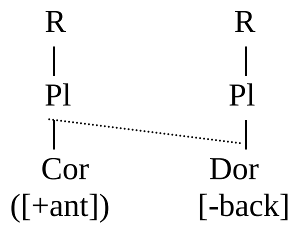

Figure 1.5 Palatalization of coronals: spreading of [-back]
(from Cavar 2004:13. R=root, Pl=place)

But it is not clear how spreading Dorsal [-back] can fully palatalize velar consonants (k→ tʃ), as the resulting palato-alveolar *tʃ* is under the Coronal Node, and thus it is not [-back]. Therefore, with this model only a secondary palatalization of a coronal consonant would be possible, and no other types of palatalization without positing other processes (e.g. spellout rules).

1.5.2 Clements/Hume (1989, 1994, 1995) : Spreading of [coronal] from the V-place node

In response to the challenges of the model in Sagey (1986), Clements (1989), Hume (1994) and Clements and Hume (1995) propose a model that capitalizes on the generalization that sounds which form a natural class tend to pattern together in phonological processes. The model is based primarily on Clements (1989), various versions of which were published later in Hume (1994) and Clements and Hume (1995). The main innovation of this model is that consonants and vocoids are both represented by a unitary set of features. Each sound has both a consonant-place (C-place) and a vocoid-place (V-place) node. For consonants, the articulator features [labial], [coronal], [dorsal] are under the C-place node, and for vocoids the same features are under the V-place node. The C-place node is always empty in vocoids, while the V-place node in consonants is where secondary articulations reside (e.g. secondary palatalization). As a direct result of this feature organization, front vowels are characterized as coronal, and therefore form a natural class with coronal consonants. Similarly, dorsal consonants and back vocoids form a natural class, as do rounded or labialized vocoids and labial consonants. Only the last of these natural classes can be captured under the Sagey (1986) model, as the feature [round] is a dependent of the labial place node; dorsal consonants are predicted to form a natural class with all vowels, as these are dorsal, and coronal consonants should not form a natural class with any vowels, as they do not share any features.

Clements and Hume analyze only secondary palatalization as *palatalization* per se, and full palatalization as *coronalization*. As mentioned earlier, in their model front vowels, like coronal consonants, have the place feature [coronal]. This feature has a dependent binary feature, [anterior], and vowels are assumed to be inherently [-anterior] (Hume 1994:121). Either the dependent feature [anterior] or the main place feature [coronal] are able to spread in an assimilation process to the place feature of an adjacent segment. In what Clements and Hume refer to as palatalization the segment acquires the [coronal] place of articulation under the V-place node in addition to its own C-place feature and thus has secondary palatalization. In coronalization, if the segment is a dorsal like *k*, it acquires the [coronal] place feature in the V-place node and becomes secondarily palatalized, then this tier must be promoted to the C-place node (i.e. the consonant delinks its original place feature) and thus completely changes its place of articulation. Thus, the change from *k*→ *tʃ* occurs in stages, first secondary palatalization then full palatalization. If the segment is an alveolar like *t*, it acquires the feature [-anterior] and becomes palatal, changing its place of articulation. The figures below schematically represent full and secondary palatalization in the Clements/Hume feature geometry model (from Cavar 2004:17).

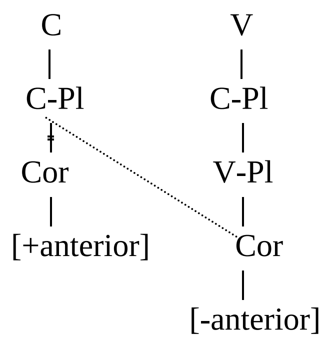

Figure 1.6 Coronalization
(represented is full palatalization of a coronal like *t*):
spreading of Coronal [-anterior] feature.

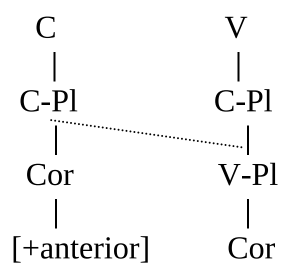

Figure 1.7 Palatalization
(represented is secondary palatalization of a coronal like *t*):
acquiring Coronal V-place by the consonant.

There are several challenges with this account. First, there is no reason to believe that an intermediary stage of secondary palatalization is always necessary for full palatalization. Diachronic evidence does not support this development (Bhat 1978). In addition, only front vowels are predicted to trigger palatalization under this account, as only the feature [coronal] or its [anterior] dependent can spread in either coronalization or palatalization. As previously mentioned, high back vowels, which would be characterized by the feature [dorsal], also trigger palatalization occasionaly, but spreading of this feature would not result in palatalization or coronalization.

1.5.3 Lahiri and Evers (1991)

Lahiri and Evers (1991) revise feature geometry representations aiming to resolve the challenges raised by the Clements/Hume model described above. Lahiri and Evers propose the representation of places of articulation given in figure 1.8 below.

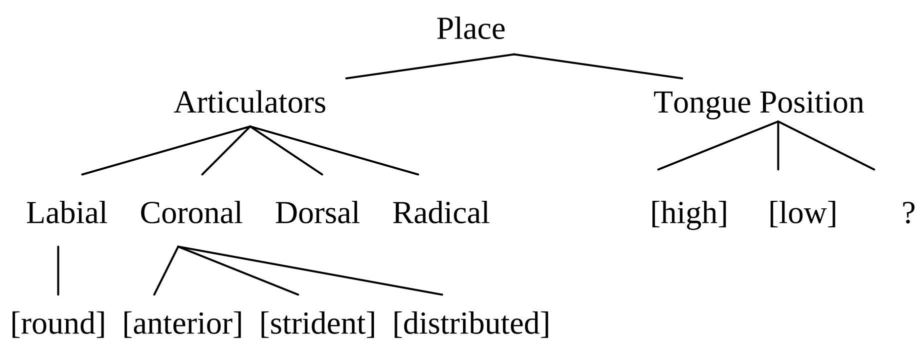

Figure 1.8 Representation of places of articulation
(Lahiri and Evers 1991:87-8)

As figure 1.8 shows, place of articulation for both consonants and vocoids is represented by a unitary set of place features, distinguishing between primary articulators and the position of the tongue (an Articulator Node and a Tongue Position Node). The articulator can be Labial [round], Coronal [anterior], [strident], [distributed], Dorsal or Radical, and the tongue body position can be either [high] or [low]. Lahiri and Evers leave the Tongue Position Node incomplete to allow for additional height classifications, should these be proved necessary. The feature [back] is not necessary, as [-back] is included under Coronal, and [+back] under Dorsal.

Furthermore, the representation above does not include all of the dependent features, such as [continuant], but these are assumed to be part of the representation (Lahiri and Evers 1991:87).

Front vowels are Coronal, back vowels are Dorsal, and rounded vowels have multiple places of articulation, as schematically represented below, where A indicates 'Articulator', and TP 'tongue position':

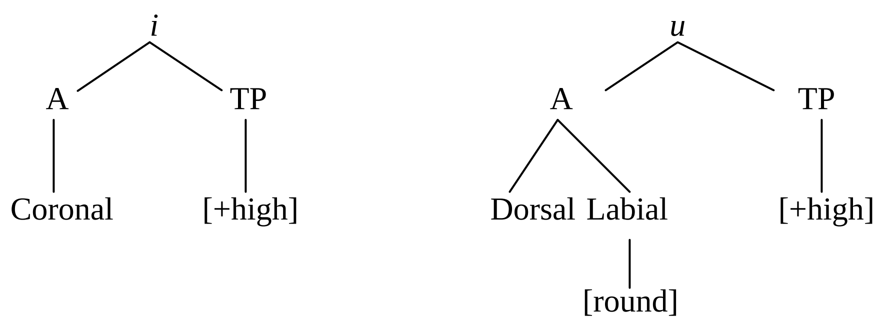

Figure 1.9 Vowel representations
(Lahiri and Evers 1991:90-110)

By having these representations, the Lahiri and Evers model can capture both the frontness and the height of the triggers of palatalization. Palatalization as secondary articulation results from the spreading of the feature [+high] to any of the places of articulation, and is thus a tongue-body effect. All consonants with secondary palatal articulation have a uniform representation, namely with their respective place of articulation (Labial, Coronal, Dorsal) and the Tongue Position [+high]. For full palatalization of velars (velar fronting in their terminology) the Coronal Node, along with the [-anterior] feature, spreads and Dorsal delinks, represented in figure 1.10. In dental/alveolar palatalization the Coronal dependent feature [-anterior] spreads within the Coronal Node.

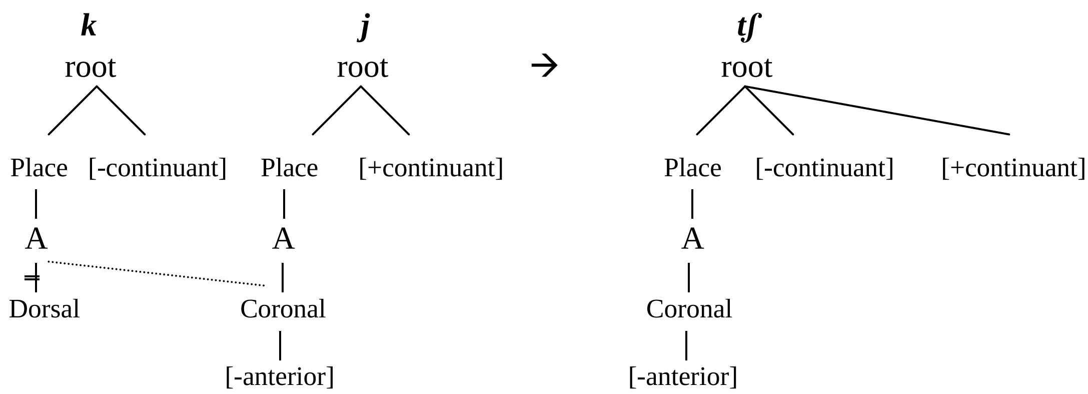

Figure 1.10 (Full) Palatalization of velars
(Lahiri and Evers 1991:91)

This model predicts that secondary palatalization could be triggered by any high vowel, not just high front vowels, in contrast to the Clements/Hume model which predicted that only high front vowels should trigger any type of palatalization. It further predicts that only high vowels, and not lower front vowels like *e*, should trigger secondary palatalization. As Lahiri and Evers themselves point out, there are languages where both *i* and *e* trigger secondary palatalization, and they suspect that this may be connected to the acoustics of the vowels, and that it is possible that the consonantal off-glide in secondary palatalization may in fact be an on-glide of the following vowel (i.e. the trigger [e] may actually be phonetically [je]).

1.5.4 Evaluating feature geometry analyses

The analyses of segmental representation and palatalization reviewed above have all attempted to account for full and secondary palatalization by positing the correct representation for consonants and the palatalization triggers: front vowels and the palatal glide *j*. Each model builds on the previous one and captures more of the palatalization processes, while at the same time making predictions about palatalization triggers and also palatalization outcomes. The Sagey (1986) model can only straightforwardly account for secondary palatalization of coronal consonants, while the other types of palatalization are represented as arbitrary feature spreading. The Clements/Hume model predicts that only high front vowels and the palatal glide trigger palatalization, and that full velar palatalization always has an intermediary step of secondary palatalization. Lahiri and Evers (1991) predict that both high front and high back vocoids can trigger secondary palatalization, but that lower front vowels should not trigger secondary palatalization. When they do, this is explained as a possible phonetic on-glide on the vowel rather than an off-glide on the consonant.

All of these accounts have appealing aspects, particularly in capturing the fact that front vowels and the palatal glide need to have a representation that allows their interaction with coronal consonants in a straightforward way. The Lahiri and Evers (1991) analysis recognizing two Place Nodes, the Articulator and the Tongue Position Nodes, is especially attractive as it predicts the fact that secondary palatalization can occur equally with consonants at all places of articulation, as it is a tongue body effect. My palatalization survey confirms this prediction. However, all of these accounts also have different shortcomings, as already mentioned during the discussion of each of these models. Just to review one example, as I discuss in detail in Chapter 2, the palatalization survey shows that front vowels, high vowels, and the palatal glide all trigger palatalization, even though high back vowels serve as palatalization triggers less often. All of the models make different predictions regarding palatalization triggers, and none of them captures all of the facts.

1.6 Proposed Analysis

The palatalization survey I conducted revealed several implicational relationships among palatalization triggers and targets that would be best captured by a different type of framework than those discussed above. For the formal analysis of palatalization I adopt a version of Articulatory Phonology (AP) developed by Browman and Goldstein (1986 et seq.), as well as subsequent researchers using this approach to phonology, including Byrd (1996a, b et seq.), Gafos (1999, 2002), Kochetov (2002), and Davidson (2004). In addition, the gestural account is couched in an Optimality Theoretic (OT) framework (Prince and Smolensky 1993).

An overview of AP is given in chapter 4. In brief, AP views the articulatory *gesture* as the main unit of phonological description. A gesture is specified in terms of an articulator (e.g. lips, tongue), a constriction location (place of articulation) and a constriction degree (manner of articulation). In addition, gestures are have a duration and are timed with respect to each other. As speech unfolds in real time, gestures must coordinate with one other and as a result they can temporally overlap. Following this approach, I propose that palatalization arises as a result of the natural interaction of the oral articulators during speech and the consequences of that interaction on speech production. The degree of gestural overlap and the participating oral articulators determine whether full or secondary palatalization results from gestural coordination. I do not discount the findings that perceptual factors may be involved in certain aspects of palatalization (Guion 1998, Ohala 1978); however, I argue that articulation is the principal reason for palatalization. More specifically, there is no change in perception without an analogous change in production.

Optimality Theory is well suited to account for cross-linguistic patterns, as it is based on the premise that all languages are governed by the same set of violable constraints, and that differences among languages result from the interaction of these constraints. However, an OT analysis which does not make reference to gestures and how they interact during articulation would not capture the palatalization generalizations in a straightforward way. A model combining AP and OT, using gesturally-based OT constraints, predicts the different attested patterns of palatalization and it also illustrates which patterns we should and should *not* expect to find in natural languages. For example, there should be no language in which labial consonants palatalize to the exclusion of coronal and dorsal consonants. The languages in my sample verify this prediction.

This dissertation is the first where both full and secondary palatalization are addressed in a unified account based on generalizations revealed by a balanced language sample. The greatest contribution of this thesis regards labial palatalization: this is the first detailed study of the process of full labial palatalization, and also one that explains the general dependency of labial palatalization on the palatalization of coronal and dorsal consonants. This is also the first study that distinguishes between palatalization in morphological vs. phonological contexts. The formal account of palatalization has implications for Articulatory Phonology and the extent to which gestures can interact, and for Optimality Theory and the types of constraints that can be used in conjunction with gestures.

CHAPTER 2

PALATALIZATION IN THE LANGUAGE SURVEY

This chapter will present empirical data on palatalization. These data will constitute the foundation on which the rest of the dissertation lies. Where appropriate, I will make comparisons with findings in previous surveys (Chen 1973, Bhat 1978, Hall 2000). Palatalization can be categorized along two dimensions: (i) whether it is full or secondary, and (ii) whether it is purely phonological (allophonic, occurring across the board in a given language) or morpho-phonological (typically conditioned by certain affixes or having other morphological restrictions). Within each dimension the same issues would need to be addressed: what are the targets, triggers, and outcomes of palatalization.

Both full and secondary palatalization are important, as they complement each other in revealing palatalization patterns both within and across languages. Also important are the effects of morpho-phonological versus phonological palatalization contexts. For example, in a given language there may be both full and secondary palatalization, in both phonological and morpho-phonological contexts, and sounds at different places of articulation may be affected by each type of palatalization. Collapsing all of these factors would miss important generalizations specific to full/secondary and morpho-phonological/phonological palatalization. Thus, in presenting the findings in the language sample for this work I will examine palatalization in both of these dimensions.

This chapter is structured as follows. In section 2.1 I give an overview of how the language sample was built. Sections 2.2 through 2.6 present the findings of the cross-linguistic survey. I present the findings of full palatalization and of secondary palatalization as a whole, and then I discuss differences arising from comparing morpho-phonological with phonological palatalization. For both full and secondary palatalization I discuss the targets, triggers, and outcomes of palatalization, along with any implicational relationships and other significant generalizations that arise thereof. Section 2.7 discusses palatalization triggers, and section 2.8 provides chapter conclusions.

2.1 The language sample

My goal has been to create a language sample that is as balanced as reasonably possible and then analyze palatalization in those languages. This is different from a language sample which includes every language that has palatalization. My sample consists of both languages which show palatalization, and languages which do not, to reflect the distribution of palatalization across languages. Later in the analysis it will be clear why it is necessary to also include languages which do not have palatalization in a study about palatalization. For now it is sufficient to say that in order to learn under what circumstances palatalization occurs it is also important to know what might prevent palatalization from taking place, and also that, despite being widespread, palatalization does not automatically occur in all languages.

In conducting a typological study it is important to avoid genetic, areal, and bibliographic biases which create an imbalanced language sample. Ideally, the language sample should include a proportional number of languages from different families and different geographic areas. If the languages are from the same language family they are more likely to show common features than languages which are from different language families, due to their having a common ancestor. In that case, a generalization cannot be considered a linguistic universal, but rather could be a feature of that language family. This is referred to as a *genetic bias*. Similarly, languages which are in close contact with one another due to geographical factors, such as the languages in the Balkan Sprachbund, can show common features even if they are not genetically related. Generalizations made in that case are said to reflect *areal biases*. A third potential problem in building a balanced language sample is a *bibliographic bias*, or the lack of availability of good and diverse language descriptions (Comrie 1989:10-12, Dryer 1989).

I could do little to avoid a bibliographic bias, being limited to languages that have been studied and about which something has been written. The grammars I referred to were primarily found in the collection of the University of California, San Diego (UCSD) library, but I also requested books from other libraries in the United States. To ensure genetic and geographic diversification I followed Dryer's (1989) guidelines that each language in a balanced sample belong to a different *genus*, a language subfamily such as Germanic or Romance, and be from one of five geographic areas: Africa, Australia-New Guinea, Eurasia, North America, and South America (Dryer 1989:267). Dryer includes Austronesian (also Oceanic, Ponapeic, etc.) languages under Eurasia. His argument for this inclusion is that Eurasian and Austronesian languages show similar structural characteristics. In my sample I separate

Eurasian and Austronesian languages in two categories, based on genetic relatedness and areal distribution. A complete list of the languages in the survey is given in Appendix 1. The last appendix contains a database entry for each language that has palatalization. Each entry contains the following information: the name of the language, the language family, the location where the language is spoken, the segment inventory, a summary of palatalization findings, representative examples of palatalization, the type of palatalization—full or secondary, the triggers and targets of palatalization, the "fate" of the triggers and the targets, the position of the trigger relative to the target, any additional comments or relevant information, and references.

A note on transcription

As the sources I consulted were published over a long span of time and represent different descriptive traditions, they utilize various types of transcriptions. The symbols are usually described in phonetic terms in the sources, so correspondent International Phonetic Alphabet (IPA) symbols can be determined. In this dissertation I use the IPA and, for consistency, when providing examples I replace non-IPA symbols with IPA ones. In the database entries I used primarily the system given in the source and provided comments with symbol descriptions where necessary. For example, the voiceless alveo-palatal affricate *tʃ*, which is what I use throughout this work, was transcribed as *c* in Amharic (Bender 1976), *tš* in Polish (Cavar 2004), and *č* in Fanti (Welmers 1946), *tʃ* in Romanian (Chitoran 2002a). Secondary palatalization was noted in many ways, including using a superscript on the consonant C^y or C^j, or a diacritic such as [C’] or [C̟]. I indicate secondary palatalization with a superscript ^{j} on the consonant, C^j. When referring to sounds in the text I will follow the convention of italicizing the symbols, as I have done in this paragraph. In examples, the symbols will be left non-italicized.

2.1.1 All languages surveyed

The cross-linguistic survey includes a total of 117 languages from 86 genera[7]. Of these, about half (58) show some form of palatalization. The table below summarizes the numbers of languages in each area and how many have palatalization. There are 25 languages surveyed from Africa, 16 from Australia-New Guinea, 34 from Eurasia, 19 from Austronesia, thirteen languages from North America, and ten languages from South America. The difference in numbers is mainly due to the paucity of relevant descriptions for South America. In each of the five areas there are languages that belong to different genera or, if they belong to the same genus, they come from different geographical areas.

Table 2.1 Language sample summary

Area	Total number of languages	Palatalization	No palatalization
Africa	25	18	7
Australia New Guinea	16	6	10
Eurasia	34	15	19
Austronesia	19	4	15
North America	13	10	3
South America	10	5	5
TOTAL	117	58	59

[7] 25 of these languages are the same as the languages described in Bhat (1978). For two of the 25 languages, Kashmiri (Dardic, India) and Cocopa (Yuman, Mexico), I have not found evidence of palatalization. Kashmiri is discussed in more detail in this chapter.

For some languages palatalization is present only in certain dialects, or there are several dialects that have palatalization, but each has its own pattern. Each dialect is specified in parentheses for those languages for which only a particular dialect is described and specified (i.e. Mongolian—Halh dialect, Coatzospan Mixtec—women's speech). Languages for which more than one dialect is described are only counted once in Table 2.1, but since various dialects present different patterns of palatalization (which also constitute subsets of palatalization patterns in other unrelated languages), each dialect, or group of dialects that share a palatalization pattern, is counted separately in the discussion of palatalization patterns, as appropriate to each case. Languages with more than one dialect described are Amharic (5), Romanian (2), and Greek (2).

2.1.2 Languages with palatalization

The sample consists of 58 languages which have palatalization and 59 languages which do not have palatalization. In this section I briefly discuss the basic selection process for languages with palatalization, and in the next section I do the same for languages without palatalization. Whether to include a language in the palatalizing group was primarily determined by examining the transcriptions and descriptions of that language. If a grammar or journal article described a palatalization process, or if the transcriptions demonstrated the presence of palatalization in a language, according to the definition of palatalization established in Chapter 1, that language was included. This was not a simple task, as some of the descriptions were ambiguous. Fifteen languages were described as having either all or only certain classes of consonants either *palatalized*, or palatalized to different degrees: *slightly, somewhat, moderately,* *strongly, phonetically*, or *redundantly* palatalized. For all but two of these languages examples were provided which clarified such descriptions. For a third language, Mwera, this is only partly the case, with clear full palatalization of velars but unclear palatalization of labials and coronals, as will be discussed below.

The qualifying terms mentioned above normally correspond to secondary palatalization, as in Amharic, Bulgarian (labial and coronal targets) Hausa, Kayardild, Mongolian and others, but there are a few cases in which full palatalization is what takes place, as in Bulgarian (dorsal targets), Luganda, and Mangarayi. For two languages, Kokota and West Greenlandic, it was difficult to determine what the description of palatalization meant because of lack of more detailed explanation or examples. In Kokota (Western Oceanic, Solomon Islands) velars *ŋ* and *ɣ* "slightly palatalize" before front vowels *i*, *e*, to a higher degree before *i* (Palmer 2002). In West Greenlandic (Inuit, Greenland) alveolars *t, s*, *n* and *l* are "slightly palatalized" in the environment of *i,* while *k*, *g* and *ŋ* are post-palatal before *i* and medio-velar/dorsal otherwise (Fortescue 1984). From this description of West Greenlandic it seems that dorsals change their place of articulation, suggesting full palatalization, but it is not clear what type of palatalization the alveolars show; therefore, I cannot establish a pattern for this language. For these reasons I include these two languages only in the general count, but not in the detailed discussion. Nevertheless, as will be described shortly, the fact that either dorsals alone, or coronals and dorsals together palatalize (either secondarily or fully) is compatible with the palatalization patterns found in the rest of the languages, so these two languages would neatly fit in to the general patterns.

In the third language, Mwera (Bantu, Tanzania), there is full palatalization of the velar stops *k* and *g* to *tʃ* and *dʒ*, respectively. However, for some labial and coronal sounds it is not clear from the description whether they are palatalized or not. Harries (1950) states that "as a palatalization, *y* [palatal semi-vowel] is used to form the following consonantal combinations: *py*, *mpy*, *mby*, *ty*, *nty*, *ndy*, *my*, *ny*, *ßy*, *ly*; while its presence in the palatals *tʃ*, *dʒ* and *ɲ* is implicit" (Harries 1950:15). He uses the term "palatalization", and the symbols indicate that this would be secondary palatalization (excluding the palatal sounds themselves), but the examples do not make it clear that this is indeed palatalization or simply a sequence of a consonant and a palatal semi-vowel. I have found no other sources discussing this process in Mwera. As nothing more is said about this, and as Harris' quote makes reference to "consonantal combinations", I will assume that coronals and labials do not undergo palatalization in Mwera and exclude these sounds from the detailed study. I will only include dorsal palatalization, which is clearly illustrated with examples in Harries (1950):

(1) Dorsal palatalization in Mwera (Harries 1950:8):

Root	Applicative		1sg.past	
i**k**a	-i**tʃ**ila	'come for, arrive at'	nāi**tʃ**e	'I came'
pote**k**a	pote**tʃ**ela	'be in pain for'	nāpote**tʃ**e	'I was in pain'
twaŋ**g**a	twan**dʒ**ila	'pound grain for'	nātwan**dʒ**ile	'I pounded'
βula**g**a	βula**dʒ**ila	'kill for'	nāmule**dʒ**e	'I killed him'

This leaves 56 languages which are included in the detailed discussion of palatalization (including Mwera, excluding Kokota and West Greenlandic). In the next section I discuss the exclusion process for languages without palatalization.

2.1.3 Languages without palatalization

As mentioned earlier, my sample includes 59 languages without palatalization. For most of these languages (54) I have made the determination that they do not have palatalization based on transcriptions and descriptions of these languages in the sources I have consulted. It is of course entirely my own responsibility if I misinterpreted the findings in those sources. The other five languages are excluded because they are reported to have only velar fronting, or they have questionable palatalization. These cases are further discussed below.

Three languages are reported to have velar fronting, with velar consonants being pronounced more fronted when they occur before front vowels. In Indonesian (Sundic, Indonesia) velar obstruents *k*, *g*, *x* are pronounced more fronted before front vowels, and more backed before back vowels (Dyen, 1967). Similarly, in Nepali (Indo-Aryan, Nepal) plain and aspirated velar stops *k*, k^h, *g* and g^h are pronounced fronted before front vowels *i* and *e* (Acharya 1991). In Karachay (Ponto-Caspian, Russia) only the voiceless velar *k* appears to be subject to fronting: *k* is pronounced as post-palatal when before front vowels, while *g* is pronounced as *g*. When adjacent to back vowels, *k* is optionally pronounced as a uvular stop *q* (Seegmiller 1996). There are other languages which have fronting, but they also have full or secondary palatalization, as summarized in the table below. These languages are obviously included in the palatalization sample.

Table 2.2 Languages with fronting

Language	Fronting	Full	Sec	Comment
Indonesian	/k, g, x/			
Karachay	/k/			
Nepali	/k, k^h, g, g^h/			
Ejagham	/t, d, k, g, tʃ, dʒ/		Dorsal	[k] and [g] show fronting or pal depending on trigger
English	/k, g/	Coronal		
Hungarian	Yes, but not discussed further		Coronal	
Japanese	/k, g/	Coronal Dorsal (/h/ only)		
Karok	/k/	Coronal		
Korean	/k, kh, k’, ŋ/	Coronal		
Mangap-Mbula	/k, g, ^{ŋ}g, ŋ/		Coronal	
Maori	/k, ŋ/	Coronal (?) Dorsal		Not clear if full pal. for coronal
Tohono O’Odham	/k, g/	Coronal	Coronal	Different coronals for full and sec.
Romanian (Standard and Moldavian)	/k, g/	(Labial-Mold.) Coronal Dorsal	Labial Coronal Dorsal	Differs by morpho-phonological vs. phonological palatalization and target type
Zoque	Velar	Coronal	Labial Dorsal	Velar fronting before vowels, palatalization before palatal glide

Velar fronting also exists in English, where the *k* sound in *keep* is pronounced more forward than the *k* in *coop*[8]. In fact, it is possible that this type of fronting is found in many of the languages which did not report it and which I consider not to have any type of palatalization. It is difficult to tell exactly what velar fronting amounts to, as it

[8] In the case of English, Mielke’s sound patterns P-base database (2006) shows that *k* and *g* palatalize to *c* and *ɟ* before front vowels, which would be full palatalization by my definition.

sometimes comes down to a judgment call: does fronting a *k* mean pronouncing it as a palatal stop *c*, or is it still a *k* but produced with tongue contact further forward from its normal position, but not enough to make it palatal? At what point in the roof of the mouth do we demarcate palatal from velar?[9] It is impossible to answer these questions for all of these languages, and for that reason I will base my generalizations and subsequent analysis on reports of sound alternations with palatal or palato-alveolar sounds in each language.[10]

In addition to the three languages which have velar fronting there are two languages excluded because of highly questionable palatalization. In Andoke (Isolate, Colombia) the coronal fricative *s* never appears before mid-front vowels *e* or *ẽ*, but instead alternates with the palatal stop *c*, which resembles palatalization (Landaburu 1979). *s* does appear before *i*, which is unexpected in cases of palatalization, as *i* is the best palatalization trigger. If Andoke had palatalization, we would expect the palatal stop to appear before *i* also, which is not the case. Some examples are provided below:

(2) Andoke (Landaburu 1979:29):

(a)	[**c**ẽme]	'the tribe of Mirãna'	(b)	[sĩ'sĩ]	'black cricket'
	[**c**ẽhẽ]	'little black bird'		[sidá̃ita]	'coral snake
	[padó**c**e]	'iguana'			

As this is the only information available regarding palatalization in this language, it is likely that the grammar is incomplete and the current data are not enough to allow a clear discernment regarding palatalization.

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[9] I am grateful to Amalia Arvaniti for discussion on this topic (2006, personal communication).
[10] As it turns out, even if more languages reported velar fronting as palatalization, those languages would fit into the implicational patterns I identify in this chapter.

For Kashmiri (Dardic, India) there are conflicting reports regarding palatalization. Kelkar and Trisal (1964) write that all consonants undergo palatalization before front vowels, and their examples indicate that this is full palatalization. However, Wali and Koul (1997) argue that all palatalized consonants are contrastive in Kashmiri, and that there is no palatalization at all in the language beyond phonemic contrasts. As seen in the following examples, plain stops contrast with stops that have secondary palatalization:

(3) Kashmiri contrastive palatalization (Wali and Koul 1997:297):

/tal/	'under'	vs.	/t^jal/	'a piece'
/nu:l/	'mongoose'	vs.	/n^ju:l/	'blue'

It is highly doubtful, therefore, that Kashmiri has an active process of full, or even secondary, palatalization, though it is possible this process did exist at some point in the history of the language. For these reasons, the languages described above are excluded from the palatalization sample.

In the next sections I present the palatalization findings for full and secondary palatalization. In each case I address the palatalization targets by major place of articulation and any differences arising from comparing morpho-phonological and phonological palatalization. I discuss palatalization triggers in a single section as there are no significant differences between full and secondary palatalization in this respect.

2.2 Full palatalization

2.2.1 Full palatalization targets: general patterns

This section presents a detailed examination of full palatalization targets by major place of articulation affected: labial, coronal, or dorsal. First I discuss the findings without distinguishing between morpho-phonological and phonological palatalization, thus allowing us to make generalizations about full palatalization as a whole. Then I will present an important difference concerning full labial palatalization when the morpho-phonological palatalization contexts are distinguished.

Table 2.3 below summarizes the full palatalization patterns for the languages in my sample, 45 languages or dialects, separated according to morpho-phonological, phonological, and total full palatalization.

Table 2.3 Full palatalization (45 languages/dialects)

POA / Full palatalization	Labial	Coronal	Dorsal	Coronal + Dorsal	Labial + Dorsal	Labial + Coronal	Labial, Coronal, Dorsal
Morpho-phonological	0	13	3	4	0	0	2
Phonological	0	14	6	8	0	0	0
Total full palatalization	0	27	9	12	0	0	2

Six of the languages included in Table 2.3 (Korean, Mina, Tswana, and the Gonder, Menz, Gojjam/Wello dialects of Amharic) have both morpho-phonological and phonological palatalization, and in five of them this occurs at the same place of articulation. This is why the numbers in Table 2.3 add up to more than 45 overall. Sixteen of these languages also have secondary palatalization at one or more places of articulation, not indicated in this table. See Appendix 2 for overall palatalization patterns in individual languages.

Let us first focus on the overall full palatalization patterns, given as the sum of morpho-phonological and phonological palatalization in the last row of Table 2.3. Notice that consonants at all three places of articulation are targeted for full palatalization, but not to the same degree. Coronals and dorsals show independent as well as co-occurring full palatalization, while labial palatalization always co-occurs with both dorsal and coronal palatalization. Coronal full palatalization outnumbers dorsal full palatalization, twenty seven (54%) vs. nine (18%) languages, and twelve (24%) languages fully palatalize both dorsals and coronals. Only two languages (4%) in my sample show full palatalization of labials, the Moldavian dialect of Romanian, and Tswana.[11] As will be discussed in the next chapter on labial palatalization, there is evidence in both languages that labial full palatalization did not in fact occur as implied by using the term "labial palatalization". Full labial palatalization did not arise directly from *p* to *tʃ* for example, but via intermediary stages. Historical evidence suggests that a series of changes not directly affecting the labial consonant itself, but rather a palatal glide which followed it, is responsible for the synchronic alternations between labials and palatalized consonants. However, as I postpone the detailed discussion of full labial palatalization until the next chapter, for the time being I will assume that labial palatalization is present in these two languages in my sample (Moldavian and Tswana).

[11] It has also been proposed that Ikalanga has full labial palatalization (Mathangwane 1999). However, with the exception of *m*, the other labials become alveolar, not palatal. See Appendix 7.

The patterns in Table 2.3 suggest the existence of an implicational relationship for full palatalization that groups coronal and dorsal sounds together, separating them from labial sounds. Labial palatalization is dependent on the palatalization of coronals and dorsals in an implicational fashion: if labial consonants fully palatalize, then so do coronal and dorsal consonants. Notice that there is no language in the above table (and in fact in the entire language sample) that palatalizes labials to the exclusion of coronals and dorsals. There is no implicational relationship between the full palatalization of coronals and dorsals, but only between that of labials and coronals/dorsals as a group. These findings are summarized in (4) below:

(4) *Full palatalization generalizations:*

- *coronal and dorsal targets may be fully palatalized independently of each other, or both places of articulation may be targeted in the same language.*
- *labial palatalization always co-occurs with both dorsal and coronal palatalization (implicational universal)* → ***labial* > *coronal & dorsal.***

The full palatalization implicational universal established here will be modified later to reflect the fact that labial consonants do not palatalize fully at all, as argued in the Chapter 4. What remains true is that if labial consonants alternate with fully palatalized consonants in a given language, then coronal and dorsal consonants will show full palatalization in that language as well. However, while for the latter using the term “palatalization” would be accurate, this would not be so for the former, as labial consonants do not in fact fully palatalize.

2.2.2 Full palatalization targets: morpho-phonological vs. phonological

When comparing morpho-phonological and phonological full palatalization, we find the same patterns as when the two were collapsed, with one significant difference: the cases of full palatalization of labials are all morpho-phonological. There are no labial consonants which palatalize in purely phonological contexts in synchronic grammars, thus we never see labials alternating with palatals in mutually exclusive contexts. Labial consonants do not palatalize fully in the same way that coronals and dorsals do. I will argue in the analysis in Chapter 4 that phonological full palatalization of labials is not expected to occur because of the articulators involved in producing labial consonants on the one hand and the palatalization triggers on the other: the lips and the tongue, respectively. These articulators can move independently of one another, therefore there is no pressure for full palatalization to occur. Instead, in phonological contexts labial consonants show secondary palatalization. Even the morphological cases, as previously stated, can all be linked to diachronic change. The full palatalization summary in (4) is repeated and expanded here to include this fact about labial palatalization:

(5) *Full palatalization generalizations:*

- *coronal and dorsal targets may be fully palatalized independently of each other, or both places of articulation may be targeted in the same language*
- *labial consonants never have full phonological palatalization in synchronic grammars*
- *full labial palatalization always co-occurs with both dorsal and coronal palatalization (implicational universal):* ***labial > coronal & dorsal***

Chen's (1973) predictions for palatalization patterns are only partially consistent with my observations. Recall Chen's prediction that if labials palatalize then so do coronals, and if coronals palatalize then so do dorsals. Thus, we should expect to find no language in which only coronals palatalize, to the exclusion of dorsals, and no language where only labials palatalize. On the other hand, we should expect to find languages with only full palatalization of dorsals[12]. As I have shown here, there are many languages with exclusive palatalization of both dorsal and coronal sounds, and indeed no language where only labials palatalize. Thus, the flaw in Chen's implicational hierarchy lies in the prediction regarding coronals and dorsals: they can palatalize independently or together. I should point out that Chen's analysis and predictions were based on a very small language sample, and it is therefore not surprising that a larger scale empirical study would contradict some of the predictions that the hierarchies make.

My observations of full palatalization patterns are consistent with Bhat (1978), who writes that full palatalization of labials is very rare (Bhat 1978:70). Most of the languages in his sample show palatalization of coronal and dorsal consonants, just as the languages in my sample do, and only a few are reported to have full palatalization of labials, among these Romanian and Tswana (see chapter 3 for further discussion on labial palatalization). Bhat does not formulate any implicational relationships for palatalization, so I cannot evaluate the findings in this regard.

[12] Chen also proposes an implicational hierarchy for palatalization triggers, whereby if lower front vowels trigger palatalization, then so do higher front vowels. This will be discussed further in the next section.

Neither Chen (1973) nor Bhat (1978) distinguished specifically among morpho-phonological and phonological palatalization contexts, rather they collapsed all contexts in their analyses. Finally, I cannot compare my findings to Hall (2000), as he is concerned with secondary palatalization, particularly at the phonemic level.

2.3 Secondary palatalization

2.3.1 Secondary palatalization targets: general patterns

This section presents a detailed description of secondary palatalization targets by discussing the major place of articulation affected, labial, coronal, or dorsal. As in the previous section, I first present the findings without distinguishing between morpho-phonological and phonological palatalization, and then I will discuss some important differences that arise when distinguishing between the two contexts. In brief, dorsals show exclusive secondary palatalization only in phonological contexts, and in morpho-phonological contexts dorsal secondary palatalization is dependent on coronal palatalization. Coronals, on the other hand, may palatalize secondarily in both contexts.

Table 2.4 below summarizes the patterns of secondary palatalization in my language sample, totaling 32 languages or dialects. As with full palatalization, the results are separated according to morpho-phonological, phonological and total secondary palatalization.

Table 2.4 Secondary palatalization (32 languages/dialects)

POA / Sec. palatalization	Labial	Coronal	Dorsal	Coronal + Dorsal	Labial + Dorsal*	Labial + Coronal*	Labial, Coronal, Dorsal
Morpho-phonological	0	2	0	0	2	1	4
Phonological	0	5	9	3	0	3	6
Total secondary palatalization	0	7	9	3	2	4	10

* all of these cases also have full palatalization of the third place of articulation (or in the case of Mandarin, do not have dorsals in the environment of the palatalizing trigger)

Table 2.4 illustrates that, as was the case with full palatalization, dorsal and coronal consonants show independent as well as co-occurring secondary palatalization. There is overlapping morpho-phonological and phonological palatalization at the dorsal place of articulation in both dialects of Romanian (standard and Moldavian) and in Polish, which explains why the total numbers add up to 35 in the last row. Thus, there are nine (26%) languages in which dorsals palatalize exclusively, seven (20%) languages where coronals palatalize exclusively, and three (9%) languages where both coronals and dorsals palatalize. Labials still never palatalize independently; however, there are sixteen (45%) languages (including dialects) in which labials have secondary palatalization, and in ten of these all consonants show secondary palatalization, compared to only two languages with full labial palatalization. Clearly, secondary palatalization affects labials differently than full palatalization does. Whenever labials show secondary palatalization so do either coronal or dorsal consonants, or both. In Bulgarian, Carib, Mandarin, and the Gonder dialect of Amharic only labials and coronals show secondary palatalization, and in Polish (Slavic, Poland) and Zoque

(Mixe-Zoquean, Mexico) only labials and dorsals show secondary palatalization in morphological contexts. All consonants show secondary palatalization in phonological contexts in Polish, with the dorsal consonants doing so before different vowels than in morphological contexts (see Appendix 3). However, in all of the languages where labials and only one other place of articulation show secondary palatalization, the third place of articulation is subject to full palatalization. In the case of Mandarin, dorsals do not appear in palatalizing environments (Duanmu 2000), making it impossible for them to show any type of palatalization. If they did occur in such contexts they would also be expected to palatalize. It is also possible that they did palatalize in these contexts and that is why they no longer appear before palatalizing triggers; however, since Mandarin does not show morphological alternations it is impossible to tell what occurred with the dorsals other than looking at the distributional facts. Below I summarize the generalizations of secondary palatalization.

(6) *Secondary palatalization generalizations:*

- *Coronal and dorsal consonants can palatalize independently, or both may palatalize in the same language*
- *Labial secondary palatalization always co-occurs with either coronal or dorsal secondary palatalization, or both (implicational universal):*

  labial > coronal or dorsal

2.3.2 Secondary palatalization targets: morpho-phonological vs. phonological

When comparing morpho-phonological and phonological secondary palatalization, two interesting patterns surface. First, independent dorsal secondary palatalization only occurs phonologically. There are no languages in which only dorsals are secondarily palatalized in morpho-phonological contexts. Typically, morpho-phonological secondary palatalization affects either coronals alone, or consonants at all places of articulation. In the case of Polish and Zoque, where dorsals and labials show morpho-phonological secondary palatalization, coronal consonants fully palatalize in the same contexts. Therefore, dorsal morpho-phonological secondary palatalization is dependent on coronal morpho-phonological palatalization (either full or secondary).

Second, consonants at all three places of articulation can show secondary palatalization, either in morpho-phonological or phonological contexts, as seen in Shilluk, Yagua, Romanian, several dialects of Amharic, Mongolian, and Nupe. This pattern confirms that labial consonants are affected by secondary palatalization differently than by full palatalization. In (7) I summarize the generalizations for secondary palatalization, taking into account the differences arising from comparing morpho-phonological and phonological palatalization.

(7) *Secondary palatalization generalizations*

- *Coronal consonants may palatalize independently in both morpho-phonological and phonological contexts*
- *Dorsal consonants can palatalize independently only in phonological contexts*

- *Morpho-phonological dorsal secondary palatalization is dependent on coronal palatalization (full or secondary):* ***dorsal > coronal***
- *Labial secondary palatalization always co-occurs with either coronal or dorsal secondary palatalization, or both (implicational universal):*

  labial > coronal or dorsal

Because of the approach to palatalization, full vs. secondary and morpho-phonological vs. phonological contexts, these generalizations have not been made in prior studies as far as I am aware. Chen (1973) did not look at secondary palatalization, and Bhat (1978) concluded that secondary palatalization is areally restricted, but that when it does occur it affects consonants at all places of articulation (Bhat 1978:76). This latter observation is generally true, as many of the languages with secondary palatalization do palatalize consonants at all places of articulation (see Table 3 of Appendix 2), though I did not find secondary palatalization to be areally restricted[13].

Although Hall's (2000) generalizations apply mainly to phonemic systems, he does claim that the implicational universal that if a language has a palatalized rhotic it will have at least one palatalized nonrhotic could be an absolute universal, applying also to the surface representation. I did not focus specifically on rhotics, but my findings are consistent with this universal, as there is no language where only *r*-sounds are palatalized, either fully or secondarily. Furthermore, I also found that rhotic consonants are resistant to palatalization, just as Hall (2000) and Bhat (1978) also found.

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[13] Maddieson (1984) states that, in phonemic systems, secondary palatalization occurs more commonly with labial and coronal stops, but this does not imply that it does not occur with velar stops (Maddieson 1984:37). Similarly, Kochetov (2002) states that dorsals show secondary palatalization less often than coronals and labials (Kochetov 2002:21).

2.4 General remarks on palatalization patterns

The full and secondary palatalization patterns discussed above converge on the fact that there is no language where only labials, or labials and either coronals or dorsals palatalize together (either fully or secondarily) to the exclusion of other sounds. This suggests that the implicational relationship established earlier regarding the dependency of labial full palatalization on both coronal and dorsal palatalization is truly a relationship that holds for palatalization as a whole. The outcome of palatalization, whether full or secondary, is more dependent on individual sounds within each language. But the major places of articulation are clearly targeted by palatalization in general in a systematic way, in which the palatalization of labials is dependent on the palatalization of both coronals and dorsals.

As a final note, for those languages with overlapping full and secondary palatalization at the same place of articulation, it does not mean that sounds randomly undergo one type of palatalization or the other. Rather, in each language either certain sets of sounds undergo one type of palatalization or another, the morpho-phonological or the phonological context determines full or secondary palatalization, or there are other factors determining full or secondary palatalization for different sounds. For a full description of these cases refer to Appendix 3. Here I will discuss just a few examples to illustrate.

In Fanti (Akan, Ghana) dorsal consonants show both full and secondary palatalization. However, this is determined by both the trigger type and by target type. Dorsal consonants *k, g, ɣ, kw* and *gw* fully palatalize before a front vowel, while *x* fully palatalizes only before a non-nasal front vowel, and it has secondary palatalization before a nasal front vowel, as seen below:

(8) Velar *x* palatalization in Fanti (Welmers 1946):

xirã	[ʃ]irã	'earthen water pot'
xe	[ʃ]e	'he located at (out of sight)'
oxĩn	o[x^j]ĩn	'chief'
ixén	i[x^j]ẽn	'boat'

In Coatzospan Mixtec (women's speech; Mixtec, Mexico) coronals *t* and *nd* undergo full palatalization before front vowels *i, e* and secondary palatalization before high back vowels *ɨ*, *u*.

(9) Coronal palatalization in Coatzospan Mixtec (Gerfen 1999:29):

/ndii/	[ndʒii]	'force'
/ndee/	[ndʒee]	'black'
/tii/	[tʃii]	'man'
/tee/	[tʃee]	'leaf used for roofing'
/nduʔu/	[nd^juʔu]	'tree trunk'
/ndɨɨ/	[nd^jɨɨ]	'flat, smooth'
/tuʔu/	[t^juʔu]	'cutting off water'
/tɨʔɨ/	[t^jɨʔɨ]	'twisted'

Therefore, while there is no general cross-linguistic pattern that can be established for overlapping full and secondary palatalization at the same place of articulation, each language has a systematic way of determining full and secondary palatalization, obeying the cross linguistic generalizations of palatalization by major place of articulation as described above.

2.5 Detail on full and secondary palatalization targets

In this section I will present details on the actual sounds that are targeted by both full and secondary palatalization. I discuss these findings in a single section as there are no significant differences between full and secondary palatalization in this respect. There are very few differences between morpho-phonological and purely phonological palatalization and these will be discussed here as well.

Most of the palatalization targets are obstruents, with stops outnumbering fricatives and affricates. The next best targets are the nasals, followed by laterals, and finally by rhotics. This is not equivalent to establishing an implicational relationship among manners of articulation, as there are languages in which such a relationship would not hold in a strict sense (for example, only fricative *s* palatalizes in Karok (Hokan, USA)). However, there is an overwhelming tendency in most languages for obstruents to palatalize most often, followed by the other manners of articulation as just mentioned. This is consistent with findings in Maddieson (1984) where phonemic palatalization is noted for a large number of languages. Numbers from this work are given below (reproduced from Hall 2000:9). Notice that the number of languages increases going from rhotics to laterals to nasals and finally to obstruents:

(10)

a. Languages with at least one palatalized rhotic phoneme: 8

b. Languages with at least one palatalized lateral phoneme (including *ʎ*): 22

c. Languages with at least one palatalized nasal phoneme (including *ɲ*): 115

d. Languages with at least one palatalized obstruent phoneme (including *c*, *ɟ*): 120

In Table 2.5 below I give a highly simplified list of the most common palatalization targets and their outcomes. For a complete inventory of targets and their outcomes refer to Appendix 5. As full palatalization of labials is extremely rare and furthermore restricted to historical developments in morpho-phonological contexts, I do not include any targets and outcomes in the table for this category. The morpho-phonological palatalization columns are shaded for visual ease. The abbreviations MP and P indicate morpho-phonological and phonological contexts, respectively.

Table 2.5 Most common palatalization targets and their respective outcomes

	Full				Secondary		
	MP	Outcome	P	Outcome	MP	P	Outcome
Labial					p	p	
					b	b	
					m	m	
Coronal	t	tʃ	t	tʃ	t	t	
	d	dʒ	d	dʒ	d	d	C^j
	s	ʃ	s	ʃ	s	s	
	n	ɲ	n	ɲ	n	n	
Dorsal	k	tʃ	k	(tʃ) c	k	k	
	g	dʒ	g	(dʒ) ɟ	g	g	

I first want to point out that the palatalization outcomes of both morpho-phonological and phonological palatalization are generally the same. For example, dorsals *k* and *g* and coronal *t* and *d* can fully palatalize to *tʃ* and *dʒ* regardless of context. Individual languages sometimes show more varied outcomes, such as *r* palatalizing to d^j in Carib (Carib, Guiana) and Yagua (Peba Yaguan, Peru).

As mentioned earlier, labial consonants most commonly show secondary palatalization. For coronal and dorsal consonants, the obstruents and nasals are the best targets. The most common full palatalization outcomes for the coronal and dorsal oral stops *t*, *d* and *k*, *g* (ejective or plain) are the palato-alveolar affricates *tʃ* and *dʒ*. The alveolar fricatives *s* (ejective or plain) and *z* are produced further back toward the palate, being realized most often as *ʃ* and *ʒ*, respectively, while the alveolar nasal *n* is mostly realized as palatal nasal *ɲ*.

When comparing palatalization outcomes within morpho-phonological and phonological contexts a few asymmetries emerge. Coronal and dorsal consonants prefer *full* palatalization in morpho-phonological contexts. The only exception seems to be the alveolar nasal which has comparable instances of full and secondary palatalization outcomes in both morpho-phonological and phonological contexts. It is often difficult to determine whether *n* is fully or secondarily palatalized, so it is possible that the numbers may not be entirely correct here. For phonological palatalization, full or secondary palatalization outcomes seem to be more balanced, with slightly higher numbers of secondary palatalization for some sounds such as *d, r, g*. There is an additional noticeable contrast for dorsals: in morpho-phonological contexts, full palatalization is preferred; however, in phonological contexts there are many cases where dorsals fully palatalize and also where they show secondary palatalization. While the most common outcomes of full morpho-phonological palatalization for *k* and *g* are *tʃ* and *dʒ*, in phonological contexts we see the palatal stops *c* and *ɟ* more often.

For secondary palatalization the common outcome is to have a secondary palatal articulation only, but in a few cases something additional takes place. For example in the Standard dialect of Romanian (SR) final consonants palatalize before *i*-initial suffixes, in particular the plural marker, but different consonants have different realizations. Labials have secondary palatalization, dorsal *k*, *g*, and coronal *s*, *z* have full palatalization with secondary release. Other coronals and the glottal fricative have secondary palatalization with the exception of *d* and *t*, which in addition to having a secondary palatal release also spirantize and affricate, respectively:

(11) *d* and *t* spirantization/affrication and secondary palatalization in SR:

/brad-i/	[braz^{j}]	'fir tree.pl'
/pot-i/	[pots^{j}]	'can.2sg'

The coronal rhotic *r* shows mostly secondary palatalization, with the additional outcome of d^{j} in Carib and Yagua, as mentioned earlier. Some examples from Carib are given below:

(12) Palatalization in Carib (Hoff 1968:32-39)[14]:

/i**r**a:ko/	[i**d**^{j}a:ko]	'large ant'
/pi:**t**o/	[pi:**t**^{j}o]	'flatus'
/i:**t**a/	[i:**t**^{j}a]	'in it'
/pi**s**u:ru/	[pi**ʃ**u:ru]	'species of fish'

Recall Hall's (2000) prediction that if a rhotic will palatalize it may sometimes change to another sound, which is exactly what happens here. Thus, such an outcome for the rhotic is not that unexpected, and it is likely that the closest palatalized variant of *r* would be a palatalized stop such as d^{j}.

Laterals primarily show full palatalization to the palatal glide, though there are also some cases of secondary palatalization. The lateral approximant shows either full or secondary palatalization, while the lateral fricatives show secondary palatalization.

2.6 Interim summary: palatalization targets

In sections 2.2 through 2.5 I presented a detailed description of the general findings on full and secondary palatalization target by major place of articulation, labial, coronal, and dorsal, and also by the most common sounds targeted by palatalization. I also pointed out differences in patterns arising from comparing palatalization in morpho-phonological contexts with those in purely phonological contexts. The most striking finding is that labial palatalization is always dependent on the palatalization of coronal and dorsal consonants, strongly indicating a separation between the labial and

[14] In Carib the palatalization trigger precedes the target.

the coronal/dorsal places of articulation. In every language where labials palatalize both coronals and dorsals also palatalize, either secondarily or fully. As mentioned earlier, I will argue that this is expected given the articulators involved in producing these target sounds and the palatalization triggers, namely the lips and the tongue.

I have also shown that there are no significant differences regarding the actual sounds that undergo palatalization in morpho-phonological and phonological contexts. The outcomes of palatalization are largely the same regardless of context: there is both full and secondary palatalization in either context, with some tendencies for coronals and dorsals to prefer full palatalization in morpho-phonological contexts. In (13) and (14) below I summarize the patterns of full and secondary palatalization, restated from (5) and (7) above.

(13) *Full palatalization generalizations:*

- *coronal and dorsal targets may be fully palatalized independently of each other, or both places of articulation may be targeted in the same language*
- *labial consonants never have full phonological palatalization*
- *full labial palatalization always co-occurs with both dorsal and coronal palatalization (implicational universal):* ***labial> coronal & dorsal.***

(14) *Secondary palatalization generalizations*:

- *Coronal consonants may palatalize independently in both morpho-phonological and phonological contexts.*
- *Dorsal consonants can palatalize independently only in phonological contexts*
- *Morpho-phonological dorsal secondary palatalization is dependent on coronal palatalization (full or secondary):* ***dorsal > coronal.***

- *Labial secondary palatalization always co-occurs with either coronal or dorsal secondary palatalization, or both (implicational universal):*
  labial > coronal or dorsal.

In the next section I turn to palatalization triggers. I discuss what the triggers are, their position with respect to the target, and their fate (whether they are pronounced or not).

2.7 Palatalization triggers

It is best to discuss palatalization triggers in a single section without making distinctions for full/secondary and morpho-phonological/phonological, because in general the same patterns are observed. An interesting finding is that there is no significant effect of triggers with respect to full or secondary palatalization. The type of palatalization that consonants undergo, full or secondary, is more a result of the nature of the target itself rather than of trigger type[15]. Therefore, this aspect will not be discussed further. Rather, this section will focus on the actual palatalization triggers, their position with respect to the target, and their fate (whether they are pronounced, or maintained on the surface, or whether they are opaque, or not pronounced/deleted).

2.7.1 What are the triggers?

It is generally well known among linguists that the typical palatalization triggers are the front vowels *i* and *e*, and the palatal glide (or semivowel) *j*. Chen (1973), Bhat (1978) and Hall (2000) all found the same common triggers. As I show in this section, this is indeed the case with a great majority of the languages in my sample. Regarding

[15] There are some languages where the trigger makes a difference, but this is not the case in general. Some examples include Coatzospan Mixtec (women's speech) and Fanti.

such features as distinctive vowel length, rounding, or nasality, I have found that in general they do not make a difference in the vowel's ability to trigger palatalization. Thus, both short and long, oral and nasalized, and rounded and unrounded high and front vowels can trigger palatalization[16]. The facts about rounding are consistent with Bhat (1978) who also found no significant effects of vowel rounding on palatalization (Bhat 1978:61). Bhat does not discuss the effects of vowel nasality or length on palatalization, but presumably he does not do so because there are no great effects to be reported.

In each language there are different combinations of triggers, and the interesting fact is that these combinations are not random but fall within predictable patterns according to vowel height and backness, as explained below. There are languages where *i* is the only palatalization trigger (e.g. Apalai, Basque, Carib, Fongbe, Kayardild), languages in which only the palatal glide is a trigger (e.g. English, Shilluk, Yagua, Zoque), and languages where *i* and the glide *j* are triggers (e.g. Luvale, Nishnaabemwin, Yimas). There are many languages where only front vowels are triggers, primarily including *i* and *e* but also *ɛ, y, ø* and the diphthong *ea̯* (e.g. Dakota, Hausa, Mwera, Nupe, Romanian, Turkish), and a few others in which front vowels and high vowels which are further back (primarily *u*, but also *ʉ, ɨ*) trigger palatalization, in addition to the usual *i* (e.g. Coatzospan Mixtec, Maori, Sentani, Tohono O'Odham).

[16] The case of Fanti palatalization of *x*, described here in (8), is a notable exception to this.

Therefore, in every language where a lower front vowel such as *ɛ* triggers palatalization we also see *i* as a trigger, and in every language where a high vowel such as *u* triggers palatalization once again we see *i* being a trigger. There are two implicational relationships that can be drawn based on these findings, both of which converge on high front vowels, particularly on *i*, as being the best palatalization triggers.

(15) **Implicational relationships among palatalization trigger vowels**

(i) if lower front vowels trigger palatalization, then so will higher front vowels

(ii) if high back/central vowels trigger palatalization, then so will high front vowels

The implicational relationship in (15i) is identical to Chen's (1973). Chen predicted that, among vowels, only the front ones would trigger palatalization, from low to high. Bhat (1973) did not make any such predictions. The relationship in (15ii) has not been identified in prior research to my knowledge. This could be due to the fact that high back vowels rarely trigger palatalization, and languages in which such vowels are triggers may have been overlooked by other studies. However, when such languages are included we can establish such relationships as (15ii), and furthermore we can confirm that [i] is the best palatalization trigger in any language, regardless of what the other triggers are.

There are only three apparent exceptions to the implicational relationships in (15), and I discuss each of these here. In Sirionó (Tupí-Guaraní, Bolivia) velar *k* shows secondary palatalization word-initially before a strongly stressed low central vowel *á*, and *g* shows secondary palatalization before a stressed high front vowel *í* (Firestone 1965). However, Bhat (1978:55) notes that *k* does not appear before *i* or *e* in Sirionó, which explains why the relationship in (15 i) above appears to be disobeyed. In Coatzospan Mixtec *i* and *e* trigger full palatalization on coronal *t* and *nd* in women's speech, while back vowels *ɨ* and *u* trigger secondary palatalization on the same consonants in both men and women's speech (Gerfen 1999). Taken together, these triggers do reflect (15 i) and (15 ii) in women's speech, but it is odd that only the high back vowels should trigger secondary palatalization in men's speech. A possible explanation may lie in the socio-linguistic domain: if full palatalization marks female speech, this may be avoided by men. Finally, in Ejagham the implicational relationships appear true for *g*, but not for *k*. In this language high vowels *i* (front unrounded) and *ʉ* (front rounded)[17] trigger fronting on non-labial or labio-velar stops, including *k* and *g*. In addition, *k* is optionally secondarily palatalized only before *ε* (mid front unrounded), and *g* is obligatorily secondarily palatalized before *ε* and *ʉ*, while before *i* it can either have fronting or secondary palatalization (Watters 1981). Keeping in mind the difficulty of determining exactly what *fronting* amounts to, it is possible for both *k* and *g* to be affected by *i* in the same way they are affected by the other vowels, *ε* and *ʉ*, in which case the hierarchies would be respected entirely.

[17] Watters 1981 treats *ʉ* as a front vowel because it patterns more with the other front vowels in the language. Typically this is a high central vowel. Note that regardless of whether it is high central or high front, my predictions would be the same, namely that if this vowel triggers palatalization, so will *i*, which is indeed the case

The implicational relationships established above are only relevant when palatalization is triggered by vowels in a language. There is no implicit claim that vowels are exclusive palatalization triggers, but that if there is a single vowel trigger in a language that vowel should be *i*. This prediction is verified by the data in the language sample, as discussed below.

All but six languages in the sample have *i* as a trigger. In five of these there are no other vowel triggers, but rather the palatal glide alone is a trigger (English, Hungarian, Shilluk, Yagua, Zoque)[18]. In the sixth language, Mongolian (Mongolian, Mongolia), the trigger is a *preceding ai*-diphthong. It is not surprising that when no vowels are triggers of palatalization, the palatal glide is. What is surprising though is that, of the languages with palatalization in the sample, fifty have the palatal glide in their sound inventory, but only nineteen have it as a trigger of palatalization (in at least one dialect studied). In the analysis in chapter 5 I will discuss why this may be the case, comparing the articulatory properties of *j* with those of *i*. Speaking in terms of sheer numbers, front vowels *i* and *e* are triggers more often than the palatal glide *j* (50 languages have *i*, 25 languages have *e*, 19 languages have *j*). However, as mentioned above, there are languages in which only the palatal glide triggers palatalization, but no languages in which only the mid front vowel *e* triggers palatalization, as predicted by the implicational relationships discussed above.

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[18] In addition to the palatal glide we see a set of palatalized alveolar stops t^j, d^j, n^j triggering palatalization on *t*, *d*, *n* in Hungarian (Uralic/Ugric, Hungary), though this could be treated as consonant harmony rather than palatalization (Hanson 2001). Gilley (1992) analyzes *i* as an unspecified vowel in Shilluk (Nilotic, Sudan), and characterizes it as the most unstable vowel, easily deleted and the default epenthetic vowel, which may explain why it is not a palatalization trigger in this language.

There are three cases in which both high and mid front vowels are triggers, but the mid front vowels appear to be stronger triggers. In Eastern Ojibwa dorsal *k* and *kk* and coronal *ʃ* and *ʃʃ* are secondarily palatalized before *i* or *e*, with *e* causing "more audible" palatalization (Bloomfield 1956). In Ejagham *k* and *g* show different behaviors before *i* and *ʉ* versus *ɛ*, (cf. section 2.7.1). In Navajo *i* does not trigger palatalization on *k* and c^h, but *e* does; both *i* and *e* trigger palatalization on other consonants (Young 1980, 1987). Bhat (1978) found that velar consonants were affected by front vowels more, while labial and coronal consonants were affected by high vowels more. In his terms, this is why velars are more prone to tongue fronting and non-velars to tongue raising. The palatalization patterns in the languages in my survey support the tendency that Bhatt reported, although I suspect that it is not front vowels that affect velars more, but that specifically the *lower front* vowels may affect velars more than other consonants. Velar consonants appear to palatalize in front of *i, e* or just *e*, while coronal consonants do so only before *i* in some languages (i.e. Maori, Navajo, Romanian). I suggest that the reason for this has to do with the fact that velar stops are themselves high, and it is possible that before a lower front vowel the tongue movements during speech production cause a larger shift in position than they would for a higher front vowel. This shift may be more noticeable than before the high front vowel *i*, which may be interpreted as velar fronting and is thus not reported.

2.7.1.1 High back vowel triggers

Languages where high back vowels trigger palatalization are not very common, although they are clearly attested. There are only four such languages in my sample, Tohono O’Odham, Coatzospan Mixtec, Maori, and Sentani. In Sentani only high vocoids trigger palatalization, and in the other three front vowels and high vowels both trigger palatalization. This is summarized in the table below.

Table 2.6 Languages with high back vowel triggers

Languge	Trigger	Target and outcome
Tohono O’Odham (Uto-Aztecan, AZ & Mexico) (Mason 1950)	*-i, -e,- u*	t→ tʃ d→ dʒ n→ n^j
Coatzospan Mixtec (women’s speech) (Mixtecan, Mexico) (Gerfen 1999)	*-i, -e*	nd→ ndʒ t→ tʃ
	-ɨ, u	nd→ nd^j t→ t^j
Maori (Austronesian, NZ) (Krupa 1968, Bauer 1993)	*-i,- ɛ*	k→ ç
	-i *-i,u* (final devoiced)	t→ tç (questionable)
Sentani (Papuan, Indonesia) (Cowan 1965)	*i-, j-, u-, w-*	d→ d^j or t^j
	i-, j-	n→ ɲ
	i-, j-, w-	j→ dʒ

As shown in table 2.6, high back vowels [u] and [ɨ] do not trigger palatalization on velar consonants, but only on coronals. This is not relevant for Tohono O’Odham, since velars are not palatalized at all (Mason 1950). In Maori, the velar shows palatalization before high front vowels, while a final devoiced [u] or [i] causes a preceding [t] to alternate with [tç] (Bauer 1993). This outcome suggests that [t] may not actually be palatalized here, but that the palatal fricative following it is the result of the devoicing of the following high vowel (Arvaniti, p.c.)[19]. As discussed elsewhere in this chapter, in Coatzospan Mixtec (women's speech) the high front vowels trigger full palatalization, while the high central and back vowels trigger secondary palatalization on the same consonants (Gerfen 1999). Finally in Sentani the high vowels [i, u] and both glides [j, w], can trigger palatalization, but not all of these are triggers for all of the palatalization targets (Cowan 1965). Thus, secondary palatalization is triggered by all of the triggers when the target is a following [d], but full palatalization is triggered only by [i] and [j] on a following [n]. The palatal glide is pronounced as the affricate [dʒ] when it follows another glide (palatal or labio-velar), or the vowel [i]. The glides are described as only recently having been ascribed phonemic status, and that they are very similar to their corresponding vowels (Cowan 1965:7, 8).

Thus, the generalization that emerges from languages where high back vowels trigger palatalization is that they only condition palatalization on coronal consonants, and not on dorsal consonants. Labial consonants do not palatalize at all in these languages, thus it is difficult to say whether high back vowels would condition palatalization on labials as well. In chapter 5 I explain that the fact that dorsal consonants share the same basic "place of articulation" with the high back vowels predicts that these vowels will not trigger palatalization on dorsals.

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[19] For this reason, I indicated palatalization of the coronal in Maori as questionable in the summary tables of the appendices.

2.7.1.2 Lonely trigger, needs support

Like Bhat (1978), I have also found some languages where the presence of a palatalizing trigger alone is not sufficient to trigger palatalization, or where palatalization is blocked.. There are ten such languages in my sample. In some cases palatalization is triggered by *i* or *e* in conjunction with other sounds, and in other cases palatalization is blocked in certain contexts. I briefly discuss these examples below.

In Dhivehi (Maldivian, Republic of Maldeves) a stem-final *i* triggers full coronal palatalization only when it is also followed by a vowel-initial suffix (Cain 2000) (16a). Palatalization is blocked if the preceding syllable is closed or if the consonant is retroflex. In these cases a palatal glide is inserted to break up the hiatus created by the stem final *i* and the vowel-initial suffix, and no palatalization occurs (16b, c). Note that the outcome of palatalization is a change in primary place of articulation and also gemination of the coronal consonant.

(16) Palatalization in Dhivehi (Cain 2000:8-10)

(a) Coronals palatalize before (stem)i + V(suffix):

eti	‘thing’	ettʃek	‘a thing’
rodi	‘thread’	roddʒek	‘a thread’
fani	‘worm’	faɲɲek	‘a worm’
duni	‘bow’	duɲɲek	‘a bow’
fali	‘oar’	fajjek	‘an oar’

(b) Palatalization blocked after CVC syllable:

batti	‘light’	battijek	‘a light’	← epenthesis
buddi	‘mind’	buddijek	‘a mind’	
bonti	‘unopened frond’	bontijek	‘an unopened frond’	
kulli	‘emergency’	kullijek	‘an emergency’	
dʒinni	‘jinni’	dʒinnijek	‘a jinni’	

(c) Palatalization not affecting retroflex consonants (*r* patterns with retroflex consonants in this language):

buri	'tier'	burijek	'a tier'	← epenthesis
faɭi	'slice (n.)'	faɭijek	'a slice'	
baɖi	'gun'	baɖijek	'a gun'	

In Mangap-Mbula (Western Oceanic, Papua New Guinea) *i* triggers full coronal palatalization when also followed by lower front vowels *e* or *a* (Bugenhagen 1995). In Sanuma (Yanomam, Brazil, Venezuela) velar stop *k* palatalizes to c^j when preceded by *i* and also followed by *a* (Borgman 1990). In Standard Modern Greek (Greek, Greece) velar obstruents fully palatalize before *i* and *e*, and also before *i* followed by one of tautosyllabic *a*, *o* or *u* (Mackridge 1985, Arvaniti 1999a). Coronals *n* and *l* may fully palatalize before *i* followed by another tautosyllabic vowel (these cases are stigmatized in this dialect, Arvaniti 2006 personal communication). In Cypriot Greek coronals palatalize before *i* followed by another tautosyllabic vowel (Arvaniti 1999b). In Turkish (Turkic, Turkey) the palatalizing front vowels *i*, *e*, *y*, *ø* must be tautosyllabic with the palatalization targets *k*, *g*, and *l* (Kornfilt 1997). In Limlingan (Non-Pama-Nyungan, Australia?) a stressed *í* triggers optional secondary palatalization on a preceding velar nasal *ŋ* unless it is also followed by a palatalized consonant (Harvey 2001). In Ikalanga (Bantu, Zimbabwe, Botswana) *l* and *n* palatalize to *dʒ* and *ɲ* when the noun stem ends in *i* or *e* and the diminutive suffix *–ana* follows (Mathangwane 1999; labials are also affected in this context as discussed later in the labial palatalization chapter). In Mina (Chadic, Biu-Mandara, Cameroon) a following or preceding *i* triggers full palatalization of *s*, *z*, *ts* and *dz* to *ʃ*, *ʒ*, *tʃ* and *dʒ*, unless there is an intervening underlying palatal glide. Frajzyngier, Johnston and Edwards (2005) present evidence that the palatal glide is underlying as it surfaces when other affixes are added, and that it blocks both palatalization and fronting vowel harmony (p. 12, 20). This seems odd, since the palatal glide is normally a good palatalization trigger; however, language particular factors may account for this behavior (see also section 4.3.1 in chapter 4, on possible differences between *i* and *j*).

In the Lekeitio dialect of Basque (Basque, Spain) full palatalization of *t*, *d*, *n*, and *l* to *c*, *ɟ*, *ɲ*, and *ʎ* respectively, is restricted to the phonological word, triggered by a preceding *i*. Other rules change *d* and *n* to other sounds, blocking palatalization from taking place (Hualde 1997, 80-83). Finally, in Yimas (Sepik-Ramu, Papua New Guinea) *t* and *n* palatalize to *c* and *ɲ* respectively, following the vowel *i*, a palatal glide, or a palatal lateral. Palatalization is blocked word-finally because Yimas phonotactics does not allow the sounds resulting from palatalization in word-final position (Foley 1991). What is clear from all of these examples is that while the palatalizing trigger may not be sufficient to trigger palatalization, it is necessary. Palatalization would not take place in the contexts described above in the absence of the palatalizing trigger.

2.7.1.3 Rare palatalization triggers and outcomes

In addition to the triggers discussed above, there are languages with some uncommon palatalization triggers, or common triggers which cause uncommon palatalization outcomes which I briefly describe here. In Mandarin underlying high front vowels /i/ and /y/ (unrounded and rounded, respectively) trigger secondary palatalization on labial and coronal consonants, except on affricates and *s*, which fully palatalize. These triggers surface as their glide counterparts *j* and *ɥ*, respectively, in prenuclear position, and as vowels *i* and *y* otherwise. The unique outcome here is that the rounded front vowel has a rounded off-glide counterpart similar to secondary palatalization such that /l/→ [l^{ɥ}] and /n/→ [n^{ɥ}] before *y*, though there are only four known cases of this, suggesting these may be lexicalized (Duanmu 2000). Affricates and *s* fully palatalize and have secondary labialization in this context, preserving the labial feature of the rounded vowel. Some examples are given below.

(17) Palatalization in Mandarin (Duanmu 2000):

a. Palatalization before /y/:

Underlying	Surface		
ly	l^{ɥ}yy	'travel'	←off glide
ny	n^{ɥ}yy	'women'	
tsy	tç^{w}yy	'tool'	← full pal. & labialization
ts^{h}y	tç^{hw}yy	'go'	
sy	ç^{w}yy	'empty'	

b. Palatalization before /i/:

piau	p^{j}au	'chart'	←secondary palatalization
p^{h}ian	p^{hj}an	'flake'	
mi	m^{j}ii	'rice'	
ti	t^{j}ii	'land'	
t^{h}ian	t^{hj}an	'sky'	
liaŋ	l^{j}aŋ	'amount'	
niaŋ	n^{j}aŋ	'mother'	
tsiəu	tçəu	'nine'	←full palatalization
ts^{h}ia	tç^{h}a	'pinch'	
sin	çin	'heart'	

In Korean (Isolate, Korea) morpho-phonological contexts the vowel *i*, the palatal glide *j*, and the sequences *hi* and *hj* trigger full palatalization of coronal consonants *t, th* and *t'* (tense *t*) at a morpheme boundary, as seen below.

(18) Palatalization in Korean (Sohn 1994; phonetic transcriptions by Nayoung Kwon, graduate student, UCSD):

kut-i	/ku.ci/	[kɨtʃi]	'positively'
kath-i	/ka.chi/	[kʌtʃi]	'together'
tat-hita	/ta-chi.ta/	[tatʃida] ~ [tatʃita]	'close, shut (passive)'
kut-hjəla	/ku.chə.la/	[kutʃɔɾa]	'harden it.'

The labio-velar glide *w* appears to trigger palatalization in Sentani and Tswana. However, given its similarities to *u* is not that surprising that *w* would trigger palatalization in some cases. In Sentani (Trans New Guinea, Indonesia) a preceding *i* or *j*, and more rarely *w* and *u* triggers palatalization on coronal *d* (Cowan 1965). In Tswana (Bantu, Botswana) a following *w* or *j* triggers palatalization on labials, while coronals and dorsals are palatalized before front vowels in the same morphological contexts (Cole 1955, Sound System of Setswana (henceforth SSS) 1999). However, as I discuss in chapter 3, at least in the case of the Tswana labials palatalization before *w* is a result of historical change, whereby a palatal glide was responsible for the palatalization rather than *w* (SSS 1999, Ohala 1978).

Finally, there are also consonant triggers in Hungarian and in Marathi. These could be considered cases of consonant palatal harmony or assimilation. As previously mentioned, in Hungarian (Uralic/Ugric, Hungary) coronals *t*, *d*, and *n* are secondarily palatalized before the palatalized consonants t^j, d^j and n^j (Siptár 2000). In Marathi (Indo-Aryan, India, Israel) the dental stop *t* fully palatalizes to *tʃ* before palatal affricates *tʃ* and *dʒ*, and the dental sibilant *s* fully assimilates to a following palatal sibilant ʃ.

Such cases of consonant-consonant assimilation are common and will not be dealt with further in this dissertation.

In summary, the most common palatalization triggers are the higher front vowels *i* and *e*, and the palatal glide *j*. There are two implicational relationships among the triggers such that if a lower front vowel triggers palatalization so will a higher front vowel, and if a high vowel that is further back triggers palatalization then so will a high vowel that is further front. Of these, the first confirms Chen's (1973) implicational relationships for palatalization triggers, and the second is newly identified. High back vowels appear to trigger palatalization only on coronal consonants. There are some non-traditional sounds which can trigger palatalization, such as *w* or consonants, though many of these cases can be traced back to historical developments or be treated as consonant assimilation. In the next two sections I discuss the position of the palatalization trigger with respect to the target, and the fate of the trigger.

2.7.2 Position of the trigger with respect to the target

2.7.2.1 Trigger immediately adjacent to the target

In most of the languages in my sample the palatalization trigger follows the target (41 of 56 languages included in the analysis)[20], resulting in regressive palatalization. In the remaining 15 languages the position of the trigger varies as follows. In nine languages the trigger precedes the target, resulting in progressive palatalization (Basque, Carib, Dakota, Karok, Mongolian, Sentani, Western Shoshoni,

[20] In Kokota and West Greenlandic, which have palatalization but were not included in the detailed analysis because of unclear type of palatalization, the situation is as follows: the trigger follows the target in Kokota, while in West Greenlandic it follows all targets (*t*, *s*, *l*, *n*) except for *j* which it precedes.

Yagua, Yimas). In three languages, Apalai, Breton, and Mina[21], the trigger is contiguous with the target, hence it may either precede or follow it.

Finally in three languages, Sanuma, Tswana, and Zoque, the trigger typically follows the target, but it sometimes precedes it. In Tswana all triggers follow the target except when part of the class 3 singular prefix *le-*, which is very rare and precedes the target (Cole 1955). In Sanuma, the trigger *i* precedes *ts* but follows *s* (Borgman 1990). In Zoque (Mixe-Zoquean, Mexico) the triggers typically follow the target. However, a *preceding* palatal glide also triggers palatalization on alveolars. Wonderly (1951) proposes that this is done first by metathesis (the glide switching places with the following consonant) and then palatalization. Alveolar stops become alveo-palatal stops, and alveolar sibilants became alveo-palatal sibilants. Hume (2002) further proposes that labials and velars undergo metathesis with a preceding glide, so that the glide surfaces after the consonant, but Sagey (1986) argues that these cases are not metathesis at all, but rather palatalization in which the preceding glide surfaces as secondary palatalization on the consonant. Following are some example illustrating the Zoque patterns:

(19) Palatalization in Zoque (Wonderly 1951, Hume 2002; a superscript ^{y} indicates alveo-palatal place of the stop):

/wih**t**-	-**j**ah-/	[wih**t**^{y}ahu]	‘they walked’
walk	suffix		
/j-pata/		[pjata]	‘his mat’

[21] In Mina (Chadic, Cameroon) the trigger can either precede or follow in phonological palatalization of *s, z, ts, dz*. In the morpho-phonological palatalization of *z* before the stative suffix *–ji* the trigger follows (Frajzyngier, Johnston and Edwards 2005).

/j-kama/	[kjama]	'his cornfield'
/j-tatah/	[t^yatah]	'his father'
/j-sʌk/	[ʃʌk]	'his beans'

These findings suggest that while there is a strong tendency for regressive palatalization, where the trigger follows the target, this is not a requirement for palatalization to take place. Based on the current evidence I conclude that the preferred, but not the only, position of the trigger is to the right of the target, resulting in regressive palatalization. These findings are consistent with Bhat (1978) who also found that the trigger primarily followed the target but also that in some cases it precedes it (Bhat 1978:62-63). He did not find any cases where the trigger both precedes and follows the target. Chen (1973) predicts that a palatalization trigger should only follow the target, which is clearly not true.

2.7.2.2 "Long-distance" palatalization (trigger not adjacent to the target)

As discussed above, in most cases the palatalization trigger either immediately follows or precedes the target. In this section I discuss a few rare cases where the trigger and the target are separated by one sound, or where palatalization spreads to more than one consonant. There are six languages in my sample where this is the case. The table below summarizes the facts regarding this position of the palatalization trigger.

Table 2.7 "Long-distance" palatalization

Language	Position of trigger	Consonants affected	Comment
Basque	preceding	C+d → palCɟ	both Cs palatalized
Cypriot Greek	following	nk → ɲɟ	both Cs palatalized (also individually)
Yimas	preceding	nt→ ɲc	both Cs palatalized (also individually)
Karok	preceding	(C)s→ (C)ʃ	optional intervening C not palatalized
Western Shoshoni	preceding	(n)ts→ (n)ʒ or tʃ	optional intervening *n* not palatalized
Romanian	following	/sk-i/ → ʃtʲ /sk-e/ → ʃte /st-i/ → ʃtʲ /str-i/ → ʃtri	both Cs palatalized (individually s→ ʃʲ, k→ tʃ(ʲ), and t→ tsʲ, r→ rʲ)

In Basque, Cypriot Greek and Yimas the process of palatalization is iterative. In Cypriot Greek and in Yimas palatalization spreads over a sequence of two consonants, and in addition these consonants are palatalization targets even when they do not appear in a consonant cluster. Some examples from Yimas are given in (20).

(20) Palatalization in Yimas[22] (Foley 1991:38, 51)

tay- 'see' + -nak IMP	[tay**ɲ**ak] ~ [taɲak]	'look at it'
tay- 'see' + REDuplicated	[ta**c**ay]	'see repeatedly, stare'
arkwi 'vine' + -ntɨmpɨt PL	[arkwi**ɲcɨ**mpɨt] ~ [arkwɨɲcɨmpɨt]	'vines'

In Basque *d* can only palatalize when the second member of a consonant cluster, otherwise palatalization is blocked by continuant formation. When *d* palatalizes the consonant immediately preceding it also palatalizes, so this is not long distance

[22] In Yimas the trigger may optionally be deleted or maintained. In the example meaning 'vines' the trigger i is first shown maintained, and in the second example it is deleted. An epenthetic ɨ is inserted to break up hiatus (Foley 1991).

palatalization but rather palatalization spreading over more than one consonant, as discussed for Cypriot Greek and Yimas above. Examples from Basque are given below.

(21) Palatalization in Basque (Hualde 1997:81)

/min-a/	mi[ɲ]a	'the pain'
/abil/	abi[ʎ]	'skillful'
/il da/	i[ʎɟ]a	's/he has died'
/indar/	i[ɲɟ]ar	'strength'

In Karok and Western Shoshoni the palatalized consonants may be separated from the preceding trigger by another optional consonant which remains non-palatalized if present. In Karok *s* palatalizes to *ʃ* in this context, and in Western Shoshoni *ts* is palatalized to *ʒ* or *tʃ* either when the trigger immediately precedes it or when there is an intervening *n*, which remains non-palatalized. Some examples are provided in (22):

(22) Palatalization in Western Shoshoni (Crum and Dayley, 1993:242):

pitsi	[p**iʒ**i] ~ [p**itʃ**ɪ]	'breast'
haintseh	[ha**ɪ́ntʃ**ɨh]	'friend' ← *n* between *i* and *ts*

The situation in Romanian appears more complex, but it is in fact very similar to the iterative instances of palatalization in Basque, Cypriot Greek, and Yimas, where the palatalization of one consonant spreads to adjacent consonants in the cluster. In both dialects of Romanian included in this study, final *s*-clusters consisting of two or three consonants palatalize before suffixes beginning with a front vowel. I focus here on the Standard Romanian dialect, since the patterns are not significantly different in the two dialects. The clusters which palatalize are *sk*, *st*, and *str*. Each individual consonant in the cluster also palatalizes independently in the same contexts, but only *s* has the same realization both as a singleton and as a cluster member, as shown in (23). Only the velar palatalizes before both *i* and *e* suffixes (23 c, e), while other consonants palatalize only before *i* suffixes.

(23) Palatalization of *s*-clusters in Romanian (Chitoran 2002a, Ruhlen 1972):

(a)	pa**s**	'step, sg.'	pa**ʃʲ**	'step, pl.'
(b)	bəja**t**	'boy, sg.'	bəje**tsʲ**	'boy, pl.'
(c)	du**k**	'go (1s, present)'	du**tʃʲ**	'go (2s, present)'
			du**tʃe**	'go (3s, present)'
(d)	pro**st**	'stupid (m.sg)'	pro**ʃtʲ**	'stupid (m.pl)'
(e)	kuno**sk**	'know (1s, present)'	kuno**ʃtʲ**	'know (2s, present)'
			kunoa**ʃte**	'know (3s, present)'
(f)	a**str**u	'star, sg.'	a**ʃtr**i	'star, pl.'
	mae**str**u	'maestro, sg.'	mae**ʃtr**i	'maestro, pl.'

The interesting fact about these forms is that alveolar *t* and velar *k* do not have the same palatalization outcomes as when they are singletons. As singletons, $t \rightarrow ts^j$ and $k \rightarrow tʃ(^j)$, but as members of a palatalizing cluster they neutralize to t^j (or *t* before *–e*, which surfaces as a full vowel (23 c, e). The alveolar fricative *s*, on the other hand, palatalizes to *ʃ* in every case, and when it is a singleton it also has secondary palatalization. What seems to occur is dissimilation in a cluster whose members undergo palatalization, and in fact this has been analyzed as such (Ruhlen 1972, Chitoran 2002a). Ruhlen (1972) proposes that the cluster *sk* must have gone through a historical period of *ʃtʃ*, and then dissimilated to *ʃt*. He supports his argument with examples that show phonemic /ʃ/ in /ʃk/ clusters causing dissimilation to [ʃt] before front vowel suffixes, instead of showing *[ʃtʃ] as would be expected by the palatalization of the singletons: tʃeaʃkə ~ tʃeʃt^j 'cup' (sg. – pl.; *tʃeʃtʃ^j). The same is the case with phonemic /ʃt/ clusters: peʃte ~ peʃt^j 'fish' (sg. – pl.; *peʃts^j) (Chitoran 2002a: 193). Similar dissimilation is attested in Slovak, where *sk* ~ *ʃt*^{j} and *zg* ~ *ʒd*^{j} (Rubach 1993).

The triconsonantal cluster *str* shows palatalization only of *s* to *ʃ*, while *t* and *r* appear unaffected by palatalization. However, this is unlikely the case, and the behavior of *t* and *r* can be interpreted as positional restrictions: (i) alveolar *r* does not show secondary palatalization because the final vowel must be syllabified and surface as a full vowel, otherwise the cluster would be unsyllabifiable, and (ii) alveolar *t* cannot show secondary palatalization because secondarily palatalized consonants cannot appear in the middle of a cluster (Kochetov 2002: 29, Telfer 2006:118). This also explains why even the palatalization of *s* does not maintain the secondary palatal articulation of the singleton when it is in a cluster. Therefore, the case of Romanian *s*-cluster palatalization is not a case of long-distance palatalization, but rather a case of iterative palatalization and concomitant depalatalization.

To sum up, what looks like long-distance palatalization is primarily palatalization spreading over more than one consonant (iterative), possibly consonantal assimilation. For the two languages where a consonant may, but does not have to, intervene between the trigger and the target without it being palatalized itself two interesting observations can be made. First, in Karok the target is *s*, one of the most common palatalization targets, and it may be the case that this sound is highly susceptible to palatalization even across consonants. Second, in Western Shoshoni the intervening consonant is *n*, and as it is often difficult to hear whether *n* is palatalized, so it is possible that this *n* is in fact palatal. It appears then that long-distance palatalization may not be an adequate term to describe such cases[23].

2.7.3 Fate of palatalization trigger

An important aspect of palatalization is that the trigger is not always pronounced. I refer to the pronunciation of the trigger as its being *maintained*, and to its absence on the surface as its being *deleted*. Recall that Bhat (1978) made similar generalizations, and that he considered cases where the trigger is deleted as "extreme palatalization", where the trigger is absorbed into the target (Bhat 1978:73-76).

I found that the palatalization trigger in most cases is maintained. In some languages some triggers are maintained, particularly the vowels, and others are deleted, particularly the palatal glide. One of the reasons that triggers delete is that the

[23] Harari and Chaha (both Ethiopian Semitic), are languages outside my sample which do present clear cases of long-distance palatalization (Rose 1997, 2004). This type of palatalization in Harari is restricted to very specific morphological contexts, induced only by the 2sg feminine non-perfective subject /–i/ suffix, and it can affect more than one coronal consonant in the same stem (prefixes included). In Chaha this is also restricted to morphological contexts, where velar consonants can palatalize in non-final position before the /–i/ suffix of the 2sg feminine.

information contained in the trigger can be recovered from the palatalization on the consonant target. Vowel triggers are usually maintained as they serve as syllable nuclei, and they are deleted when they do not need to fill this role. The palatal glide, on the other hand, does not serve as a syllable nucleus, and it is therefore more easily deleted without much information being lost.

For example, in Luvale (Bantu-Chowke Luchazi, Zambia) the trigger *i* is maintained following palatalization, while *j* is deleted (Horton 1949). In Shilluk (Nilo-Saharan, Sudan) *j* coalesces with the consonant it palatalizes (Gilley 1992), while in Yimas (Sepik-Ramu, Papua New Guinea) the trigger *j* is optionally maintained or deleted (Foley 1991). In Mandarin (Sino-Tibetan, China) nuclear *i* is maintained, while the glide *j* is deleted (Duanmu 2000). In Standard Romanian (Romance, Romania), the trigger *i* is deleted word-finally if it is not syllabified, and it is maintained otherwise; *e* is maintained (Chitoran 2002a). Some examples from Standard Romanian are given below.

(24) Palatalization in Standard Romanian:

/fak-i/ → [fa**tʃʲ**]	‘you make/do’	(deleted)
/fak-e/ → [fa**tʃe**]	‘s/he makes/does’	(maintained)

In Zoque (Mixe-Zoquean, Mexico) the trigger *j* is deleted in all cases except before a palatalizing *t* in non-initial clusters (recall that a superscript ^{y} indicates alveo-palatal place of the stop):

(25) Palatalization in Zoque:

/wiht- -jah-/ → [wiht^{y}ahu] (deleted) (Wonderly 1951:117)
walk suffix
'they walked'

/tej- + -tih/ → [tejt^{y}ih] (maintained) (Hume, 2002)
there suffix
'right there'

In Amharic (Ethio-Semithic, Ethiopia) in general *i* appears to be deleted when it is the feminine singular suffix, as in (26a), but it is maintained when part of the root, and realized as *ɨ* in the dialects of Menz, Wello, and Gojjam, as in (26b). The trigger *e* is maintained even when a suffix, as shown in (26c), but it can optionally lose its fronting:

(26) Palatalization in Amharic (Bender 1976, Leslau 1995):

a. kɨfə**t** 'open!' (m sg)
kɨfə**tʃ**-(i) 'open!' (f sg) (all dialects)

b. ɨngɨ**di**h ɨngɨ**d^{j}ɨ**h 'so, therefore' (Menz, Wello, Gojjam)

c. kəfɨ**tʃtʃ**-e kəfɨ**tʃtʃ**-ə 'I having opened' (all dialects)

For details on the deletion/maintenance of palatalization triggers, see Appendix 4.

2.8 Chapter conclusions

In this chapter I presented the findings about palatalization as evident from a sample of 117 languages, 58 with palatalization and 59 without. First, palatalization is common but not automatic, as clearly seen from the fact that half the languages in this sample do not show palatalization. Second, both full and secondary palatalization result from the interaction of the same sounds, but the patterns of palatalization differ in each case. For full palatalization we can establish an implicational hierarchy *labial > coronal and dorsal*, whereby if labial consonants undergo full palatalization then so will coronals and dorsals (but see discussion below and Chapter 3 for more on full labial palatalization). For secondary palatalization, the implicational relationship is slightly different, with labial palatalization being dependent on the palatalization of either dorsal or coronal sounds, *labial > coronal or dorsal.*

Two of the more significant findings of this study are that labial consonants never show full palatalization in purely phonological contexts, and that they never show independent palatalization regardless of whether we consider full or secondary palatalization, morpho-phonological or phonological. Furthermore, even when labials do appear to show full palatalization, this is the result of historical changes. As I discuss in the next chapter, synchronic alternations between plain labial consonants and palatal or palatalized consonants (distinct from secondary palatalization of labials) are the result of a progression of changes which did not affect the labial consonant itself. The current outcome is the result of palatal glide fortition which created a labial+palatal consonant cluster, followed ultimately by the deletion of the labial. Thus, the implicational hierarchy for full palatalization is really no implication at all at the phonological level, as labial consonants do not in fact fully palatalize. Coronal and dorsal consonants can palatalize either together or independently in the same language, in a non-implicational fashion.

Languages that have both full and secondary palatalization at the same place of articulation may do so for several reasons. For example, a different set of consonants undergoes each type of palatalization, or palatalization differs by phonological and morpho-phonological contexts.

Regarding palatalization triggers, high front vowels, particularly *i*, are the best, followed by the palatal glide *j*. If lower front vowels trigger palatalization, then so do higher front vowels, in an implicational fashion. Also in an implicational fashion, if high vowels that are further back trigger palatalization, then so do high vowels that are further front. Regarding the position of the trigger, a following vocoid is more likely to trigger palatalization than a preceding vocoid, though this is not a necessary condition. Finally, triggers are usually maintained along with palatalization, particularly the vowels, as they serve as syllable nuclei, while the palatal glide is more easily deleted. I summarize these generalizations below.

(27) Palatalization targets and triggers
Targets

- Labial consonants never palatalize, fully or secondarily, to the exclusion of coronal and/or dorsal consonants
- **Full palatalization**
    - implicational hierarchy: *labial > coronal and dorsal*
    - labial full palatalization is rare, linked to historical developments, and restricted to morpho-phonological contexts in synchronic grammars
    - coronals and dorsals may palatalize independently or together in both morpho-phonological and phonological contexts

- **Secondary palatalization**
    - implicational hierarchy: *labial* > *coronal or dorsal*
    - dorsal consonants may palatalize independently only in phonological contexts
    - dorsal morpho-phonological secondary palatalization is dependent on coronal morpho-phonological palatalization (either full or secondary): *dorsal* > *coronal*

Triggers

- the best palatalization triggers are high front vowels, particularly *i*
- implicational hierarchy: *if lower front vowels trigger palatalization then so do higher front vowels*
- implicational hierarchy: *if high central/back vowels trigger palatalization, then so do high front vowels*
- high back vowels trigger palatalization only on coronal consonants
- palatalization triggers typically follow the target (regressive palatalization)
- palatalization triggers are typically maintained if they are vowels; a palatal glide trigger may be deleted

As already discussed, these generalizations are compatible with some of the previous findings, such as Bhat (1978) and Hall (2000), but they also challenge Chen's (1973) implicational hierarchy of full palatalization. Chen predicts no independent coronal palatalization, which is not true. I have also established universal tendencies for secondary palatalization, which had not been previously established, as well as an additional implicational relationship among high vowel palatalization triggers.

Furthermore, separating palatalization according to context, morpho-phonological vs. phonological, also revealed important generalizations, particularly regarding labial palatalization, as well as the dependency of dorsal morpho-phonological palatalization on coronal palatalization.

CHAPTER 3

FULL PALATALIZATION OF LABIALS

This chapter addresses the issue of full labial palatalization in more detail. As I have shown in Chapter 2, there is a significant difference between full and secondary palatalization regarding labials. While consonants at all three major places of articulation (labial, coronal, dorsal) can undergo secondary palatalization, full palatalization of labials is very different from that of coronals and dorsals in two respects. First, full labial palatalization is rare, occurring in only two languages in my sample, Romanian and Tswana. Second, I will show that in each of these cases, palatalization appears to be diachronic rather than synchronic, arising from a series of historical changes which did not involve direct palatalization of the labial itself. These changes ultimately led to the current situation in which a labial alternates with a palatal consonant in paradigmatic forms. I argue that full labial palatalization does not actually occur directly, and that the cases that appear to exhibit such phenomenon are inaccurately labeled as 'labial palatalization'.

In this chapter I discuss in more detail the cases of Romanian and Tswana and situate them within the larger context of their respective language families, Romance and Bantu, as such types of 'labial palatalization' are found in other members of these two language families. Specifically, I argue that 'labial palatalization' is more accurately analyzed as involving hardening of a glide adjacent to a labial, followed by deletion or absorption of the labial. Based on the evidence presented I conclude that full labial palatalization as a one-step change from a labial to a palatal consonant is not predicted to occur. However, for the sake of simplicity in expression, I will continue to refer to the set of processes involved as *labial palatalization*.

The chapter is organized as follows. In section 3.1 I discuss the situation of labial palatalization in Romanian, followed by a discussion of labial palatalization in Romance in section 3.2. Sections 3.3 and 3.4 investigate labial palatalization in Tswana and Bantu, respectively, and also present relevant alternative analyses. In section 3.6 I discuss other cases of apparent full labial palatalization, and I provide a summary of other explanations of labial palatalization in general, not specific to Romance or Bantu languages, in section 3.7. The final section concludes the chapter.

3.1 Romanian: the case of Moldavian

Palatalization is common both in Standard Romanian (SR) and in the Moldavian dialect. In both dialects velar obstruents *k*, *g* show phonological secondary palatalization before front vowels. All consonants show either full or secondary palatalization (or some assibilate, such as *t* → *ts* in Moldavian, *t* → ts^j in SR) in morpho-phonological contexts, before suffixes that contain a front vowel, such as the plural *–i* and the second person singular verbal suffix *–i*. As the focus of this chapter is on labials, and as the palatalization of coronal and dorsal consonants does not show significant differences between the two dialects, I will limit my discussion to the labial place of articulation and only provide some examples of the other places of articulation for comparison. Labial consonants in Standard Romanian show secondary palatalization before the suffixes mentioned above; these suffixes are in turn deleted or absorbed by the palatalization.

(1) Palatalization in SR:

	Singular	Plural	
t→ ts^j	bərbat	$bərbats^j$	'man'
k→ $tʃ^j$	rak	$ratʃ^j$	'lobster'
p→ p^j	episkop	$episkop^j$	'bishop'
b→ b^j	krab	$krab^j$	'type of fish'
f → f^j	vətaf	$vətaf^j$	'bailiff'
v → v^j	brav	$brav^j$	'brave'
m → m^j	pom	pom^j	'tree'

While this type of labial palatalization always occurs in SR, in the Moldavian dialect[24] there is a significant subset of lexical items in which labial consonants alternate with palato-alveolar fricatives or secondarily palatalized stops at a non-labial place of articulation, an apparent case of full palatalization. Such alternations within Moldavian are found synchronically in the same morpho-phonological contexts mentioned above: before the *–i* suffix of the 2nd singular for some verbs, and the *–i* suffix of the plural (feminine and masculine nouns, adjectives). As in Standard Romanian, these suffixes are deleted (or themselves expressed as secondary articulation [^{j}] - see discussion in section 3.1.1.1 on the nature of this palatalization trigger).

[24] This also occurs in some dialects of Oltenia and Muntenia (Ionică 1973, Avram 1977). Here I specifically discuss the dialect spoken in the North Eastern region of Romania known as Moldova, specifically in the villages of Cozia, Costuleni, and Răducăneni.

(2) Singular and Plural forms in Moldavian:

	Singular	Plural	
p→ k^j	plop	$plok^j$	'poplar tree'
f→ ʃ	kartof	$kartoʃ^j$	'potato'

Besides alternations accompanying the plural suffix and the second singular suffix in verbs, no other clear alternations can be observed within Moldavian. However, if Moldavian is compared with SR cognates, the same correspondences between labials and palatal or palatalized sounds are seen within root nouns, adjectives, and other lexical categories.

(3) Comparison of Moldavian with SR:

	SR	Moldavian	
p→ k^j	pjatrə	k^jatrɨ	'rock' (noun)
b→ g^j	albinə	alg^{j}inɨ	'bee' (noun)

This suggests that diachronically there was a process that caused a sound shift in these words, where we now see a different consonant in place of the labial. Furthermore, the fact that the labials and their palato-alveolar or secondarily palatalized stop counterparts occur both within roots (as shown in (3) above) and in morpho-phonological contexts indicates that the process affected labials across the board, post-lexically, and that the alternations we see today in verbs and plurals are the end result of these historical changes.

In the following sections I discuss the synchronic situation of labial palatalization in Moldavian. I then present diachronic evidence supporting the position that the changes from labial to palato-alveolar fricative or secondarily palatalized non-labial stop occurred in a succession of sound changes which did not directly involve palatalization of the labial itself. Rather, the labial deleted following the hardening of a following palatal glide. As I discuss in section 3.3, this appears to be a phenomenon characteristic of Romance, where earlier labials have various palatal synchronic reflexes.

3.1.1 Synchronic situation of labial palatalization in Moldavian

As stated earlier, in Standard Romanian all consonants show an alternation between plain and palatalized consonants before a suffix containing the vowel *–i*, a clear palatalizing context. Labial consonants show only secondary palatalization, while different coronal and dorsal consonants show either secondary or full palatalization. This pattern is consistent with the behavior of secondary labial palatalization in the database – it always occurs in addition to palatalization of both coronals and dorsals. As previously mentioned, in the Moldavian dialect, plain and secondarily palatalized labial consonants alternate in the same contexts as above, but in addition there is a group of verbs and noun/adjective plurals where labial consonants alternate with some type of palatal or palatalized consonant, an example of full palatalization. Specifically *p, b, m, f, v* alternate with k^j, g^j, n^j, *ʃ*, *ʒ* respectively before the vocoids *i* and *j* (an underlying /i/) (Ionescu 1969; Avram 1977). Some of these alternations are unexpected when compared with other cases of labial palatalization reported in the literature. For example, Ohala (1978) does not mention k^j as the result of palatalization of *p*, but rather *t*, *ts* or *tʃ*. Although k^j and g^j are not typical outcomes of full palatalization, such as *tʃ*, I consider all of these as full palatalization for two reasons: (i) the change from *p* to k^j involves a shift in major place of articulation, as is characteristic of full but not of secondary palatalization, and (ii) all of the labials were affected by the same phenomena.

3.1.1.1 Labial palatalization in plural forms and verbs

In (4) I provide examples of masculine noun plurals where the palatal/palatalized consonant is seen alternating with the labial of the singular. Generally, the plural for masculine nouns is formed by suffixing *–i*, most often realized as secondary palatalization[25] (see discussion later in this section for evidence of underlying /i/). As already mentioned, palatalization in the plural before *–i* is a common process in Romanian (SR and other dialects) and it affects coronal and dorsal consonants as well: dorsals have full palatalization with secondary palatal release (*k*→ $ʃ^j$, *g*→ $ʒ^j$ in Moldavian, *k*→ $tʃ^j$, *g*→ $dʒ^j$ in SR), some coronals assibilate and may also have secondary palatal release (*t*→ *ts*, *d*→ *z* in Moldavian, *t*→ ts^j, *d*→ z^j in SR), others have full palatalization (*s*→ *ʃ* in Moldavian, *s*→ $ʃ^j$ in SR). Labial palatalization involves the following alternations:

[25] See Bateman and Polinsky (2007) for rules of plural formation in Romanian.

(4) Labial palatalization in Moldavian noun plurals[26]

	Singular	Plural	
p→ k^j	plop	plok^j	‘poplar tree’
	tsəp	tsək^j	‘splinter, thorn’
	strop	strok^j	‘drop (of liquid)’
	ʃjorap	ʃjorak^j	‘sock’
b→ g^j	bumb	buŋg^j	‘button’
	ʃerb	ʃerg^j	‘deer-buck’
	drob	drog^j	‘block (of salt)’
v→ ʒ	pəstrəv	pəstrəʒ^j	‘type of fish’
	bolnav	bolnaʒ^j	‘sick (person)’
f→ ʃ	kartof	kartoʃ^j	‘potato’
m→ n^j	psalm	psaln^j	‘psalm’

The same type of alternations are observed in the plural of adjectives before –*i*, as in [alb] ‘white, m. sg.’ ~ [alg^j] ‘white, m. pl.’. So, labial stops shift to a secondary palatalized velar articulation, fricatives to a palato-alveolar articulation and the nasal to a secondary palatalized alveolar articulation.

While the plural forms in (4) lack an overt suffix –*i*, when the genitive/dative suffix -*lor* is added to the plural the –*i* suffix is realized overtly, providing evidence that –*i* is underlying.

[26] There are fewer forms which show the alternation of *f* ~ *ʃ*, *v* ~*ʒ*, and *m* ~ *n^j* because there are fewer nouns which end in *f*, *v*, and *m* in the singular.

(5) Overt *–**i*** suffix in Romanian dialects: plural

Nouns (Nominative/Accusative = N/A; Genitive/Dative = G/D)

Standard Romanian		Moldavian		
/bəjat-i/	bəjets^{j}	/bəjet-i/	bəjets	‘boy N/A, pl.’
/papuk-i/	paputʃ^{j}	/papuk-i/	papuʃ^{j}	‘shoe N/A, pl.’
/bəjat-i-lor/	bəjetsilor	/bəjet-i-lor/	bəjetsɨlor	‘boy G/D, pl.’
/papuk-i-lor/	paputʃilor	/papuk-i-lor/	papuʃilor	‘shoe G/D, pl.’

The N/A forms of [bəjat] ‘boy’ and [papuk] ‘shoe’ show that before the plural *–i* a final *t* is assibilated and has secondary palatalization in Standard Romanian, and it is only assibilated in Moldavian, while a final *k* fully palatalizes to *tʃ*^{j} with secondary palatal release in Standard Romanian, and it fully palatalizes to *ʃ*^{j} with secondary palatal release in Moldavian. The G/D forms show that the plural suffix *–i* is overt when the G/D suffix *-lor* is attached to plural forms.

Among the Moldavian verbs which show full labial palatalization, there are those where the final stem consonant is palatalized only for 2nd singular as in (7a), others where it is palatalized in every form as in (7b), and another category where it is palatalized in 2nd singular and 1st and 2nd plural as in (7c) in two related verbs: [dormi] ‘to sleep’, and [adormi] ‘to fall asleep’. Evidence of underlying *–i* in 2sg verb forms as in (7a) somes from verbs where i surfaces after an otherwise illegal syllable coda.

(6) Overt –*i* suffix in Romanian dialects: 2sg verbal suffix

Standard Romanian		Moldavian		
/umbl-a/		(*[umbl^{j}] 2ndsg.)		'to wonder around'
1 umblu	umbləm	umblu	umbləm	
2 umbl**i**	umblats^{j}	umbl**i**	umblats	
3 umblə	umblə	umblɨ	umblɨ	

(7) Labial palatalization patterns in Moldavian verbs:

	a. /ɨntreb-a/ 'to ask' [ɨntreba]		b. /rəzb-i/ 'to overcome' [rəzg^{j}i]		c. /dorm-i/ 'to sleep' [dorn^{j}i]	
	SG	PL	SG	PL	SG	PL
1	ɨntreb	ɨntrebəm	rəz**g**^{j}esk	rəz**g**^{j}im	dorm	dor**n**^{j}im
2	ɨntre**g**^{j}	ɨntrebats	rəz**g**^{j}eʃt^{j}	rəz**g**^{j}its	dor**n**^{j}	dor**n**^{j}its
3	ɨntreabɨ	ɨntreabɨ	rəz**g**^{j}eʃti	rəz**g**^{j}esk	doarmi	dorm

Other verbs showing the same pattern as (7a) are [səpa] 'to dig', [astupa] 'to cover', [skəpa] 'to escape', [rupi] 'to tear-up'(SR [rupe]); [temi] 'to fear'(SR [teme]). Verbs sharing the pattern in (7b) include [otrəʒi] 'to poison'(SR [otrəvi]); [vorg^{j}i] 'to speak'(SR [vorbi]); [lik^{j}i] 'to glue'(SR [lipi]); [ʒuk^{j}i] 'to peel'(SR [ʒupi]).

There are two interesting facts to observe in the above table: first, while 2nd singular forms show palatalization (due to the suffix –*i* as discussed above) a following –*i* does not always trigger labial palatalization, as seen in the 3rd singular form of 'to sleep'. Second, palatalization appears to be triggered by either –*i* or –*e* suffixes, unlike in the rest of the language where –*e* does not trigger labial palatalization. There are two factors which explain these patterns, and I briefly outline them below (see Bateman 2007 for full analysis).

First, the final vowel of the infinitive determines whether the palatalized labial will appear in every form or only in the 2nd singular. The infinitive form is used selectively as the base to which other suffixes attach. If the verb is an *i*-infinitive, there will be palatalization if the infinitive vowel is contained in the actual conjugated form. This occurs throughout the paradigm for verbs such as /rəzb-i/ ‘to overcome’, which have ‘extended’ suffixes[27], whereas it occurs only in the 1pl and 2pl for verbs such as /dorm-i/ ‘to sleep’, which have non-extended (short) suffixes. If the verb is a non-*i* infinitive there will be palatalization only in the 2nd singular, before the 2nd singular inflectional suffix –*i* (Bateman 2007).

Second, there is a series of vowel neutralizations which took place in Moldavian, such as the raising of *e* to *i*, which are responsible for the failure of the final [i] in the 3sg of [dormi] ‘to sleep’ in (6c) to condition palatalization. I do not attempt here a detailed analysis of vowel neutralization processes in Moldavian, but merely mention some observations which are pertinent to the understanding of full labial palatalization. Final *i* vowels in Moldavian are most often raised from /e/, as in [feti] ‘girls’ ([fete] in SR). Although [i] is typically a trigger for palatalization, those

[27] Verbs in the same conjugation class can take either short (non-extended) suffixes (1a) or extended suffixes (1b). Chitoran (2002a:35) treats the extended suffixes as empty derivational suffixes, or extensions of the stem.

(1)

(a)	SG	PL	(b)	SG	PL
1	zero	-m	1	-əsk	-m
2	-i	-ts	2	-əʃtʲ	-ts
3	-e	zero	3	-əʃte	-əsk

[i] which raised from /e/ fail to condition palatalization. The SR final vowels *e* and *ə* correspond to *i* and *ɨ*, respectively, in Moldavian, and there is evidence to suggest that palatalization took place prior to this vowel raising process, as there are forms with no palatalization before [i] where it would be expected to occur. This explains the lack of palatalization in the 3sg in verbs like /dorm-i/, which derives historically from /dorm-e/ (Bateman 2007). In fact, it is likely that the palatalization caused by a following *i* took place before any of the vowel neutralizations in Moldavian, including the backing of final *i* to *ɨ*, which would explain why we see assibilation of *t* to *ts* before surface *ɨ* in the G/D form of 'boy' in (5).

3.1.1.2 Palatalization within roots

'Labial palatalization' within roots can only be identified by comparing Moldavian with Standard Romanian:

(8)	<u>SR</u>	<u>Moldavian</u>	
p→ kʲ	pjatrə	kʲatrɨ	'rock' (noun)
	pitʃjor	kʲiʃjor	'foot, leg' (noun)
b→ gʲ	albinə	algʲinɨ	'bee' (noun)
	bine	gʲini	'good, well' (adverb)
f→ ʃ	ɨnfiripa	ɨnʃ**i**ripa	'to take shape' (verb)
	finə	ʃinɨ	'god-daughter' (noun)
v→ ʒ	ɨnvija	ɨnʒ**i**je	'to come back to life' (verb)
	vin	ʒin	'wine' (noun)

m→ n^j	mic	n^jik	'small' (adjective)
	mije	n^jiji	'me, Gen/Dat' (pronoun)

This type of palatalization in Moldavian is not present in all words that contain a /labial+j, i/, but rather in older words. New forms generally do not show it. This indicates that the process is no longer active. Newer forms which do show a correspondence are most likely produced by analogy, as people are generally aware that this feature is characteristic of Moldavian. If speakers are asked how a word would be pronounced in the Moldavian dialect, they respond by noting the *p* to k^j shift, clearly through analogy. The process that led to the current situation in Moldavian is no longer active. Frățilă (1974:13) reports labial palatalization in Romanian dialects to have taken place before the year 1000, although based on written records Candrea (1916) and Avram (1994) suspect that even during the early part of the 16th century the changes were still in progress (Avram 1994:280). In the next section I describe the changes that are responsible for the sound alternations we see today. I review evidence that the labial consonants did not themselves undergo change(s) to palatal or palatalized sounds. There was not a direct shift from *p* to k^j, for example, but rather a series of changes that did not actually involve the labial.

3.1.2 Diachronic progression of 'labial palatalization'

There is ample evidence to suggest that labial consonants did not themselves palatalize. Ionescu (1969) and Avram (1977) provide a series of rules which trace the development from labial consonant to palatal or palatalized consonant. These rules are established based on forms recorded in several volumes of the Romanian Linguistic Atlas (henceforth ALR, Pop 1938a, b; Petrovici 1940a, b) and in Dialectal Texts (Petrovici 1943). These forms show intermediate stages, wherein labials occur both with and without a following palatal or palatalized consonant. Ionescu (1969) and Avram (1977) argue that the presence of such forms demonstrates that the labials themselves did not palatalize. I concur with their account, and develop it further below.

In brief, the account proposed by Ionescu and Avram is that a palatal continuant sound (most likely a glide, but see discussion below) was inserted between the labial and a following *i* or *j*, e.g. [rəzbi] → [rəzbji] 'to overcome'. Subsequently this sound became a palatal fricative ([rəzbʝi]) and then hardened to a palatalized stop after the bilabial stops ([rəzbg^{j}i] 'to overcome'), and remained a fricative after the labio-dental fricatives ([fʃer] 'iron'). Velars k^j, g^j appear instead of palatal stops presumably because there are no palatal stops in this dialect[28]. The final stage involved the deletion of the labial. Hence the labial never palatalized in the first place. This account is in line with the general tendency reported in chapter 2 that labials do not undergo full palatalization. The abbreviated illustration in (9) is adapted from Avram (1977).

(9) rəzbi → rəzbji → rəzbʝi → rəzbg^{j}i → rəzg^{j}i 'to overcome'

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[28] It is possible that k^j and g^j are alternative transcriptions of palatal stops. Recall that for English fronted velars before front vowels are transcribed as palatal stops by Mielke (2006), but velar fronting does not always mean that the velars become palatal.

Below I present a more detailed account of the stages in the development of 'palatalized labials'. Both Ionescu (1969) and Avram (1977) agree that what has been referred to as 'labial palatalization' in fact describes a hardening process of a palatal sound (glide) which followed the labial consonant, and not changes in the labial consonant itself. Their analyses are identical with the exception of the first stage of this process, namely the source of the palatal sound that followed the labial and which then hardened. While Ionescu proposes that this palatal sound was inserted in every case, Avram argues that it was inserted only in some contexts, while it was already present in others. With the exception of this first stage Avram adopts Ionescu's analysis in describing the subsequent stages. Clearly, it is difficult to determine exactly what the first stage involved, as recorded forms only show later intermediate stages. However, Avram's (1977) proposal of the first stage accounts for data which is left unaccounted for by Ionescu (1969), as shown below.

Ionescu (1969) assumes that all labials which show alternations with (or which shifted to) palatalized consonants were originally followed by a yod (palatal glide), and proposes that a fricative-like palatal element was inserted between the labial and this following yod. Subsequently this inserted palatal element hardened and, depending on the nature of the preceding labial, it became a palato-alveolar fricative or a secondarily palatalized stop[29], ultimately followed by the deletion of the labial

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[29] The outcomes are somewhat different in other dialects, even within the Moldavian region, particularly regarding the changes following the labio-dental fricatives *f* and *v*. In some dialects these changes followed the same path as in the case of bilabials *p* and *b* and the resulting sound is a secondarily palatalized velar k^j or g^j. In others, they followed a different path and, as in the Moldavian dialect I discuss here, resulted in *ʃ* and *ʒ*. The changes following the bilabial nasal *m* are consistent across dialects, always converging on a secondarily palatalized n^j (Ionescu 1969, Avram 1977).

consonant. Crucially, it was not the yod which followed the labial that hardened, but the palatal element inserted between the labial and the yod.

There are a few problems with Ionescu's (1969) account that Avram identifies. First, the source of the yod following the labial, which is required in order for a palatal element to be inserted between the labial and this yod, is not made clear in all cases. For example, Ionescu assumes that, prior to hardening, the labial in [bine] 'well (adj.)' preceded a yod (Ionescu 1969:50). As Avram (1977) points out, Ionescu's (1969) account cannot explain where the yod came from in this form, or in forms like [albinə] 'bee'. In both [bine] and [albinə] the labial [b] has the reflex [g^j] in Moldavian, where we see [g^{j}ini] 'well (adj.)' and [alg^{j}inɨ] 'bee'. In order for these forms to obtain under Ionescu's account, there must have been a glide between the labial and the following [i] so that a palatal element could therefore be inserted and subsequently harden.

Second, Ionescu (1969) does not address cases where the labial had secondary palatalization as a result of suffixing the plural –*i*, as in (10b) below, /lup-i/ $\rightarrow$ [lup^j] (SR) and [lupk^j] (Moldavian) 'wolf, pl.'. Presumably these would also be treated as being followed by a palatal glide (perhaps the one resulting from secondary palatalization) and having the palatal-element inserted between the labial and the palatal glide. Thus, the main problem with Ionescu's (1969) analysis resides in the first stage of the hardening process: the source of the yod which is required to follow the labial and thereby creating the necessary environment for the insertion of a palatal element and its subsequent hardening. Avram (1977) fills in these gaps and adopts the rest of Ionescu's (1969) analysis, as described below.

Avram (1977) proposes that labial palatalization occured before an underlying /i/ and suggests that the first stage in the process of labial palatalization depended on what surface realization of this /-i/ followed the labial, as shown in (10):

(10) First stage in ‘labial palatalization’ (Avram 1977:278)

(a) zero → j / lab___i	albinə → albjinə	‘bee’
(b) ^{j}→ j or {ʝ, ç} / lab___	lup^j → lupj or lupç	‘wolf, pl.’
(c) j→ {ʝ, ç} / lab ___	vjer → vʝer	‘boar’

In the first context (10a) when a labial was followed by the vowel –*i* a [j] was inserted, and attested historical forms such as [albjinə] ‘bee’ with an inserted glide validate this claim (Avram 1977:278). In (10b) when a labial was followed by what he calls a ‘pseudovowel’ - ^{j} (secondary palatal articulation, such as that resulting from plural formation), this [^{j}] was realized as a full glide [j] or fricative [ʝ, ç], and in (10c) when a labial was followed by the palatal glide –*j*, this glide became a fricative [ʝ, ç].

The table below provides an initial summary of the stages of labial palatalization which are believed to have occurred in Moldavian.

Table 3.1 Summary of changes from labial to palatal(ized) consonant in Moldavian.

	Glide	Hardening		Labial Deletion	Current form	Gloss
a. alb/i/nə	albjinə	albʝinə	albg^{j}inə	alg^{j}inə	alg^{j}inɨ	‘bee’
b. lup/i/	lup^j → ↓ lupj →	lupç	lupk^j	(not for this word)	lupk^j	‘wolf, pl.’
c. f/i/er	fjer	fçer	fʃer	ʃer	ʃer	‘iron’

Therefore, a palatal glide followed labial consonants in every case at some point, but this palatal glide had different sources: it was already present via glide formation before another tautosyllabic vowel in cases such as (10c) and (3.1 c), it resulted from secondary palatalization in cases such as (10b) and (3.1 b), and it was inserted in cases such as (10a) and (3.1 a). The changes in (10b-c) further assume that the palatal fricative assimilated voicing from the labial consonant.

Notice that in (10a) one could also propose that the glide was not inserted as a full glide, but that the following [i] triggered secondary palatalization on the labial. Subsequently, the secondary palatal glide hardened in the same way as in (10b). The fact that a following *i* can condition secondary palatalization on a preceding labial, thereby creating a palatal off-glide which can harden, makes Ionescu's (1969) assumption that a palatal glide followed the labial and then another palatal element was inserted in between even more problematic, which is why Avram (1977) rejects this portion of her analysis. What is crucial is that in each of the three contexts a palatal glide followed the labial, and the glide underwent a hardening process leading to the synchronic forms (Lloyd 1987; Posner 1996).

The main difference between Ionescu (1969) and Avram (1977) then regards the palatal element that hardened: under Ionescu's account, it was not the palatal glide (yod) following the labial which hardened, but rather a different palatal element which was inserted between the labial and a following yod. Under Avram's account, the palatal glide which followed the labial was the sound that hardened. The only inserted element was the palatal glide between a labial and [i], which could be interpreted as secondary palatalization of the labial, as discussed above.

The table below summarizes the different stages in the development of 'palatalized labials', adapted from Avram (1977) and Ionescu (1969). The point of departure here assumes that the first stage has already occurred, to avoid the disagreement between the two authors. Therefore, a palatal glide follows the labial in every case. Regardless of what this first stage actually involved, the current forms which the rules below are based upon demonstrate that it was a hardening process that led to the appearance of 'labial palatalization' and that the labial deleted.

Table 3.2 Stages of 'labial palatalization' in Moldavian

	pjele 'skin'	bjet 'poor'	fjer 'iron'	vjer 'boar'	mjel 'lamb'
Voicing/nasality assimilation of palatal sound (glide)	pç	bʝ	fç	vʝ	mʝ̃
Nasalized fricative→ stop	--	--	--	--	mn^j
Deletion of labio-dentals	--	--	ç	ʝ	--
Pal. fricative → palato-alveolar, except after labials (applies only in contexts where the labio-dentals had deleted)	--	--	ʃ	ʒ	--
Pal. fricative → stop after labial stop	pk^j	bg^j	--	--	--
Deletion of bilabials	k^j	g^j	--	--	n^j
Final outcome	k^j	g^j	ʃ	ʒ	n^j
Actual forms	k^jeli	g^jet	ʃer	ʒer	n^jel

Note that the development of the bilabial stops is different from that of the labio-dental fricatives in this dialect: they are believed not to have deleted at the same time. In some dialects the fricatives followed the same path as the labial oral stops *p*, *b*, but in the region of Moldavia which I discuss here they followed the path illustrated in the table. Ionescu (1969) mentions that ALR does not register any forms with the stages [fʃ] and [vʒ], suggesting that the labio-dentals must have deleted earlier than the labial stops in such dialects, and that the palatal fricatives subsequently shifted to palato-alveolar fricatives *ʃ* and *ʒ*. She further mentions that there are no recorded forms with [mʝ̃], but such a change is assumed given the trajectory of the other labial consonants.

Intermediate forms confirming the later stages which still contain the labial alongside the palatal or palatalized consonant have been recorded in ALR and reported by both Ionescu (1969) and Avram (1977). The table below provides examples of words in intermediate stages alongside forms in SR and Moldavian. The particular dialects where the intermediate forms are found are indicated where such information was provided in Ionescu (1969) or Avram (1977):

Table 3.3 Intermediate forms
Labial + palatal(ized) consonant in Romanian dialects

Standard Romanian	Intermediate (other dialects)	Moldavian	English
kopil	kopkʲil kopçil (Muntenia)	kopkʲil	child
pitʃjor	pkʲiʃor (Vâlcea)	kʲiʃjor	leg
--	obgʲalə (Vâlcea)	ogʲal	comforter
pjele	pkʲele pçele (Muntenia)	kʲeli	skin
fjer	fçer (Vâlcea) fkʲer (Oltenia)	ʃer	iron
pjept	pçept	kʲept	chest
mjel	mnʲel	nʲel	lamb
vjespar	vgʲespar (Oltenia) gʲespar (Oltenia)	ʒespar	wasp hive
albinə	albʝinə (Muntenia)	algʲinɨ	bee
vitsel	vʝitsel (Vâlcea)	ʒitsəl	calf (m.)
lupʲ	lupç	lupkʲ	wolf (m.pl)

Ionescu (1969) also provides a table with all of the coexisting consonantal sequences (but not actual word forms) at ten different locations (points) recorded in ALR in the Moldavian region. It is unnecessary to reproduce the table here, but for illustrative purposes I provide the recorded consonants at three such points:

Table 3.4 Coexisting labials, 'palatalized labials', and labials+ palatalized consonants (Ionescu 1969:55)

Point #	p	b	m	f	v
520	**pk^j** k^j p	g^j	n^j m	ʃ f	v
365	**ptʃ** tʃ p	**bdʒ** b	**mn^j** m	ʃ f	ʒ dʒ v
574	k^j	**bg^j** g^j	n^j	ʃ f	ʒ v

The existence of intermediate stages is further confirmed by written texts, even though these are more rare. Roman-Moraru (1984) presents evidence in particular for the palatalization of the bilabial nasal *m*. Spelling conventions allow us to infer the pronunciation represented in the texts, and even though we cannot know this exactly, it is reasonable to assume that a spelling with *mn*, a labial followed by an alveolar, for a word which in SR only has the labial, indicates a sound change. The fact that SR *m* corresponds to n^j in Moldavian and other Romanian dialects further supports the idea that the texts recorded the sound changes in progress. The first written example indicating the palatalization of this consonant dates to the 13th century, in the writings of Cantemir, a Romanian scholar who noted *ngie* 'me, 1st sg. G/D' (*mie* in SR) as an uneducated form used by women in Moldova. Later we find two instances of *tocmnim* 'negotiate, 1st pl.' in a letter written at the Bistrița Monastery, dated in 1592. Further examples of the stage mn^j are found after 1750, in forms such as *mneu* 'mine (1sg.poss.)', *mnere* 'apples', *pomni* 'trees', *lumnina* 'light'. Currently, the bilabial nasal is *n*^{j} in Moldova and Southern Transylvania, and *mn*^{j} in Northern Transylvania and part of Northern Moldova (Roman-Moraru 1984:127).

It is clear from Tables 3.3 and 3.4, and from the evidence from written texts, that the labial consonants themselves did not undergo the process of palatalization. Rather, the palatal glide which followed the labial hardened to the palatal or palatalized consonants we see today, being dependent to a certain extent on the preceding labial (i.e. for voicing, nasality). Ultimately the labial deleted from the consonant cluster created, leaving only the palatal or palatalized consonant. Thus, when comparing SR with the Moldavian dialect we notice the correspondences between labials in SR and palatals or palatalized consonants in Moldavian, and within Moldavian we notice the alternation in verbs and plurals, discussed in the previous section.

3.1.3 Outside evidence for glide hardening

I agree with the account of labial palatalization in Moldavian outlined above for two reasons. First, the evidence from existing forms which show both a labial and a palatal(ized) consonant proves convincingly that labials themselves were not affected by the process. Second, glide hardening of this type is known to occur in the world's languages.

Kenstowicz (1994:35) maintains that hardening (also known as fortition or strengthening) occurs post-consonantally or initially, which is in line with the context where hardening occurred in the Moldavian dialect of Romanian. Both initial and post consonantal hardening is attested in other languages, and frequently involves hardening of a glide to either a fricative or a stop. I provide some examples of each below.

In Cypriot Greek (Attic, Greece) a post consonantal palatal glide is realized as a palatal or velar stop after most consonants (e.g. /teri-azo/ → terjazo → terkazo 'I match'; Kaisse 1992:317). In different varieties of Spanish (Romance) the palatal glide undergoes fortition in word initial position, changing to a palatal fricative *ʝ* identical to the one in earlier stages in Moldavian. In Argentinian Spanish the palatal glide strengthens to *ʝ* and then further to *ʒ* and *ʃ* in word initial position, so that *yo* 'I' is pronounced as either [ʒó] or [ʃó] (Hualde 2005).

In the history of Chamorro (Austronesian, Guam) both the labio-velar and the palatal glides underwent hardening: **w* became a labiovelar stop *gw*, and **j* became an alveolar affricate *dz* (Blust 2000:97).

(11) Glide hardening in Chamorro (Blust 2000)

*w → gw	*wada → gwaha	'have, there is, there exists'
	*walu → gwalu	'eight'
*j → dz	*qajuju → adzudzu	'coconut crab'
	*lajaR → ladzak	'sail'

Similarly, in Gothic (Germanic, extinct) and Norse (Norwegian) *w* and *j* hardened to "*ggw* (a geminate labiovelar stop) and *djj* (a palatal stop followed by a spirantic glide)"(Blust 2000:98). Blust (2000) further mentions other cases of glide hardening in Native American languages, where both the labio-velar and the palatal glides became stops: **w* became *gw* in Coeur d'Alene and Lushootseed, *g* in Comox, *kw* in

Salishan, and **j* also became a stop in the same languages (Thompson 1979:712, cited in Blust 2000:98).

A similar process of glide hardening can be found in the diachrony of labial-velar stops *kp* and *gb*. In Egbema, a dialect of Igbo spoken in Nigeria, we find $k^{w}a$ or *kpa*, from Proto Igboid *kʊa (Connell 1994:473). Ponelis (1974) proposes a parallel development of labial-velar stops in West African languages, where he analyzes *kp* and *gb* as derived from /k^w/ and /g^w/ (cited in Connell 1994:473). Thus, the labio-velar glide hardened to a labial stop following the velars, producing a complex stop. This case is particularly interesting, as it is similar to the stop-stop or stop-fricative sequences found in Romanian, with the exception that the labial element occurs first in Romanian.

Finally, a related process occurs synchronically in Polish (Slavic, Poland). Kochetov (1998) describes four types of palatalized labials in four Polish dialects: [p^j], [pj], [pç], and [pɕ]. Voiced versions also exist, as shown in the examples below.

(12) Palatalized labials in Polish dialects (Kochetov 1998:2)

I	II	III	IV	Gloss
[p^j]ivo	[pj]ivo	[pç]ivo	[pɕ]ivo	'beer'
[b^j]ały	[bj]ały	[bʝ]ały	[bʑ]ały	'white'

Notice that only in the first dialect is the labial itself palatalized, showing secondary palatalization. In the other dialects the labial is followed by a palatal glide (II), or followed by a palatal obstruent (III and IV). The forms in these dialects are strikingly similar to the diachronic changes in the "palatalization" of labials in Moldavian, and their synchronic status supports the claims made in the previous section with regard to labial palatalization. I discuss Kochetov's analysis of these processes in the next chapter.

3.2 Labial palatalization in Romance

Labial palatalization is found in other Romance languages besides Moldavian. It is best to present the facts on labial palatalization in Romance within a larger discussion of palatalization in general in this language family, as palatalization is one of the major sound changes which occurred from Latin to Romance (Elcock 1960; Lloyd 1987; Calabrese 1991; Posner 1996). To take just one example, (13) shows a comparison between the consonantal system of Italian with that of Latin, clearly illustrating that Latin lacked the Italian palato-alveolar and palatal consonants:

(13) Latin and Italian consonants[30] (Calabrese 1991:65)

Latin: /p b t d k g (k^w g^w) f s m n l r/
Italian:/p b t d k g **ts** **dz** **tʃ** **dʒ** f v s (z) **ʃ** m **ɲ** l **ʎ** r/

The same can be said of other Romance languages which also have a series of palatal consonants. In this section I briefly discuss the processes of palatalization in early Romance, pointing out the parallels and differences between the palatalization of coronal and dorsal consonants versus labial consonants. I show that there are two different, but connected sources of labial palatalization in Romance, and that in both cases the labials themselves were not the sounds that changed: in one case a palatal

[30] The phonemic status of k^w and g^w is the subject of debate. Some, like Calabrese (1991), include them as phonemes, others do not (Lloyd 1987).

glide following the labial hardened, and then the labial deleted, and in the other a lateral following the labial became a palatal, and the labial deleted.

3.2.1 Developments from earlier Latin to later Latin

Palatalization in the development of Romance is reported to have occurred during two time periods, first between the 1st and 2nd centuries AD, then again sometime after the 5th century AD (Elcock 1960; Lloyd 1987; Calabrese 1991). The first palatalization process began in spoken Latin, was triggered by the glide *j* and it affected all consonants in all Romance languages (Penny 2002; Calabrese 1991). The second palatalization process only affected velar stops *k* and *g* and was triggered by a following front vowel *i* or *e*. This latter process affected all of Romance except Sardinian and Dalmatian (Elcock 1960; Lloyd 1987; Posner 1996).

Much of the information on the shape of Vulgar Latin (the spoken variety of Latin) comes from inscriptions, many of which are from Pompeii, referred to as Pompeian *graffiti*, and from *Appendix Probi*, a text from around the 4th century A.D. (Elcock 1960; Rohlfs 1970). *Appendix Probi* was written by an author known only as Probus, who wanted to teach the proper way of expression, and wrote examples showing the "correct" form alongside the "incorrect" (but commonly used) one. Some examples are given below, where the spelling with *I* indicates that that an unstressed *e* had become a palatal glide when preceding another vowel (hiatus resolution) in later stages of Latin:

(14) *Appendix Probi* examples (Rohlfs 1970:26)

VINEA	NON	VINIA
CAVEA	NON	CAVIA
LANCEA	NON	LANCIA
BALTEUS	NON	BALTIUS

3.2.1.1 First palatalization in Romance

3.2.1.1.1 Hiatus resolution and palatal glide formation

Hiatus resolution and the formation of palatal glides is one of the phonological processes that are responsible for the development of the palatal series of consonants in the Romance languages. Another is the hardening of the palatal glide *j*, and finally velar fronting before front vowels (Grandgent 1927; Rohlfs 1970; Lloyd 1987). Vowel hiatus reduction led to the formation of new palatal glides, as unaccented *i* before another vowel was pronounced as *j*, and later unaccented *e* before another vowel was also pronounced as *j*. Again, this shift is documented in inscriptions which show PARIAT instead of PAREAT, ABIAT instead of HABEAT (Lloyd 1987), as well as in *Appendix Probi*, as shown in above in (14).

The resulting palatal glide had different effects on preceding consonants. When a *t* preceded, this was assibilated to t^{sj}, as indicated by inscriptions of the 2nd century A.D.: CRESCENTSIANUS instead of CRESCENTIĀNUS (A.D. 140), VICENTZA instead of VICENTIA (4th century A.D., Lloyd 1987:133). A velar stop *k* followed by the palatal glide was also assibilated, becoming increasingly confused with the assibilated *t*, as seen in the forms FATIO instead of FACIO, and DEFINICIO instead of DEFINITIO (A.D. 222-35, Lloyd 1987:133). In some areas (including in

Spanish) these sounds merged to a single phoneme, while in others they remained distinct (Ibid.). The voiced counterparts of *t* and *k*, *d* and *g*, underwent parallel changes, with some important differences: these consonants are believed to have been pronounced more laxly to begin with, therefore, the palatal glide assimilated them more completely and they did not assibilate like the voiceless stops[31]. Instead, *dj* and *gj* had either a fricative geminate pronunciation [j:] (ʒʒ) or an affricate [d:ʲ] (ddʒ), as seen in inscriptions of ZABULUS instead of DIABOLUS (Lloyd 1987:133).

The palatal glide also had a palatalizing effect on a preceding *l* and *n*, which became palatalized consonants ʎ and ɲ in Spanish: VĪNEA > [βiɲa] 'vineyard'; FOLIA > [foʎa] 'leaves' (Lloyd 1987:134). When following those consonants which are typically resistant to palatalization, such as rhotics, the palatal glide tended to delete, though there are a few cases it was maintained, as in PAREIETEM > PARETE > *pared* 'wall' (Ibid.). There is no discussion at this stage of how the labial consonants were affected by a following glide, although later discussions of palatalization for individual Romance languages indicate that the palatal glide following a labial hardened and that the labial subsequently deleted[32].

[31] I interpret the "lax" pronunciation of *d* and *g* as an articulation without a complete stop closure. As such, they were more easily shifted to the palatal place of articulation of the following glide.
[32] Calabrese (1991) states that the first palatalization affected all consonants, including labials, but he provides synchronic reflexes. As the second palatalization in Romance involved only velar fronting before front vowels, it is true that the first palatalization triggered by the palatal glide is responsible for all other palatalizing outcomes in Romance, including the outcomes of the labials. However, this did not happen in the same way for all consonants, as implied by Calabrese (1991).

3.2.1.1.2 Glide hardening

Beginning during the 1st century A.D. and later, the pronunciation of the semivowels *j* and *w* began to harden (Lloyd 1987; Posner 1996). These semivowels had existed only as allophones of *i* and *u* before another vowel until that time. The labio-velar glide was pronounced as a bilabial fricative, while the palatal glide became more consonantal *word*- and *syllable-initially*, as indicated by spellings of IANUARIO as ZANUARIO, where 'Z' represents either a palatal fricative [ž] (ʒ) or an affricate [dž] (dʒ) (Lloyd 1987:132). This pronunciation of *j* is believed to be connected to the palatalization process that produced new series of palatal, fricative and affricate consonants in Romance languages (Lloyd 1987:225). Posner (1996) states that palatal glide hardening produced the same result as the change from Latin *g* followed by either *e* or *i*, as seen in the following examples:

(15) Hardening of word-initial *j* in Romance (Posner 1996:111; Romanian data provided by me—note that the Romanian *deja* [deʒa] 'already' most likely entered the language later as a borrowing from French).

Latin	Italian	French	Spanish	Romanian	
IAM	già [dʒ]	déjà [ʒ]	ya [j]	(deja [ʒ])	'already'
GELU	gelo [dʒ]	gel [ʒ]	hielo [j]	ger [dʒ]	'frost'

Posner (1996:111) adds that in literary Latin post-consonantal ĭ often hardened to a non-syllabic *j*, while word-initially it sometimes counted as a syllable. This seems to describe the same process as glide formation before another vowel (hiatus reduction), as Posner discusses it under the rubric of 'jodization', or glide formation.

3.2.1.2 Second palatalization in Romance

As already mentioned, the second process of palatalization involved fronting of the velars before front vowels. Velars were fronted in this context throughout the Romance speaking region, with the exception of Sardinia and part of Dalmatia (Lloyd 1987:136, Elcock 1960:54; Posner 1996:113). This is believed to have taken place after the 5th century A.D., as borrowings in Basque and Germanic maintain the velars as stops during this time: *Kaiser* 'emperor' from Latin CAESAR, *Keller* 'cellar' from Latin CELLARIUM (Lloyd 1987:137, Elcock 1960:53). Generally, velars before front vowels were pronounced more fronted, $k \rightarrow k^j$, $g \rightarrow g^j$, and they continued to change in one of two directions in different Romance languages. In some languages a palatalized *k* ended up as a dental affricate *ts*, and then de-affricated to a sibilant *s*, while in other languages it ended up as a palatal stop *c* or a palato-alveolar affricate *tʃ*, sometimes also de-affricating to a simple fricative *ʃ* (Posner 1996:113).

To summarize, later stages of Latin, early stages of Romance, showed the following consonantal changes relevant to palatalization.

Table 3.5 Sound changes in late Latin/early Romance (Lloyd 1987:132-7; Elcock 1960:153):

Target sound	Environment	Outcome
ĭ (unaccented)	__ V	j
ĕ (unaccented)	__ V	j
j	word- & syllable-initially	ʒ or dʒ
t	__ j	ts^j
k	__ j	t^j
d	__ j	ʒʒ or ddʒ
g	__ j	ʒʒ or ddʒ
l	__ j	ʎ
n	__ j	ɲ
k	__ e, i	k^j → t^j (→ ts(j) or tʃ in Medieval Romance)
g	__ e, i	g^j → ʒʒ or dʒ (similar to g + j)

The outcomes of the palatalization of *t*, *d*, *k*, and *g* continued to change, taking slightly different paths in the various Romance languages. Thus, in modern Romance we encounter *dʒ*, *ʒ*, *dz* or *z* as reflexes of **g* and **d*, and *tʃ* and *ts* as reflexes of **t* and **k* (Elcock 1960:54-5).

Although it is not my goal to provide a complete historical account of the sound changes in individual Romance languages, it is important to review the facts concerning non-labial consonant palatalization in order to have a basis for comparison with the 'palatalization' of labial consonants. Below I briefly discuss some of the facts on the palatalization of dorsal consonants in the development of French.

In Old French velar palatalization before front vowels created affricates ts^j and *dʒ*. During the 13th century these affricates were reduced to *s* and *ʒ* (the timing is indicated in part by the fact that the affricate *dʒ* is maintained in the English borrowed words *gentle*, *giant*, *general* (Elcock 1960:363)).

(16) Velar palatalization before front vowels in French
(from Elcock 1960:363):

k + *e* or *i* → k^j → ts^j, e.g. CERA > [*tsʲeirə] > Old Fr. [tsirə] > *cire* [si:ʁ] 'wax'

g + *e* or *i* → *gj* → *dʒ*, e.g. GENTEM > Old Fr. [dʒã] > *gent* [ʒã] 'race, type'

Unlike in the rest of Romance, velar stops in French also palatalized before *a* (Elcock 1960:342). This indicates that the vowel *a* in French was front, while in other Romance languages it might have been a central or back vowel (Posner 1996). The voiceless velar palatalized to *tʃ* and later de-affricated to *ʃ*, while the voiced velar palatalized to *dʒ*, later de-affricating to *ʒ*. This reduction also occurred during the 13th century, indicating that de-affrication might have been a common process in French at that time (Posner 1996).

(17) Velar palatalization before *a* in French (from Elcock 1960:364):

Latin	French		English
GAMBA	*jambe*	[ʒãb]	'leg'
GAUDIA	*joie*	[ʒwa]	'joy'
GALBINUM	*jaune*	[ʒon]	'yellow'
CAPUM > chief >	*chef*	[ʃεf]	'chief, head'
CARA > chiere >	*chère*	[ʃεʁ]	'dear'

In some contexts the velars were ‘replaced’ by the palatal glide, for example inter-vocalically before a front vowel for *g*: PAGENSE > *pays* ‘country’. When *k* and *g* occurred before another consonant they also palatalized to the palatal glide, as in FACTUM > *fait* ‘fact’, unless the second consonant was *n* or *l*, in which case the resulting sound was a palatal nasal *ɲ* and a palatal lateral *ʎ*, respectively: AGNELLUM > *agnel*, *agneau* ‘lamb’, MACULA > *maille* ‘mesh’ (Elcock 1960:364).

The palatalization of velars in French demonstrates that dorsal consonants were in fact themselves affected by palatalization, and they did not delete following the hardening of a following palatal glide, in contrast to labial consonants. Palatalization of velars is still attested in Parisian French (Gadet 1992) and in Acadian French (Lucci 1972, Flikeid and Cichocki 1988), and palatalization of dentals is attested in Belgian French (Corneau 2000).

3.2.2 Interim conclusion

As the facts about the early palatalization of coronal and dorsal sounds show, the palatal glide and the front vowels triggered direct changes in *the sounds themselves*, causing them to shift to more palatal, or dental, positions. Some of the synchronic palatal sounds in Romance are the result of a hardening pronunciation of the palatal glide in word- and syllable-initial position, others of palatalization of a coronal or dorsal consonant followed by the palatal glide, and yet others are the result of velar fronting before front vowels. In contrast, as I discuss below, synchronic palatalized reflexes of Latin labial consonants arose via a different path. The palatal glide did not cause direct changes in the labials; rather its increasingly hardened pronunciation is responsible for the synchronic palatal sounds, and the labial consonant was ultimately elided. In what follows I review the instances of labial palatalization as they occurred in Romance languages such as Spanish, French and Italian. Where I have found them, I also include references to other Romance languages.

3.3 Labial palatalization in Romance

As indicated in the previous sections, in some Romance languages (e.g. French) Latin labial consonants have palatalized synchronic reflexes when they were followed by a palatal glide. Another context which is cited as showing labial palatalization in Romance is that of a labial followed by *l* (Ohala 1978; Lathrop 1980 and Penny 2002 also discuss historical accounts of Romance languages, but not under the rubric of 'labial palatalization'). Both contexts share the fact that the labial was deleted from a consonantal group consisting of a labial followed by a palatal or palatalized sound, despite claims to the contrary (Ohala 1978). Therefore, labial palatalization did not occur in a single step, but it occurred in stages that did not involve the labial consonant itself.

As illustrated in (18), Spanish and Portuguese have a palatal consonant where Latin labials were followed by *l*:

(18) Labial + *l* palatalization (data from Malkiel 1963, via Ohala 1978:371, and from Lathrop 1980:82).

Latin	Spanish	Portuguese	
AMPLU	antʃo		'large, spacious'
PLŌRĀRE	dʒorar	dʒorar	'to weep'
	ʎorar		
FLAMMA	--	dʒama	'flame'
PLUVIA	dʒovia		'rain'
	ʎovia		

In Romanian, these groups were maintained unchanged: *am**pl**u* [amplu] 'ample, spacious', ***pl**ânge* [plɨndʒe] 'to cry', ***fl**acără* [flakərə] 'flame', ***pl**oaie* [ploaje] 'rain'. The same is the case in French: *am**pl**e* 'ample', ***pl**eurer* 'to cry', ***fl**a⇓me* 'flame', and ***pl**uie* 'rain'. Ohala (1978) cites the data in (18) as examples of labial palatalization where it is not necessary to posit intermediate steps from labial to palatal, as I have done for Moldavian. He does, however, acknowledge that palatalization most likely happened via intermediary stages in various Tai languages (Tai-Kadai, Thailand, Viet Nam, China), where the same phenomenon is found. A palatal consonant is observed in some Tai languages in the same contexts where others have labials followed by the lateral *l*, as shown below:

(19) Tai (data from Li 1977, via Ohala 1978:371)

Siamese	Lungchow	T'ien-chow	English
plaa	pjaa	tʃaa	'fish'
plau	pjau	tʃuu	'empty'
phaai	phjaai	tʃaai	'to walk'

Ohala (1978) writes that the post-consonantal lateral *l* changed to the palatal glide *j* first, then the sequence *p(h)j* changed to the palatal affricate (implying that the labial was involved in the change). The labial thus became a palatal via an intermediary stage, one which involved the lateral changing into the palatal glide, and then the labial followed by this palatal glide directly changed to *tʃ*.

Ohala (1978) suggests that the Romance cases with C+*l* clusters followed a parallel development. Contrary to Ohala's (1978) position, there is evidence which demonstrates that this process occurred in stages in Romance, and that it did not affect the labial consonant directly, in a similar fashion to Moldavian.

Lathrop (1980) maintains that in Spanish labial consonants did not palatalize at all. The only labials which seem to have palatal reflexes in Spanish appear in the sequences *pl*-, *fl*- word-initially, and word-medially following another consonant. Furthermore, these sequences are part of a group of consonants which all share the same reflexes in Spanish, *pl*-, *fl*-, and *kl*-. Lathrop (1980) states that in Vulgar Latin the lateral in initial clusters *kl*-, *pl*-, *fl*- was already palatal, and it eventually "released a yod to give *kʎ*, *fʎ*, *pʎ*" and subsequently *the obstruents were lost* (Lathrop 1980:82). I interpret this as the lateral being initially more palatal than alveolar, and then becoming palatal, possibly followed by a palatal glide (the released yod). The palatal lateral + glide subsequently hardened, which led to the different realization we see today in the various Romance languages.

Penny (2002:71) also maintains that the lateral following *p*-, *k*-, and *f*- already had a palatal pronunciation in spoken Latin, but suggests that these consonants were assimilated to the lateral and 'absorbed' by it. There is no evidence provided to support or discount this claim, and it is just as likely that the consonants were deleted, as Lathrop (1980) argues. For example, Elcock (1960) and Lloyd (1987) maintain the same proposal as Lathrop (1980). In discussing the palatalization of Latin *l* during the evolution of the Castilian sound system, Elcock (1960) writes that in initial position *kl*-, *pl*-, and *fl*- had become *kʎ*-, *pʎ*-, *fʎ*- "after which they lost the first element to converge as *ʎ*" (Elcock 1960:421). Lloyd (1987) proposes that there was a series of changes in these initial clusters, which began with a palatalization of the lateral following *k*, thus this series of clusters would have had the allophones [pl], [fl] and [kʎ]. Further he suggests that *pl*- and *fl*- became [pʎ] and [fʎ] due to unification of these clusters. The intermediate pronunciation with the palatal following *p, f* and *k* is still found in a conservative area of Hispania called Aragon (Lloyd 1987:225). Lloyd then goes on to say that in the areas which adopted this pronunciation further shifts were made so that the initial consonant *was dropped*, leaving only the palatal lateral as the initial consonant (Lloyd 1987:225).

There are two different outcomes of the palatalization of *pl*-, *kl*-, and *fl*-: word-initially there is a palatal lateral *ʎ*, and word-medially following another consonant these sequences created a palato-alveolar affricate *tʃ* (matching the voicing of the 'lost' obstruent):

(20) Spanish C+ l palatalization (Penny 2002:71-72)

Latin	Spanish		English
PLAGA	llaga	[ʎ]aga	'wound'
CLAUSA	llosa	[ʎ]osa	'enclosed field'
FLACCIDU	llacio	[ʎ]acio	'lank'
IM**PL**ERE	henchir	hen[tʃ]ir	'to cram'
MAN**CL**A	mancha	man[tʃ]a	'stain'
IN**FL**ARE	hinchar	hin[tʃ]ar	'to inflate, swell'

It is possible that these consonantal sequences followed different paths word-initially versus word-internally because of the preceding alveolar nasal in word-medial position. However, this is not made clear. Interestingly, both the labials and the velar followed the same path, which suggests that they key to this process lies not in the obstruent, but in the palatal lateral which followed it. Notice that the three authors mentioned here, Elcock (1960), Lathrop (1980), and Lloyd (1987), who provide support for the idea that *l* palatalized and the previous consonant subsequently deleted, discuss this process not as palatalization of the consonant preceding the *l*, but as palatalization of the *l* itself. Thus, citing these as examples of labial palatalization as Ohala (1978) does is not accurate.

Beyond these clusters, labials did not show palatalization in Spanish. While some coronals and dorsals palatalized or assibilated when followed by the palatal glide *j*, labial *p* is reported to show metathesis with *j*, while *b* and *m* remained unchanged (Penny 2002:65).

Table 3.6 Spanish C + j (Penny 2002:62-65; rules somewhat simplified)

C + j	Latin	Spanish	English
tj → t^s (→d^z/V_V)	PUTEU MARTIU	[ˈpot^so], later [pod^zo] [ˈmart^so]	‘well’ (water) ‘March’
kj → tʃ (in some dialects → d^z/C__ → t^s/V__)	ĒRĪCIU CALCEA	[eˈɾitʃo] or [erid^zo] [kaltʃa] or [kalt^sa]	‘hedgehog’ ‘stockings’; later ‘breeches’
lj→ ʎ → ʒ	ALIU	[aʒo]	‘garlic’
nj→ ɲ	HISPANIA	[espaɲa]	‘Spain’
dj→ ddʒ → dʒ	PODIU	[podʒo]	‘hill, bench’
gj→ ddʒ → dʒ	EXAGIU	[ensadʒo]	‘attempt’
bj (unchanged)	RUBEU	[ruvio], later [rubio]	‘blond’
mj (unchanged)	PRAEMIU	[premio]	‘prize’
pj (metathesis)[33]	CAPIAM	[kepa]	‘to fit into’ (pres. subj.)

Let us now consider a different palatalizing context, that of a Latin labial followed by the palatal glide. In Modern French, when the palatal glide was preceded by labials *p*, *b*, *v*, and *m*, it became *ʃ* or *ʒ*, depending on the voicing of the preceding labial, and the labial itself was elided (Nyrop 1914). Evidence of the intermediate stage with both the labial and the palato-alveolar fricative can be found in forms such as *apje* for *ache* ‘celery’, and *salvje* for *salge* or *sauge* ‘sage’ (Ibid.). Forms at intermediate stages have also been recorded in spellings of Medieval Provençal, where we see labial stops followed by palato-alveolar affricates, such as *sepcha* from Latin *sepia* ‘cuttlefish’, *apche* from Latin *apium* ‘celery’, alongside spellings of just the labial stop followed by *i*, or just of a palato-alveolar affricate like *ch* (Thomason

[33] The metathesis case is not very transparent, but presumably the disappearance of the vowel *i* following the labial and the appearance of *e* preceding the labial represents indicates metathesis.

1986:184). This evidence indicates that during the Medieval period there was either an alternation between the labial +*i*, the labial + palato-alveolar affricate cluster, and just the palato-alveolar affricate, or that the pronunciation was being altered and spelling conventions alternated between the old pronunciation and the new one. What is clear, however, is that the labial consonants were not the ones which had altered their pronunciation. The following examples show the correspondence of Latin labials with French palatal sounds:

(21) Latin and Modern French (Ohala 1978:372—Latin words in lower case; Nyrop 1914:423-4—Latin words in upper case):

Latin	French	English
*sapius (from sapiens)	sage [saʒ]	'wise'
rŭbĕus	rouge [ʁuʒ]	'red'
răbĭes	rage [ʁaʒ]	'rabid'
căvĕa	cage [kaʒ]	'cave'
SAPIAM	sache [saʃ]	'that s/he know'
SEPIA	sèche [seʃ]	'dry'
*PROPIUM	proche [pʁoʃ]	'close'
*APIA	ache [aʃ]	'celery'
TIBIA	tige [tiʒ]	'stem (of flower)'
CAMBIARE	changer [ʃãʒe]	'to change'
SALVIA	sauge [sɔʒ]	'sage'
VINDEMIA	vendange [vãdãʒ]	'(wine-grape) harvesting'
SIMIUM	singe [sʌ̃ʒ]	'type of primate'

The changes from Latin to Modern French were not sudden from the labial to the palatal fricative, as Ohala (1978) implies. In the words of Picard (1984), sound correspondence is not the equivalent of direct change. Nyrop (1914) maintained that the sound changes in French arose via palatal glide hardening and deletion of the labial, a similar path to the sound changes in Moldavian. Pope (1961) writes that "only the consonants made with the movement of the tongue, the linguals, were palatalized; i.e. the dentals and velars, including the labio-velar *w*; the labials neither induced palatalization nor underwent it" (Pope 1961:120). Regarding the changes in (20) above Pope (1961) proposes more stages than Nyrop (1914). She states that when labials were juxtaposed to jod (palatal glide) this sound closed and shifted to *dʒ* (or *tʃ* after a "breathed labial"). The resulting groups *bdʒ* and *ptʃ* subsequently simplified by dropping the labial (Pope 1961:129-149), and then the remaining affricates became simple fricatives *ʒ* and *ʃ* during the 13th century (Pope 1961:93; see discussion in section 3.3.1.4 above on affricate simplification in French).

Ohala (1978) mentions one other Romance language where labials seem to have palatalized directly. In Genoese and neighboring dialects of Italian there are palato-alveolar affricates where the Roman dialect has labials followed by a palatal glide.

(22) Latin and Italian (Jaberg and Jud 1928-1940, via Ohala 1978:372):

Roman dialect	Genoese and neighboring dialects	
pjento	tʃena	'full'
pjanta	tʃanta	'to plant'
er fjato	uʃa	'breath'
bjanko	dʒanku	'white'

I have not found any sources that trace the development of the palatalized labials in the Italian dialects where this type of labial palatalization appears to have occurred. It is clear that this is not the case in the standard dialect of Italian, which still has labials as shown in (22). In (23) the Latin cognates for these words are provided. All except the word for 'white' contain a consonant + lateral, identical to the forms that underwent labial palatalization in Spanish and French.

(23)

Latin	Italian (Roman)	Italian (Genoese)	
PLENUS	pjento	tʃena	'full'
PLANTO	pjanta	tʃanta	'to plant'
EF**FL**O	er fjato	uʃa	'breath'
AL**BE**O	bjanko	dʒanku	'white'

Grandgent (1927:73) states that initial consonantal groups ending in *l* kept the preceding consonant but changed the *l* to a palatal glide *j*, and Maiden (1995:50) writes that *all consonants but the labials* were affected by the "jod" (palatal glide) in the development of Italian. It is very likely that in the Genoese and neighboring dialects this palatal glide hardened in a way similar to Moldavian, followed by the deletion of the labial consonant.

After reviewing the general palatalization and labial palatalization facts in Romance, I maintain that there is ample evidence demonstrating that palatalization of labials is very different from palatalization of coronal and dorsal consonants. It is clear that labials did not undergo full palatalization. The data showing intermediary stages in the development of palatalized labials in Moldavian, as well as the evidence from French, Spanish and Italian presented above, clearly indicate that in Romance labials were not directly involved in the changes toward palatal sounds. The common theme among all of these languages is that the sound following the labial, which was a palatal glide or a palatal lateral, hardened and produced the palatal or palatalized outcomes we see today.

Coronals and dorsals, on the other hand, can shift to a palatal sound in a single step (Penny 2002, Calabrese 1995). When stages of palatalization are involved in the case of coronals and dorsals, the changes directly affect the coronal or dorsal consonant itself. For example, Latin velar consonants which palatalized before front vowels (second palatalization in Romance) have reflexes either as a dental affricate *ts* or sibilant *s*, or a palato-alveolar affricate *tʃ*.

In the next section I turn my attention to Tswana, the other language in my sample which shows labial palatalization, and then discuss labial palatalization in Southern Bantu.

3.4 Tswana (Southern Bantu, Botswana)

Tswana exhibits a type of labial palatalization which is rather different from what Romanian and the other Romance languages show. The most striking aspect of labial palatalization in Tswana is the fact that it occurs in particular morphological contexts which do not have an obvious surface palatalizing trigger, and furthermore that it appears to target labials more than it does coronal and dorsal consonants. The morphological contexts where labials are 'realized' as palatal consonants include causative, passive, and diminutive formation.[34] In these contexts, stem final labials *p*,

[34] There are three other morphological contexts where labial palatalization occurs, in some words with the 5th noun class singular prefix *le-* which is becoming obsolescent, in the formation of some perfect tense forms, and in the formation of locative nouns (Ohala 1978:384). These contexts are never analyzed in depth in the literature on the premises that they are better understood and less controversial than the other three contexts.

p^h, *b*, and *ɸ* are ‘palatalized’ to *tʃ^w*, *tʃ^wh*, *dʒ^w*, and *(t)ʃ^w*, respectively[35]. Coronal and dorsal consonants show alternations as well (assibilation or palatalization) in the causative and the diminutive, but only if they are followed by common palatalization triggers such as the palatal glide of the causative suffix or a final stem non-low front vowel *i* or *e* in the diminutive.

In the next sections I describe palatalization in causative, passive, and diminutive formation. I then present some existing explanations for this type of palatalization, followed by evidence that the labial consonants did not shift their pronunciation to palatals but that, in a similar fashion to Romance, the labials were deleted following a series of changes which affected a palatal sound immediately following the labial.

3.4.1 Contexts for labial palatalization in Tswana

Let me begin by providing the sound inventory of Tswana and then describe the palatalization contexts in the following sections. The voiceless stops in Tswana are ejective; however the ejection is not essential to the pronunciation and is “very slight”, therefore it is not indicated (Cole 1955:19).

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[35] The bilabial nasal *m* does not undergo palatalization in these contexts. Rather, it is velarized, becoming a velar nasal *ŋ* (Cole 1955:107).

Table 3.7 Tswana phonemes (Cole 1955; SSS 1999)

Labial	Alveolar	Lateral-alveolar	Palato-alveolar	Palatal	Velar	Uvular	Glottal
p^h	t^h				k^h	q^h	
p	t				k		
b							
	ts^h	tɬ^h	tʃ^h				
	ts	tɬ	tʃ				
			dʒ				
ɸ	s		ʃ		x		h
m	n			ɲ	ŋ		
w				j	(w)		
	r	l					

Notice that there are very few voiced obstruents (*b* and *dʒ*). Furthermore, the voiced bilabial *b* often weakens to a bilabial voiced fricative, and it does not show palatalization. Zsiga, Gouskova and Tlale (2006) propose that Tswana does not actually have any voiced stops. The lateral *l* has an alveolar flap allophone [ɾ] which is relevant for palatalization, and occurs only before close vowels *i* and *u*. The labio-velar semivowel *w* occurs "almost exclusively" before the vowels [a, ɛ, e] (Cole 1955:31)

Table 3.8 Tswana vowels (Cole 1955)

Close	i	u
Semi-close	ι ɪ	ω ʊ
Semi-open	e ɛ	o ɔ
Open	a	

3.4.1.1 Palatalization in causative formation

Although Cole (1955) is generally credited as the main source of Tswana data, there is some disagreement in the analysis of causative formation. Cole (1955) provides two causative suffixes, *–isa* or *–ja* the first of which is reported to be a compound derived from combining Proto Bantu **-iga* or **-ega* with *–ja*, **-iga* + *-ja* > **-igja* > *-isa* (p. 203). Of these suffixes, only *-ja* triggers a change in the final stem consonant. Verbs select one of the two causative affixes depending on their ending, but the general rule is that *–isa* is suffixed in place of the final verbal stem vowel (Cole 1955:204). If the stem ends in [ɸa] either suffix can be selected, with *–isa* being preferred, but if the stem ends in [na], is a derivative stem ending in [la] or [xa] then the causative suffix *–ja* is used. If the stem ends in [ma], [ka], [ba], or is a primitive stem in [la] or [xa], then the causative *–isa* is used. Most verb stems end up selecting this latter non-palatalizing suffix, and in fact modern Tswana prefers it; therefore, palatalization is not as frequent in this paradigm (Cole 1955:205).

As indicated in the above paragraph, only those stems ending with one of the consonants [ɸ, l, n, x] select the palatalizing suffix and undergo a change. LaCharité (1993) also provides an example of a verb stem in [p] which shows palatalization, but I have found no other examples. Of these consonants, only the labials and the alveolar nasal have palatal reflexes, while *l* and *x* assibilate, as shown in the table below. Among different dialects, and sometimes within the same dialect, there is variation in the realization of consonants (e.g. ɸ → $tʃ^{hw}$or ts^{h}, although Cole (1955) states that for this consonant in particular the assibilated outcome appears on few verbs, and he suspects that this is a newer development from the palatalized outcome, p. 205). The data here and in later sections are from Cole (1955) and LaCharité (1993), and only the reported alternations are provided. For the bilabial fricative, Cole (1955) indicates aspiration along with labialization in the palatalization outcome (*tʃ*^{hw}), while LaCharité (1993) does not indicate aspiration. Both Cole and LaCharité indicate aspiration on the non-palatalized outcome (*ts*^{h}).

As Cole (1955) appears to be very thorough in describing each alternation, I assume that if a particular sound is not mentioned in the discussion of sound alternations, it does not occur in the relevant context. In the table below as well as in subsequent tables I indicate what appears to be a non-occurring sound in a given context by "n/a". Sounds which do occur in a particular context, but are unaffected by palatalization/assibilation are represented as themselves.

Table 3.9 Consonantal alternations in Tswana causative formation

	Input	Causative *-ja*
Labial	p	tʃ^{w}, ts
	p^{h}	n/a
	ɸ	tʃ(^{h})^{w}, ts^{h}
	b, m	n/a
Coronal	t, t^{h}, ts, ts^{h}, s	n/a
	r	n/a
	l (derived stem)	ts
	n	ɲ
	ɲ	n/a
Dorsal	x (derived stem)	s, ts^{h}
	k, k^{h}	n/a
	ŋ	n/a

Some examples of causatives are given in (24) below.

(24) Causative formation in Tswana with -*ja*
(LaCharité 1993:266-7, and Cole 1955:203-205):

			Causative	
(a)	-lap-	'become tired'	-lapisa ~ -latsa ~ -latʃ^{w}a	'make someone tired'
(b)	-leoɸ-	'sin, err'	-leoɸisa ~ -leots^{h}a ~ -leotʃ^{w}a	'make someone sin'
(c)	-nateɸa	'be nice, pleasant'	-nateɸisa ~ -natets^{h}a ~ -natetʃ^{hw}a	'make nice, flavour'
(d)	-tɬala	'become full'	-tɬatsa	'fill'
(e)	-xakala	'become zealous, indignant'	-xakatsa	'cause to be indignant'
(f)	-tsena	'enter, go in'	-tseɲa	'put in, cause to go in'
(g)	-lekana	'be equal'	-lekaɲa	'make equal, measure'
(h)	-foloxa	'climb down'	-folosa ~ -folots^{h}a	'cause to come down'
(i)	-huɾuxa	'move residence'	-huɾusa ~ -huɾuts^{h}a	'cause to move residence'

Ohala (1978) adopts the same view as Cole (1955), with –*ja* as the causative suffix which triggers palatalization, but Myers (1990) and LaCharité (1993) hold different views. Cole (1955) and Ohala (1978) would say that the first form for the above examples in (a), (b) and (c) simply selects the –*isa* suffix, while the other forms select the *–ja* suffix, which triggers palatalization on labials and *n*, and assibilation on *l* and *x*. On the other hand, Myers (1990) proposes that the causative is the suffix *–s*, where the vowel *i* is epenthesized. The final vowel *a* is analyzed as marking the indicative mood, and thus not part of the suffix. This is the typical ‘final vowel’ of Bantu morphology. LaCharité (1993) proposes that the causative is a floating feature [+strident] which sometimes associates with the final stem consonant to produce palatalization, and other times it forms its own syllable with an epenthetic [i]. I discuss the details of her analysis in section 3.4.2.1.

3.4.1.2 Palatalization in passive formation

The passive is formed by suffixing *–wa*[36] to the verb (Tucker 1929:80, Sound System of Setswana 1999:28, henceforth SSS). As a result, non-labial consonants are labialized, but labials *p*, p^h, *b* and *ɸ* are palatalized when this suffix is attached (Cole 1955:43, 193). The labials appear to change into labialized palato-alveolar affricates $tʃ^w$, $tʃ^{hw}$, $dʒ^w$ or a fricative $ʃ^w$, as seen in the table below. The forms in parentheses represent realizations in different dialects[37].

[36] LaCharité (1993:268) provides an alternative account where the passive morpheme is not *–wa*, but rather a floating feature [+round] which links to the final stem consonant in forming the passive.
[37] In Sesotho, a related language spoken in the same country—Botswana—labial palatalization in the passive is rarely used correctly by children age 3 and even older (Demuth, 2007).

Table 3.10 Consonantal alternations in Tswana passive formation

	Input	Passive -*wa*
Labial	p	tʃ^{w} (pʃ^{w}, ps)
	p^{h}	tʃ^{hw} (pʃ^{hw})
	ɸ	ʃ^{w} (ɸʃ^{w})
	b	dʒ^{w} (bdʒ^{w})
	m	ŋ^{w}
Coronal	t	n/a or t^{w}
	s, ts^{h}	n/a
	s (very rarely)	ʃ^{w}
	ts	n/a
	ts (eastern dialects)	tʃ^{w}
	l, r	n/a
	n	n/a
	ɲ	ŋ^{w}
Dorsal	x	n/a or x^{w}
	k, k^{h}	n/a or k^{w}
	ŋ	n/a

Some examples of labial ~ palatal alternations in the passive are given in (25).

(25) Labial palatalization in Tswana passive formation:
(SSS 1999:28; LaCharité 1993:269)

p → tʃ^{w} /lɔpwa/ → [lɔ́:tʃ^{w}à] 'be requested'

p^{h} → tʃ^{hw} /tl^{h}ʊp^{h}wa/ → [tl^{h}ʊ:tʃ^{hw}à] 'be chosen'

b → dʒ^{w} /robwa/ → [rɔ̀:dʒ^{w}à] 'be broken'

ɸ → ʃ^{w} /alaɸwa/ → [áláʃ^{w}à] 'be cured'

Cole (1955) and Ohala (1978) provide –*iwa* as an alternative passive suffix which is used more rarely with stems other than disyllabic (disyllabic stems can use

–*iwa* more often). The following examples show that this suffix does not trigger palatalization on any consonants:

(26) No palatalization/labialization before passive suffix –*iwa*

(Cole 1955:192-3):

Plain	-*iwa*	-*wa*	
-bopa	-bopiwa	-botʃʷa	‘be created’
-lɪba	-lɪbiwa	-lɪdʒʷa	‘be looked at’
-ɸapʰa	-ɸapʰiwa	-ɸatʃʰʷa	‘(wood) be split lengthwise’
-bɔɸa	-bɔɸiwa	-boʃʷa	‘be bound, tied up’
-rata	-ratiwa	-ratʷa	‘be loved’
-bɔna	-bɔniwa	-bɔnʷa	‘be seen’
-rʊka	-rʊkiwa	-rʊkʷa	‘be sewn, stitched’
-axa	-axiwa	-axʷa	‘be built’

The examples in (26) show that the suffix –*wa* triggers palatalization on preceding labials, but not on coronal or dorsal consonants. The latter show labialization when this suffix is selected. As indicated in table 3.10, the bilabial and the palatal nasals undergo velarization and labialization before –*wa*, and they rarely may also select the suffix –*iwa*, which leaves them unaffected (27 a). In addition, the alveolar fricative *s* and the affricate *ts* can show palatalization in the passive before the –*wa* suffix, but this is a rare occurrence in the case of *s*, and it is restricted to eastern dialects in the case of *ts* (Cole 1955:194; LaCharité 1993:269). Otherwise, stems ending in these consonants typically select the suffix –*iwa*. Some examples are given below (27 b).

(27)

(a) Nasal velarization and labialization in the passive:

Plain	-*iwa*	-*wa*	
-loma	-lomiwa	-loŋʷa	'be bitten'
-akaɲa		-akanŋʷa	'be thought, considered'

(b) Palatalization of *s* and *ts* in the passive:

Plain	-*iwa*	-*wa*	
-dis	-disiwa	-diʃʷa	'be herded'
-bitsa	-biɾiwa	-bitʃʷa	'be called'
-ɸatsa	-ɸatsiwa		'be chopped (wood)'

3.4.1.3 Palatalization in diminutive formation

The diminutive of nouns and adjectives in Tswana is formed by suffixing –*ana* or –*ɲana* (Cole 1955:43). The suffix –*ana* causes palatalization and labialization of the final stem consonant, while –*ɲana* is suffixed without causing a change in the final stem consonant unless this consonant is –*ŋ* (Cole 1955:105, 145). In addition, suffixing -*ɲana* sometimes carries a derogatory connotation (Cole 1955:105). Nevertheless, the younger generation of speakers prefers using –*ɲana* with no apparent difference in meaning, and also without palatalization of final stem consonants (Cole 1955:108).

Labial consonants usually palatalize when the diminutive suffix is attached, and so do some coronal and dorsal consonants (the latter may assibilate instead, depending on dialect). Whether palatalization of the final stem consonant occurs depends on the nature of the final vowel of the noun. The table below summarizes the palatalization or lack thereof in the diminutive. Labial consonants [p, p^h, b, ɸ] palatalize in the diminutive when the final vowel is anything other than *a*, while coronal consonants [t, r, n, l, ɾ] palatalize or assibilate when this vowel is a non-low front one. Furthermore, the alveolar flap [ɾ] (an allophone of *l* before close vowels *i* and *u*; Cole 1955:28, 107)[38] palatalizes before close *u*. The only velar sound that undergoes a change in the diminutive is the syllabic velar nasal, which palatalizes when it is the final consonant of the noun, regardless of which diminutive suffix is used. Other consonants remain unchanged when the final stem vowel is *i* or *e*, and are labialized as usual when the final stem vowel is a back vowel.

[38] The alveolar flap is being replaced by plain [d] and is used by the younger generation of Tswana speakers (Cole 1955:28).

Table 3.11 Consonant alternations in Tswana diminutive formation

	Input	(a) Diminutive *– i, e + ana*	(b) Diminutive *– u, o + ana*	(c) Diminutive *– a + ana*
Labials	p	tʃ^{w} (pʃ^{w} pʃ)		p
	p^{h}	tʃ^{hw} (pʃ^{hw} pʃ^{h})		p^{h}
	b	dʒ^{w} dʒ (bdʒ^{w} bdʒ)		b
	ɸ	tʃ^{hw}		ɸ
	m	ŋ^{w} (velarized) ɲ (one case only)		m
Coronals	t	ts tʃ	t^{w}	t
	ɾ /l/	ts	tʃ^{w}	l
	r	ts^{h}	r^{w}	r
	l	dʒ	l^{w}	l
	n	ɲ	n^{w}	n
	s	s	s^{w}	s
	ts	ts	ts^{w}	ts
Dorsal	k	k	k^{w}	k
	x	x	x^{w}	x
	ŋ	ŋ	ŋ^{w}	ɲ
	w	w	n/a	w

If the final vowel is low open vowel *–a*, there is no palatalization (3.10 c), as illustrated in (28). The suffix *–ana* simply attaches to the stem after *–a* is dropped (Tucker 1929; Cole 1955:106):

(28) No palatalization with stem final *-a*:

t^{h}ipa	t^{h}ipana	‘knife’
p^{h}aɸa	p^{h}aɸana	‘type of beer-pot’
tsela	tselana	‘road’

If the final vowel is a non-low front vowel (or in Cole’s terms, semi-open, semi-close or close), (3.10 a), then this vowel is deleted and *–ana* is suffixed with no other changes, unless the final stem consonant is a bilabial obstruent or one of alveolar *t, r, ɾ, l, n*. In the latter case the consonants palatalize (or assibilate), as shown in (29).

(29) Palatalization with stem final non-low front vowels (labials and alveolars) (SSS 1999:28, Cole 1955:45, 107):

tl^{h}api – ana	tl^{h}atʃ^{w}a:na	‘a small fish’
tshipi – ana	tshitʃ^{w}ana	‘small piece of iron’
marop^{h}i – ana	marotʃ^{hw}ana	‘small blisters’
kolobe – ana	kolodʒwane OR kaloʒane	‘piglet’
xauɸi – ana	xautʃ^{hw}ane	‘fairly nearby’
-ʃumo – ana	-ʃuɲana OR -ʃwiɲana	‘(fairly?) white-faced’[39]
lobati - ana	lobatsana OR lobatʃana	‘a small board/plank’
lemɔtɛ - ana	lemɔtʃana	‘small mud wall’
poɾi – ana	potsane	‘small goat’
lorole – ana	lorodʒana	‘small dust’
p^{h}iri – ana	pits^{h}ane	‘small hyena’
namane - ana	namaɲane	‘small calf’

[39] This is the only example where *m* is palatalized. Normally it is velarized (Cole 1955:44).

If the final stem vowel is a back vowel, as in (3.10 b), this vowel "becomes consonantalized" (undergoes glide formation) changing to *w* and then *–ana* is suffixed (30), unless the preceding consonant is bilabial or the alveolar flap *ɾ* before *u*, in which case palatalization (or assibilation) takes place (31). All consonants are labialized before back vowels in terms of lip rounding and "whenever possible" tongue body raising toward the velum (Cole 1955:33), which suggests that the consonants preceding the derived glide *w* also have labialization, but that this is in addition followed by a separate *w* segment. Cole (1955) refers the reader to Tucker (1929) for an analysis of labialization of consonants, who states that labialized consonants have lip rounding throughout their pronunciation, further supporting the claim that a consonant before derived *w* should be transcribed with labialization as well (Cole 1955 assumes this and does not indicate it in transcription).

(30) Glide formation with back vowels (Cole 1955:107):

tau - ana	tawana	'lion cub'
ntlo - ana	$ntl^{w}wana$	'little house'
lekoto - ana	$lemot^{w}wana$	'little leg'
louʃo - ana	louʃ^{w}wana	'small spoon'

(31) Palatalization with stem final back vowels (labials and alveolar flap):

kɛpɔ - ana	kɛtʃ^{w}ana	'a small spade'
molapo – ana	molatʃ^{w}ana	'a small water-course'
seɸoɸu –ana	seɸotʃ^{hw}ana	'little blind person'
tʃ^{h}ukuɾu – ana	tʃ^{h}ukutʃ^{w}ana	'young rhinoceros'

Finally, in (32) I provide examples which show palatalization of the syllabic velar nasal in the diminutive before *-ana*:

(31) Palatalization of syllabic velar nasal:

logoŋ - ana	logoɲana	'small piece of firewood'
moɛŋ -ana	moɛɲana	'little stranger'

In summary, labial consonants in standard Tswana undergo palatalization in all three contexts, while coronal and dorsal consonants only undergo a sound change in the diminutive and the causative, but not in the passive. The causative is the most restrictive environment, due to the selection of the causative suffix based on the final stem consonant. Of the labial consonants, only the fricative appears to be most affected, since stems having this as the final consonant select the palatalizing causative suffix *-ja*. Coronals *l* (in derived stems) and *n* and velar *x* assibilate before the *–ja* suffix. In the diminutive some coronals palatalize and some assibilate, while the velar nasal palatalizes[40]. Furthermore, in the diminutive coronal consonants are palatalized when appearing before typical palatalization targets (front vowels, and *u*). The table below summarizes the outcomes for the labial consonants in each of the three contexts. Notice that aspiration is acquired from the labial in the case of p^h, and it is also added to the palatalized outcomes for ϕ in the diminutive and causative. Recall that Cole (1955) marks aspiration on the causative palatalized outcome for ϕ while LaCharité (1993) does not. Labialization is also acquired from the labial in all cases

[40] Voiceless velar [k], [k^h] and [x] undergo phonological full palatalization before front vowels (Cole 1955:22-5).

except for some of the dialectal forms with the labial consonant preceding the palatal, for the assibilated outcomes of *p* and *ɸ*, and for the alternate *dʒ* outcome of *b*.

Table 3.12 Summary of labial palatalization outcomes in Tswana

	Causative	Diminutive	Passive
p	tʃʷ ts	tʃʷ (pʃʷ pʃ)	tʃʷ (pʃʷ, ps)
pʰ		tʃʰʷ (pʃʰʷ pʃʰ)	tʃʰʷ (pʃʰʷ)
b		dʒʷ dʒ (bdʒʷ bdʒ)	dʒʷ (bdʒʷ)
ɸ	tʃ(ʰ)ʷ, tsʰ	tʃʰʷ	ʃʷ (ɸʃʷ)

The sound changes characteristic of the three morphological contexts described above are rather different from what was observed in Romance. Labial consonants in Tswana appear to be palatalized by unconventional palatalization triggers, such as the –*wa* of the passive and the –*ana* of the diminutive (even perhaps by the –*s* of the causative, if we adopt Myers' (1990) proposal). In the discussion below I show that these consonant changes can all be traced to historical developments which did not involve the palatalization of the labial consonant itself, but rather the hardening of a palatal glide which followed the labial.

3.4.2 Explanation of labial palatalization in Tswana

Researchers who have either described Tswana or analyzed the phonology of the language have attempted to explain the apparent palatalization of labials (Cole 1955, Ohala 1978, LaCharité 1993, SSS 1999). There are three explanations offered for either one or all of the processes which have come to be referred to as "labial palatalization" in Tswana: (i) consonant mutation; (ii) dissimilation; (iii) perception. I review these explanations below and then offer an alternative solution which relies on historical evidence that the labial consonant did not itself palatalize, but that a glide which followed it gradually hardened, ultimately leading to the deletion of the labial consonant.

3.4.2.1 Labial palatalization as consonant mutation

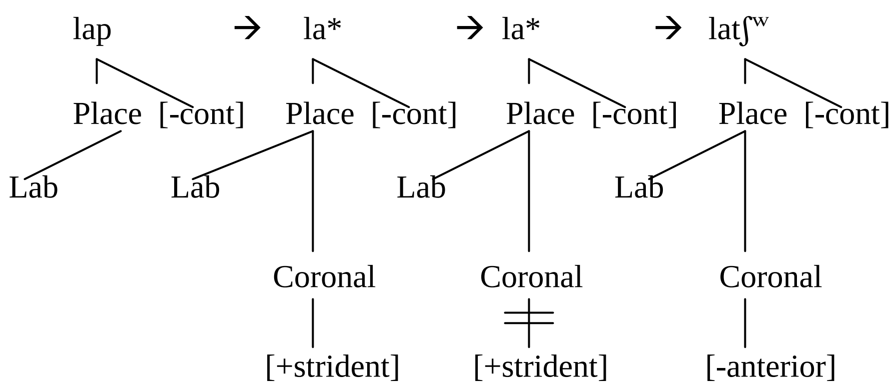
LaCharité (1993) proposes a mutation type of analysis for the Tswana labial ~ palatal alternations[41]. I discuss here LaCharité's account of palatalization in the causative. LaCharité proposes that consonant mutations (here assibilation or palatalization) are the result of the interaction of constraints, within the Theory of Constraints and Repairs or TCRS (Paradis 1988a, b). She analyzes the causative as a floating feature [+strident] rather than a suffix -*isa*. A proposed Strident-Labial Constraint present in Tswana prohibits both [Labial] and [+strident] in the same syllable. When the causative floating feature [+strident] is realized as the –*isa* suffix, LaCharité analyzes it as not linking to the labial consonant, but being realized as an onset of a separate syllable (p. 267). The vowel *i* is epenthesized between the final labial and the strident *s*, and *a* is added as a verbal marker. If, on the other hand, the floating feature [+strident] links to the final consonant of the verb stem, it adds a [Coronal] node if the consonant happens to be a labial, or it creates a strident coronal

[41] Zoll (1995) proposes a mutation analysis for several consonantal alternations in Bantu languages in general. She analyzes mutation before superclosed vowels *į* and *ų* as spreading of [+consonantal], since these vowels behave like [+consonantal] segments. Such an analysis is not suitable for explaining the Tswana data for two main reasons: (i) superclosed vowels are not always present after labials, and (ii) mutation would not explain why labial consonants are affected primarily, while others are not.

if the consonant is already a coronal. In the former case, the Strident-Labial Constraint would be violated by the addition of the [Coronal] node, and a repair is necessary.

LaCharité proposes two repairs depending on whether the labial will be realized as a strident, e.g. [ts], or a labialized palato-alveolar fricative, e.g. [tʃʷ]. In the former case the [Labial] node is delinked, and what results is a [+strident] Coronal stop: -lap- → [-latsa] 'make someone tired'. In the latter case, the feature [+strident] is delinked, not the [Labial] node, leaving a bare [Coronal] node which violates the Bare Coronal Node constraint. The Bare Coronal Node Constraint states that a Coronal node must be filled by a dependent. The dependent feature [-anterior] is selected as the minimal and most efficient repair, according to the Minimality Principle. The Minimality Principle states that a repair (context free phonological operation like insertion or deletion, which makes a phonological unit conform to a phonological constraint) "must apply at the lowest phonological level to which the violated constraint it preserves refers" (LaCharité 1993:257). Since Tswana only has two coronal fricatives, [ʃ] and [s], [-anterior] is selected to fill the Coronal node; [+anterior] would create [sʷ], violating the Strident-Labial Constraint. Thus, the addition of the feature [-anterior] creates a non-anterior [ʃʷ]. The diagram below illustrates the derivation for the word [latʃʷa] 'make someone tired'.

(32) Causative: p→ tʃʷ (from LaCharité 1993:268)



LaCharité's analysis is attractive because it accounts for the consonantal changes in the causative in a uniform way without referencing two different suffixes (non-palatalizing -*isa* and palatalizing -*ja*). However, the analysis is dependent on the theoretical assumptions and constraints established by the author. It seems arbitrary to say that sometimes the floating feature [+strident] forms a separate syllable onset, therefore not causing a change in the verbal stem consonant, and other times it attaches to the final stem consonant. Also arbitrary is the fact that sometimes [Labial] is delinked and other times [+strident] is delinked. This fits in with the theoretical assumptions and describes the data, but does not explain why labial consonants would change in these specific ways.

As I show in section 3.4.2.4, by adopting the two suffixes proposed by Cole (1955) and Ohala (1978) I provide a unified explanation for "labial palatalization" in all three contexts, and also demonstrate that labial palatalization of this type is the result of historical changes obscured by synchronic alternations.

3.4.2.2 Labial palatalization as dissimilation

A dissimilation type of explanation has been offered for labial palatalization in the Tswana passive. The proposal is that Tswana has a constraint against labialized labials, sounds which would result from the suffixation of the passive –*wa* to a verb stem ending in a labial (Doke 1926, Cole 1955, LaCharité 1993, SSS 1999). SSS (1999:27) simply states that in Tswana labial consonants cannot be followed by a labio-velar glide *w*. When the –*wa* passive suffix is attached to a verb stem, the final consonant is labialized (e.g. $k \rightarrow k^w$). If this consonant is a labial, the general constraint against labialized labials would be violated by a change from $p \rightarrow p^w$; therefore, a different sound must be realized, one which is not both labial and labialized (e.g. a labialized coronal $tʃ^w$).

Evidence supporting a constraint against labialized labials is brought by appealing to the sound inventory of Tswana and to reported cross linguistic tendencies. First, labialized labial sounds are not part of the consonant inventory of Tswana, therefore they are not allowed to surface in the passive (LaCharité 1993:265; Cole 1955:42; SSS 1999:26). Second, labialized labials are reported to be rare cross-linguistically, as Maddieson (1984) found that of 317 languages only three show labialized labials, Irish, Nambakaengo, and Washkuk (cited in LaCharité 1993:265). According to Maddieson, Irish has bilabial labialized and velarized consonants, although no further references to labialized labials have been found. Nambakaengo has labialization at all places of articulation, and Washuk has labialized labials and velars, but not coronals (Maddieson 1984: 263, 367, 356). On the other hand, Tswana does have labialized alveolar (t'^{w}, t^{hw}, d^{w}), alveo-palatal ($tʃ'^{w}$, $dʒ^{w}$) and dorsal consonants (k'^{w}, $ŋ^{w}$), which explains why coronals and dorsals simply have labialization in the passive (LaCharité 1993:260). While the language-specific explanation is correct, the cross-linguistic generalization does not hold up under closer scrutiny with respect to the difference between coronals and labials being labialized. In some languages, labials are *better* licensors of labialization than coronal consonants. Chaha (Ethio-Semitic, Ethiopia) is an example, where labialized alveolar consonants are not found, but labialized labials are found (Leslau 1964, Hetzron 1977, Rose 1997). In Nawuri (Kwa, Ghana), there are four labialized labial consonants p^{w}, b^{w}, f^{w}, m^{w} and three non-labials s^{w}, $tʃ^{w}$ and k^{w} (m^{w} and $tʃ^{w}$ are extremely rare; Casali 1995:650). Ohala and Lorenz (1977) cite Ruhlen (1976) who catalogued sound inventories in 706 languages and found that labialization occurs most often with velar, uvular and labial consonants. Of the 706 languages, 318 have at least one labialized velar, 107 have at least one labialized uvular, and 48 languages have at least one labialized labial (cited in Ohala and Lorenz 1977: 580).

Nevertheless, assuming that it is true that Tswana has a constraint against labialized labials raises the following question: why is the ban against labialized labials reconciled by having a palato-alveolar affricate with labialization instead, as shown in (33) where *p* alternates with $tʃ^{w}$?

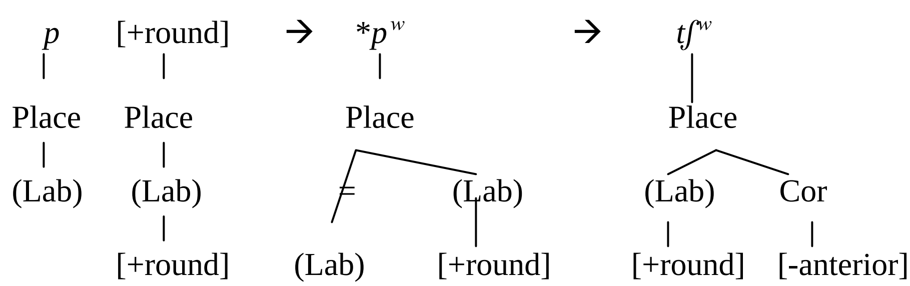
(33) No labialized labials in Tswana:

-bopa	-botʃ^{w}a	'be created'
	-*bop^{w}a	

One answer to this question could be that labialization of the final stem consonant is what indicates the passive, which is why labialization must still remain (otherwise one could have simply removed the labialization; cf. (26) where coronals and dorsals show labialization). In other words, the passive must be expressed via overt labialization. If so, then one might suggest two options for satisfying the "no labialized labials" constraint: i) delete the labial and add the passive suffix *–wa*, or ii) change the labial to a non labial sound and add labialization. The second of these has been adopted, with the assumption that the labial must have changed to the labialized palato-alveolar affricate or fricative that shows up in the passive form (LaCharité 1993, Cole 1955). Why this was the best possible way to satisfy the constraint has been explained via theory-specific mechanisms. I review one such mechanism below.

LaCharité (1993) proposes first of all that the passive is not *–wa*, but a floating feature [+round]. When a verb is made passive, this floating feature adds [+round] to the main place feature [Labial] of the consonant. If nothing is done to the consonant's main place feature [Labial], then an illegal labialized labial would be created. The change from a labial to a palato-alveolar affricate then occurs because it is the "most minimal and efficient repair" necessary to avoid violations of a proposed Labialized Labial Constraint and the Minimality Principle mentioned earlier. The Labialized Labial Constraint states that if a consonant is [Labial] [+round] it must also be specified for another place of articulation (such as [Coronal]; LaCharité 1993:265). As such, this constraint not only penalizes labialized labials, but also specifies how this violation will be repaired (TCRS). Under LaCharité's account, if a labial is faced with the option of being labialized in the passive, then the interaction of the Labialized Labial Constraint and the Minimality Principle will result in the delinking of the [Labial] node associated with the labial consonant, and the insertion of a Coronal node with the terminal feature [-anterior], thus providing *tʃ*^{w} as the best repair of an illegal *p*^{w}. An abbreviated diagram is given below in (34):

(34) Repair of labialized labial (adapted from LaCharité 1993)



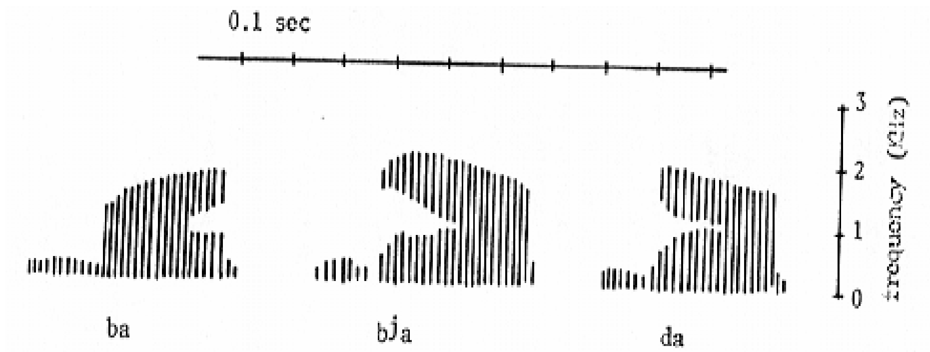
Although a general constraint against labialized labials seems to be true of Tswana, as discussed earlier, the specific constraint proposed by LaCharité (1993) where the labial must also be specified for an additional place of articulation seems rather arbitrary. Why would delinking the [Labial] node associated with the consonant not be sufficient (e.g. -bopa → *bowa)? The insertion of another place of articulation to repair the labialized labial is a strange repair, and furthermore, having *tʃ*^{w} as the result of a repair of illegal *p*^{w} it is not characteristic of what takes place in palatalization, where a consonant is actually affected by the following (or more rarely, preceding) high front vocoid. In summary, the main issue with the dissimilation account is why the resolution of *p^w results in an alveopalatal consonant in particular.

3.4.2.3 Labial palatalization as misperception

Ohala (1978) discusses labial palatalization in general in Southern Bantu, proposing that changes from p^j (secondarily palatalized labials) to *tʃ* (fully palatalized labials) are very common. In brief, he argues that labial palatalization results from misperception which is subsequently repeated and perpetuated. For example, a listener hears [tʃi] instead of [pi], then she repeats [tʃi], and eventually a sound change can take place whereby [tʃi] replaces the labial.

Ohala (1978) provides perceptual explanations for the palatalization of labials in general, citing evidence from acoustic and perceptual studies. On the acoustic side, Fant (1960) showed that secondarily palatalized labials, or labials followed by a palatal off glide, are acoustically more similar to dentals than to labials. For example, spectrogram tracings of Russian syllables [ba], [b^ja] and [da] show that the F2 transition (the one identifying place of articulation) for [b^ja] is more similar to that of [da] than to [ba], as shown below.

(35) Tracings of spectrographic patterns for Russian [ba], [b^{j}a], [da] (from Fant 1960, via Ohala 1978:374).



As Ohala (1978) himself indicates, the reason for this spectral similarity is because the tongue gesture immediately transitioning into the vowel is that of the tongue at the palatal region, not that of the lips. I suggest that this acoustic result does not necessarily imply that [b^{j}a] and [da] are more similar perceptually than [b^{j}a] and [ba].

In a perceptual study, Winitz et al (1972) presented subjects with CV confusion matrices where the consonants were /p, t, k/ and the vowels were /i, a, u/ (notice that these do not involve secondarily palatalized labials, but *p* + *i* sequences). One of the tasks involved identifying the consonant when followed by one of the vowels /i, a, u/, with the burst isolated and with 100 ms of the adjacent vowel. Other tasks involved identifying the correct consonant /p, t, k/ while knowing in advance the CVC sequence they were lifted from (i.e. *pop*, *top*, *cop*), and identifying the correct CVC sequence from which the stops were lifted (i.e. they knew *keep*, *cop*, *coop* and that /k/ was constant, but had to select one of the three words).

The results showed that /t/ was identified correctly the most, followed by /p/ and then by /k/. The burst isolated from the sequence /pi/ was most often confused with /t/, which Winitz et al explain as being due to the high energy concentration of /i/ which is interpreted as /t/ (p. 1311). But note that /pi/ changing to /ti/ is not palatalization. If it is true that /pi/ is confused with /ti/, why are there not more cases where *pi* alternates with *ti*? Other findings are that /k/ is more frequently identified as /t/ than /p/, except before /u/. Note that this was a forced choice task, and the subjects did not have an option to select sounds other than /p/, /t/, or /k/. We do not know how likely it would be for subjects to select something like *tʃi* or $p^j i$ instead of *ti* under the same circumstances.

Given the acoustic and perceptual evidence (e.g. [b^ja] spectrogram more similar to [da] spectrogram, and /pi/ being perceived as /ti/), Ohala (1978) maintains that labial palatalization is phonetically motivated as long as the labial is secondarily palatalized, or at least followed by a palatal glide (Ohala 1978:373, 380). The reasoning might be that if *pi* is confused with *ti*, then p^j could be confused with t^j, and even with *tʃ*.

Ohala (1978) does not address the rarity of labial palatalization, on the contrary, he states that there are “quite a few” independent cases of changes from labials to dentals, alveolars or palatals (p. 370). Note first that these are not all palatalization, and in addition, the palatalization cases he discusses are Bantu and Romance languages, and also Tai and Tibetan (see earlier discussion of Tai in section 3.3). If the process of labial palatalization is phonetically motivated and thus natural as suggested in Ohala (1978), the question is why it is not found more commonly.

With regard to Bantu languages, Ohala does not provide much discussion of the causative because the palatalizing causative suffix -*ja* already contains a palatal sound, thereby providing the optimal environment for the palatalization of the labial. Instead, he focuses on the diminutive and the passive, as these contexts lack an obvious palatalizing trigger. Ohala considers it odd that the passive –*wa* and the diminutive –*ana* would trigger palatalization on labials and not on other consonants (unless in the diminutive the final stem vowel is a front vowel *i* or *e*). In order for the phonetic perceptual explanation to hold, Ohala needs proof that at some point in Bantu the passive and diminutive had a palatal glide *j* which immediately followed the labial. He bases his arguments in part on evidence uncovered by Talmy Givon and Erhard Voeltz in 1970, which they presented during various lectures but which were never published to my knowledge. This information was obtained via personal communication between Ohala and Givon (Ohala 1978:379). Stahlke (1976) also argued for the existence of a palatal segment following the labial.

Ohala (1978) capitalizes on the fact that in the case of Southern Bantu both the passive –*wa* and the diminutive –*ana* contained a palatal vocoid at some earlier point in the history of the language, and that this was most likely a palatal glide which triggered the changes in the labial. As we already know, there is an alternative passive suffix –*iwa* which does not trigger palatalization synchronically (see (24)), but Ohala suggests that historically this could have been the only passive suffix, and –*iw* could have merged to the palatal glide *j*, or even a rounded palatal glide *ɥ*, as seen in some forms in Pedi, a related Bantu language (Ohala 1978:380).

(36) Glide formation in Pedi:

-ripa + wa → -ripɥa 'be cut'

Similarly, the diminutive suffixes *–ana* and *-ɲana* can both be traced to a common morpheme *–jana*, which still exists in many Bantu languages and carries the meaning 'child' (Ohala 1978:381). Ohala claims that evidence for this now-deleted palatal glide can be found in the palatalization of the Tswana velar nasal when *–ana* is suffixed, as one would have to assume the presence of a palatal in the suffix to explain the change from *ŋ* to *ɲ*: [logoŋ] → [logoɲana] 'small piece of wood' (Ibid.). Note that the velar nasal could be palatalized by the *-ɲana* suffix instead, in which case it would assimilate to the palatal place of articulation.

Therefore, the alternations between labials and coronal consonants in these morphological contexts are historically motivated, but can be explained via perceptual means. As I discuss in the next section, I agree with Ohala (1978) regarding the connection to a historical palatal glide; however, I argue that the historical explanation goes much further. Instead of a perceptual explanation for labial palatalization I propose that the palatal glide which followed the labial hardened, in a similar fashion to Romance. Evidence for this hardening is found in intermediate forms of other Tswana dialects and also of related Bantu languages. The labial consonant subsequently deleted, leaving labialization as a trace on the palatalized consonant resulting from hardening.

3.4.2.4 Proposed historical explanation of labial palatalization[42]

I propose that the changes from labials to palato-alveolar affricates or fricatives in Tswana did not occur in a single step, but that in a similar fashion to Romanian, there were a series of intermediate changes which led to the current situation. The main supporting evidence for my proposal comes from existing forms at intermediate stages in Tswana dialects and in related Bantu languages. Some of these forms are actually provided by Cole (1955) and Ohala (1978), while the rest are gathered from Guthrie's (1970) Comparative Bantu atlases. In this section I first present evidence supporting the historical account involving stages of palatalization, and then I propose the stages of 'labial palatalization' for each of the three contexts, causative, diminutive and passive.

As I have indirectly suggested in the above discussion, palatalization of the type attested in Tswana is actually quite common to the Southern Bantu language group. Ohala (1978) argues that intermediate stages in labial palatalization are not necessary. However, evidence from some of the languages he discusses, as well as

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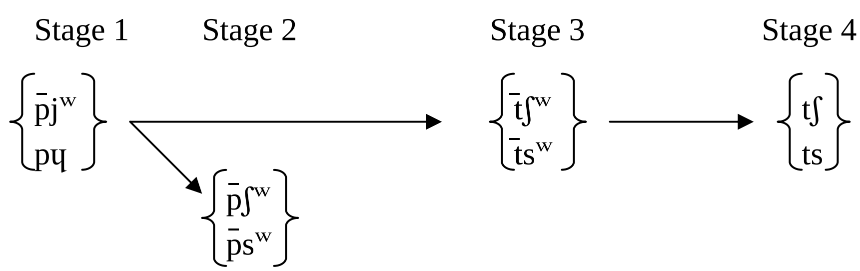
[42] A historical explanation with intermediate stages is proposed in SSS (1999) as well. The claim is that when a labial was followed by the *w* of the passive suffix, the fricative *ʃ* was inserted to form an affricate. Subsequently, the labials *p* and *b* are said to have changed to *t* to assimilate to the inserted *ʃ* as much as possible.

(1) Stages of development of palatalized labials in Tswana (SSS 1999:26)
/lɔp-w/ → /lɔp-w-a/ → /lɔp-ʃ-w-a/ → [lɔ́:tʃʷà] 'be requested'
/alaf-a/ → /alaf-w-a/ → /alaf-ʃw-a/ → [álá:ʃʷà] 'be cured'
/arab-a/ → /arab-w-a/ → /arab-ʃ-w-a/ → [árá:tʃʷà] 'be answered'

SSS (1999:26) mentions intermediate forms still attested in some Sotho languages such as Sebirwa: [lopʃʷa] 'be requested'. This historical explanation is highly simplified; however, it does capture the basic fact that the labials did not palatalize, and that a palatal sound following the labial is the one which underwent consonantal changes.

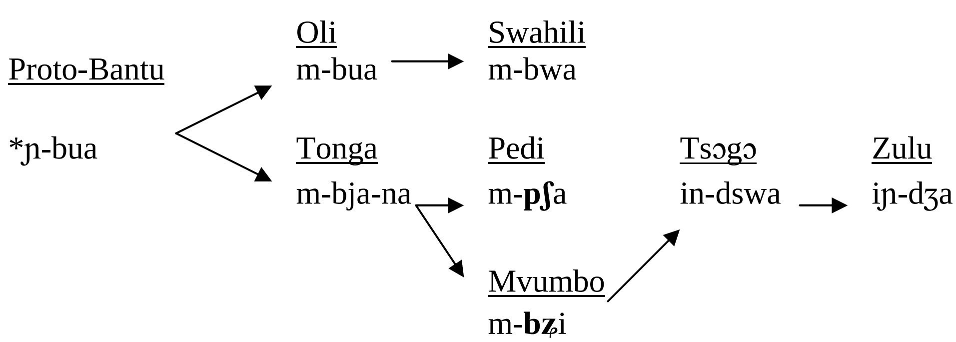
from related Bantu languages, suggests otherwise. Ohala provides the following scenario for the possible development of palatalized labials in Bantu.

(37) Stages in palatalization (Ohala 1978:382). The bar ¯ above the consonant indicates that labialization persists through the segment.



Ohala (1978) and I both agree that the first stage in the palatalization of labials in Bantu is basically secondary palatalization. I disagree with Ohala with respect to the second stage. Ohala (1978:382) states that there is evidence for stage 2 (with a labial followed by a coronal sound) in some variant reflexes for the Bantu word ‘dog’, shown below, but *emphasizes* that this is *not* a necessary intermediate stage in going from a labial to a palatal. Misperception is all that is needed to account for the change. I argue that Stage 2 in (37) *is* in fact *necessary* to explain the ‘palatalization’ of labials in Bantu, paralleling the development of the ‘palatalization’ of labials in Romance and other languages such as Tai.

(38) Evidence for Stage 2 from Proto-Bantu ‘dog’ (Ohala 1978:382)



Notice in particular the forms in Pedi and Mvumbo, where there is a palatal fricative between the labial and the following vowel.

Besides the evidence in (38) provided by Ohala (1978) himself, further evidence comes from Cole (1955), who mentions alternative forms in Tswana dialects where there is both a labial and a coronal sound, as summarized in the table below (and indicated in parentheses in earlier tables):

Table 3.13 Dialectal labial+coronal forms in Tswana (Cole 1955: 43, 107,193)

Labial	Passive forms in Tswana dialects			Diminutive forms in Tswana dialects		
-p	tʃʷ	pʃʷ	psʷ	tʃʷ	pʃʷ	pʃ
-b	dʒʷ	bdʒʷ		dʒʷ, dʒ	bdʒʷ	bdʒ
-pʰ	tʃʰʷ	pʃʰʷ		tʃʰʷ	pʃʰʷ	pʃʰ
-ɸ	ʃʷ	ɸʃʷ		ʃʷ		

There are in fact many Southern Bantu languages where such forms are found (Guthrie 1970; see tables 3.14 and 3.15), and I interpret this as evidence that intermediate stages are necessary to explain the development of palatals where there used to be labials. The existence of these forms suggests that the labials themselves did not palatalize, supporting my proposal of the development of labial ‘palatalization’.

Tucker (1929) compares the phonetics of Suto-Chuana (Bantu subgroup) languages, particularly of Sesotho (formerly SeSuto), Tswana (formerly SeChuana) and Pedi (a.k.a. SePedi, Sotho), and reports that bilabial plain and aspirated plosives *p* and p^h are found before all vowels in all three languages. In Sesotho there is a slight palatal friction on *p* before the vowel *i*, and this palatal friction is much more noticeable on the aspirated stop p^h. Tucker notes that in a narrow transcription the sequence $p^h i$ would be more accurately transcribed as *pçi* (Tucker 1929:52), with a palatal fricative between the labial and *i*.[43]

Tucker (1929) further discusses the presence of what he calls ‘compound labial plosives’ in Sesotho and Pedi. In Pedi there are unaspirated and aspirated *ps* and ps^h, and in Sesotho and Pedi there are *pʃ* and $pʃ^h$. Tucker notes that the *ʃ* in these compounds are “more palatal and *ç*-like” than palato-alveolar *ʃ* (Tucker 1929:53). Some examples are given below, where Proto Bantu is abbreviated as PB.

(39) Compound labial plosives (Tucker 1929). The initial nasal in the forms for ‘dog’ is a class prefix. The PB forms are from Guthrie (tones omitted) (1970).

PB	Sesotho	Pedi	Tswana	
* bua	ntʃā	mpʃā	ntʃā	‘dog’
* puani	pʃhatɬa̠	pʃhatɬa̠		‘to smash’

Notice that in (39) the source of the palatalized consonant appears to be *u. It is possible that both *i and *u first triggered secondary palatalization of the labial, and that subsequently the resulting secondary palatal glide hardened. Although clear evidence of this is lacking, this sequence of sound changes is possible. As the

[43] This suggests an that alternative solution is available for labial palatalization, different from the glide hardening which I propose here. The alternative would be that the fricative arose from the voiceless aspirated noise of a stop releasing into a following high vowel (Clements 1999, Thomason 1986). However, this solution is less satisfactory for two reasons: (i) labials which ‘palatalized’ were not always followed by high vowels, and (ii) why were other consonants not affected in the same way?

palatalization survey in chapter 2 showed, *u* can also be a palatalization trigger, even though it does so more rarely.

The type of outcome shown in (39), with labials followed by coronals, has been documented in several other Bantu languages reported in Guthrie (1970). The tables below give examples from various languages where Proto-Bantu (PB) *p + *i or *u, and PB *b + *i or *u are synchronically a sequence of *p* or *b* and another sound, usually a palatal or alveolar.

Table 3.14 Intermediate stages in the palatalization of PB *p
(see Table 1 of Appendix 6 for more examples)

Lg. Group	Language	PB	Meaning	Form	Gloss (if different)
Tumbuka	Tumbuka	*-pí̧à-	‘new’	-pɕa	
Chopi	Tonga	*-pí̧à-	‘new’	-phja	
Tumbuka	Tumbuka	*-pí̧ágid-	‘sweep’	-pɕeɽ-	
Yao	Yao	*-pí̧ágid-	‘sweep’	-pjā̄ɟil-	
Nyanja	Maŋanja	*-pí̧yò	‘kidney’	im|pɕo	
Sotho-Tswana	S. Sotho (Suthu) (Lesotho, S.Africa)	*-pù̧ànj-	‘pound’ (verb)	-pɕhatl’	‘smash’
Sotho-Tswana	Pedi	*-puany-	‘pound’	-pɕhanj-	‘smash’
Nyanja	Maŋanja	*-pí̧ù	‘red’	pɕu	

Table 3.15 Intermediate stages in the palatalization of PB *b
(See Table 2 of Appendix 6 for more examples)

Group	Language	PB	Meaning	Form
Umbundu	Mbundu (Nano)	*-bíá	‘cord, strap’	u|βja
Tswa-Ronga	Tswa	*-bíád-	‘plant’	-bz̯al-
Kaonde	Kaonde	*-bíád-	‘plant’	-βjāl-
Ruanda-Rundi	Ruanda	*-bį́ád-	‘bear’ (child)	-bɟār-
Sotho-Tswana[44]	S. Sotho (Suthu) (Lesotho, S. Africa)	*-búà	‘dog’	m̄|pʃ’a
Maka-Njem	Mvumbo	*-bų́à *-mbį́à	‘dog’	mbʑi
Ruanda-Rundi	Ruanda	*-búéd- *-búíd-	‘tell’	-bgīr-

As the tables above show, there are intermediate stages in languages very closely related to those where the labials are palatalized, such as Southern Sotho, a Sotho-Tswana language in the same group with Tswana. This, along with the facts reported by Tucker (1929), Cole (1955) and Ohala (1978) is evidence to strongly indicate that it is very common for labials in this language family to have a coronal sound, usually a fricative, appearing right after the labial. I interpret this as indication that this coronal sound arose via the hardening of a glide that followed the labial at some point (c.f. footnote 20). It is the changes that gave rise to this sound that are interpreted as the palatalization of labials.

[44] It has been proposed that Tswana has post-nasal devoicing (Hyman 2001), but Zsiga, Gouskova and Tlale (2006) argue that this is not the case, and that all stops are not actually voiced in Tswana. For details of the analysis see Zsiga, Gouskova and Tlale (2006).

In summary, the historical evidence of palatalization in Tswana supports an analysis which relies on the development of palatal consonants arising out of a palatal glide which followed the labial, and then subsequent deletion of the labial. Because this is a historical explanation rather than a synchronic one, the only evidence we have to prove these developments consists of the existence of earlier forms with a palatal glide, intermediate forms with a labial followed by a palatal consonant, and parallel developments in other language families, such as Romance. As discussed earlier, similar processes are actually evident synchronically in various dialects of Polish (Slavic, Poland), where labials are followed by a palatal glide (*pj*) in some dialects, and by a palatal fricative (*pç, pɕ*) in other dialects (Kochetov 1998).

The proposed stages in the 'palatalization' of labials in Tswana are described below for each of the three contexts where this occurs. As an overview, the first stage involved the creation of a palatal glide following the labial, which could be interpreted as secondary palatalization of the labial. In the case of the causative, the palatal glide was already supplied by the suffix *-ja*. In the other two contexts, the palatal glide resulted from glide formation and dissimilation. Subsequently this glide hardened into a fricative, which could have been *ɕ* as seen in the Nyanja form for 'kidney' [im|pɕo], or *ʃ*, as in the Pedi form for 'dog' [mpʃā]. The fricative acquired the aspiration of the labial as well as its voicing, and it further hardened to a palato-alveolar affricate[45]. One exception is in the diminutive outcome of the bilabial fricative, where a palato-

[45] It is possible that the hardening of the palatal glide followed one of two paths: it hardened to a palatal-type of sound, or to an alveolar affricate or fricative. This would explain the few but attested outcomes of the labials as non-palatal obstruents, as shown in (40).

alveolar fricative surfaces instead of the affricate (*ϕ* → *ʃ*ʷ not *tʃ*ʰʷ). Labialization of the coronal consonant appears not as feature preservation of the deleted labial, but most likely due to overlap of the lip articulation during the production of the complex labial+palatal obstruent, e.g. *ptʃ*ʷ. In those cases where there is no labialization, I assume that such overlap was lacking. The voicing and aspiration of the resulting palatals further indicate that there was articulatory overlap with the labial (e.g. the voicing of the glottis during the articulation of the labial was extended over the articulation of the hardened glide). The final step was the deletion of the labial consonant. For convenience, the summary table 3.12 is repeated below in (40).

(40)

	Causative	Diminutive	Passive
p	tʃʷ ts	tʃʷ (pʃʷ pʃ)	tʃʷ (pʃʷ, ps)
pʰ		tʃʰʷ (pʃʰʷ pʃʰ)	tʃʰʷ (pʃʰʷ)
b		dʒʷ dʒ (bdʒʷ bdʒ)	dʒʷ (bdʒʷ)
ɸ	tʃ(ʰ)ʷ, tsʰ	tʃʰʷ	ʃʷ (ɸʃʷ)

3.4.2.4.1 Development of palatalization in the causative and diminutive

I follow Cole (1955) and Ohala (1978) in adopting *–ja* as the palatalizing suffix in the causative. Thus, palatalization in this context is the simplest to account for, as the palatalizing suffix contains an initial palatal glide, and furthermore, because all consonants which appear before this suffix are affected in this context (recall that very few stems types actually select the palatalizing suffix *–ja*: [(p), ɸ, l, n, x]). Thus, the palatal glide hardened following labials, and it conditioned assibilation on coronals and the velar fricative. Examples of 'labial palatalization' is given below illustrating the proposed stages.

(41) Stages of 'labial palatalization' in the causative:

-lap- + ja → -lap**j**a → -lapʃa → -laptʃʷa → [-latʃʷa] 'make someone tired'

-leoɸ- + ja → -leoɸja → -leoɸʃa → -leoɸtʃʷa → [-leotʃʷa] 'make someone sin'

As described earlier, in the diminutive labial consonants palatalize when the final stem vowel is either a front vowel (*i*, *e*) or a back vowel (*o*, *u*), but not when it is a low vowel (*a*). Coronal consonants palatalize (or assibilate) only when followed by a front vowel, and the alveolar flap also palatalizes when followed by close *u*. While palatalized coronals before front vowels do not show labialization (e.g. *t* → *tʃ*, *ɹ* → *ts*), the alveolar flap palatalizing before *u* does show labialization: tʃʰuku**ɹu** – ana → tʃʰuku**tʃʷ**ana 'young rhinoceros'.

The facts summarized in the above paragraph suggest that the vowel following the final stem consonant is responsible for palatalization, not only of coronals, but also of labials[46]. If it were only the form of the suffix which mattered, as Ohala (1978) proposes, then it would be odd that labials do not palatalize when followed by *a*. If the final vowel deletes and the palatalizing suffix –*jana* attaches, why does the initial glide not cause misperception in these cases? Furthermore, Ohala (1978) does not address the possible effects the proposed historical suffixes containing an initial palatal glide could have had on preceding coronals and dorsals. The stages of

[46] As only dorsal *ŋ* palatalizes when word final in the diminutive, while the voiceless velar stops and the fricative show phonological full palatalization before front vowels, I focus here on labials and coronals.

'palatalization' I propose for the diminutive diverge from Ohala's historical diminutive suffix *–jana* which provides a palatal glide following the labial. Rather, the palatal glide is the result of glide formation due to vowel hiatus. In addition, this proposal also accounts for the behavior of both labials and coronals/dorsals.

I propose that when the passive suffix *–ana* attached to stems containing labial consonants followed by front vowels or back vowels, these vowels became corresponding glides *j* or *w*.[47] In the case of the low vowel *a*, there was no glide formation. This vowel either fused with *–ana* or deleted, which explains why there is no consonantal alternation with this vowel (Hyman 2006).

The palatal glide hardened after labials and triggered palatalization or assibilation after the coronal and dorsal consonants which are affected (other constraints which I am not exploring here are responsible for the fact that not all coronals and dorsals are affected). The labio-velar glide remained intact after non-labials, but dissimilated to a palatal glide after labials, a consequence of the 'no labialized labial (or no Labialized Labial)' constraint discussed earlier by LaCharité (1993). It subsequently hardened in the way described in the previous section and the labial consonant eventually deleted. As stated earlier, labialization of the 'palatalized labial' comes from articulatory overlap obtained during the stages of a labial+palatal complex, carried over even after the labial deleted. An illustration summarizing the stages of palatalization in the diminutive is provided in (42):

[47] Presumably this did not happen when close vowel *u* followed the alveolar flap, since this is the only non-labial which palatalizes and labializes in this context. Alternatively, glide formation could have occurred here as well, but [w] triggered palatalization, or there may be a constraint against a sequence of a flap followed by *w*.

(42) Stages of ‘labial palatalization’ in the diminutive

pi/e + ana → p**j**ana → pʃ → ptʃʷ → tʃʷ

po/u + ana → p**w**ana → p**j**ana → pʃ → ptʃʷ→ tʃʷ

tship**i** + ana → tship**j**ana → tshipʃana → tsiptʃʷana → [tshitʃʷana] ‘small piece of iron’

kep**ɔ** + ana → kep**w**ana → kep**j**ana → kepʃana → keptʃʷana → [ketʃʷana] ‘small spade’

Thus, in both cases it was a palatal glide which hardened and the labial deleted. In languages which do not have a constraint against labialized labials, a labio-velar glide could harden to either a labial or a velar, as is attested in Bergüner Romansch, and in Fula as a result of consonant mutation – some /w/ in Fula become [b], others [g] (Kaisse 1992, Sherer 1994). However, given the evidence for such a constraint in Tswana we can assume that hardening to a labial is ruled out. Thus, the remaining possibility would be for *w* to harden to a velar *k* or *g*, depending on the voicing of the preceding labial. A velar realization is attested in Ikalanga (Narrow Bantu, Botswana): chibgá ‘a lanky dog’, where [bg] is referred to as a “remnant consonant cluster” (Letsholo p. 5, no year provided), and also in Ruanda-Rundi (Narrow Bantu, Ruanda): -bgi̅r- ‘tell’ (Guthrie 1970). However, such outcomes are not attested in Tswana, which means that *w* did not harden. There are two possibilities for satisfying the constraint against labialized labials. The first possibility is dissimilation of *w* to a palatal glide and its subsequent hardening, which appears to have taken place in the diminutive and the passive with -*wa*. The second possibility would be to insert a vowel between the labial and *w*, which could be the paths that resulted in the alternative non-palatalizing passive suffix *–iwa*.

Coronal consonants, on the other hand, could have been palatalized either by the following front vowel itself, or by the palatal glide resulting from glide formation and the glide was absorbed. Therefore, they followed a different path: their palatalization is not the result of glide hardening. It is not entirely clear why the alveolar flap palatalizes before close *u* while the other coronals do not, but the data indicate that flaps do not always pattern with other coronal consonants in palatalization. Nevertheless, the fact that when this vowel triggers palatalization on the flap the palatalized coronal shows labialization as well suggests that the labialization came from the rounded vowel.

Regarding the only velar consonant which palatalizes in the diminutive, syllabic *ŋ*, Cole (1955) states that in final position it palatalizes to *ɲ* before *–ana* and to *ŋɲ before –ɲana*. He transcribes palatal nasals as [ny], and the outcome before -*ɲana* is transcribed as [nny], which can be interpreted either as [nɲ] or as a geminate [ɲɲ]. Either way, it is difficult to determine exactly how the outcome of palatalization before one suffix is different from the outcome before the other. I claim that it is possible that the velar nasal is palatalized only before *–ɲana* and not also before *–ana*, and that the velar nasal assimilates to the palatal place of the following nasal.

3.4.2.4.2 Development of palatalization in the passive

On the face of it, palatalization in the passive is puzzling, since it affects only labial consonants, while coronals and dorsals simply show labialization. However, by pursuing a historical explanation of palatalization the situation becomes clearer. As stated earlier, Ohala (1978) proposes that the suffix *–iwa* most likely caused labial palatalization by merging *i* and *w* to a plain (or rounded) palatal glide and resulting in *–ja* (or *-ɥa*). However, note that the suffix *–iwa* does not trigger palatalization even when *i* directly follows the consonant (c.f. 27). I propose instead that the glide of the *–wa* passive suffix caused labial 'palatalization' in a similar fashion to diminutives (as stated earlier, the alternative suffix *–iwa* could be derived by vowel insertion before *–wa*). The glide of the *–wa* suffix triggered labialization on non-labials, but after labials it dissimilated to a palatal glide, given the prohibition against labialized labials in Tswana. Subsequently, this glide hardened in the same way as it did in the previous contexts. The proposed stages of palatalization in the passive are given below.

(43) Stages of in the passive:

(a) 'Labial palatalization'

lɔp + wa → lɔp**w**a → lɔpja → lɔpʃa → loptʃʷa → lɔ́:tʃʷ̀a 'be requested'

(b) Coronal and dorsal labialization

-rʊk- + wa → -rʊkʷa 'be sewn, stitched'

-rat- + iwa → -ratʷa 'be loved'

Ohala's (1978) proposed historical suffix *-ja* cannot account for the behavior of the coronals and dorsals in passive formation, but only for that of labials. The crucial difference between my proposal and Ohala's is in the role of the palatal glide: while he argues for a perceptual analysis whereby labials become palatals in a single step, I maintain that the 'labial palatalization' is the result of glide hardening and subsequent labial deletion.

To sum up, the proposed account of 'labial palatalization' as a series of diachronic changes that did not actually affect the labial consonant itself (in the sense that the consonant changed, not in the sense that it was ultimately affected by deletion) is superior to other analyses which attempt to situate labial palatalization in these contexts in the synchronic grammar. While it is generally recognized that some historical factors obscure the facts of labial palatalization in Tswana, attempts at synchronic analyses of the process must resort to arbitrary constraints and repairs (e.g. LaCharité 1993). This analysis is compatible with Ohala (1978) who believes in a historical connection with a following palatal glide following the labial, but it diverges from it after this point. While Ohala argues that the presence of the palatal glide is sufficient to provide a perceptual explanation of labial palatalization in Southern Bantu and in other languages in general, I maintain that the historical explanation goes much further, and that the palatal glide underwent actual changes and continued to appear alongside the unchanged labial for some time, in a labial + palatal complex. The series of sound changes culminated with the deletion of the labial, which removed the evidence that the labial itself did not actually change. Parallel developments in other languages such as Romance, and the existence of forms still at intermediate stages in related Bantu languages serve as evidence that the historical explanation proposed here accounts best for these sound changes.

3.5 Interim conclusion

The previous two sections have demonstrated that what has been called 'labial palatalization' in the Moldavian dialect of Romanian and in Tswana are very similar cases of palatal glide hardening characteristic of Romance and Southern Bantu in general. The fact that the labial consonants themselves did not palatalize had been previously recognized for Moldavian (Ionescu 1969; Avram 1977, *inter alia*). In the case of Tswana, several explanations have been offered to account for the alternations between labials and palato-alveolar consonants (LaCharité 1993; Ohala 1978). Empirical evidence from Tswana dialects and other Bantu languages demonstrates that a historical analysis appealing to palatal glide hardening can best explain these alternations. Labial consonants did not fully palatalize, neither in Romance nor in Bantu.

In the next section I briefly discuss other extant research on full 'labial palatalization', including languages other than Romance and Bantu. I show that these do not constitute bona fide cases of palatalization; therefore, the prediction that labial consonants do not undergo full palatalization is borne out even when it might seem otherwise.

3.6 Other research on full labial palatalization

3.6.1 Ohala (1978)

Ohala (1978) states that there are "quite a few" independent cases exhibiting sound changes from palatalized labials[48] and labial + palatal glide sequence, to dentals, alveolars, or palatals, i.e. *pj*, p^j → *t*, *ts*, *tʃ*; *bj*, b^j → *d*, *dz*, *dʒ*, or *mj*, m^j → *n*, *ɲ*. Ohala includes more sounds under palatalization than my own definition allows. For my purposes, only the palatal sounds are relevant, as changes to dental or alveolar do not meet the criteria for palatalization established in this dissertation.

As discussed in earlier sections of this chapter, Ohala provides examples from languages which have palatal sounds where the ancestor language used to have labials (Tai, Tibetan, Spanish, Portuguese, French, some Italian dialects, English, Classical Greek, Guari languages, and several Bantu languages). All such changes involve historical developments rather than synchronic processes. Ohala states that "occasionally, but not necessarily, intermediate stages may be found", such as *pj*→ *pʃ*→ *tʃ* (Ohala 1978:370, 382), implying that there are cases where this change took place in a single step. As I have demonstrated in this chapter, intermediate stages are found in most cases, and I further suggest that it is very likely that where the evidence of such changes cannot be found it does not mean that the intermediate stages did not occur, rather that they have not been recorded or yet discovered.

[48] Palatalized labials for Ohala (1978) are analogous to my secondarily palatalized labials.

3.6.2 Bhat (1978)

Bhat's (1978) study of palatalization does not discuss any aspect of palatalization in great detail, as already mentioned in chapter 1, yet his study is cited most often by anyone who researches palatalization from a cross-linguistic perspective. He writes that there is a general tendency for labials not to alter their main articulation (i.e. rare full palatalization), though earlier in the same paper he states that changes of the type *p*→ *tʃ* are quite common:

> "The occurrence of spirantization with raising only is quite common, as is seen in the case of apicals and labials (*t*→ *tʃ* or *p* → *tʃ*)." (p. 59)

> "There are comparatively few instances in which the main articulation of a labial has been changed into palatal or apical by palatalization." (p. 70)

These are contradictory statements, and it probable that the 'quite common' in the first statement refers more to the apical shift than the labial one. Bhat (1978) gives five languages which have labial full palatalization, two of which are the languages in my sample: Romanian, where *p, b, f, v, m* palatalize to k^j, g^j, *ʃ*, *ʒ*, n^j, and Tswana, where *p, ph, b, f, m* are palatalized to [$tʃ^w$, $tʃh^w$, j^w, $ʃ^w$, ny] (Bhat 1978, p. 70). The other three languages, along with the labials that are subject to full palatalization are listed in Table 3.16 below.

Table 3.16 Bhat (1978) additional examples of labial full palatalization (p. 70)

Language	**Target**	**Outcome**	**Trigger**
Chontal (town of Tres Pueblos)	w	dy_x	__i, e
Fula (of Adamawa)	ɓ	ˀj (optional)	__front vowels
Lumbaasaba	p	j	__i, e except after w

First, notice that these cases appear simpler than both Romanian and Tswana. Only one sound may be palatalized in each case, and for the stops the outcome is a palatal glide rather than an affricate as is usually the case with full palatalization. Another possible interpretation of these cases is that the palatal glide emerged between the labial and the front vowel and that the labial deleted. I will discuss each of these languages below, demonstrating that they all follow the pattern predicted by the general findings discussed in Chapter 2.

3.6.2.1 Chontal (Hokan, Tequistlatecan, Mexico)

There are several arguments against the case of apparent full palatalization of *w* in Chontal. First, this is most likely secondary rather than full palatalization; second, these changes are linked to diachronic sound change; and third the glide *w* is labio-velar, and it is possible that it patterns more with velar consonants than with labials when it comes to palatalization. I discuss these arguments below.

The outcome of palatalization of *w* in Chontal is described as a “palatalized, fricativized dental stop”. This description suggests that such a change would not qualify as full palatalization under my definition, as the outcome is not a palatal sound. Justeson (1985) provides the symbol [dy_x] for the description of this sound change in Chontal, suggesting that this is a case of secondary palatalization, with further modification of the primary place of articulation, not unlike the alternation of *r* with d^j in Carib, where the rhotic becomes a stop and has secondary palatalization at the same time (Hoff 1968).

Furthermore, Justeson (1985) pursues Bhat's (1978) analysis of palatalization and investigates the palatalization of *w* in more detail. He finds via historical reconstruction that in most Chontal dialects *w* shifted to *j* before front vowels *i* and *e* via a merger of the semivowels, and that only in two dialects *w* shifted to other sounds: a labiodental fricative [v] in Tapotzingo, and the change reported by Bhat (1978) in Tres Pueblos, a palatalized, fricativized dental stop [dy_x][49]. Justeson (1985) states that in these two cases the shift from *w* to *j* is basically incomplete, and interprets these two outcomes as possible stages in the change from *w* to *j*:

> The merger in other Chontal dialects of **w* > *j* before *e* and usually also before *i* can be seen as having arisen via an allophone similar to Tres Pueblos [dy_x], but with the process continuing toward less occlusion (Justeson 1985, p. 316).

Notice that the realization of the palatal glide as [dy_x] could be interpreted as a hardening of the palatal glide, rendering it similar to the cases of Bantu and Romance.

Last, but certainly not least, Justeson (1985) argues that *w* would be better classified with the velars rather than the labials. Referencing Bhat (1978), Justeson

[49] Notice that for Chontal the change from *w* to *j* is primarily at the phonemic level, while the change in the Tres Pueblos and Tapotzingo dialects appears to be allophonic.

states that palatalization of *w* is treated under labial palatalization, although Bhat's "cross-linguistic evidence concerning palatalization of *w* is better accounted for as an effect primarily on its velar component", as *w* is most frequently palatalized among labials, and velars are palatalized much more frequently than any labials (Justeson 1985:316). If indeed *w* should be treated more like a velar then a labial in this case, as Justeson (1985) proposes, then the issue of labial palatalization becomes moot, and this pattern fits straightforwardly into the established palatalization hierarchies.

3.6.2.2 Fula (Niger-Congo, Fulani-Wolof, Cameroon)

In the Adamawa dialect of Fula both implosives *ɓ* and *ɗ* (the only implosives in this language, Arnott 1970:42) may be replaced by a preglottalized palatal glide *ˀj* (implosive palatal glide) before front vowels. This process is discussed by Greenberg (1970:137) in the context of the types of processes implosive consonants may undergo. In some languages such consonants may lose their glottalic feature or the supraglottal articulation is lost so that only a glottal stop remains, debuccalization. The case of Fula is mentioned as a related phenomenon. It is very possible that the implosives undergo debuccalization to *ʔ* in Fula, namely that only a glottal stop remains, and that the palatal glide is produced in anticipation of the following front vowel. It is not at all uncommon for front vowels to have palatal on-glides, which is what may be the case here. As this process is reported to only occur before front vowels, and not before other vowels, such an analysis seems reasonable.

3.6.2.3 Lumaasaba (Narrow Bantu, Uganda)

In Lumaasaba underlying /p/ has several phonetic realizations, more than any other labial consonants. Table 3.17 gives the phonetic realizations of the labials and the environments in which they occur.

Table 3.17 Phonetic realizations of labials in Lumaasaba (Brown 1972:3)[50]
(N is an underlying nasal consonant which occurs before another consonant)

Labial phoneme	Phonetic realization	Environment
/p/	p	N__ elsewhere
	j	**__i, e**
	h	__a
	w	__o, u
/b/	b	everywhere
/m/	Ø	N__
	m	elsewhere
/β/	b	N__
	Ø	N__ when 2nd stem C is nasal[51]
	β	elsewhere
/f/	f	everywhere

Notice that the stop feature of /p/ is eliminated before all vowels (Lumaasaba has five vowels, *i, e, a, o, u*; Brown 1972:4), and it is only maintained when adjacent to consonants, as indicated by the environment for its realization as phonetic [p]. This behavior of /p/ is more indicative of weakening, or lenition, whereby this stop becomes a glide that takes on some of the features of the following vowel. Thus, it becomes a palatal glide before front vowels, a labio-velar glide before round vowels, and before the vowel /a/ it becomes [h], as the only possible alternative weakened stop in this environment. As shown in the table above, this is not the case for any of the

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[50] Velar consonants *k, g, ŋ* become palatal stops with affricated release *c, ɟ, ɲ* respectively, before front vowels, and are realized as stops elsewhere (the velar nasal is deleted following another nasal; Brown 1972:3).
[51] Meinhof's Law (Herbert 1986)—pertaining to dissimilation in nasal compounds.

other labial consonants. Furthermore, while the distribution of allophones above suggests that *p* can fully palatalize to *j* in phonological contexts, this is not the case. Brown (1972) states that *j* which alternates with *p* occurs in different *morphological* environments, seen as correspondences in verbal paradigms (Brown 1972:6). The same is the case for the *p* ~ *w* alternation. The underlying /N/ in the examples below does not surface, but its presence is indicated by the overt realization of *p*.

(44) Lumaasaba (Brown 1972)

/ku + pila/	[kujila]	'to take'
/i + N + pila/	[i:pila]	'I take'
/ku + pula/	[kuwula]	'to conquer'
/i + N + pula/	[i:pula]	'I conquer'

Brown notes that young children have great difficulty with the labial ~ glide alternations and that the names of many common animals and domestic objects, words used with higher frequency by children, are pronounced with a *p* even in contexts where adults use the corresponding glide.

(45) Lumaasaba child/adult forms (Brown 1972:81):

ADULT	CHILD	
[kajiso]	[kapiso]	'a small needle'
[kahale]	[kapale]	'pants'
[kawusu]	[kapusu]	'a little cat'

Based on the evidence examined here, I conclude that these additional three cases mentioned in Bhat (1978) do not constitute bona fide cases of full labial palatalization.

3.7 Prior analyses of labial palatalization

Full labial palatalization has known several types of phonetic explanations, acoustic, perceptual, and articulatory (Andersen 1973, Catford 1977, Ohala 1978). As I have already shown for Tswana, it has also been formally explained via a series of theory specific mechanisms (LaCharité 1993). In this section I briefly review some additional analyses which are not specific to Tswana or Moldavian, and then compare these with my own proposal that labial consonants themselves do not undergo full palatalization.

3.7.1 Acoustic/perceptual analyses

In addition to Ohala (1978), Andersen (1973) also offers an acoustic explanation for changes from labials to non-labial alveolar sounds. Andersen (1973) appeals to acoustic tonality (e.g. peripheral vs. non-peripheral articulation in the vocal tract, and higher vs. lower frequencies) to explain some sound correspondences from Old to Modern Czech. In the distinctive features tradition of Jakobson and Halle, Andersen (1973) analyzes labial consonants and back vowels as having low tonality ([+grave]), and alveolar consonants and front vowels as having high tonality ([-grave]). Palatalized labials (called [+sharped] in the same tradition) thus have intermediate tonality, since they are peripheral (low tonality), but also have the secondary palatal articulation (high tonality). Old Czech palatalized labials correspond to apical stops before high front vocoids, and with plain labials elsewhere. Andersen's explanation for this historical change is that the intermediate tonality of palatalized labials were reinterpreted as high-tonality apicals rather than low-tonality labials when occurring before high front vocoids such as front vowels and the palatal glide. Therefore, p^j, b^j, m^j were reinterpreted as *t*, *d*, *n* before high front vocoids (Andersen 1973:770-1).

Thomason (1986) pushes Andersen's (1973) explanation further to account for changes from labials to alveolar and palato-alveolar affricates. Her reasoning is that since affricates *ts* and *tʃ* share the high-tonality acoustic feature with *t*, the same acoustic explanation would account for the changes from p^j to *ts* and *tʃ* particularly in the vicinity of front vowels.

Catford (1977) offers an articulatory/perceptual explanation for full palatalization of labials (at least for the voiceless labials) which would not involve any intermediary stages. He describes secondarily palatalized labials as having double articulation, a bilabial stop articulation and a simultaneous palatal articulation "of, roughly, approximant type" (Catford 1977:194, cited in Thomason 1986:183). Catford (1977) defines approximant as a continuant which has non-turbulent airflow when voiced, but turbulent airflow when voiceless. As the perceptual consequence of turbulent airflow is audible friction, approximants become fricatives when devoiced. Thus, high front vowels such as *i* and *u*, and glides such as *j* and *w* are perceived as fricatives if during articulation they are devoiced. Therefore, Thomason (1986) maintains that it is much more likely to have an apical stop rather than a labial stop as the phonetic realization of a complex sequence *oral stop* + *palatal friction* (assuming the tongue body is raised toward the position of the palatal glide *j*). Following with the same line of reasoning, she adds that it should be common to find a change from a voiceless palatalized labial stop to an palato-alveolar affricate (Thomason 1986:184). Thomason believes that it is reasonable to find a direct change from *p to $t\int$ or ts, given the acoustic and articulatory/perceptual explanations described above (1986:185). Thomason (1986) does not make any claims about the palatalization of coronal and dorsal consonants, but focuses on the palatalization of labials. If, however, the perceptual explanation in Catford (1977) is true for labial palatalization, then a question arises as to why only labials should be affected in this way by a following devoiced approximant, and why coronals and dorsals should not be.

I argue that the explanation in Catford (1977) and Thomason (1986) actually supports the idea that full labial palatalization arose via strengthening of the palatal glide which followed the labial. Thomason (1986) briefly discusses the situation in Romance languages which also show labial palatalization, and in particular dialects of Romanian where "the strengthening of the *j* itself has gone so far as to turn it into a palatal or even a velar stop, so that clusters of pk^j occur" (Thomason 1986:184). She further adds that this strengthening occurs not only after voiceless stops, but also after voiced ones (and in fact after labio-dental fricatives in Moldavian, as already discussed)[52]. What is interesting is that while Thomason (1986) believes that full labial palatalization from p to $t\int$ (or assibilation from p to ts) can occur in a single step based on the perceptual explanation, at the same time she acknowledges that in Romanian the development of a two-stop cluster is a "more extreme stage of yod-

[52] Thomason (1986: 185) cites examples from Albanian dialects which show a similar pattern to the Moldavian dialects, (i) with clusters of a labial stop followed by a palatal fricative, palatal affricate or palatal stop, or (ii) a simple palatal with no preceding labial.

strengthening than the mere development of a palatal fricative or even an affricate *after* a labial stop. These less extreme changes are more directly relevant to the present discussion." (italics added; Thomason 1986:185). This statement clearly indicates that the palatal fricative or affricate "resulting" from full labial palatalization is not actually due to palatalizing the labial itself, but rather due to strengthening of the following glide, and that the strengthening explanation extends not only to Romanian dialects, but also to the other languages she discusses, as indicated by her reference to "these less extreme changes".

3.8 Conclusion

In this chapter I presented the findings of an in-depth investigation of full labial palatalization in Moldavian and Romance, in Tswana and Southern Bantu, and also other cases reported in the literature (e.g. Fula). I have shown that all of these cases have been incorrectly characterized as having full labial palatalization. For each language there is a historical explanation which did not involve changes in the labial consonant itself. For Moldavian and Tswana (and Romance and Southern Bantu) it was a palatal glide following the labial consonant which hardened, leading ultimately to the deletion of the labial. In the next chapter I show that an articulatory analysis of palatalization best accounts for the difference in full palatalization between labial and coronal/dorsal consonants.

CHAPTER 4

ANALYSIS OF PALATALIZATION TARGETS

The previous two chapters presented detailed accounts of both full and secondary palatalization as it occurs in 58 languages. In this chapter I provide a unified analysis of full and secondary palatalization, taking into account the generalizations established in the previous chapters for palatalization targets (palatalization trigger patterns are addressed in chapter 5). As evident in Chapters 2 and 3, the most significant contributions of this study regard labial consonants. First, I have shown that palatalization of labial consonants is dependent on the palatalization of both coronal and dorsal consonants. Second, I have shown that labial consonants do not undergo full palatalization. Chapter 3 in particular demonstrated that when synchronic grammars show an alternation between plain and what appear to be fully palatalized labial consonants, one can easily be misled into believing that such changes occurred in a single step, and that labial full palatalization, while more rare, is really no different from full palatalization of coronal and dorsal consonants. I argued that 'labial full palatalization' is very different indeed, and that it is due to palatal glide hardening and subsequent deletion of the labial consonant.

Given these findings about palatalization and how it affects the three major places of articulation in an asymmetric fashion, I propose that the best way to account for these patterns is to utilize an approach which makes a clear distinction between labial consonants on the one hand, and coronal and dorsal consonants on the other. Traditional phonological theory treats all three places of articulation equally, without according special status to one place versus another (except perhaps to coronal consonants, cf. Paradis and Prunet 1991). However, the patterns of palatalization indicate that labial consonants should be treated as "special". Intuitively the most basic distinction between labials and other places of articulation is the fact that labials are the only sounds produced with the lips. Thus, my account of palatalization builds on an approach which captures this special status of labials as provided by the framework of Articulatory Phonology (henceforth AP; Browman and Goldstein (1986, 1989, 1991, 1992, 1995), Byrd (1996b), Kochetov (2002), Gafos (2002), Davidson (2004) Goldstein et al. (2007), among others). Broadly speaking, in AP consonants are characterized in terms of the major articulator used to produce them, the *lips*, the *tongue tip*, or the *tongue body*. Thus, labial consonants are articulated with the lips, while coronal consonants, dorsal consonants and the palatalization triggers *i*, *e*, *j*, are articulated with some part of the tongue (tip or body). This provides the needed distinction between labials and all other sounds, thereby laying the foundation for why labials are expected to behave differently from coronals and dorsals when it comes to palatalization[53].

Formally, the proposed gestural account of palatalization is further couched in an optimality theoretic (OT) framework (Prince and Smolensky 1993) which utilizes gesturally-based constraints (see also Kochetov 2002, Gafos 2002, Davidson 2003, 2004). In OT the grammar of a language consists of a set of violable universal constraints, and grammars differ from each other in the relative ranking of these

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[53] Models that also incorporate a distinction between lips and tongue by utilizing a lingual node to subsume [coronal] and [dorsal] (e.g. Clements and Hume 1995, Hume 1996, Romero 1996) reference Browman and Goldstein (1989) who first proposed a Tongue node. Halle, Vaux and Wolfe (2000) argue against the lingual node. See further discussion in section 4.1.2.

constraints. A set of different candidate surface forms corresponding to a given underlying form are compared against the constraint ranking, and the candidate surface form that best-satisfies the constraint hierarchy, through a systematic evaluation of violations, is selected as the optimal form, which is the grammatical output. Thus, the variation observed in full and secondary palatalization is the result of different rankings of constraints in each individual language's grammar.

This chapter is organized as follows. I begin with a brief overview of Articulatory Phonology in section 4.1. Sections 4.2 and 4.3 detail the analysis of palatalization using gesturally based OT constraints, showing that this approach best explains the patterns of palatalization regarding targets and triggers. Section 4.4 presents conclusions.

4.1 Articulatory Phonology

To account for the crosslinguistic palatalization patterns I pursue a gestural approach to palatalization building on the models developed in Browman and Goldstein (1986 et seq.), Byrd (1996b), Kochetov (2002), Gafos (2002), and Davidson (2004). Gestural approaches to phonology share the view that any theory of phonology should take into account the fact that linguistic form is expressed in both *space* and *time* as different articulators produce constrictions at different points along the vocal tract as they move in real time. While the spatial aspect has been indirectly addressed in non-gestural phonological theories (i.e. through reference to place of articulation), the temporal aspect has been incorporated primarily via static linear ordering and 'spreading' of features so that adjacent segments share a feature. Other proposals that incorporated a notion of timing assume a correlation between moraic structure and duration of vowels and consonants in different types of rhymes, e.g. VC vs. VVC (Broselow, Chen, and Huffman 1997).

Proponents of Articulatory Phonology argue that phonological processes such as consonantal assimilation and vocalic epenthesis are best explained by making reference to gestures and their *coordination* as speech unfolds through time, rather than to, for example, feature spreading and delinking of place nodes in other non-linear phonological theories (Clements 1985). Therefore, phonological representation must include information about temporal structure, and phonological processes must refer to temporal interaction in a more direct way than is done via standard notions of timing units and autosegmental spreading. I argue that the crosslinguistic patterns of palatalization are best explained using a similar gestural approach whereby the different types of palatalization result from the coordination of consonantal and vocalic gestures in specific ways. In this section I outline the main principles of Articulatory Phonology, mainly as developed in Browman and Goldstein (1986 et seq.), Byrd (1996b), and Gafos (2002).

In Articulatory Phonology the *gesture* is the main unit of phonological contrast, with an intrinsic spatial and temporal structure (Browman and Goldstein 1986 et seq., Byrd 1996b, Gafos 2002). As such, gestures are abstract, discreet, and dynamically defined units which are invariant, but they can overlap in time due to their internal spatio-temporal organization (Browman and Goldstein 1990:342). The dynamical aspect of gestures results from the fact that they represent continuous articulatory trajectories[54] (Ibid.). Each lexical item is composed of a *constellation* of pre-specified gestures that are *phased* (timed) in particular ways with respect to each other. Thus, lexical items can contrast either due to their gestural composition—whether certain gestures are present or not, or due to inter-gestural timing.

Each gesture is specified with reference to different vocal *tract variables* that involve different sets of articulators (e.g. upper and lower lip, jaw), as well as a *constriction location* (CL), and a *constriction degree* (CD). These specifications converge on a desired speech task (e.g. lip closure in the formation of a bilabial sound; Browman and Goldstein 1990:343). Gestures also have a degree of stiffness (duration), "roughly" the time that it takes for the tract variables to reach their target (Browman and Goldstein 1989:208). This corresponds to the feature [± consonantal] of Chomsky and Halle (1968), distinguishing between consonants and vowels, though it is not currently well understood (Gafos 1999:8; Browman and Goldstein 1989). The exact duration—as that corresponding to an external clock—of each gesture is not crucial, as this is an intrinsic property of each gesture. In Articulatory Phonology the crucial reference to timing pertains to the coordination of gestures which is expressed as degree of temporal overlap (Browman and Goldstein 1990). Kelso and Tuller (1987:206) present evidence supporting the idea that it is better to measure aspects of speech production in relative rather than absolute terms.

Articulatory Phonology assumes three main articulatory subsystems, *oral*, *velic*, and *laryngeal* or *glottal*, of which the oral system is most crucial for the analysis

[54] The dynamic aspect of gestures is modeled using the task dynamics model of Saltzman 1986, and Saltzman and Kelso 1987. This model assumes that in speaking a primary task is to control coordinated movements of sets of articulators, and that such movements can be characterized using dynamical equations (Browman and Goldstein 1990:343).

of palatalization. Browman and Goldstein themselves (1990), as well as others pursuing articulatory approaches to phonology (Gafos 2002, Byrd 1996b, Goldstein et al. 2007) also refer to the oral articulatory subsystem most often. The tract variables and the sets of articulators involved in each are given in (1).

(1) AP tract variables and articulator sets (based on Browman and Goldstein 1991, and Gafos 2002):

Tract variables:	Articulator sets:
• Lip protrusion	upper and lower lips, jaw
• Lip aperture	upper and lower lips, jaw
• Tongue Tip Constriction Location (TTCL)	tongue tip, body, jaw
• Tongue Tip Constriction Degree (TTCD)	tongue tip, body, jaw
• Tongue Body Constriction Location (TBCL)	tongue body, jaw
• Tongue Body Constriction Degree (TBCD)	tongue body, jaw
• Velic aperture	velum
• Glottal aperture	glottis

The last two of these tract variables correspond to the velic and laryngeal/glottal articulatory subsystems, respectively, and involve a single variable. The others are pairs of variables, e.g. lip protrusion and lip aperture, tongue tip constriction location and tongue tip constriction degree. The tract variable Tongue Tip (TT) can refer to either the tip or the blade of the tongue (Browman and Goldstein 1989). The *constriction location* (CL) corresponds to *place of articulation* of Ladefoged (1989): [labial], [dental], [alveolar], [post alveolar], [palatal], [velar], [uvular], and [pharyngeal] (Gafos 2002). *Constriction degree* (CD) indicates the distinction between different types of obstruents and between obstruents and sonorants. There are five categorical distinctions for CD, given in (2), ranging from the smallest to the largest constriction, although gestures are specified for a range of variation along these five distinctions (i.e. [wide] does not always mean the same degree of wideness):

(2) CD categorical distinctions:

- [closed] (specification for stops)
- [critical] (specification for fricatives)
- [narrow]
- [mid]
- [wide] or [broad]

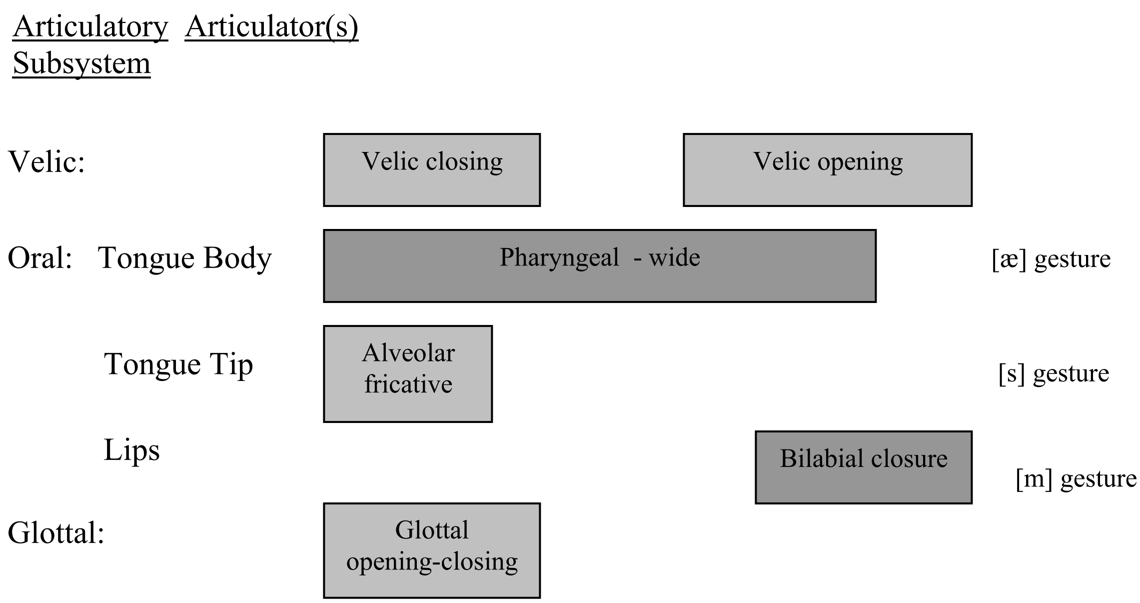
The first distinction is used to characterize the CD for stops, the second for fricatives. Affricates might be characterized as having both a [closed] and a [critical] constriction location. The last three CD distinctions are used to distinguish between obstruents and approximants/glides and vowels. As Gafos (2002) explains, the feature [mid] is similar to the [approximant] feature of Catford (1977), and is also used to distinguish between vowels of different heights[55]. For example the front vowels [i] and [e], which have a [palatal] constriction location, can be distinguished from one another by [narrow] and [mid] constriction degrees, respectively. Low vowels have a [wide] constriction degree. This type characterization is similar to other proposals that describe vowels in terms of aperture or degrees of openness. For example vowel height is described in terms of vocal tract aperture in Schane (1985). Clements (1991) proposes a single binary feature [± open], which is arrayed on several ranked tiers to describe vowels of different heights. This is particularly helpful when there are more than three vowel heights in one language.

The temporal dimension of gestures can be represented in at least two ways, as described below, and I use both to illustrate different aspects of gestural coordination. The first is a *gestural score*, whereby each gesture is shown separately on a tier,

[55] The distinction between the palatal glide [j] and the high front vowel [i], both of which share CL [palatal] and CD [narrow], is still under investigation in the literature and I postpone the discussion until section 4.3.1 when I present the analysis of palatalization triggers.

represented by a horizontal bar (Browman and Goldstein 1986 et seq.). The overlap among the bars on the horizontal time axis represents overlapping gestures. Below I give an example of the gestural score for *Sam* [sæ̃m] from Browman and Goldstein (1991).

(3) Gestural Score for [sæ̃m] (Browman and Goldstein 1991):

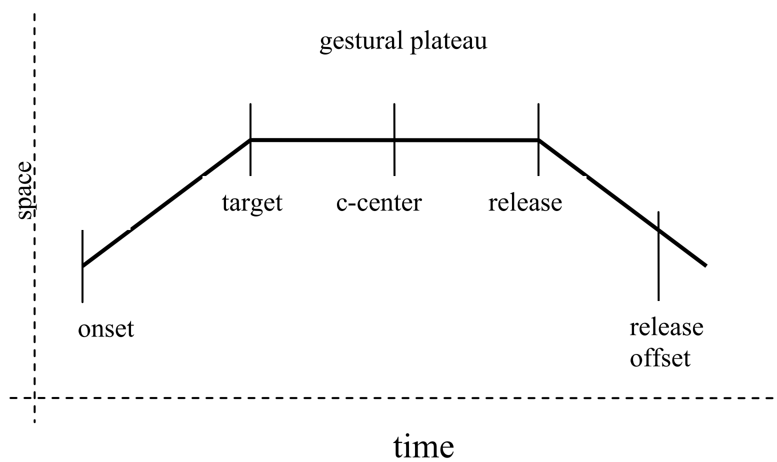


Descriptively the gestural score above shows that the velum is closed for the articulation of oral [s]. The velum is opened during the latter part of the vowel gesture, shown by the second bar for the TB gesture, in anticipation of the nasal stop bilabial closure [m]. This overlap expresses the contextual nasalization of the vowel: [æ̃m]. The glottis is first open for the voiceless quality of [s] and then closes for the voiced quality of the vowel and the bilabial nasal. The tongue tip is also active in performing the gesture for the alveolar fricative [s]. Note that even though this description is sequential, the consonantal and vocalic gestures for [sæm] are executed in real time and that several portions of these gestures overlap, as illustrated by the overlapping horizontal bars.

Gafos (2002), Davidson (2004), and Borroff (2007)[56] utilize a different representation of gestures which allows for a more straightforward explanation of what happens articulatorily when gestures overlap. Each gesture has temporal *landmarks*: the *onset* of movement, achievement of the *target* location when maximal constriction is reached, the *center* of the constriction phase, the articulatory *release* of the constriction, and the release *offset*, when the articulator ceases to be under active control.

These are illustrated in (4) below, where the bold line represents the movement of the articulator through space over time.

(4) Gestural landmarks (Gafos (2002), modified to show time/space axes):



[56] Borroff (2007) provides evidence that "the acoustic cues of a gesture of closure associated with a given stop consonant provide the perceptual system not only with enough evidence to posit the presence of the gesture itself, but also provide all the evidence needed to posit the gestural landmarks of ONSET, TARGET, RELEASE and OFFSET for that gesture" (p. 89).

The *gestural plateau* is the time during which the constriction is held by a particular articulator, such as the tongue tip or the tongue body, between the target and the release, and the *c-center* (constriction phase center) is the mid-point of the gestural plateau. Thus, for an [m] gesture the onset occurs when the lip articulators begin the movement toward the constriction location, the target is reached during lip closure, the c-center temporal landmark is reached while the lips are closed. Lip opening marks the release of the gesture, and the release offset occurs when the lips cease to be under active control.

To sum up, gestures are abstract phonological units with an internal spatio-temporal organization, and they make direct reference to physical implementation by the articulators. Thus, gestures are both phonological representation and phonetic implementation. In the next section I discuss gestural coordination, a basic principle of AP which is the basis for phonological processes, and to which I have already referred.

4.1.1 Gestural Coordination

As speech unfolds in real time, gestures must coordinate with one another to achieve the speech output, as they transition from one into the other. In other words, some phase (time point) of one gesture must be synchronized with some phase of another adjacent gesture. Browman and Goldstein (1990) state that for a given lexical item with *n* gestures, the number of phasing (coordination) relations is *n*-1 (e.g. five gestures, four phasing relations). Gafos (2002) defines a gestural coordination relation as “a relation between two gestures stating that a specified landmark (within the temporal structure) of one gesture is synchronous with a specified landmark of another gesture" (Gafos 2002:9).

There are a limited number of possible effects of gestural coordination. The strong view of AP (Browman and Goldstein 1986 et seq.) maintains that gestural coordination can only result in: (i) gestural magnitude reduction in space and/or time, and (ii), in gestural temporal overlap. Gestures are not inserted, deleted, or otherwise modified[57]. However, gestural coordination is further restricted depending on whether the same or different tract variables used to perform the coordinating gestures (Browman and Goldstein (1990:360) also refer to the tract variables in this context as *articulatory tiers*). This is an important difference for palatalization, and I discuss it in more detail in the two sections below.

4.1.1.1 Temporal overlap and "hidden" gestures

If different tract variables are involved for two coordinating gestures, such as the lips and the tongue tip in a [pt] sequence, the gestures can temporally overlap to different degrees, from minimal, to partial, to complete overlap. This is because the separate tract variables can move independently of one another without perturbing each other's movements[58]. The overall shape of the vocal tract changes and so do acoustic and perceptual attributes of the gestures. As a result, various types of

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[57] Because temporal overlap occurs only in the temporal dimension, coordinating gestures are assumed to remain intact. Gestures cannot blend with each other to create a new gesture (gestural blending). Thus, the prediction of the strong view of Articulatory Phonology is that gestural overlap can result in a different sound only via the *perception* by the listener, while gestural blending would produce a different sound via the *articulation* by the speaker.

[58] This claim is consistent with Ohala (1978) who states that perceptual assimilation is not very likely with cases of same-articulator production, hence it is more likely when different articulators are used.

assimilation, deletion[59], or regular phonological alternations can take place, all of which are explained as perceptual effects of temporal overlap.

Depending on the point in time when two gestures are synchronous (e.g. whether the onset of one is synchronous with the target of another, or whether two gestures have exactly the same onset timing) gestural coordination can result in partial or even complete overlap of gestures, which can lead to surface sounds different from the ones in the input. Crucially, with temporal gestural overlap when different tract variables are used, gestures are still performed, but the degree of overlap may lead to the perception of different sounds than the non-overlapping gestures would normally allow. Thus, one of the gestures is "hidden" by the overlapping gesture.

Research in AP has shown that the gestures for the deleted sound are actually still produced (Browman and Goldstein 1990 discuss X-ray evidence, Barry 1985 presents electropalatographic evidence for "residual" articulations; see also Hardcastle and Roach 1979, and Kohler 1976). Recent work by Goldstein et al (2007) has demonstrated via kinematic data—observation of the speech articulators—that in speech errors[60] gestural constrictions appear to be mislocated, or activated at incorrect temporal locations during the production of the intended word. Contrary to the general claim that speech errors conform to the phonology of the language, meaning that in speech errors entire segments are believed to substitute for one another, Goldstein et al. find that gestures corresponding to illegal sequences in English

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[59] Browman and Goldstein (1990:366) suggest that the percept of gestural deletion can also be viewed as a case of extreme magnitude reduction.

[60] Speech errors are commonly known as slips of the tongue, such as the pronunciation of "coffee pot" as "poffee tot" or "poffee pot" (Goldstein et al. 2007).

actually occur during speech errors. In eliciting speech errors for a target phrase *cop top*, Goldstein et al. found that during some repetitions of this word pair when perceptually there was no speech error, there was a tongue dorsum constriction (for [k]) activated at the same time as the tongue tip constriction (for [t]), and vice versa. This is interpreted as gestural intrusion (due to temporal mislocation). If the intrusion is of large magnitude, then this can be perceived as a sound substitution. If the intrusion is of minimal magnitude, no speech error is perceived, though the gesture is performed (but hidden).

The production-perception distinction is very fine-grained in the case of hidden gestures phenomena, since the production does not change in the sense that a different gesture is performed, rather the temporal overlap causes the perception of a different sound. There is no change in perception without an analogous change in production, and crucially the production change is only in the temporal dimension.

The following are examples of perceptual assimilation from Browman and Goldstein (1991):

(5) Examples of perceptual assimilation:

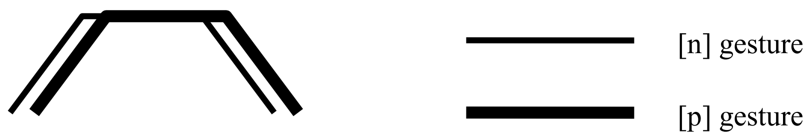
(a) place assimilation: seve**n p**lus → [sɛv**m̩p**lʌs] (TT and lips)

(b) consonant deletion: perfec**t** memory → [pərfɛkmɛməri] (TT and lips)

(c) consonant epenthesis: Old English [θymle] → [θɪm**b**l̩] 'thimble' (lips and TT)

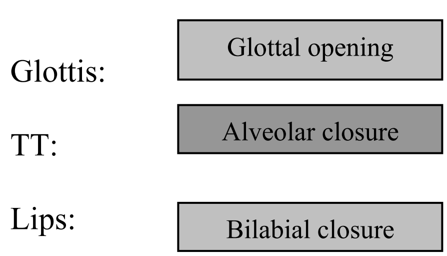
In (5a) the gestures of the tongue tip and the lips overlap to such a degree that the hearer perceives [n] as [m], when in fact the tongue tip still performs the movement required for producing [n]. The tongue tip reaches the target CL but the temporal overlap between the release of the [t] and the onset of the lips' movement is very close to the target thus creating the illusion that [n] was never produced. This can be schematically represented as in (6):

(6) Schematic representation for seve**n p**lus → [sɛv**m̩p**lʌs]



Similarly in (5b) above there are two gestures produced with different articulators, the tongue tip for [t] and the lips for [m]. The tongue tip moves toward the alveolar ridge to reach the target [alveolar] CL for [t]; however, the overlap with the lip gesture for [m] results in [t] not being perceived at all. The gestural target for [t] and the gestural onset for [m] along with the voicing (open glottis) that accompanies it are closely synchronized (near complete overlap). Moreover, [t] is not released, while [m] is released into the following vowel, leading to the perception of [m] alone. A partial representation of this is given below, using Browman and Goldstein's gestural score, since this allows for the representation of the simultaneous overlapping gestures:

(7) Partial gestural score for [**tm**] in [pərfɛk**m**eməri] 'perfec**t m**emory':



Finally in (5c) we see a change that has been adopted into the English lexicon, *thimble*, where the lip closure for [m] and the velic opening for [l] overlap and cause the perception of a voiced bilabial stop. This is a case of 'stop intrusion' between a nasal and a fricative/continuant that has been proposed as the transitional element between the two distinct sounds (Clements 1987). Another well known example from English where stop intrusion occurs is in the pronunciation of *prince*, where a [t] is perceived between the nasal and [s], [prɪnts]. The release of the alveolar nasal [n] and the transition into the [s] gesture produce the acoustic effect of an alveolar stop [t] (see also Yoo & Blankenship 2003). Arvaniti, Kilpatrick and Shosted (*submitted*) tested the perception of epenthetic and underlying [t] in the same [n_s] context as in *prince* vs. *prints*, and found that American English speakers could not distinguish reliably between epenthetic and underlying [t], which suggests that the [nts] and [ns] alternation is moving toward complete neutralization.

Further support for perceptual epenthesis is provided by Davidson (2004) who presents experimental evidence showing that native speakers of English do not repair illegal onset clusters such as [zb], [zd], and [zg] by epenthesizing schwa, as is typically assumed. Davidson claims that the English speakers, not having experience coordinating the gestures of the consonants in these clusters, instead pull them apart, mistiming the gestures, which leads to the perception of an epenthesized schwa. This schwa, however, is qualitatively different from other schwa sounds that are normally produced during speech (lexical schwas; see Hall (2006) for additional evidence of perceived schwas resulting from gestural overlap).

Gestural temporal overlap has been experimentally investigated over the last few years. Byrd (1992, 1996a) used EPG to investigate the articulatory timing and overlap for consonant clusters, and found that onset clusters are less overlapped than coda clusters, providing evidence that inter-gestural coordination is affected by both gestural and prosodic factors (such as syllabic position). The effects of the syllable have also been addressed by Browman and Goldstein (2000) who propose that consonants in an onset cluster have a higher “bonding strength” than consonants in a coda cluster or than they do to the nucleus vowel. I do not discuss such syllable position effects further except to say that in palatalization the palatalization trigger is typically the nucleus of a syllable containing the palatalization target as its onset. Cho (1998) conducted eletro-magnetic midsagital articulometer (EMA) and electropalatography (EPG) studies of Korean palatalization showing that intergestural timing and temporal overlap is linked to the lexical item that the coordinating gestures belong to (e.g. tautomorphemic, heteromorphemic, lexical compound).

In summary, gestural temporal overlap, whereby gestures are not changed but just overlap in time, is a real phenomenon which has been experimentally investigated and which can have the different perceptual effects discussed above. It is important to clarify that these effects are based on a change in articulation, namely the articulatory timing of gestures. Thus, temporal overlap of gestures can have the perceptual effect of deletion, epenthesis, or other regular phonological processes, and while these are explained perceptually, they are based in a change in articulation.

4.1.1.2 Temporal overlap and blending

I now turn to the possible outcomes of temporal overlap when the same set of tract variables are involved for two coordinating gestures. If two gestures employ the same tract variables, for example the tongue body, then higher than minimal degrees of temporal overlap can result in *blending* of the two gestures. Minimal degree of overlap is interpreted as occurring sometime around the release phase of the first gesture, while higher than minimal overlap is interpreted as occurring sometime during the closure phase of the first gesture. Gestural blending results because the gestures using the same tract variable are attempting to force it to perform two tasks (achieve two targets) almost simultaneously, and it is impossible for this to happen without the gestures perturbing each other's movements. Therefore, if the overlap is greater than minimal, the target is undershot and what results is a shift in the location of the constriction (target) to some place between the two coordinating gestures.

For example, the pronunciation of *eight things* is often realized as [ɛit̪θɪŋz], with a dental [t̪]. Here the final consonant of *eight* has a CL [alveolar] and the initial consonant of *things* has a CL [interdental], both produced with a tongue tip gesture. The articulatory pressures on the tongue tip lead to a blending of the gestures and thus the pronunciation of a dental consonant—in between the alveolar and the interdental constriction locations (Browman and Goldstein 1991:325). In this case [t] assimilates to the following [θ] and the gesture actually changes to one that has a different CL than the one specified for [t] or [θ].

Zsiga and Villafaña (2002) show that in Florentine Italian, vowel assimilation at word boundaries must make use of gestural blending (in addition to reference to abstract phonological units). Lee (1999, 2000) proposes an account of velar palatalization which is based on gestural overlap instantiated primarily as blending of two tongue-body gestures. He demonstrates that palatalization of *k* to [k^j], [c], [tɕ] or [tʃ] is primarily due to articulatory factors, contra Ohala (1978, 1993), who attributes such outcomes solely to perceptual similarity. Furthermore, Romero (1996) shows that for assimilation in Spanish clusters such as [ld], both articulated with the tongue tip, where [l] has the specifications Tongue-tip Constriction-location (TTCL) [alveolar], Tongue-tip Constriction-Degree (TTCD) [closed], and [d] has the specifications TTCL [dental], TTCD [closed], there is a single constriction at a location somewhere between the alveolar and the dental region—another example of blending of gestures.

In summary, greater temporal overlap of coordinating gestures employing the same tract variable results in gestural blending. Note that gestural blending, although a modification of the original gestures, still arises as the result of temporal overlap, so it is still an effect of the temporal organization of coordinating gestures. Therefore, while varying degrees of temporal overlap *in the production* of gestures employing separate tract variables leads to *perceptual* effects of deletion, assimilation, insertion, greater temporal overlap *in the production* of gestures employing the same set of tract variables leads to actual changes in the *articulation* (primarily of a change in constriction location, but sometimes also in constriction degree).

In my account of palatalization I extend the notion of gestural blending to apply to gestures produced with the same major articulator, namely tongue gestures. Thus, full palatalization arises from greater gestural temporal overlap which leads to blending of tongue gestures, and secondary palatalization arises from a slight gestural temporal overlap which leads to the perception of a secondary palatal articulation on the consonant. The prediction is that gestures using the same articulator are not always blended when they temporally overlap, but only when the degree of overlap is large enough (e.g. sometime during the closure phase of the consonant).

4.1.2 Articulatory Phonology, Optimality Theory, and Palatalization

I propose that palatalization, whether full or secondary, can be profitably viewed as being largely the result of gestural coordination, manifested as temporal overlap. Articulatory Phonology can provide an explanation for why palatalization happens in the first place: it is the natural result of coordinating consonantal and vocalic gestures while producing speech. As mentioned in the introduction of this chapter, having *tongue* as a major articulator allows for a straightforward distinction between sounds articulated with the lips and those articulated with the tongue. Thus, labial consonants are produced with the lips, while coronal and dorsal consonants, as well as palatalization triggers, are produced with the tongue.

Browman and Goldstein (1986 et seq.) distinguish three main articulators, the *lips*, the *tongue tip* and the *tongue body*. As mentioned in footnote 53, they introduce the notion of a Tongue node, which subsumes tongue tip and tongue body, on the basis of anatomical independence, and although they do not use tongue as a basic articulator in their proposal, Browman and Goldstein "predict that more evidence of phonological patterns based on the anatomical interdependence of parts of the tongue should exist" (Browman and Goldstein 1989:225).

A concept parallel to the Tongue node has been used in various instantiations of feature geometric frameworks (Romero 1996, Hume 1996, Clements and Hume 1995), and also in other frameworks inspired by Articulatory Phonology (Adler 2006). Romero (1996) uses the cover term *lingual* to subsume coronal and dorsal, which could be used to describe gestures produced with the tongue as lingual gestures, and the same lingual node is proposed by Clements and Hume (1995) to account for [back] harmony in Turkish, where either [coronal] or [dorsal], dependents of the lingual node, can spread. Hume (1996) uses the lingual node to explain the rarity of what I have been calling "full labial palatalization", since lingual dominates [coronal] and [dorsal], but not [labial], and therefore [coronal] cannot spread directly to a [labial] consonant (p. 199). Adler (2006) also recognizes the usefulness of a lingual node in accounting for the form of English words borrowed into Hawaiian (e.g. *crease* [kri**s**] > [kəlí**k**i] and *fork* [**f**ork] > [**p**ókə], p. 1028). Among other things, Adler proposes that a change in *articulator* is more noticeable than a change in *place of articulation*, therefore changes in lingual places of articulation are less noticeable than changes between the lips and the tongue (2006:1037). On the other hand, Halle, Vaux and Wolfe (2000) argue against the necessity of a lingual node, and propose that phonological processes such as Turkish [back] harmony can be explained without it by adopting a different approach called Revised Articulator Theory (RAT). In RAT features do not dominate other features, as lingual does [coronal] and [dorsal].

As I show in this work, the typological evidence regarding palatalization provides support for positing a lingual or tongue articulator, although I do not adopt the feature geometric model of Clements and Hume (1995). I further propose that the *tongue* should be referenced as a major articulator which subsumes the two sub-articulators, tongue tip and tongue body. As *tongue* more straightforwardly indicates an *articulator,* I will use this term in my analysis, recognizing that it refers to the same organ that produces lingual gestures.

Having this distinction between tongue and lips is crucial for explaining palatalization patterns. As already mentioned in the conclusion of the previous section, I argue that full palatalization results from a large degree of overlap of gestures produced with the same major articulator, the tongue, while secondary palatalization results from a minimal degree of temporal overlap of gestures produced with either the same or different articulators (tongue and tongue, or lips and tongue). Thus, full palatalization is a case of gestural blending resulting from high degrees of temporal overlap of tongue gestures, while secondary palatalization is a case of minimal temporal overlap of lips or tongue gestures.

The tongue and the lips are separate articulators, free to move independently of one another. The prediction of AP is that tongue and lips gestures can have no overlap, or they can overlap minimally, partially, or fully. Interestingly, both "no overlap" and "overlap" of such gestures have the same explanation, namely that the movements of the separate articulators do not perturb each other. On the one hand, the lips and the tongue can each perform their respective tasks sequentially, and on the other they can perform them simultaneously. Either way, there is no pressure for lip and tongue gestures to "blend" and thereby create a new sound. In palatalization, the lips gesture would be performing the task of lip closure to achieve a [p], for example, while the tongue gesture would be performing the task of achieving a palatalization trigger, such as [i]. It follows that if a lips gesture and the following tongue gesture were fully overlapped, the lips gesture would obscure the tongue gesture, since the lips are physically in front of the tongue; therefore, the outcome of complete gestural overlap of [p] and [i] gestures would be [p][61]. A minimal degree of temporal overlap (e.g. synchronizing the onset phase of the vowel gesture with the release phase of the consonant gesture) will lead to the labial acquiring a secondary palatal articulation, which I argue is the only way that a labial consonant can be affected by palatalization (in the sense that it itself shows a surface change). Finally, a larger, but not complete, degree of temporal overlap of [p] and [i] gestures would produce sequences of labial and palatal sounds, which is what I have shown in chapter 3 (see also Kochetov 1998). The labial itself is not changed. I defer this discussion until later in this chapter.

On the other hand, coronals are articulated with the tongue tip and dorsals are articulated with the tongue body, both of which are sub-articulators of the more basic tongue articulator. Even though the tongue is a large and rather flexible organ, its two sub-articulators are very closely connected to each other, much more than either is to the lips; therefore, when the tongue body makes a gesture it is more likely for this to

[61] Ohala (1978) claims that labials followed by a palatal glide can be perceived acoustically as palato-alveolars such as [tʃ], but as I discussed in Chapter 3, this outcome is due to palatal glide hardening.

affect the movement of the tongue tip, and vice versa. I propose that this close connection between the tongue sub-articulators is the main reason why coronal and dorsal consonants show both full and secondary palatalization more easily and more freely, either independently of each other or together in the same language. The degree of temporal overlap among the gestures of tongue sub-articulators determine whether dorsals and coronals show full or secondary palatalization: a smaller degree will result in secondary palatalization, and a larger degree will result in full palatalization[62]. While secondary palatalization is just temporal overlap with no effect on the individual gestures, the temporal overlap of full palatalization creates blended gestures, whereby the target of the consonant is undershot and the constriction occurs at a different location[63].

The remainder of this chapter details the proposed analysis of palatalization targets. The goal is to account for the attested cross-linguistic patterns which were revealed by the palatalization survey discussed in chapter 2. In doing so I also explore the range of possible but yet unattested patterns, as well as patterns of palatalization which we should not expect to find in any language (such as full palatalization of labials, or secondary palatalization of only labials and coronals). For easy reference I repeat the patterns of palatalization established in Chapter 2 in (8) below, this time

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[62] In addition to degree of gestural overlap of gestures produced with the same articulator (the tongue), whether coronal and dorsal consonants undergo full or secondary palatalization will also depend on other constraints that are prominent in a particular language (e.g. constraints aimed at preserving contrast or other features).

[63] For velar consonants, it is the back portion of the tongue body which is active during the consonantal gesture, while the front part of the tongue body is active in performing the palatal trigger vocalic gesture. This explains why minimal overlap can in fact result in secondary palatalization of velar consonants, and why overlap of tongue body gestures does not automatically mean gestural blending. It is the degree of overlap that matters, minimal versus larger (see also Lee 2000).

taking into account the fact that labial consonants do not undergo full palatalization and thus eliminating the implicational universal for full palatalization.

(8) Palatalization patterns (Targets)

- *Full palatalization*
    - no implicational hierarchy: *coronal and dorsal*: coronals and dorsals may palatalize independently or together in both morpho-phonological and phonological contexts.
- *Secondary palatalization*
    - implicational hierarchy: *labial* > *coronal or dorsal*, but when only labials and coronals or only labials and dorsals show secondary palatalization, the third place of articulation shows full palatalization.
    - dorsal consonants may palatalize independently only in phonological contexts.
    - dorsal morpho-phonological secondary palatalization is dependent on coronal morpho-phonological palatalization (either full or secondary): *dorsal* > *coronal.*

4.2 A unified account of palatalization targets

Here I address the issue of how gestural coordination is implemented in the grammar to account for the full and secondary palatalization patterns described. The fundamental type of constraint that favors palatalization, or any other type of phenomenon arising from consonant-vowel interactions, is one that favors coordination of consonantal and vocalic gestures. Gafos (2002) and Davidson (2004) utilize COORD(INATION) and ALIGN(MENT) constraints that are designed to do just that. The coordination constraints are defined in terms of alignment of gestural landmarks of the consonantal and the vocalic gestures (onset, target, c-center, etc.).[64] A generalized constraint is given below, adapted from Gafos (2002) and Davidson (2004):

(9) ALIGN (Align landmark α of gesture 1 with landmark β of gesture 2)

This constraint states that some landmark of a gesture must be aligned/synchronized with some other landmark of a following gesture. For example, coordination relations between CV, VC and CC in English are defined as in (10) below through constraints that utilize the definition of alignment. An illustration of landmark alignment is given in figure 4.1 for VC coordination (10b).

(10) Alignment constraints for CV, VC, and CC coordination in English:

a. CV-COORD: ALIGN (C, center, V, onset)

Align the center landmark of the consonant gesture with the onset landmark of the following vowel gesture.

b. VC-COORD: ALIGN (V, release, C, target)

Align the release landmark of the vowel gesture with the target landmark of the following consonant gesture.

c. CC-COORD: ALIGN (C1, release, C2, target)

Align the release landmark of a consonant with the target landmark of the following consonant.

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[64] Davidson builds on Zsiga's (2000) work and talks mainly about these constraints as pertaining to English CC, VC and CV coordination, but also discusses briefly a generalized way of defining them, by leaving the particular landmarks unspecified.

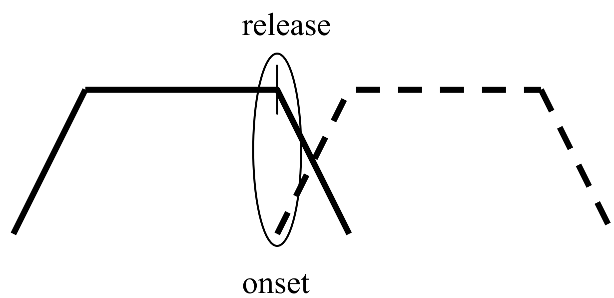


Figure 4.1 Landmark alignment for VC coordination in English
(Solid line = V-gesture; dotted line = C-gesture)

CV coordination, as in (10a) characterizes onsets and nucleus vowels, and states that all the consonants in an onset have a coordination relationship with the nucleus vowel. VC coordination characterizes nucleus vowel--coda consonant coordination; however, only the first consonant in a coda cluster has a coordination relationship with the vowel nucleus. Consonants in a cluster always have a coordination relationship with each other, captured by the constraint CC-COORD in (10c) (Gafos 2002). COORD(INATION) constraints expressed in terms of landmark alignment are the same in every language, but they are ranked differently with respect to each other and with respect to other constraints, thus giving each language a slightly different gestural coordination pattern.

Speaking generally about palatalization, each individual landmark will vary depending on which target consonant and trigger vocoid are involved in the coordination relationship. For example, if a [k] is targeted for palatalization, the CL is [velar] so the target landmark would be [velar], while for a [t] the target landmark would be [alveolar].

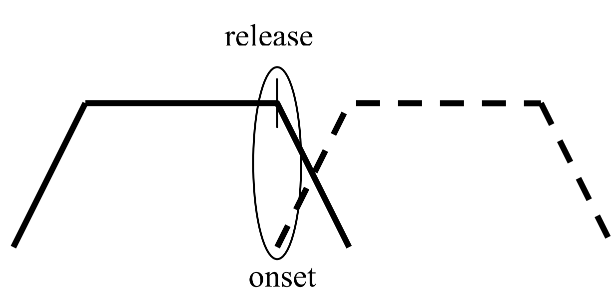
Following the argument put forth in the previous section, coordination of consonants with a following high vocoid can result in full palatalization only if the tongue articulator alone is employed; if the lips and the tongue are employed, only secondary palatalization can ensue. I propose that there are two principal constraint types which drive palatalization, both of which specify how consonantal and vocalic gestures must coordinate. In both constraints V indicates "vocoid". At this point I assume that the V-gesture is associated with one of the palatalization triggers, such as the vowels *i, e*, or the palatal glide *j*. I postpone the discussion of differences among palatalization triggers until chapter 5.

The first constraint in (11) requires secondary palatalization of consonants at any place of articulation.

(11) CV-COORD-release: ALIGN (*release landmark of C-gesture with onset landmark of V-gesture*).

CV-COORD-release drives secondary palatalization by preferring a minimal degree of overlap between consonantal and vocalic gestures: the release landmark of a consonantal gesture is aligned with the onset landmark of the following vocalic gesture, and this has the effect of creating a secondary palatal articulation on the consonant. I represent this schematically below in (12).

(12). *Secondary palatalization*: align release of C-gesture (solid line) with onset of V-gesture (dotted line): minimal overlap.



C^j

CV-COORD-release, is violated by outputs with a different gestural coordination pattern which would be expressed as surface fully palatalized consonants (e.g. [ti]→ [tʃi]), or as plain consonants (e.g. [ti]→ [ti]).

Given the asymmetry regarding full palatalization between labial consonants and coronal/dorsal consonants, I propose two full palatalization coordination constraints, one pertaining to CV coordination of lips C-gestures with tongue V-gestures, and the other to CV coordination of tongue gestures only, as given in (13 a) and (13 b).

(13) Full palatalization constraints[65]

(a) CV-COORD-center (Lips):
CV-COORD-C(Lips)

ALIGN (*c-center landmark of lips-gesture with onset landmark of V-gesture*).

(b) CV-COORD-center (Tongue):
CV-COORD-C(Tongue)

ALIGN (*c-center landmark of tongue-gesture with onset landmark of V-gesture*).

Like their secondary palatalization counterparts, the constraints above which drive full palatalization are violated by outputs that have different gestural coordination patterns expressed either as secondary palatalization (e.g. [ti]→ [tʲi], [pi] → [pʲ]) or no palatalization in the case of coronal and dorsal consonants (e.g. [ti]→ [ti]). Both constraints in (13) prefer larger degrees of overlap between the consonantal

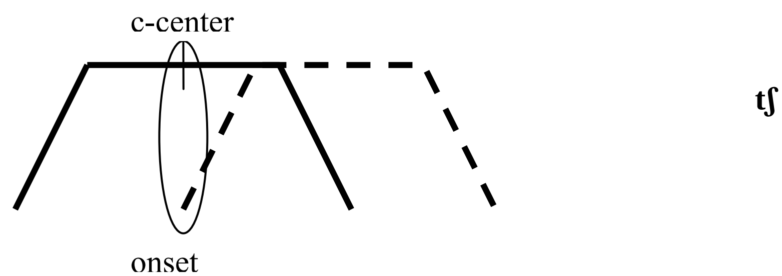
[65] The c-center landmark in these constraints is a general landmark. The key idea is that the onset of the following vocoid be synchronized with some point during the closure phase of the consonantal gesture, which is within the c-center landmark phase. This is compatible with Byrd's (1996b) phase window model, where variability in temporal coordination of gestures is attributed to windows in the confines of which other gestures can "begin".

gesture and the following vocalic gesture; however, while (13 b) results in full palatalization, (13 a) does not. As I explain in section 4.2.2, faithful surface realizations of labials (e.g. [pi]) can both satisfy and violate CV-COORD-C(Lips), depending on what overlap pattern [pi] results from. If [pi] results from partial overlap, then CV-COORD-C(Lips) is satisfied, and if [pi] results from no overlap, than CV-COORD-C(Lips) is violated. Thus, any time CV-COORD-C(Lips) is highly ranked, a faithful surface realization of labial consonants will be selected as the optimal candidates. When CV-COORD-C(Lips) is ranked lowly, secondary palatalization may obtain, depending on the ranking of constraints pertaining to secondary palatalization.

The split between the CV-COORD-center constraints will be motivated later in section 4.2.5, where I discuss mixed palatalization patterns, for example where labials and dorsals have secondary palatalization, while coronals have full palatalization. The competing constraints in such cases are CV-COORD-C(Tongue) and CV-COORD-release, as coronals and dorsals may not show exactly the same outputs, but labials can only show secondary palatalization. CV-COORD-C(Lips) must be ranked below CV-COORD-release to allow for this type of pattern. I postpone the detailed discussion of this until section 4.2.5.

To illustrate how the CV-COORD-center constraints operate, I will use the palatalization of alveolar stop *t* to *tʃ*. In this case, the c-center landmark of [t] is synchronized with the onset landmark of the following [i]. In individual languages landmark alignment will be more specific; however, specifying exact landmark alignment for palatalization requires detailed phonetic study of each individual language, which is beyond the scope of the current study[66].

(14) *Full palatalization*: align c-center of tongue-gesture (solid line) with onset of V-gesture (dotted line): greater overlap.



The faithfulness (identity) constraints which full and secondary palatalization outcomes violate will be introduced in the next sections which deal with the full and second palatalization patterns.

4.2.1 Typology of palatalization

The full and secondary palatalization generalizations and implicational universals emerging from the language sample make predictions about possible patterns we might expect to find in any given language. The logical possibilities for palatalization patterns are listed below in tables 4.1 and 4.2, with representative languages where these are present in my sample. Table 4.1 illustrates the patterns where consonants at a given place of articulation show either full or secondary palatalization, but not both, while table 4.2 illustrates those patterns which allow for

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[66] Browman and Goldstein (1995) provide more specific COORD constraints for English, and Gafos (2002) for Moroccan Colloquial Arabic. These specific constraints are based on findings in laboratory studies.

both full and secondary palatalization at a single place of articulation. Of course, given the generalizations of this study, only the possibility of secondary palatalization is indicated for labial consonants.

Table 4.1 Predicted palatalization patterns

(excluding full/secondary palatalization at the same place of articulation):

	Labial	Coronal		Dorsal		Examples
	Sec	Full	Sec	Full	Sec	
A		x		x		Breton, Cypriot and Standard Modern Greek, Japanese, Maori, Sanuma
B		x				Apalai, Basque, English, Fongbe, Karok, Korean, Dhivehi, Marathi, Nishnaabemwin, Yimas
C				x		Luganda, Nkore-Kiga, Roviana, Dakota, Somali
D	x		x		x	Shilluk, Mongolian
E	x	x		x		n/a
F	x	x			x	n/a
G	x		x	x		Bulgarian
H			x		x	Eastern Ojibwa, Navajo, Turkish
I			x			Mangap Mbula, Hungarian, Tiwa, Watjarri
J					x	Ejagham, Kayardild, Koromfe, Limlingan, Sirionó, So
K			x	x		n/a
L		x			x	n/a in sample, but attested in Chaha

Four of the patterns above (4.1 E, F) and (4.1 K, L) are not attested in my language sample, although this most likely represents an accidental gap, or may be due to other independent reasons (see section 4.2.5 regarding Chaha, Ethio-Semitic, Ethiopia, a language outside my sample which fits pattern 4.1 L). Some of the gaps result from the fact that there are languages where coronal or dorsal consonants show both full and secondary palatalization. Appendix 3 summarizes these patterns for each language where this occurs, and shows various factors that can determine which type of palatalization will be present. For example, in women's speech in Coatzospan Mixtec, coronals [t] and [nd] show full palatalization before front vowels [i, e], and secondary palatalization before high vowels [ɨ, u] (Gerfen 1999). If we consider the possibilities where some consonants at either the coronal or dorsal place of articulation can show full and some can show secondary palatalization, then the number of possible grammars expands to include those in table 4.2.

Table 4.2 Predicted palatalization patterns

(with full and secondary palatalization at the same place of articulation)

	Labial	Coronal		Dorsal		Examples
	Sec	Full	Sec	Full	Sec	
A	x	x	x		x	Nupe, Yagua
B	x		x	x	x	Fanti
C	x	x	x	x	x	Menz, Gojjam and Wello dialects of Amharic, Standard Romanian, Moldavian Romanian
D	x	x	x	x		Carib, Gonder dialect of Amharic[67]
E	x	x		x	x	Polish
F			x	x	x	n/a
G		x	x		x	n/a
H		x		x	x	Hausa
I		x	x	x		Tswana
J		x	x			Coatzospan Mixtec (women's speech) Sentani, Tohono O'Odham, Zoque
K				x	x	n/a

[67] Mandarin could possibly fall under this category. In Mandarin labials show secondary palatalization, and coronals show full and secondary palatalization. Dorsals do not palatalize because they never appear in palatalizing contexts, as already mentioned in the text, but if they did appear in such contexts we would expect that they, too, would show palatalization, either full, or secondary, or both.

The patterns in (4.2 F, G) and (4.2 K) are not attested in the languages in my sample, but again this is likely due to an accidental gap rather than a systematic one. For example, it is reasonable to expect that a language would have secondary palatalization only of labials, while coronal and dorsals show full palatalization (cf. 4.2 F).

The patterns in table 4.2, which show combinations of palatalization types at the same place of articulation, are difficult to implement in a general analysis of palatalization that deals with major places of articulation, which is what I have pursued here. The range of possible reasons determining which consonants at a given place of articulation will show full and which will show secondary palatalization requires a separate analysis for individual languages and providing separate grammars, which is beyond the scope of the current work. To take one example, in Nupe, a Nupoid language of Nigeria, coronal stops undergo secondary palatalization, and coronal fricatives undergo full palatalization. The grammar of Nupe would place constraints pertaining to constriction degree (or in traditional terms, manner of articulation) higher in the hierarchy than they would be in other languages where constriction degree distinctions do not play a role.

A general analysis for the patterns in table 4.1 is possible under the scope of this work, as these patterns take into account only place of articulation, and not other factors such as differences in constriction degree (e.g. stops vs. fricatives) at the same constriction location. In the next section I show how these patterns are straightforwardly accounted for by grounding phonology in phonetic articulation and establishing constraints which make reference to the gestural properties of the sounds involved in palatalization. For example, the prototypical palatalization trigger [i] is specified for the tongue body (TB) oral articulator as constriction location (CL) [palatal] and constriction degree (CD) [narrow], or [palatal, narrow]. Other front vowels are also [palatal], with different constriction degrees as already discussed earlier. When [t], specified for tongue tip (TT) as CL [dental/alveolar] and CD [closed] is a palatalization target, the outcome [tʃ] is CL [alveo-palatal] and CD [closed- critical]. The table below illustrates the interaction of these gestural in one example of full and one of secondary palatalization.

Table 4.3 Oral articulator gestures in palatalization: *t* + *i*

<table>
<tr><td>Target
TT: CL/CD</td><td>[t]
[dental/alveolar, closed]</td><td colspan="2">[t]
[dental/alveolar, closed]</td></tr>
<tr><td>Trigger
TB: CL/CD</td><td>[i]
[palatal, narrow]</td><td colspan="2">[i]
[palatal, narrow]</td></tr>
<tr><td rowspan="2">Palatalization Outcome</td><td rowspan="2">[tʃ]
TT: [alveo-palatal,
closed-critical]</td><td colspan="2">[t^j]</td></tr>
<tr><td>TT:
[dental/alveolar,
closed]</td><td>TB:
[palatal,
narrow]</td></tr>
</table>

As already mentioned, gestural coordination leads to different outcomes in each type of palatalization. As the table above illustrates, both full and secondary palatalization show the target consonants becoming more like the trigger vowels in terms of constriction location: they move toward the palatal region. The main distinction is that in full palatalization gestural coordination results in a shift of constriction location, while in secondary palatalization gestural coordination results in the consonant acquiring a secondary articulation by way of the trigger vocoid, namely a tongue body articulation CL [palatal], CD [narrow].

4.2.2 No full palatalization of labials

As summarized in table 4.1, there are languages where both coronal and dorsal consonants undergo full palatalization, languages where only coronal consonants undergo full palatalization, and languages where only dorsal consonants do so. There is no language in which labials show true full palatalization. As argued earlier, this is because full palatalization can only be obtained via large degrees of temporal overlap of gestures of the tongue articulator. However, in order to avoid circular motivations, I spend some time here exploring the reasons why labial consonants cannot show full palatalization as a result of gestural coordination.

There are at least three degrees of temporal overlap that two gestures can have: minimal, partial, and complete. Minimal overlap results in secondary palatalization, and complete overlap would result in the “hiding” of the tongue gesture, as already discussed. The term “partial” overlap here refers to what would take place in “full palatalization”, where the onset of the vowel gesture would be synchronized with some point around the c-center phase of the consonantal gesture. The question is, why does the labial not show full palatalization? Part of the answer seems obvious: there is not enough impetus for the lips and the tongue to “blend”, which is what happens in full palatalization. It is difficult to conceive of an articulation which would consist of both tongue and lip gestures (unless we consider secondary articulations, such as labialization or secondary palatalization). Nevertheless, because the lips and the tongue are independent articulators, they can temporally overlap “partially”, where the following vocoid-gesture onset landmark is synchronized with the c-center of the labial consonantal gesture. I argue that in this case the only possible outcome is the labial followed by the vocoid, unchanged: [p] + [i] → [pi].

Upon the release of the consonant, the vocoid gesture is already in motion, and it continues after the release of the consonantal gesture in the same way as when the vocoid gesture simply followed the lips gesture, and thus only the actual vocoid surfaces after the consonantal gesture. This would in essence be the same as if the two gestures were successive, as when the offset of the consonantal gesture is synchronized with the onset of the vowel gesture. So both no overlap and partial overlap of a lips gesture and a following tongue gesture would have the same output: [pi]. In contrast, when the vocoid gesture begins upon the release of the consonant, the burst and the vocoid combine to produce secondary palatalization by narrowing the constriction of the vocoid to match that of the consonant at the point of release.

There is one other possible outcome from the temporal overlap of lips and tongue gestures, and this provides an insight into the misunderstood and mislabeled “full palatalization” of labials. Recall that the cases of full labial palatalization involve hardening of a following glide. As first introduced in chapter 3, Kochetov (1998) analyzes labial palatalization in four Polish dialects, each with a different type of “palatalized” labial. In (15) I repeat the data for ease of reference.

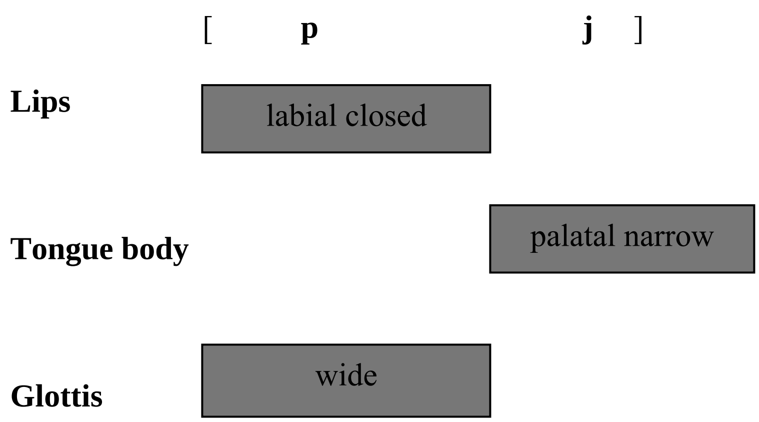
(15) Palatalized labials in Polish dialects (Kochetov 1998:2)

I	II	III	IV	Gloss
[pʲ]ivo	[pj]ivo	[pç]ivo	[pɕ]ivo	‘beer’
[bʲ]ały	[bj]ały	[bʝ]ały	[bʑ]ały	‘white’

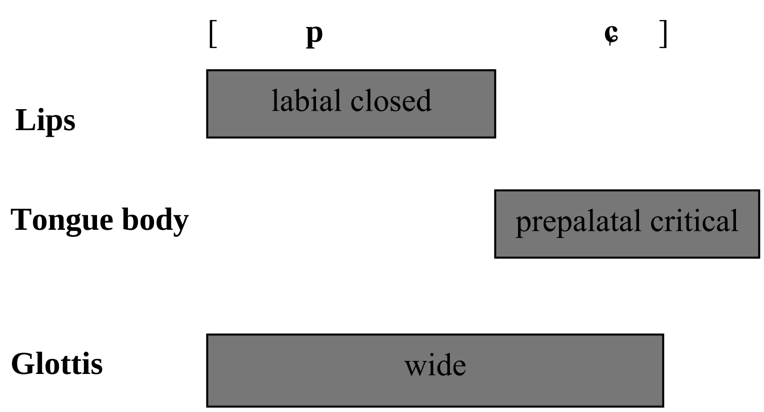
Kochetov restricts his analysis to the voiceless consonants above. Only in the first dialect is the labial itself palatalized, showing secondary palatalization. In the other dialects the labial is followed by a palatal glide (II), or followed by a palatal obstruent (III and IV). The forms in these dialects bear striking resemblance to the diachronic stages of ‘labial palatalization’ in Romance. Kochetov proposes that all dialects share the same phonological representation, with a palatal glide following the labial consonant. The different realizations of the palatal glide (to which he refers as palatalized labials) are attributed to differences in temporal overlap, and also to differences in *which* gestures overlap (oral gestures vs. glottal gestures). In the first dialect there is minimal overlap of the oral consonantal gesture with that of the palatal glide, and secondary palatalization results (here the glide is no longer realized on the surface separate from the labial consonant). In the second dialect there is no overlap between the two gestures, so the glide simply follows the labial.

Dialects III and IV are analyzed also as having no overlap of the oral gestures, as in dialect II, but the glottal gesture of the labial is extended and overlaps that of the palatal glide gesture. Thus, the palatal glide is devoiced after the voiceless stop, and this devoicing, combined with the friction of the palatal glide, create a palatal fricative. Notice that this *follows* the labial consonant, it is not incorporated in it. This is a positive step toward explaining palatal glide hardening, at least following voiceless consonants. I provide schematic representations for no overlap of both oral and glottalic gestures, as in [pj] outcomes, and for no overlap of oral gestures, but extension/overlap in glottalic gestures, as in [pç] outcomes.

(16) No overlap: [p] + [j] → [pj] (adapted from Kochetov 1998:8):



(17) Overlap/extension of glottalic gesture: [p] + [j] → [pç] (adapted from Kochetov 1998:8) (adapted from Kochetov 1998:10):



To sum up, the sequence labial + palatal fricative, which I have argued is a typical step in the changes which have resulted in synchronic "palatalized labials", results from the wide glottal gesture of the labial extending over the glottal gesture of the following palatal glide (corresponding to voicelessness). Crucially, this sequence is <u>not</u> the result of overlap of the oral articulator gestures of the labial and the following vocoid.

Given the above discussion, changing a labial consonant into a fully palatalized consonant such as [tʃ] has no articulatory impetus, and would not result from gestural overlap. It would be an unmotivated change. To formally account for this lack of full palatalization of labials I argue for the existence of a faithfulness constraint for major articulators. Such a constraint was also proposed in Adler (2006:1037), to account for consonantal changes in Hawaiian loan words, where a [t] can be changed to [k], but not to [p], in a borrowed word. The proposed constraint, IDENT-Articulator, rules out any full palatalization-type outputs as the result of temporal overlap of lips gestures with tongue gestures (characteristic of palatalization triggers). Here I follow Gafos (2002) and refer to segments which are associated with specific sets of gestures, of which the oral gesture serves as the head gesture of the segment (Gafos 2002:15):

(18) IDENT-Articulator IO (IDENT-Artic)

An input oral gesture of a particular major articulator, tongue or lips, must be associated with an output segment which is associated with the same major articulator.

This constraint favors gestures which are faithful to the major articulator specified in the input, the tongue or the lips. For example, sounds specified for the tongue articulator must be produced with the tongue in the output, and those specified for the lips articulator must be produced with the lips in the output. IDENT-Artic would be violated by full labial palatalization, as a consonant like *p* is specified for a lips-gesture, and full palatalization to *tʃ*, or even k^j as in Moldavian, would no longer be associated with a lips-gesture in the output, but with a tongue-gesture (because blending presumably would have occurred—which is not actually possible, thus making such violations gratuitous). Secondary palatalization of labial consonants would not violate this constraint, as the consonant would still be associated with a lips-gesture, in addition to a tongue-gesture for the secondary palatal articulation. On the other hand, any coronal or dorsal consonant is specified for tongue gestures, and when fully palatalized to *tʃ* or *c* it is still associated with tongue gestures. Therefore, full palatalization of coronal and dorsal consonants satisfies the IDENT-Artic constraint.

The following tableau illustrates that IDENT-Artic and CV-COORD-C(Lips)—the constraint which would in theory create a fully palatalized labial—are unranked with respect to each other. Ranking either one above the other would produce the same effect: the selection of a faithful labial surface form. Since CV-COORD-C(Lips) is satisfied by aligning the c-center of the lips gesture with the onset of the following vocoid gesture, yet this is still realized faithfully on the surface as [pi], I include two [pi] outcomes. One results from no overlap of the lips and tongue body gestures, violating CV-COORD-C(Lips), and the other results from overlap of the lips and tongue body gestures, satisfying CV-COORD-C(Lips). I indicate the overlap candidate by using a capital *P*, even though the surface realization is the same in both cases, and I schematically represent the degree of overlap with horizontal bars. This winning candidate is assumed to violate some low ranked faithfulness constraint that bans any type of overlap. As it is not necessary to use such constraints in the general analysis, I simply indicate this as IDENT(overlap).

Tableau 1. No full labial palatalization

/pi/	IDENT-Artic	CV-COORD-C(Lips)	IDENT (Overlap)
☞a. Pi [pi] Lips TB			*
b. pi Lips TB		*!	
b. tʃi	*!		

In the next section I turn to the analysis of full palatalization patterns. As labial consonants do not show full palatalization, CV-COORD-C(Lips) can be assumed to be highly ranked in grammars which show only full palatalization of coronals and dorsals. This ranking would still result in the selection of a plain labial realization (e.g. [pi]), as just demonstrated above. For simplicity, I will only use the CV-COORD-C(Tongue) constraint when discussing these languages.

4.2.3 Full palatalization patterns

Let me begin the analysis with languages where consonants articulated with the tongue, coronals and dorsals, both show palatalization. Languages in my sample which show this pattern are Breton (Celtic, France), Cypriot and Standard Modern Greek (Attic, Greece), Japanese (Japanese, Japan), Maori (Austronesian, New Zealand), and Sanuma (Yanomam, Brazil). I will illustrate the pattern by using Standard Modern Greek as an example.

In Standard Modern Greek (SMG), velar consonants /k, g, x, ɣ/ are fully palatalized to [c, ɟ, ç, ʝ] before the vowels /i, e/, and the coronal consonants /n, l/ are also fully palatalized to [ɲ, ʎ] before /i/, although this is highly stigmatized (the nasal also palatalizes before a weakened *i* followed by another vowel; Mackridge 1985; Arvaniti 1999a[68]).

(19) Palatalization in SM Greek (Arvaniti 1999a, Mackridge 1985):

/**ké**rasa/	[ˈ**ce**rasa]	'I treated (to a drink)'
/ton**gé**rasa/	[toŋˈ**ɟe**rasa]	'I treated him (to a drink)'
/**xé**ri/	[ˈ**çe**ri]	'hand, arm'
/**ɣe**rós/	[**ʝe**ˈros]	'strong, robust'
/tsa**kí**zo/	[tsaˈ**ci**zo]	'I snap'
/anán**gi**/	[aˈnaŋ**ɟi**]	'need, necessity'
/**xi**óni/	[ˈ**ç**oni]	'snow'
/**ɣi**ásu/	[ˈ**ʝ**asu]	'hello, good bye'
/beto**ni**éra/	[betoˈ**ɲ**era]	'cement-mixer'
/ma**liá**/	[maˈ**ʎ**a]	'hair (of head)'
/ja**lí**/	[ja**ʎí**]	'glass'

[68] Bilabial [m] also has alternate pronunciations, as [mj] or [mɲ]: /dzá**mi**a/ [ˈdza**mj**a] or [ˈdza**mɲ**a] 'window-panes' (Arvaniti 1999a)

To distinguish between full palatalization of dorsals and coronals I propose the following faithfulness constraints which refer to the sub-articulators of the tongue, the tongue tip and the tongue body, and changes in constriction location (recall that the tongue tip subsumes both the tip and the blade of the tongue, Browman and Goldstein 1986 et seq.). These two constraints are only relevant for full palatalization, as it is here that the constriction location seems to change. In secondary palatalization the constriction location remains unchanged, except that an additional tongue body gesture is introduced.

(20) IDENT-Tongue Tip Constriction Location IO
IDENT-TTCL

An oral gesture specified for a particular tongue tip constriction location in the input must have the same constriction location in the output.

When coronals undergo full palatalization the gesture of the consonant blends with the gesture of the following vocoid, and the constriction is undershot. The input constriction location of the tongue tip is changed to a different constriction location in the output, violating IDENT-TTCL. Thus, /ti/ → [tʃi] (or /l/ → [ʎ] in Greek) violates IDENT-TTCL because the constriction location in the input is [alveolar] but the constriction location in the output is [palato-alveolar].

(21) IDENT-Tongue Body Constriction Location IO
IDENT-TBCL
An oral gesture specified for a particular tongue body constriction location in the input must have the same constriction location in the output.

This constraint is violated when dorsals undergo full palatalization: the input constriction location of the tongue body is changed from velar to palato-alveolar or palatal, thus, /ki/ → [tʃi] and /ki/ → [ci] both violate IDENT-TBCL.

The tableau below shows how the interaction of the constraints introduced above model the general pattern of palatalization of coronals and dorsals in Standard Modern Greek. Since both coronals and dorsals palatalize fully, the faithfulness constraints which would prevent a change in primary place of articulation, IDENT-TBCL and IDENT-TTCL, are both ranked below CV-COORD-C(Tongue), and they are unranked with respect to each other.

Since there is no secondary palatalization in Greek, or in the other languages discussed in this section with only full palatalization, CV-COORD-release is also assumed to be ranked below CV-COORD-C(Tongue). For the same reason, a constraint penalizing secondary articulations, which will be introduced in the next section, is assumed to be highly ranked. To avoid unnecessary crowding of the tableaux, I do not include these constraints pertaining to secondary articulation in the tableaux below and focus only on full palatalization outcomes.

Tableau 2. Full palatalization of coronals and dorsals (Standard Modern Greek)

CV-COORD-C(Tongue) >> IDENT-TBCL, IDENT-TTCL

/tsa**kí**zo/ 'I snap'	CV-COORD-C(Tongue)	IDENT-TBCL	IDENT-TTCL
a. tsakízo	*!		
☞b. tsacízo		*	
/jalí/ 'glass'	CV-COORD-C(Tongue)	IDENT-TBCL	IDENT-TTCL
a. jalí	*!		
☞b. jaʎí			*

Candidates such as *[tsatʃízo], where *k* → *tʃ* rather than *c* are ruled out either by the specific landmark synchronization of the CV-COORD-C(Tongue) in Greek, or by other factors pertaining to the consonantal inventories of individual languages. The same constraint ranking as above would be present in the other languages which show this pattern of palatalization.

Notice that while for coronal consonants the overlapping tongue gestures blend to produce a new gesture that combines elements of the two (e.g. [t] is [alveolar, closed] and [i] is [palatal, narrow], producing [tʃ], which is [palato-alveolar, closed-critical]—where [critical] is a blend of the [closed] and [narrow] values of the consonant and the vowel, respectively), not all dorsal full palatalization outcomes create a similar blend. If a velar stop has a [velar] constriction location, and the palatalization trigger has a [palatal] constriction location, why do these blend to produce a [palato-alveolar] gesture as in [tʃ], in a way overshooting both targets?

Why are not all fully palatalized velars realized as palatal stops, for example [c]? A possible answer to this is provided by Lee (2000), who proposes that palatal stops, e.g. [c], require a great articulatory effort, since the front part of the tongue body must make contact with the entire palatal region. If we adopt the view that coarticulation is a natural process that occurs in order to minimize articulatory effort, then changing /k/ to [c] in palatalization minimizes effort on one dimension (coarticulation), but not on another. A easier articulation is an affricate, [tʃ] or more rarely [tɕ], even though these both overshoot the palatal region (Lee 2000:423-4). Furthermore, [c] and the two affricates, [tʃ] and [tɕ], share acoustic properties which make them similar, but [c] and [tɕ] require almost the same degree of articulatory effort, which explains why the most common full palatalization outcome of /k/ is [tʃ] (Lee 2000:425).

For languages where only dorsal consonants or only coronal consonants show full palatalization, the IDENT-TTCL and IDENT-TBCL constraints are simply ranked with respect to each other and to CV-COORD-C(Lips). Languages which show only full palatalization of dorsal consonants include Luganda (Central Bantu, Uganda), Nkore-Kiga (Bantu, Uganda), Roviana (Austronesian, Solomon Islands), Dakota (Siouan, USA), Mwera (Bantu, East Africa), and Somali (Cushitic, Kenya and Somalia).

In Mwera only dorsal consonants show full palatalization. Dorsal [k] and [g] palatalize to [tʃ] and [dʒ] respectively, before suffixes beginning with the vowels [i] and [e], shown in (22).

(22) Palatalization in Mwera (Harries 1950:8):

Plain	Palatalized	
i**k**a	-i**tʃ**ila	‘come for, arrive at’
	nāi**tʃ**e	‘I came’
dʒumu**k**a	-dʒumu**tʃ**ila	‘be awake for’
	nādʒumwi**tʃ**e	‘I awoke’
twaŋ**g**a	twan**dʒ**ila	‘pound grain for’
	nātwan**dʒ**ile	‘I pounded’
dʒo**g**a	dʒo**dʒ**ela	‘bathe for’
	nādʒo**dʒ**ile	‘I bathed’

In Mwera IDENT-TBCL must be ranked below IDENT-TTCL, and furthermore CV-COORD-C(Tongue) must be ranked below IDENT-TTCL, since coronals do not show palatalization. Therefore, the faithful outputs of coronals violate CV-COORD-C(Tongue), as shown below. Note that for Mwera the velar stops fully palatalize to *tʃ* and *dʒ*, unlike in Greek where they palatalized to *c* and *ɟ*, yet CV-COORD-C(Tongue) is still satisfied. This is because in Mwera the CV-COORD-C(Tongue) landmarks which must be synchronized are different from those in Greek. From this point forward I will assume that the CV-COORD-C(Tongue) constraint is satisfied by individual language outputs and not consider the other potential full palatalization outcomes for specific consonants.

Tableau 3. Full palatalization of dorsals in Mwera.

IDENT-TTCL >> CV-COORD-C(Tongue) >> IDENT-TBCL

/twan**g-**ila/ 'pound grain for'	IDENT-TTCL	CV-COORD-C (Tongue)	IDENT-TBCL
☞a. twan**dʒ**ila			*
b. twaŋ**g**ila		*!	
/nātwan**gil**e / 'I pounded'	IDENT-TTCL	CV-COORD-C(Tongue)	IDENT-TBCL
a. nātwaŋ**gi**ʎe	*!	* (g)	
b. nātwan**dʒ**iʎe	*!		*
c. nātwan**gil**e		**! (g, l)	
☞d. nātwan**dʒil**e		* (l)	*

As shown in the tableau above, CV-COORD-C(Tongue) can be violated more than once if there is more than one sound in a given form where consonants would have to coordinate gestures with following front vowels, as they do in palatalization. Because IDENT-TTCL outranks CV-COORD-C(Tongue) and because the latter outranks IDENT-TBCL, there is no full palatalization of coronal consonants, but only of dorsal consonants.

The reverse ranking of IDENT-TBCL and IDENT-TTCL with respect to CV-COORD-C(Tongue) predicts the opposite outcome, namely a grammar where only coronal consonants show full palatalization. Several languages in my sample fall into this category, including Apalai (Carib, Brazil), Basque (Basque, Spain), English (Germanic, USA), Fongbe (Atlantic Creole, Benin and Togo), Karok (Hokan, USA), Korean (isolate, Korea), Dhivehi (Maldivian, Republic of Maldeves), Marathi, Nishnaabemwin, and Yimas (Sepik-Ramu, Papua New Guinea) among others (see

Appendix 2). To take one example, in some dialects of Fongbe, an Atlantic Creole language spoken in southern areas of Benin and Togo, alveolar stops /t/ and /d/ palatalize to [tʃ] and [dʒ] respectively when before the vowel /i/ (Lefebvre and Brusseau 2002).

(23) Palatalization in Fongbe (Lefebvre and Brusseau 2002):

/é nɔ̀ **dí** / → [é nɔ́ **dʒí**]
It HAB be.very.good
'It is very good'

/à **tì** klé/ → [à **tʃì** klé]
you squeeze lemon
'You squeezed some lemons'

This pattern of palatalization is illustrated in the tableau below.

Tableau 4. Full palatalization of coronals in Fongbe

IDENT-TBCL >> CV-COORD-C(Tongue) >> IDENT-TTCL

/dí/ 'be very good'	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL
a. dí		*!	
☞b. dʒí			*
/tì/ 'squeeze'	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL
a. tì		*!	
☞b. tʃì			*
/ kíkló/ 'big'	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL
☞a. kíkló		*	
b. tʃíkló	*!		

The constraints introduced above are articulatorily motivated by taking into account the articulators and sub-articulators used to execute gestures associated with particular consonants and vocoids. They are sufficient to provide an explanation of the full palatalization patterns uncovered by the palatalization survey. To summarize, the interaction of CV-COORD-C(Tongue) with the two faithfulness constraints IDENT-TTCL and IDENT-TBCL accounts for the full palatalization patterns. Part of table 4.1, which pertains only to full palatalization, is repeated below, this time including constraint rankings for each full palatalization pattern.

Table 4.4. Full palatalization patterns and constraint rankings

(patterns 4.1 A, B, C)

	Labial	Coronal		Dorsal		Examples and ranking
	Sec	Full	Sec	Full	Sec	
A		x		x		**CV-COORD-C(Tongue)** >> IDENT-TBCL, IDENT-TTCL Breton, Cypriot and Standard Modern Greek, Japanese, Maori, Sanuma
B		x				IDENT-TBCL >> **CV-COORD-C(Tongue)** >> IDENT-TTCL Apalai, Basque, English, Fongbe, Karok, Korean, Dhivehi, Marathi, Nishnaabemwin, Yimas
C				x		IDENT-TTCL >> **CV-COORD-C(Tongue)** >> IDENT-TBCL Luganda, Nkore-Kiga, Roviana, Dakota, Somali

In the next section I account for the secondary palatalization patterns of palatalization in table 4.1.

4.2.4 Secondary palatalization patterns

The constraint CV-COORD-release, introduced earlier, favors secondary palatalization, where the onset landmark of the vocalic gesture is aligned with the release landmark of the preceding consonantal gesture. A markedness constraint which penalizes segments associated with complex gestures, where there is a secondary gesture superimposed on the primary gesture, is defined below:

(24) *SUPERIMPOSE

Segments must not be associated with both a primary and a secondary oral gesture.

*SUPERIMPOSE is violated by secondary palatalization outcomes, since these segments are associated with a complex gesture, the primary gesture and the secondary gesture. Full palatalization outcomes do not violate this constraint, as such outcomes do not have secondary oral gestures.

The patterns of secondary palatalization are more numerous than those of full palatalization because labial consonants can also show secondary palatalization. Nevertheless, even here there is an implicational relationship among the three major places of articulation: labial consonants are dependent on the palatalization of coronal and dorsal consonants, whether this be full or secondary palatalization. If we consider secondary palatalization alone, there are five languages in the language sample where labials and only one other place of articulation show palatalization: labials and coronals in Bulgarian (Slavic, Bulgaria), Carib (Cariban, Guiana), Mandarin (Sino-Tibetan, China), and the Gonder dialect of Amharic (Ethio-Semitic, Ethiopia), and labials and dorsals in morphological contexts in Polish (Slavic, Poland). However, when we consider palatalization in each of these language as a whole, we notice that the third place of articulation also has palatalization, but that this is full palatalization (or, as indicated in chapter 2, in the case of Mandarin, dorsal consonants never appear in palatalizing contexts; therefore, they cannot show any kind of palatalization).

The dependency of secondary labial palatalization on the palatalization of both coronal and dorsal consonants in a given language can be explained in two ways: (i) by considering the markedness of secondarily palatalized outputs (e.g. p^j, t^j, k^j), or (ii), by considering the necessity of the process that leads to secondarily palatalized outputs (e.g. CV-COORD-release constraints pertaining only to lip gestures, tongue tip gestures, and tongue body gestures, respectively). Thus, by using the first explanation one could propose markedness constraints against secondarily palatalized segments, for example $*p^j$, $*t^j$, $*k^j$, while by using the second explanation one could propose coordination constraints pertaining to each of the tongue tip, tongue body and lips articulators, for example CV-COORD-release[t], etc. In both cases, there would be a fixed ranking separating labials from coronals and dorsals, to capture the dependency of labial palatalization. These fixed rankings are illustrated below. I abbreviate CV-COORD-release as CV-COORD-R.

(25) $*p^j >> *t^j, *k^j$

(26) CV-COORD-R[k], CV-COORD-R[t] >> CV-COORD-R[p]

Regardless of which solution we choose, the same results are obtained, with labial palatalization being dependent on the palatalization of coronals and dorsals[69]. Nevertheless, I adopt the markedness solution, because it is more reasonable to expect that some types of sounds would be more marked than others, while there is no impetus to coordinate just lips and tongue gestures. Further support for this solution is discussed below.

I interpret the dependency of labial palatalization on the palatalization of dorsals and coronals as suggesting that even secondarily palatalized labial consonants are more marked than secondarily palatalized coronal and dorsal consonants. Spinu (2007) found in a perceptual study that Romanian speakers are more sensitive (show greater identification accuracy) to secondarily palatalized labial consonants than to secondarily palatalized coronal consonants. Although the results of the study did not reach statistical significance, they do suggest that this increased sensitivity to secondarily palatalized labials may be due to the fact that such sounds are more marked. Dorsal consonants were not included in the study because they show full palatalization in the same contexts. The reasoning that secondarily palatalized labials are more marked than their coronal and dorsal counterparts is in line with Prince and Smolensky (1993:202-208). They claim that the Yidin^{y} pattern whereby coronal, but not labial, consonants have secondary palatalization is due to coronals being less marked than labials and dorsals (see Paradis and Prunet (1991) for discussions on the

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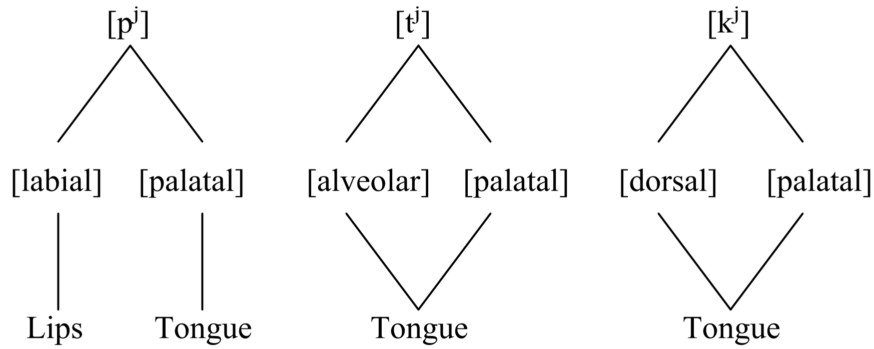
[69] I have used both types of constraints in OT Soft 2.1 software package (Hayes, Tesar and Zuraw 2003), and there were no differences in predicted patterns.

unmarked status of coronals). Prince and Smolensky (1993) assume the same for dorsal consonants, namely that they are more marked than coronals.

However, the palatalization typology established in the present study has demonstrated that dorsal and coronal consonants both pattern together, and that they are both better licensors of palatalization than labial consonants are (but see discussion in section 4.2.6 on secondary palatalization in morpho-phonological contexts, where the palatalization of dorsal consonants seems to be dependent on the palatalization of coronal consonants). Furthermore, the cross linguistic evidence that secondarily palatalized labials are less attested also justifies the claim that such sounds are more marked than secondarily palatalized coronals and dorsals. Therefore, if the labial primary place of articulation licenses secondary palatalization so would the coronal primary place, since the presence of a more marked segment implies the presence of a less marked one. The marked status of a secondarily palatalized labial in comparison to a secondarily palatalized coronal or dorsal can be captured by any representation that makes reference to lips and tongue (lingual) gestures or features, as shown below, where I indicate the constriction location of the oral articulators for each secondarily palatalized consonant. [palatal] indicates the secondary tongue body articulation for each of the consonants.

(27) Markedness of secondarily palatalized consonants:



To capture the markedness differences in secondary palatalization I propose to split the *SUPERIMPOSE constraint, which generally bans complex gestures as those occurring in secondary palatalization, into three separate constraints which ban complex gestures according to the primary gesture: (i) when the primary gesture is a labial gesture; (ii) when the primary gesture is a tongue tip (coronal) gesture; and (iii), when the primary gesture is a tongue body (dorsal) gesture. The need for such a constraint family is motivated by the fact that secondary palatalization targets consonants at different places of articulation in any given language; therefore, different classes of secondarily palatalized consonants will be avoided in each language. The three constraints are given below, where vocoid is assumed to be one of the palatalization triggers.

(28) *[Lips]^j

A primary lips gesture must not have a secondary palatal gesture superimposed on it.

(29) *[Tongue tip]^j
*[TT]^j

A primary tongue tip gesture must not have a secondary palatal gesture superimposed on it.

(30) *[Tongue body]^j
*[TB]^j

A primary tongue body gesture must not have a secondary palatal gesture superimposed on it.

Each of these constraints will be violated by a secondarily palatalized sound whose primary gesture is a labial, a tongue tip, or a tongue body gesture, respectively (e.g. [p^j] violates *[Lips]^j, [t^j] violates *[Tongue tip^j, and [k^j] violates *[tongue body]^j).

To reflect the fact that secondarily palatalized labials are more marked than secondarily palatalized coronal and dorsals, I establish the following universal markedness scale for secondary palatalization, with *[Lips]^j ranked above *[Tongue tip]^j and *[Tongue body]^j.

(31) Universal markedness scale of secondary palatalization

*[Lips]^j >> *[Tongue tip]^j, *[Tongue body]^j

Let us first consider languages where consonants at all three major places of articulation show secondary palatalization, such as Mongolian (Altaic, Mongolia) and Shilluk (Nilo Saharan, Sudan). In Shilluk, root initial consonants show secondary palatalization before the glide *j* (Gilley 1992). Some examples are given below.

(32) Palatalization in Shilluk (Gilley 1992:25):

b^{j}ɛ́l	'millet'
am^{j}ɛ̠́l	'stubborn'
d^{j}ɛ̀l	'goat'
ót^{j}ɛ̂m	'dragonfly'
g^{j}ɛ̠̀k	'Nile lechwe'
k^{j}ɛ́ɲ	'horse'
ŋ^{j}ɛl	'to trundle'

Tableau 5 illustrates the ranking in a grammar which produces the outcomes as in Shilluk (4.1 D). If the constraint favoring secondary palatalization, CV-COORD-release, outranks all other constraints (faithfulness and markedness), then secondary palatalization will be preferred to any other outcomes. Since fully palatalized outcomes are never selected as optimal, this means that CV-COORD-C(Tongue) is low ranked, while the faithfulness constraints IDENT-TTCL and IDENT-TBCL are ranked highly. For this reason, as well as to simplify the tableaux, I consider only secondary palatalization outcomes. The only relevant constraints then are CV-COORD-release (CV-COORD-R) and the markedness constraints which ban secondary palatal articulations, *[Lips]^j, *[Tongue tip]^j, *[Tongue body]^j.

Tableau 5. (4.1 D) Secondary palatalization of labials, coronals, and dorsals (Shilluk)

CV-COORD-R >> *[Lips]^j >> *[Tongue tip]^j, *[Tongue body]^j

/bjɛ́l/ ‘millet’	CV-COORD-R	*[Lips]^j	*[TT]^j	*[TB]^j
☞a. bʲɛ́l		*		
b. bjɛ́l	*!			
/djɛ̀l/ ‘goat’	CV-COORD-R	*[Lips]^j	*[TT]^j	*[TB]^j
☞a. dʲɛ̀l			*	
b. djɛ̀l	*!			
/kjɛ́ɲ/ ‘horse’	CV-COORD-R	*[Lips]^j	*[TT]^j	*[TB]^j
☞a. kʲɛ́ɲ				*
b. kjɛ́ɲ	*!			

In Navajo (Na-Dene, USA) and Turkish (Altaic, Turkey), some coronal and dorsal consonants show secondary palatalization. To take Turkish as an example, velar stops *k* and *g* show secondary palatalization to *k^j* and *g^j* before a tautosyllabic front vowel, and the coronal lateral *l* also shows secondary palatalization to *l^j* in the same context, as shown below.

(33) Palatalization in Turkish (Kornfilt 1997:484-6):

k^{j}ese	‘pouch’
g^{j}eze**g^j**en	‘planet’
bi**l^j**e	‘even’

Grammars of languages such as Turkish (the pattern in 4.1 H), must rank *[Lips]^j above CV-COORD-release, since there is no secondary palatalization of labials, while the other two markedness constraints militating against secondary palatalization rank below CV-COORD-release, as shown in Tableau 6.

Tableau 6. (4.1 H) Secondary palatalization of coronals and dorsals (Turkish)

$*[\text{Lips}]^j >> \text{CV-COORD-R} >> *[\text{TT}]^j, *[\text{TB}]^j$

/bile/ 'even'	*[Lips]^j	CV-COORD-R	*[TT]^j	*[TB]^j
a. bile		**! (b, l)		
☞b. bi**l**^{j}e		* (b)	*	
c. **b**^{j}i**l**^{j}e	*!			
/kese/ 'pouch'	*[Lips]^j	CV-COORD-R	*[TT]^j	*[TB]^j
a. kese		**! (k, s)		
☞b. k^{j}ese		* (s)		*

In the above tableau, candidate (b) for the word 'even' is selected as optimal, with secondary palatalization of the lateral and no palatalization of the labial. The other candidates are ruled out either because they incur violations of the higher ranked *[Lips]^j (c), or because they incur more violations of CV-COORD-release (a). A candidate such as *[k^{j}es^{j}e] for the word meaning 'pouch', where both the coronal and the dorsal show secondary palatalization, is not selected as optimal because of another constraint pertaining to the manner of articulation of the coronal [s], as palatalization is restricted to the coronal lateral liquid. To avoid unnecessary complications of the tableaux I leave out discussion of such constraints, although as I mentioned before, constraints pertaining to constriction degree also play a significant role in the grammars of individual languages (e.g. earlier discussion of Nupe).

I now turn to the pattern in (4.1 I), with secondary palatalization of coronals alone, as occurs in Watjarri, a Pama-Nyungan language of Australia. In Watjarri, dental consonants show secondary palatalization before /i/:

(34) Palatalization in Watjarri (Douglas, 1981):

/jamat̪i/	[jamat^{j}i]	‘a person’
/t̪ina/	[t^{j}ina]	‘foot’

This pattern of palatalization results from a grammar which ranks *[TT]^j below CV-COORD-release, while *[Lips]^j and *[TB]^j are ranked above CV-COORD-release, since dorsals and labials do not show secondary palatalization.

Tableau 7. (4.1 I). Secondary palatalization of coronals (Watjarri)

*[Lips]^j >> *[TB]^j >> CV-COORD-release >> *[TT]^j

/pika/ ‘sore’	*[Lips]^j	*[TB]^j	CV-COORD-R	*[TT]^j
☞a. pika			*	
b. p^{j}ika	*!			
/t̪ina/ ‘foot’	*[Lips]^j	*[TB]^j	CV-COORD-R	*[TT]^j
a. t̪ina			*!	
☞b. t^{j}ina				*
/-ki/ nominalizer suffix	*[Lips]^j	*[TB]^j	CV-COORD-R	*[TT]^j
☞a. -ki			*	
b. -k^{j}i		*!		

The pattern which allows for only secondary palatalization of dorsals, in (4.1 J), is obtained by having a mirror image ranking of the constraints pertaining to dorsal consonants, namely *[TB]^j is ranked below CV-COORD-release and *[TT]^j is ranked above it, as shown in Tableau 8. In Kayardild, an Australian language of Australia, velars /k/ and /ŋ/ show secondary palatalization before /i/, and no other consonants show any type of palatalization. Some examples are provided below (Evans 1995).

(35) Palatalization in Kayardild (Evans 1995):

[**k**^{j}it̪ant]	'clap on water'	
[ˈ**ŋ**^{j}ime͡i]	'night'	
[ŋapa͡i]	'spirit'	(no palatalization before /a/)
[wakat̪]	'sister'	

Tableau 8.[70] (4.1 J). Secondary palatalization of dorsals (Kayardild)

*[Lips]^j >> *[TT]^j >> CV-COORD-release >> *[TB]^j

/pijarp/ 'dugong'	*[Lips]^j	*[TT]^j	CV-COORD-R	*[TB]^j
☞a. ˈbiɖarp			*	
b. ˈb^{j}iɖarp	*!			
/patinta/ 'carrying'	*[Lips]^j	*[TT]^j	CV-COORD-R	*[TB]^j
☞a. badind			*	
b. bad^{j}ind		*!		
/ŋime͡i/ 'night'	*[Lips]^j	*[TT]^j	CV-COORD-R	*[TB]^j
a. ŋime͡i			*!	
☞b. ŋ^{j}ime͡i				*

[70] In this tableau notice that phonemic /p/ and /t/ are realized as voiced unless they are word-final and there is no vowel phoneme following (/**p**ijar**p**/ → [ˈ**b**iɖar**p**], vs. /**p**a**t**in**t**a/ → [**b**a**d**in**d**]).

In summary, grammars which allow only secondary palatalization are crucially determined by the ranking of CV-COORD-release with respect to the markedness constraints that ban secondary palatal articulations at different places of articulation (e.g. *[Lips]^j). The universal markedness hierarchy which states that secondarily palatalized labials are more marked than both secondarily palatalized coronals and dorsals is responsible for the dependency of palatalized labials on the palatalization of coronals and dorsals. The table below summarizes the secondary palatalization patterns from table 4.1, indicating the relevant constraint rankings.

Table 4.5 Secondary palatalization patterns

	Labial	Coronal		Dorsal		Examples
	Sec	Full	Sec	Full	Sec	
D	x		x		x	**CV-COORD-R** >> *[Lips]^j >> *[TT]^j, *[TB]^j Shilluk, Mongolian.
H			x		x	*[Lips]^j >> **CV-COORD-R**>> *[TT]^j, *[TB]^j. Eastern Ojibwa, Navajo, Turkish.
I			x			*[Lips]^j >> *[TB]^j >> **CV-COORD-R** >> *[TT]^j Mangap Mbula, Hungarian, Tiwa, Watjarri.
J					x	*[Lips]^j >> *[TT]^j >> **CV-COORD-R** >> *[TB]^j Ejagham, Kayardild, Koromfe, Limlingan, Sirionó, So

Before turning to the discussion of mixed palatalization patterns, I present an additional ranking which places all of the faithfulness and markedness constraints discussed above at the top of the hierarchy, and places the CV-COORD constraints at the bottom. This ranking would predict no palatalization, as illustrated below. Thus CV-COORD-C(Tongue) and CV-COORD-release, which drive palatalization, are violated in favor of faithful realization of both consonants articulated with the lips as well as those articulated with the tongue tip or the tongue body. For simplicity I group the three markedness constraints under the general *SUPERIMPOSE constraint. This ranking is present in many of the languages in my sample where there is no palatalization, such as Babungo (Bantu, Cameroon), Noon (Cangin, Senegal), Djingili (West Barkly, Australia), Molikese (Ponapeic-Trukic, Micronesia), Mundari (Munda, India), and many others.

Tableau 9. No palatalization.

IDENT-TTCL, IDENT-TBCL, *SUPERIMPOSE >>
CV-COORD-C(Tongue), CV-COORD-R

/pi/	IDENT-TTCL	IDENT-TBCL	*SUPERIMPOSE	CV-COORD-C(Tongue)	CV-COORD-R
☞a. pi					*
b. p^ji			*!		
/ti/	IDENT-TTCL	IDENT-TBCL	*SUPERIMPOSE	CV-COORD-C(Tongue)	CV-COORD-R
☞a. ti				*	*
b. t^ji			*!	*	
c. tʃi	*!				*
/ki/	IDENT-TTCL	IDENT-TBCL	*SUPERIMPOSE	CV-COORD-C(Tongue)	CV-COORD-R
☞a. ki				*	*
b. k^ji			*!	*	
c. tʃi		*!			*

In the next section I discuss the patterns which show both full and secondary palatalization in the same language. These patterns are derived by intersecting the types of constraint rankings discussed above for full and secondary palatalization patterns. In this section I also motivate the split of the full palatalization constraint into CV-COORD-C(Lips) and CV-COORD-C(Tongue).

4.2.5 Mixed full/secondary palatalization patterns

Of the possible patterns which combine full and secondary palatalization in a single language, but which do not mix both types of palatalization at a single place of articulation, only one is attested among the languages in my sample: Bulgarian (Slavic, Bulgaria), which shows secondary palatalization of labial and coronal consonants, and full palatalization of dorsal consonants (pattern 4.1 G) As stated earlier, I suspect that this is an accidental gap in my language sample[71]. In fact, there are languages outside of my sample which show some of the predicted patterns. For example Chaha (Ethio-Semitic, Ethiopia) shows the pattern in (4.1 L) (Leslau 1964, 1979, Rose 1994, 1997, Banksira 2000). This language was not included in the sample because another Ethio-Semitic language, Amharic, was included. The exclusion was intentional, to insure a balanced language sample, but it created an accidental gap in the pattern. Nevertheless, the pattern is predicted to occur based on the generalizations revealed by the language sample.

As stated previously, the mixed patterns of palatalization which show secondary palatalization of labial consonants motivate the split of the full palatalization constraint into CV-COORD-C(Lips) and CV-COORD-C(Tongue). In a

[71] Another possible explanation could be that gestural coordination patterns might be skewed either toward full palatalization or toward secondary palatalization in a given language, meaning that languages prefer either full or secondary palatalization overall. Nevertheless, such an explanation quickly falls apart when considering the number of languages which have both full and secondary palatalization at the same place of articulation, leaving the accidental gap explanation as the best alternative.

language where *all* consonants show secondary palatalization, the necessity for the split is not evident, as this pattern can be obtained from ranking a single general CV-COORD-center constraint below CV-COORD-release, and CV-COORD-release above *[Lips]^j (the faithfulness constraints IDENT-TTCL and IDENT-TBCL are also ranked highly). This is shown in the tableau below.

Tableau 10. Secondary palatalization with a single CV-COORD-center constraint

IDENT-TTCL, IDENT-TBCL >> CV-COORD-R >>

CV-COORD-center, *[Lips]^j

/pi/	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	CV-COORD-C	*[Lips]^j
a. pi			*!	*	
b. Pi [pi]			*!		
☞ c. p^ji				*	*
/ti/	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	CV-COORD-C	*[Lips]^j
a. ti			*!	*	
☞ b. t^ji				*	
c. tʃi	*!		*		
/ki/	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	CV-COORD-C	*[Lips]^j
a. ki			*!	*	
☞ b. k^ji				*	
c. tʃi		*!	*		

However, having a single CV-COORD-center constraint would not allow for secondary palatalization of labial consonants if only labials and one other place of articulation show secondary palatalization, while the other place of articulation shows full palatalization, as is the case in Bulgarian. In Bulgarian, pattern (4.1 G), there is secondary palatalization of labials and coronals, and full palatalization of dorsals.

Dorsal consonants /g/, /k/, and /x/ are always realized as [ɟ], [c] and [ç] before front vowels, and labial and coronal consonants show secondary palatalization in these contexts (Scatton 1984). Some examples are provided below.

(37) Palatalization in Bulgarian (Scatton 1984):

No palatalization		Palatalization	
[knˈi**g**ə]	'book'	[knˈi**ɟ**i]	'books'
[mˈar**k**ə]	'stamp'	[mˈar**c**i]	'stamps'
[t͡ʃe**x**]	'Czech' (noun)	[t͡ʃˈe**ç**i]	'Czechs'
		[pˈə**tʲ**iʃtə]	'roads'
		[**bʲ**éʃe]	'you were'

Therefore, in a grammar like that of Bulgarian the single CV-COORD-center constraint would need to be ranked *above* CV-COORD-release to allow for the full palatalization of dorsals:

/mˈarki/ 'stamps'	CV-COORD -center	CV-COORD -release	IDENT-TBCL
a. mˈarki	*!	*	
b. mˈarkʲi	*!		
☞c. mˈarci		*	*

At the same time, CV-COORD-center would need to be ranked *below* CV-COORD-release to allow for secondary palatalization of labial consonants:

/beʃe/ 'you were'	CV-COORD -release	CV-COORD -center	*[Lips]ʲ
a. béʃe	*!	*	
b. Béʃe [béʃe]	*!		
☞ c. bʲéʃe		*	*

Recall that with a high ranked CV-COORD-center constraint plain labial consonants are always selected as optimal, because they are the result of overlap and thus satisfy CV-COORD-center, as illustrated below:

/beʃe/ ‘you were’	CV-COORD -center	CV-COORD -release	*[Lips]^j
a. béʃe	*!	*	
💣 b. Béʃe [béʃe]		*	
☹ c. b^{j}éʃe	*!		*

Therefore, the pattern in Bulgarian motivates the split of the CV-COORD-center constraint into the two constraints introduced earlier, CV-COORD-center(Lips) and CV-COORD-center(Tongue). When secondary palatalization of labials occurs, CV-COORD-C(Lips) is always low ranked, below CV-COORD-release. When it does not occur, CV-COORD-C(Lips) is high ranked. I include CV-COORD-C(Lips) in the tableau below to illustrate the pattern in Bulgarian, but I omit it from subsequent tableaux where there is labial secondary palatalization, since its low ranking can be assumed.

The palatalization pattern in Bulgarian is thus modeled by ranking CV-COORD-C(Tongue) above IDENT-TBCL, as dorsals show full palatalization, and by also ranking CV-COORD-release highly, since the other two places of articulation show secondary palatalization. As discussed in the previous paragraph, CV-COORD-C(Lips) ranks below CV-COORD-release, because labials show secondary palatalization. The markedness constraints against secondary palatalization are ranked at the bottom. A basic ranking is shown below, where I include two faithful outputs of the labial for the word meaning ‘you were’, one resulting from no overlap (**b**eʃ́e) and one resulting from overlap (**B**eʃ́e).

Tableau 11. (4.1 G). Secondary palatalization of labials and coronals, full palatalization of dorsals (Bulgarian).

IDENT-TTCL >> CV-COORD-C(Tongue) >> IDENT-TBCL, CV-COORD-R >> CV-COORD-C(Lips), *[Lips]ʲ

/beʃe/ ‘you were’	IDENT-TTCL	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	CV-COORD-C(Lips)	*[Lips]ʲ
a. beʃ́e				*!	*	
b. Beʃ́e [beʃ́e]				*!		
☞c. bʲeʃ́e					*	*
d. dʒeʃ́e				*!		
/pətiʃtə/ ‘roads’	IDENT-TTCL	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	* CV-COORD-C(Lips)	*[Lips]ʲ
a. pˈətiʃtə		*		*!		
☞b. pˈətʲiʃtə		*				
c. pˈətʃiʃtə	*!			*		
/mˈarki/ ‘stamps’	IDENT-TTCL	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	CV-COORD-C(Lips)	*[Lips]ʲ
a. mˈarki		*!		*		
b. mˈarkʲi		*!				
☞c. mˈarci			*	*		

The patterns in (4.1 E and F), and (41 K and L), for which I do not have representative languages in my sample but which are expected, are illustrated in the tableaux below. For pattern (4.1 L) I use Chaha, from outside the language sample.

To derive the pattern in (4.1 E), with secondary palatalization of labials and full palatalization of dorsals and coronals, CV-COORD-C(Tongue) ranks above CV-

COORD-release, IDENT-TTCL and IDENT-TBCL. As labials do show secondary palatalization, *[Lips]^j and the other markedness constraints mitigating against secondary palatalization are ranked at the bottom.

Tableau 12. (4.1 E) Secondary palatalization of labials, full palatalization of coronals and dorsals

CV-COORD-C(Tongue) >> IDENT-TBCL, IDENT-TTCL, CV-COORD-R >> *[Lips]^j

/pi/	CV-COORD-C(Tongue)	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	*[Lips]^j
a. pi				*!	
☞b. p^ji					*
c. tʃi				*!	
/ti/	CV-COORD-C(Tongue)	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	*[Lips]^j
a. ti	*!			*	
b. t^ji	*!				
☞c. tʃi		*		*	
/ki/	CV-COORD-C(Tongue)	IDENT-TTCL	IDENT-TBCL	CV-COORD-R	*[Lips]^j
a. ki	*!			*	
b. k^ji	*!				
☞c. tʃi			*	*	

The palatalization pattern in (4.1 F), where there is secondary palatalization of labials and dorsals and full palatalization of coronals[72], suggests that IDENT-TBCL

[72]This is the pattern of Japanese mimetic (sound-symbolic) palatalization which targets the rightmost non-*r* coronal segment, which undergoes full palatalization. If no such segment is present, then the leftmost dorsal or labial segment is secondarily palatalized (Mester and Itô 1989). Examples:

dosa		doʃa-doʃa	'in large amounts'
toko	'trotting'	tʃoko-tʃoko	'childish small steps'
poko	'up and down movement'	p^joko-p^joko	'flip-flop, jumping around imprudently'
koro		k^joro-k^joro	'look around indeterminately'

ranks above CV-COORD-C(Tongue), and that in turn CV-COORD-C(Tongue) ranks above IDENT-TTCL and CV-COORD-release. Furthermore, CV-COORD-release ranks above the *[Lips]^j and *[TB]^j, as labials and dorsals show secondary palatalization.

Tableau 13. (4.1 F). Secondary palatalization of labials and dorsals, full palatalization of coronals.

IDENT-TBCL >> CV-COORD-C(Tongue) >> IDENT-TTCL , CV-COORD-R >> *[Lips]^j >> *[TB]^j

/pi/	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[Lips]^j	*[TB]^j
a. pi				*!		
☞b. p^ji					*	
c. tʃi				*!		
/ti/	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[Lips]^j	*[TB]^j
a. ti		*!		*		
b. t^ji		*!				
☞c. tʃi			*	*		
/ki/	IDENT-TBCL	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[Lips]^j	*[TB]^j
a. ki		*		*!		
☞b. k^ji		*				*
c. tʃi	*!			*		

The last two patterns in table 4.1, with secondary palatalization of coronals and full palatalization of dorsals (4.1 K) and its opposite, secondary palatalization of dorsals and full palatalization of coronals (4.1 L) involve the reverse ranking of the constraints. Thus, for (4.1 K), illustrated in Tableau 14, IDENT-TTCL ranks above CV-COORD-C(Tongue), while *[TB]^j ranks above CV-COORD-release. The reverse is true for (4.1 L), illustrated in Tableau 15 for Chaha. Because labial consonants do not show secondary palatalization in these two language types, *[Lips]^j must be ranked above CV-COORD-release. In the same vein, CV-COORD-C(Lips) can be ranked at the top of the hierarchy, since a faithful surface representation (e.g. [pi]) will always be selected as the optimal candidate with this ranking. To keep the tableaux simpler, I omit the CV-COORD-C(Lips) constraint.

Tableau 14. (4.1 K). Secondary palatalization of coronals,
full palatalization of dorsals

IDENT-TTCL, *[Lips]^j >> CV-COORD-C(Tongue) >>
IDENT-TBCL, CV-COORD-R >> *[TT]^j

/pi/	IDENT-TTCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	*[TT]^j
☞a. pi					*	
c. p^ji		*!				
/ti/	IDENT-TTCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	*[TT]^j
a. ti			*		*!	
☞b. t^ji			*			*
c. tʃi	*!				*	
/ki/	IDENT-TTCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TBCL	CV-COORD-R	*[TT]^j
a. ki			*!		*	
b. k^ji			*!			
☞c. tʃi				*	*	

As stated earlier, although not attested in the languages in my sample, but predicted based on the generalizations, pattern (4.1 L) is found in Chaha, where alveolar consonants fully palatalize to palato-alveolars, and velar consonants acquire secondary palatalization (Leslau 1964, 1979, Rose 1994, 1997 Banksira 2000). Labial consonants do not palatalize. Some examples are given below, where the palatalization trigger is the *–i* suffix of the 2sg feminine imperative, absorbed as a result of palatalization. When the final consonant is labial, the suffix combines with the final vowel of the stem, so with the verb [nɨzəβ], the vowel /ə/ is fronted to [e]. [ɨ] is epenthetic.

(38) Palatalization in Chaha (Rose 1994:104)

2sg masc	2sg fem	
kɨft	kɨftʃ	'open!'
nɨkɨs	nɨkɨʃ	'bite!'
dɨrg	dɨrg^j	'hit!'
fɨrəx	fɨrəx^j	'be patient!'
nɨzəβ	nɨzeβ	'be flexible!' (vowel fronting)

Tableau 15. (4.1 L). Secondary palatalization of dorsals, full palatalization of coronals (Chaha)

IDENT-TBCL, *[Lips]^j >> CV-COORD-C(Tongue) >> IDENT-TTCL, CV-COORD-R >> *[TB]^j

/nzəβ-i/ 'be flexible!'	IDENT-TBCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[TB]^j
☞a. nɨzeβ					*	
b. nɨzeβ^j		*!				
/kft-i/ 'open!'	IDENT-TBCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[TB]^j
a. kɨft			*!		*	
b. kɨft^j			*!			
☞c. kɨftʃ				*	*	
/drg-i/ 'hit!'	IDENT-TBCL	*[Lips]^j	CV-COORD-C(Tongue)	IDENT-TTCL	CV-COORD-R	*[TB]^j
a. dɨrg			*		*!	
☞b. dɨrg^j			*			*
c. dɨrdʒ	*!					

To conclude, the five patterns which show both full and secondary palatalization are modeled by different ranking permutations of the constraints proposed in this chapter. These patterns are summarized in the table below, with the relevant constraint rankings indicated.

Table 4.6 Mixed palatalization patterns

	Labial	Coronal		Dorsal		Relevant Rankings and Examples
	Sec	Full	Sec	Full	Sec	
E	x	x		x		CV-COORD-C(Tongue) >> IDENT-TBCL, IDENT-TTCL, CV-COORD-R >> *[Lips]^j n/a in sample
F	x	x			x	IDENT-TBCL >> CV-COORD-C(Tongue) >> IDENT-TTCL , CV-COORD-R >> *[Lips]^j n/a in sample
G	x		x	x		IDENT-TTCL >> CV-COORD-C(Tongue) >> IDENT-TBCL, CV-COORD-R >> *[Lips]^j Bulgarian
K			x	x		IDENT-TTCL, *[Lips]^j >> CV-COORD-C(Tongue) >> IDENT-TBCL, CV-COORD-R n/a in sample
L		x			x	IDENT-TBCL, *[Lips]^j >> CV-COORD-C(Tongue) >> IDENT-TTCL, CV-COORD-R n/a in sample but attested in Chaha

The types of palatalization patterns presented in this section can all be expected, and predicted, by referring to the articulators used to produce the sounds involved in palatalization, the lips and the tongue. The OT approach is a straightforward method of modeling these patterns, but the crucial generalizations are captured by grounding the OT constraints in the physical properties of the speech articulators and considering the limits of gestural coordination (see also Kochetov 2002, Gafos 2002, Davidson 2004, Adler 2006 among others who have used OT and various models of Articulatory Phonology). OT shows how different palatalization patterns are obtained from grammars which differ in the ranking of the same set of universal constraints — in the case at hand, constraints which encode information about the gestural properties of sounds and gestural coordination. In the next section I provide a brief discussion of one aspect of palatalization targets which is linked to more than the properties of adjacent gestures: morphological vs. phonological context.

4.2.6 Morpho-phonological vs. phonological palatalization contexts

In Chapter 2, palatalization patterns were identified according to morpho-phonological (e.g. before –*i* suffix, or root-initially before -*i*) vs. purely phonological (e.g. before any –*i*) contexts. For full palatalization the context does not make a difference, as coronal and dorsal consonants show full palatalization independently or together in either context, and labial consonants never show full palatalization. However, the situation is slightly different for secondary palatalization. As summarized in (8) earlier in this chapter, dorsal consonants can show secondary palatalization independently only in phonological contexts. I did not find independent cases of dorsal secondary palatalization in morpho-phonological contexts. In such contexts, dorsal secondary palatalization appears to be dependent on the palatalization of coronal consonants (whether coronals palatalize fully or secondarily in the same context as the dorsals). There seems to be an implicational relationship such that if dorsals show secondary palatalization in a morpho-phonological context, then coronals will also show some kind of palatalization in that same context: *dorsal > coronal*.

This implicational relationship is somewhat unexpected since there are very few differences overall when it comes to coronal and dorsal palatalization. Of course, it is possible that this is a false generalization, representing an accidental gap, and that there are languages attested where the only consonants that show palatalization are dorsals, and they show secondary palatalization in morpho-phonological contexts. However, I believe that this is not the case, and that there is an explanation for the pattern.

There are only six languages/dialects where dorsal consonants show secondary palatalization only in morpho-phonological contexts, and eighteen languages/dialects where dorsals show secondary palatalization in purely phonological contexts (see Table 1 of Appendix 2). In contrast, there are nine languages/dialects where dorsals show full morpho-phonological palatalization, and 15 languages/dialects where dorsals show full phonological palatalization. This is summarized in the table below.

Table 4.7 Dorsal palatalization (summary)

	Morpho-phonological	Phonological	Total Full/Sec
Full	9	15	**24**
Secondary	6	18	**24**
Total MP/P	**15**	**33**	

The above table indicates that when comparing full with secondary palatalization regardless of context there is no difference (24 full to 24 secondary). However, the table also shows that overall, dorsal consonants are more likely to palatalize in phonological contexts (33 to 15). I put forward the hypothesis that the prevalence of dorsal—velar—palatalization in phonological contexts is closely connected to the fact that velar consonants and the palatalization triggers are both articulated with the same subarticulator, the tongue body, leading to the well attested process of velar fronting, and this would happen regardless of the morphological source of the palatalizing trigger (e.g. any *i* or a suffix –*i*). As a result, there will be more cases of phonological velar palatalization than of morphological palatalization.

Within phonological contexts whether the outcome is full or secondary palatalization does not seem skewed one way or another (15 to 18), but within morphological contexts there seems to be a tendency for velars to show full palatalization (9 to 6)[73]. Table 4.8 provides the typical reported outcomes of the palatalization of velars *k* and *g*.

Table 4.8 Typical velar palatalization outcomes (see Appendix 5)

	Morpho-phonological	Phonological	Morpho-phonological	Phonological
	k		***g***	
Full	tʃ (5) c (1)	tʃ (8) c (7)	dʒ (4) ɟ (1)	dʒ (4) ɟ (5)
Secondary	kʲ (3)	kʲ (12)	gʲ (2)	gʲ (11)

[73] An additional factor—transcription—may play a role in distinguishing between velar secondary palatalization and velar full palatalization to a palatal stop (as opposed to a palato-alveolar affricate). Fronted velars are sometimes transcribed as palatal stops, and other times as secondarily palatalized velars, and it is possible that some of these are transcribed incorrectly, given that [kʲ] and [c], and [gʲ] and [ɟ] are very similar. Recall from chapter 2 that even for English there is not a consensus on the exact outcome of velar palatalization. There is general agreement that velars are fronted before front vocoids, as in the pronunciation of *coop* vs. *keep*. However, Mielke (2006) transcribes these fronted velars as palatal stops [c] and [ɟ], which would qualify as full palatalization, since there is a shift in the constriction location. Cavar (2004) transcribes secondary palatalization of Polish velars with palatal stop symbols, while Szpyra-Kozłowska (1995) transcribes them with secondary articulation; both authors refer to it as secondary palatalization. The transcription issue does not come into play when the velars palatalize to palato-alveolar affricates such as *tʃ* and *dʒ*, as these are perceptually further apart from both palatal stops and secondarily palatalized velars. Guion (1998) argues that velars followed by front vowels are acoustically and perceptually similar to palato-alveolars. However, intuitively it seems that there is a greater distinction between a palato-alveolar affricate and a velar stop then between a secondarily palatalized velar and a palatal stop.

The palatalization outcomes above support the claim that full palatalization is preferred within morpho-phonological contexts, particularly full palatalization to palato-alveolar affricates: five instances of *k* → *tʃ*, and four instances of *g* → *dʒ*. For both *k* and *g* there is one instance of a palatal stop outcome in a morpho-phonological context. On the other hand, there are more instances of secondary palatalization in phonological contexts than there are in morphological contexts, twelve instances of [k^j] and eleven instances of [g^j]. This suggests that secondary palatalization of velars will typically occur in phonological contexts, offering a partial explanation of the generalization that there are no independent cases of dorsal secondary palatalization in morpho-phonological contexts. There are just fewer potential such cases, since secondary palatalization of dorsals is primarily phonological, and furthermore because morphological palatalization may often be subsumed by phonological palatalization (due to velar fronting regardless of morphological status of trigger *i*).

The other side of the explanation comes from looking at the six languages where there is secondary palatalization in morpho-phonological contexts. In each of these languages, all consonants are affected in the respective morpho-phonological contexts. This is compatible with Bhat (1978) who found that secondary palatalization usually affects consonants at all places of articulation, although I have found that it also can affect coronal consonants alone. It seems then that the palatalization becomes an expression of the particular morphological information, regardless of the place of articulation of the consonant. Therefore, all consonants are going to show some type of palatalization in these contexts.

For example in Shilluk, all root initial consonants show secondary palatalization before the palatal glide [j]. As discussed in depth in chapter 3, in Moldavian and Standard Romanian, all consonants are affected by –*i* suffixes (they either assibilate or fully palatalize). Velar consonants /k/ and /g/ are fully palatalized before –*i* and –*e* initial suffixes (to [ʃ] and [ʒ] in Moldavian, and to [tʃ] and [dʒ] in SR), while in purely phonological contexts the same consonants show secondary palatalization. Similarly, in Polish all consonants show palatalization before a suffix that begins with a front vowel: coronals show full palatalization, labials show secondary palatalization, and dorsals show secondary palatalization before surface [i] and [e], and full palatalization before surface [ɨ] and [ɛ] (Cavar 2004). In Yagua a morpheme or word-final palatal glide triggers secondary palatalization on a following consonant regardless of its place of articulation (Payne and Payne 1990). Finally, in Zoque dorsals and labials show secondary palatalization, while coronals show full palatalization in the same contexts (Sagey 1986).

To sum up, there are two reasons why dorsal consonants do not seem to show secondary palatalization in morpho-phonological contexts independently. First, there is a general tendency for secondary palatalization of dorsals to occur in phonological contexts. And second, morpho-phonological palatalization typically affects all consonants in the languages where dorsal consonants are also affected. The combination of these two factors provide an explanation for the dependency of dorsal secondary palatalization on the palatalization of coronals in morpho-phonological contexts.

4.3 Conclusion

In this chapter I presented my proposal for accounting for the patterns of full and secondary palatalization revealed by the typological study. By adopting the framework of Articulatory Phonology (Browman and Goldstein 1986 et seq. among others) and making some stronger assumptions about the organization of gestures according to the primary articulator (tongue vs. lips), and by extending the notion of gestural blending to apply to tongue gestures in general, the analysis presented here captures the fundamentals of palatalization. The main contribution of this general study regarding the palatalization of labials, or rather its lack thereof when it comes to full palatalization, is straightforwardly predicted by referencing the coordination of tongue and lip gestures. Full palatalization is the result of gestural blending resulting from large temporal overlap of tongue gestures, while secondary palatalization is the result of minimal temporal overlap of tongue or lip/tongue gestures. Therefore, the behavior of the labials is expected.

I have shown that the various attested and predicted palatalization patterns can be modeled by using OT constraints which reference the gestural properties of palatalization triggers and targets and their coordination. These patterns are modeled by the ranking of the constraints which drive palatalization, CV-COORD-C(Tongue) (full palatalization) and CV-COORD-release (secondary palatalization) with respect to faithfulness constraints prohibiting changes in the constriction location of a gesture (IDENT-TTCL, IDENT-TBCL) or in superimposing a secondary palatal gesture onto a primary gesture (*SUPERIMPOSE and its three members, *[Lips]^j, etc.). For those languages where there is both full and secondary palatalization at the same place of articulation (cf. Table 4.2) there are additional constraints pertaining to factors such as constriction degree, which can account for the patterns.

With regard to the difference in palatalization patterns between morph-phonological and phonological contexts, I have suggested a possible explanation which is based on the findings of the typological study: dorsal consonants simply prefer to have (secondary) palatalization in phonological contexts, and they show secondary palatalization in morphological contexts when all other consonants palatalize as well. In the next chapter I turn to the discussion of palatalization triggers. I show that here, too, the gestural properties of the triggers are responsible for the implicational trigger hierarchies, just as the gestural properties of the targets were for the implicational target hierarchies.

CHAPTER 5

ANALYSIS OF PALATALIZATION TRIGGERS

In this chapter I address the issues surrounding palatalization triggers. As is the case with palatalization targets, I propose that a gestural account is best for explaining the trigger patterns. For ease of reference, the generalizations regarding these patterns are repeated below.

(1) Palatalization patterns (Triggers)

- the best palatalization triggers are high front vowels, particularly *i*.
- implicational hierarchy: *if lower front vowels trigger palatalization then so do higher front vowels.*
- implicational hierarchy: *if high central/back vowels trigger palatalization, then so do high front vowels.*
- high back vowels trigger palatalization only on coronal consonants.
- palatalization triggers typically follow the target (regressive palatalization)
- palatalization triggers are typically maintained if they are vowels; a palatal glide trigger may be deleted.

The chapter is organized as follows. In section 5.1 I discuss the distinction between the two seemingly identical palatalization triggers, *i* and *j*, since they do not behave identically in conditioning palatalization. I provide evidence that language-specific articulatory differences between *i* and *j* may be responsible for their asymmetric behavior. In section 5.2 I present an analysis of the implicational relationships established among palatalization triggers using gesturally based constraints similar to those introduced in chapter 4. Sections 5.3 and 5.4 address the position of the palatalizing trigger, particularly when this precedes the target, and the "fate" of the trigger, which sometimes creates opacity effects, respectively. Section 5.5 provides conclusions.

5.1 Distinguishing between *i* and *j*

As previously discussed, the best trigger of palatalization is the high front vowel *i*, followed closely by the glide *j* and other front vowels like *e*. Front vowels *i* and *e* are triggers more often than the palatal glide *j* (50 languages have *i*, 25 languages have *e*, 19 languages have *j*), but while there are languages in which only the palatal glide triggers palatalization, there are no languages in which only the mid front vowel *e* triggers palatalization. This is predicted by the implicational relationships presented in (1). In Chapter 2 I raised the issue of why the palatal glide *j* is not a palatalization trigger in all of the languages where it is present and in which *i* does trigger palatalization (50 languages in the palatalization sample have *j* in their inventory, and in only 19 the glide is a trigger). Here I discuss the possibility that the difference between *i* and *j* in their ability to condition palatalization often results from differences in the gestural properties of *i* and *j* in different languages.

In Browman and Goldstein's (1986 et seq.) terms, front vowels are produced with the tongue body at the constriction location (CL) [palatal] but have varying degrees of constriction depending on height. High vowels are also produced with the tongue body, having a constriction degree (CD) [narrow]. Thus, the best triggers of palatalization, *i* and *j*, being both front and high, have the features [palatal, narrow]. Browman and Goldstein hypothesize that what distinguishes *i* from *j* is their stiffness (duration that it takes for the articulator to reach its target). They suspect that there is a greater level of stiffness for a *j* gesture than for a *i* gesture, though this is not completely worked out in their proposal (Browman and Goldstein 1989:229). The traditional assumption of generative phonology that glides and vowels primarily differ due to syllable position has not been adopted in AP to my knowledge. In fact, Padgett (to appear) presents evidence that such a phonological distinction is unnecessary, and that glides and vowels differ in constriction degree[2]. In more recent AP literature there have been proposals for gestural differences due to syllable position effects, but these studies have looked primarily at positional variants (e.g. light vs. dark in English; Browman and Goldstein 1995, 2000, Gick 2003, Kochetov 2006).

The main articulatory features for the triggers are summarized below, following Browman and Goldstein (1986 et seq.), and Kochetov (2002). I give [u] as representative of the high non-palatal triggers, including [ʉ, ɨ], and [e] as representative of other non-high palatal vowels, such as [ɛ, æ]. To distinguish between the characteristics of *i* and *j* I indicate *stiffer* for *j*, to indicate that *j* is stiffer than *i*.

Table 5.1 Palatalization triggers

	Main oral articulator	Constriction Location (CL) and Constriction Degree (CD)
i	Tongue body	[palatal, narrow]
j	Tongue body	[palatal, narrow] stiffer
e	Tongue body	[palatal, mid]
u	Tongue body	[velar, narrow]

The triggers [i, j, e] all share the constriction location [palatal], and the high vocoids [i, j, u] have the constriction degree [narrow]. The best triggers, [i, j] have both of these attributes, [palatal, narrow], which implies that if both [i] and [j] are in a language where palatalization occurs they both should trigger palatalization. Nevertheless, this is not always the case, as discussed in chapter 2: six languages do not have *i* as a palatalization trigger, even though this is part of their sound inventory. In five of these there are no other vowel triggers, but rather the palatal glide alone is a trigger (English, Hungarian, Shilluk, Yagua, Zoque). In the sixth language, Mongolian, the trigger is a *preceding ai*-diphthong. Furthermore, in several of these languages there are additional factors which can provide a simple explanation for the lack of palatalization by *i*. For example in English, palatalization before *j* is not obligatory, but rather arises during casual or fast speech, and in Shilluk the vowel *i* is characterized as the most unstable vowel (Gilley 1992). In Yagua and Zoque the palatal glide can precede the trigger, and in both languages secondary palatalization has also been analyzed as metathesis rather than palatalization (Payne and Payne 1992 for Yagua, and Hume 2002 for Zoque, although Sagey 1986 analyzes the Zoque case as palatalization)[74]. Clearly, there must be additional factors which determine whether *i* and *j* will both trigger palatalization in the same language, besides the mere presence of *i* and *j* in the sound inventory of that language.

As it turns out, the search for what exactly distinguishes *i* from *j* is ongoing, and it is unlikely to result in a single characterization of *i* vs. *j* in all languages[75]. Hall, Hamann and Źygis (2004) propose a hierarchy of assibilation (t→ ts), not palatalization (t→ tʃ) whereby if *i* triggers assibilation, then so will *j*, making *j* the best assibilation trigger, and for the most part they find this to be cross-linguistically verified, at least for the assibilation of *t* and *d* (in their sample of 45 languages). Cases which do not follow the hierarchy require an explanation, and this is provided by exploring differences between *i* and *j*. These differences, which I discuss below, could be relevant for palatalization as well, thus explaining why *i* and *j* do not always trigger palatalization in the same language.

Hall, Hamann and Źygis (2004) first propose what has been assumed to generally be the case: that the glide is produced with a narrower constriction than the vowel. If, as in assibilation, the constriction degree is most important, it follows that if *i*, with a wider constriction, triggers palatalization, then so will *j*, with a narrower

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[74] In Zoque there is also full palatalization triggered by a preceding palatal glide, and the glide does not delete in such cases (Hume 2002). Wonderly (1951:117-8) treats the Zoque cases as metathesis followed by palatalization.

[75] Padgett (*to appear*) argues that glides and vowels are phonologically distinct, contrary to general assumptions that they are identical and that their realization is determined by syllable position (vocalic if nucleus, consonantal if not). Furthermore, Padgett proposes that it is useful to distinguish between two types of phonetic glides, semivocalic (e.g. [i̯]) and consonantal (e.g. [j]). The distinction between vowels and glides is claimed to be rooted in constriction degree, and it is motivated by cross-linguistic generalizations about palatalization and assibilation (p. 11; Chen 1973, Hall and Hamann 2003). These studies, particularly on assibilation, find that the palatal glide is a better trigger of consonantal changes like palatalization and assibilation, which is different from what I have found in my study, where *i* appears to be a better trigger. It is still an open question why *i* and *j* do not always behave the same in all languages with respect to consonantal changes (palatalization, assibilation).

constriction. Since these vocoids show different patterns in various languages, there must be something that accounts for such variation. Hall et al. discuss evidence which supports the idea that *i* and *j* may be articulatorily different in various languages. The possibilities for constriction degree are: (i) *j* is narrower than *i*; (b) *i* is narrower than *j*; and (c) there is no significant distinction between *i* and *j*.

X-ray evidence shows that in Polish (Slavic, Poland) the constriction is longer and narrower for *j* than it is for *i* (Wierzchowska 1971, cited in Hall et al. 2004:208), while for German (Germanic, Germany) X-ray tracings show that the two segments are articulated almost identically, the only difference being that for *j* the tongue front is raised just a bit further than for *i* (Wängler 1961, cited in Hall et al. 2004:209). Chitoran (2002b, 2003) shows that the same is true for (Standard) Romanian, where the difference between the glide and the vowel is not significant. Hall, Hamann and Źigys (2004) further mention that this interpretation of the articulatory differences between *i* and *j* is based on acoustic studies, so articulatory studies to test the difference between *i* and *j* are still needed (p. 210). Nevertheless, these findings suggests the possibility that *i* and *j* can be different enough in a given language that they will not both trigger assibilation (t→ ts).

The same conclusion can be extended to cases of palatalization (t→ tʃ). In palatalization both constriction degree and constriction location of the trigger are important, converging toward the highest and most front vocoid, *i*[76]. I speculate at this

[76] See also Wilson (2006) who states that [i] is the most front vowel, even more front than other front vowels, which suggests that the best palatalizing trigger may be just the most front one. Nevertheless, the fact that high vowels such as [u] can trigger palatalization, while mid front vowels such as [ø] do not, points to the role of height.

point that *i* and *j* may differ in constriction location as well, and even though *i* and *j* are both [palatal], it may be that in some languages one is articulated further forward than the other. While a definite answer to the question of what distinguishes *i* from *j* has yet to be provided, the above discussion serves as evidence to suspect that language specific differences in the gestural structure of the high front vowel *i* and the palatal glide *j* can determine whether they will both trigger palatalization.

In the next section I turn to the discussion of the implicational hierarchies of palatalization triggers. Keeping in mind the fact that *i* is the most common trigger of palatalization as found in the typological survey, as well as the above discussion regarding possible differences between *i* and *j*, I will primarily refer to the vowel as the prototypical trigger of palatalization.

5.2 Palatalization trigger hierarchies

The implicational hierarchies of palatalization triggers are explained in terms of the gestural properties of the sounds involved in palatalization. It is clear that a combination of both high and front ([palatal] and [narrow]) is optimal for triggering palatalization—the trigger "strives" to be both high ([narrow]) and front ([palatal]), hence explaining why *i* is the best trigger. Thus, if sounds sharing either [palatal] or [narrow] with *i* trigger palatalization, then sounds which share only one of these properties, and which have a value for the other which is closer to that of *i*, will do so as well. For example, if the high back vowel *u* triggers palatalization, and this shares [narrow] with *i*, than a high central vowel also will condition palatalization, since such a vowel also shares [narrow] with *i* but is also closer to the [palatal] feature of the *i*.

Although the constriction location for central vowels has not been formalized in AP as far as I am aware, I propose that such vowels are neither [palatal] nor [velar], but that they have no specified constriction location. By virtue of their being further forward than the [velar] *u*, they are closer to the [palatal] specification of *i*, but they are not themselves [palatal]. Similarly, when a lower front vowel such as [ɛ] triggers palatalization, because it shares [palatal] with *i* but has a wider constriction degree than [narrow], then other [palatal] vowels with narrower constriction degrees (higher front vowels) will also trigger palatalization. The figure below schematically represents these implicational hierarchies, showing how the palatalization triggers converge on *i*.

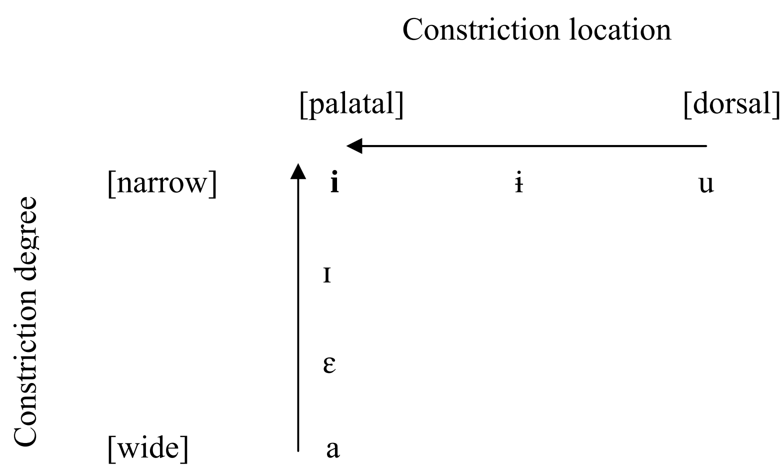

Figure 5.1 Palatalization triggers

Both implicational hierarchies can thus be expressed as follows: *Vocoid CL [palatal], Vocoid CD[narrow] > Vocoid CL/CD [palatal, narrow]*. This states that if a vocoid with a constriction location [palatal] (front vowels) or a constriction degree [narrow] (high vocoids) triggers palatalization, then so will one that has both of these features (high and front → *i*). The hierarchy holds asymmetrically, so if a [palatal, narrow] vocoid triggers palatalization we should not expect that [palatal] or [narrow] vocoids alone do so[77].

Although the discussion of [palatal] and [narrow] above suggests that having just one of the two properties makes for as good a trigger as having just the other, the palatalization survey indicates that this is not the case. There are few languages where high back vowels are triggers, and therefore where only [narrow] vowels are triggers, but *all* languages have front vowels as triggers, thus [palatal] vowels. This suggests that being [palatal] is a stronger indicator that a particular sound will be a palatalization trigger than being [narrow]. The fact that the best trigger *i* is both [palatal] and [narrow] attests to the importance of both properties and the ability to condition palatalization. The closer a sound is to both [palatal] and [narrow], the more likely it is for it to be a trigger, as shown in figure 5.1. At the same time, the fact that front vowels in general are better palatalization triggers attests to the superiority of [palatal] over [narrow] in this regard. This seems intuitively correct, as palatalization involves either shifting articulation toward the palatal region of the vocal tract or acquiring a secondary palatal articulation; therefore, we should expect that [palatal] matters more than [narrow]. This also explains why we see much fewer cases of high back vowels triggering palatalization, as these only have the feature [narrow], and also why we do not see languages where only vowels specified with [narrow] but not

[77] Expressing the two implicational hierarchies separately is unnecessary, since this one formulation captures them both. We could have *Vocoid CL/CD [dorsal, narrow] > Vocoid CL/CD [palatal narrow]* for the implicational relationship among high vocoids, and *Vocoid CD [wide] > Vocoid CD [mid] > Vocoid CD [narrow]* for the implicational relationship among front vocoids, but these separate formulations are captured by the single formulation referencing the pertinent features for palatalization, namely CL[palatal] and CD[narrow].

[palatal] trigger palatalization (e.g. languages where *u* triggers palatalization, but not *i*).

As the best triggers of palatalization are both [palatal] and [narrow], the selection of such triggers is a phenomenon similar to what is handled by local conjunction constraints (Smolensky 1995). These types of constraints have been designed to handle avoidance of the worst of the worst possible output (the most marked output). Local conjunction conjoins two markedness constraints into a single constraint, and violating both conjuncts is worse than violating either of the individual constraints separately. To illustrate I will use the example of syllable-final devoicing in German (Germanic, Germany), as in /bund/ → [bunt] 'league' (Itô and Mester 1996). Voiced obstruents like [d] are universally marked, and this markedness can be expressed through a markedness constraint such as *[+voice, -sonorant]. In addition, syllable codas are marked, which is expressed through the markedness constraint NO CODA (a violation for each coda consonant). A constraint conjoining these two markedness constraints penalizes outputs that have voiced coda obstruents, thus the optimal outcome is one that devoices the obstruent when in coda position (constraints such as MAX—no segment deletion, and IDENT(voice)—no voicing changes— are used to eliminate other candidates). The effects of the local conjunction constraint are illustrated in the tableau below (from Itô and Mester 1996):

Tableau 1. Local conjunction in German

/bund/ 'league'	MAX	**NO CODA & *[+voi, -son]**	NO CODA	IDENT(voice)	*[+voi, -son]
a. bund		*!	**		**
b. bun	*!		*		*
☞c. bunt			**	*	*
d. punt			**	**!	

The selection of the best palatalization trigger can be predicted using a similar approach, only this time the conjunction constraint selects *the best of the best* (trigger) rather than rule out the worst of the worst.

The constraints which are responsible for the trigger patterns are defined below. The first two constraints, in (2) and (3), favor palatalization triggered by either high (CD [narrow]) or front (CL [palatal]) vowels. Notice that *i* is subsumed under both constraints, as it is both [narrow] and [palatal]. The third constraint, defined in (4), refers specifically to *i* as the palatalization trigger and is a conjunction of the previous two constraints. This constraint would be violated only when both of its conjuncts are violated, namely when a vocoid that is neither [narrow] nor [palatal] triggers palatalization (for example, [o]). All three constraints are more specific cases of the CV-COORD constraints discussed earlier, yet they are general enough to capture the fact that the best triggers of palatalization are high front vocoids. They do not specify gestural landmark alignment in terms of center or release phases, but only that the vocoid gesture which temporally overlaps with the consonantal gesture must have CL [palatal], CD [narrow], or both.

(2) CV-COORD [palatal]
CV[pal]

ALIGN (α landmark of C-gesture with onset landmark of V-gesture with CL[palatal]).

This constraint favors palatalization when the following vocoid is [palatal], namely front vowels (and the palatal glide), and is thus violated by [Ci] or [Ce] sequences with no palatalization.

(3) CV-COORD [narrow]
CV[nar]

ALIGN (α landmark of C-gesture with onset landmark of V-gesture with CD[narrow]).

This constraint favors palatalization when a consonant is followed by a high vocoid, with a [narrow] constriction degree. This includes high vowels (and the palatal glide). CV[nar] is violated by [Ci] and [Cu] sequences. Furthermore, since [narrow] back vowels trigger palatalization only on coronal consonants but not on dorsals, it follows that this constraint has little effect on dorsal consonants (c.f. section 2.7.1.1).

(4) CV-COORD [palatal, narrow]
CV[pal, nar]

ALIGN (α landmark of C-gesture with onset landmark of V-gesture with CL[palatal] and CD[narrow]).

This is a conjoined constraint that is violated by [Ci] sequences where the consonant and vowel gestures do not coordinate. This constraint captures the generalization that [i] is the best trigger of palatalization. Given that [i] is both [narrow] and [palatal], and that the other common triggers of palatalization are either [narrow] or [palatal], the conjoined constraint would never be violated unless [i] itself does not trigger palatalization.

The constraints in (2) through (4) above seem to suggest that the result of palatalization will be different in each case. Thus, when consonant gestures coordinate with a vocoid with a [palatal] constriction location that consonant will fulfill this requirement by surfacing as one sound, and when that same consonant coordinates gestures with those of a vocoid with a [narrow] constriction degree it will surface as another sound. This does not appear to be true. It turns out that while each trigger promotes gestural coordination based on a particular CL or CD, coordination is often satisfied by the same output, or by a limited number of outputs that share some set of features. Therefore, a consonant such as [k] that is subject to full palatalization will correspond to a surface [tʃ], a palato-alveolar affricate, or [c], a palatal stop, whether it appears before [e] or [i] in a given language.[78] Similarly [t] fully palatalizes to [tʃ], and less commonly to [c] before [i] or [u] (see Appendix 5). This suggests that when gestures blend in full palatalization they will converge on certain outputs regardless of whether the vocoid gestures are either CD [narrow] or CL [palatal]. The table below illustrates some instances of gestural blending.

[78] Different languages show different palatalized consonants that result from palatalization. Language particular constraint rankings will determine the exact palatal consonant result of palatalization, but in each case the prediction is that the same underlying consonant will have a consistent surface form as a result of palatalization.

Table 5.2 Full palatalization resulting from gestural blending

Target	Trigger	Outcome	Palatalization
t [alveolar, closed]	***i*** [palatal, narrow]	***tʃ*** [alveo-palatal, closed-critical] ***c*** [palatal, closed]	Full
	u [velar, narrow]		
k [velar, closed]	***i*** [palatal, narrow]	***tʃ*** [alveo-palatal, closed-critical] ***c*** [palatal, closed]	Full
	u [velar, narrow]	? ***x*** [velar, critical] ? ***kx*** [velar, closed-critical]	N/A

As shown above, when [alveolar, closed] (*t*) combines with [velar, narrow] (*i*) the resulting gesture can be either [alveo-palatal, closed-critical] (*tʃ*) or [palatal, closed] (*c*). These both represent true blends, where some feature of the trigger and the target gestures is preserved in the resulting gesture. When [alveolar, closed] (*t*) combines with [velar, narrow] (*u*), the resulting gesture [alveo-palatal, closed-critical] (*tʃ*) has shifted backward toward the velar constriction location, but it has not become velar. The constriction degree represents a true blend. This type of blend from the gestures of *t* + *u* can be explained by the fact that as the tongue body raises to execute the narrow velar constriction it pulls the tongue tip slightly, and the tongue tip executes its gesture at a constriction location further back—at the alveo-palatal region. Furthermore, the [narrow] constriction of the vowel gesture causes the preceding consonantal gesture to have both a [closed] and a [critical] value. The [closed] value is provided by the consonant target gesture itself, and the [critical] value is the combination of [closed] (from *t*) and [narrow] (from following high vowel), which translates into an even narrower constriction, characteristic of fricatives. Hence, the *tʃ* outcome.

Similarly, when [velar, closed] (*k*) combines with [palatal, narrow] (*i*), either [palatal, closed] (*c*) or [alveo-palatal, closed-critical] (*tʃ*) can be the result of gestural blending (cf. discussion in chapter 4 on *tʃ* outcomes for *k* palatalization; Lee 1999, 2000). On the other hand, palatalization of *k* before *u* is unlikely, as both gestures have the same constriction location [velar]. There is no pulling (or pushing) toward a more palatal constriction location in this case, and not even a secondary palatal articulation could result from this. The velar could weaken to a fricative or it could have labialization, but neither of these outcomes are palatalization. This explains why coronal consonants can show palatalization both before high front and before high back vowels, while dorsal consonants can only do so before front vowels.[79]

5.2.1 Palatalization trigger hierarchies in OT

Different ranking permutations of the constraints in (2) through (4) with respect to each other and faithfulness constraints, such as IDENT-TTCL and IDENT-

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[79] This pattern raises an interesting question: since [u] does not trigger palatalization on dorsals, can we predict that coronal consonants would pattern with labial consonants and show palatalization before [u] to the exclusion of dorsals? As labials do not palatalize at all in any of the languages where high back vowels are triggers, I cannot determine whether this is indeed possible. However, if it is true that labials and coronals would show palatalization in a given language before [u], I would argue that dorsals would also show palatalization in that language, but before [i]. As predicted by the trigger hierarchy, if [u] triggers palatalization in a given language, then so will [i], and I would expect that dorsals would palatalize in this context if labials and coronals palatalized before [u]—and also before [i]. Furthermore, I would predict that both labials and coronals would show secondary palatalization in this case.

TBCL, introduced in the previous sections, model a number of typologies of palatalization triggers. Recall that each of the IDENT constraints is violated by a change in constriction location of a tongue body gesture (IDENT-TBCL) and a tongue tip gesture (IDENT-TTCL). Because here I am interested only in modeling the palatalization triggers implicational hierarchies, and not the different places of articulation of the targets, I will subsume both faithfulness constraints under one, IDENT-CL (constriction location).

Below I explore the different possibilities of ranking the constraints in (2) through (4) and IDENT-CL, and evaluate the predictions each ranking makes with respect to palatalization triggers. Table 5.3 summarizes these possible constraint rankings and predictions, and also provide examples of languages where such patterns are attested.

Table 5.3 Trigger hierarchies patterns

	Ranking	Outcome	Examples
A	**IDENT-CL** >> CV[pal, nar] >> CV[pal], CV[nar]	No palatalization	Babungo, Noon, Djingili, Mundari, and others
B	CV[pal, nar] >> **IDENT-CL** >> CV[pal], CV[nar]	Only high front vocoids triggers palatalization (i) (j) or (i, j)	English, Hungarian, Luvale, Dhivehi, Marathi, Nishnaabemwin, Shilluk, Somali, Swahili, Yagua, Zoque, and others
C	CV[pal, nar], CV[nar] >> **IDENT-CL** >> CV[pal]	Only high vocoids trigger palatalization (i, u) or (i, j, u)	Sentani
D	CV[pal, nar], CV[pal] >> **IDENT-CL** >> CV[nar]	Only front vocoids trigger palatalization (i, e) (or i, j, e)	Amharic, Hausa, Mwera, Romanian, Polish, Yurak (Nenets), Breton, Bulgarian, Eastern Ojibwa, Fanti, Koromfe, So, Turkish, others
E	CV[pal, nar], CV[pal], CV[nar] >> **IDENT-CL**	Both high and front vocoids trigger palatalization (i, e, u) or (i, j, e, u)	Tohono O'Odham, Coatzospan Mixtec (women's speech), Maori

Let me begin with the first pattern (5.3 A), where no vocoids trigger palatalization, characteristic of languages such as those listed in the table. The ranking of IDENT-CL above the coordination constraints results in no palatalization, and all consonants surface faithfully, as illustrated in the following tableau.

Tableau 2. (5.3 A) No palatalization

IDENT-CL >> CV[pal, nar] >> CV[pal], CV[nar]

/ti/	IDENT-CL	CV[pal, nar]	CV[pal]	CV[nar]
☞ a. ti		*	*	*
b. tʃi	*!			
/te/	IDENT-CL	CV[pal, nar]	CV[pal]	CV[nar]
☞ a. te			*	
b. tʃe	*!			
/tu/	IDENT-CL	CV[pal, nar]	CV[pal]	CV[nar]
☞ a. tu				*
b. tʃu	*!			

The second pattern in (5.3 B), ranking CV[pal, nar] above the faithfulness constraint IDENT-CL, characterizes a grammar where high front vocoids, such as *i* and *j*, will trigger palatalization, as in English (Germanic, USA), Shilluk (Nilo-Saharan, Sudan), Luvale (Niger-Congo, Zambia), and other languages (of course, we need to keep in mind the possible differences between *i* and *j*, and why both vocoids do not always trigger palatalization even in a language with this constraint ranking, such as English). In Luvale coronal consonants [t, n, nd, s, z] are fully palatalized by a following *i* or *j*, as shown below in (5), and further modeled in tableau 3:

(5) Palatalization in Luvale (Horton 1949):

olozjetu		→	oloʒetu	'but we'
-ɲina	'climb'		-ɲiɲisa	'climb' (causative)
-hita	'pass'		-hitʃisa	'pass' (causative)

Tableau 3. (5.3 B)Trigger: [i], [j] or [i, j]

(Luvale)

CV[pal, nar] >> **IDENT-CL** >> CV[pal], CV[nar]

/oloz**j**et**u**/ 'but we'	CV[pal, nar]	IDENT-CL	CV[pal]	CV[nar]
a. olozjetu	*! (j)		* (j)	** (j, u)
b. olozjetʃu	*! (j)	*		
c. oloʒetʃu		**!		
☞d. oloʒetu		*		
/mande/ 'fields'	CV[pal, nar]	IDENT-CL	CV[pal]	CV[nar]
☞a. mande			*	
b. mandʒe		*!		

As this tableau illustrates, being only [narrow] or only [palatal] is not sufficient to trigger palatalization, as this would include [u] and [e]. The palatalizing trigger must be both [palatal] and [narrow], namely [j] in this example.

Languages in which the palatalization triggers are only [narrow] vocoids, [i, j] as well as high vowels that are further back, such as [u], rank CV[nar] above IDENT-CL, as in pattern (5.3 C). This type of language is not very common, although it is attested, as discussed in chapter 2 (c.f. section 2.7.1.1). Of the languages in my sample where [u] triggers palatalization (Tohono O'Odham, Coatzospan Mixtec, Maori, and Sentani), Sentani is the only one where only high vocoids trigger palatalization. In the other three, front vowels and high vowels both trigger palatalization. Some examples from Sentani are given in (6), but there were no examples provided with palatalization triggered by [u].

(6) Palatalization in Sentani (Cowan 1965):

awəjjajde	→	awəj**dʒ**aj**d**ʲe	'they are rowing all the time'
əhoj-je	→	əhoj-**dʒ**e	'do not kill!'
kejnəhi	→	kɛj**ɲ**əhi	'throw it away'

The pattern in (5.3 C) can be obtained by ranking CV[pal], militating against CV-coordination with only front vowels, below IDENT-CL, as illustrated below.

Tableau 4. (5.3 C) Triggers: [i, j, u]

CV[pal, nar], CV[nar] >> **IDENT-CL** >> CV[pal]

/ti/	CV[pal, nar]	CV[nar]	IDENT-CL	CV[pal]
a. ti	*!	*		*
☞b. tʃi			*	
/tu/	CV[pal, nar]	CV[nar]	IDENT-CL	CV[pal]
a. tu		*!		
☞b. tʃu			*	
/te/	CV[pal, nar]	CV[nar]	IDENT-CL	CV[pal]
☞ a. te				*
b. tʃe			*!	

The converse of this ranking, where CV[nar] is lowly ranked is found much more commonly. This describes the pattern in (5.3 D), where only front vowels trigger palatalization. In Standard Romanian (Romance, Romania), velars /k, g/ palatalize to [tʃ] and [dʒ] before [i, e] suffixes, and when palatalization is triggered by a desyllabified word-final [i], this is realized as secondary palatalization on the consonant (Chitoran 2002a).

(7) Standard Romanian [k] palatalization:

/plak-e/	[platʃe]	‘like (3sg.)’
/plak-i/	[platʃʲ]	‘like (2sg)’
/plak-ut/	[pləkut]	‘like (past part.)’

This pattern is illustrated in the following tableau, where the low ranking of CV[nar] prevents [u] from triggering palatalization, as in candidate (b) for the past participle form of the verb ‘like’ *[plətʃut]. Moreover, recall that [k] is not expected to palatalize before [u] given the properties of the two gestures.

Tableau 5. (5.3 D) Triggers: [i, e]

(Romanian)

CV[pal, nar], CV[pal] >> **IDENT-CL** >> CV[nar]

/plak-i/ ‘like 2s’	CV[pal, nar]	CV[pal]	IDENT-CL	CV[nar]
a. plaki	*!	*		*
☞b. platʃʲ			*	
/plak-ut/ ‘like, past p.’	CV[pal, nar]	CV[pal]	IDENT-CL	CV[nar]
☞a. pləkut				*
b. plətʃut			*!	
/plak-e/ ‘like 3s’	CV[pal, nar]	CV[pal]	IDENT-CL	CV[nar]
a. plake		*!		
☞b. platʃe			*	

Finally, the pattern in (5.3 E), where all high vocoids and front vowels trigger palatalization, occurs in a language whose grammar ranks IDENT-CL at the bottom of the hierarchy, thus CV-coordination with both [palatal] and [narrow] vocoids must occur. Below I give some examples from Tohono O'Odham (Uto-Aztecan, Arizona and Mexico), where [t, d, n] palatalize before [i, e, u].

(8) Palatalization in Tohono O'Odham (Mason 1950:16-19):

/**de**/we-'ko'	[**dʒe**]we-'ko'	'remove hair'
va'/**tu**/m	va'[**tʃu**]m	'drown, dive'
co/**ni**/'-cu't	co[**n^{j}i**]'-cu't	'break by hitting with (smth. in) hand'

The constraint ranking for this pattern is illustrated in the following tableau, where the optimal candidates are those where the consonant preceding any of the high or front vowels are palatalized. Notice in the first example co[n^{j}i]'-cu't 'break by hitting with (something in) hand' the consonant *c* before [u] is already palatal, so it does not need to palatalize further.

Tableau 6. (5.2 E) Triggers: [i, e, u]

(Tohono O'Odham)

CV[pal, nar], CV[pal], CV[nar] >> IDENT-CL

co/ni/'-cu't 'break by hitting...'	CV[pal, nar]	CV[pal]	CV[nar]	IDENT-CL
a. co[ni]'-cu't	*!	*	*	
☞b. co[n^{j}i]'-cu't				*
va'/tu/m 'drown, dive'	CV[pal, nar]	CV[pal]	CV[nar]	IDENT-CL
a. va'[tu]m			*!	
☞b. va'[tʃu]m				*
/de/we-'ko' 'remove hair'	CV[pal, nar]	CV[pal]	CV[nar]	IDENT-CL
a. [de]we-'ko'		*!		
☞b. [dʒe]we-'ko'				*

In this section I showed that the patterns of palatalization triggers found in the palatalization survey can be modeled by various rankings of OT constraints which reference the trigger vocoid gestural properties relevant for palatalization, CL [palatal] and CD [narrow]. The constraint rankings capture the fact that the best palatalization trigger in any language is *i*, both [palatal] and [narrow]. As already discussed, when *i* does not trigger palatalization there are other language specific factors which explain its behavior, and moreover in such languages it is another [palatal, narrow] sound which does trigger palatalization, namely the palatal glide *j*.

In the next two sections I address two remaining issues regarding palatalization triggers: the position of the trigger with respect to the target, and the "fate" of the trigger, namely whether the trigger is overtly expressed or opaque. The latter of the two is an issue which will have to be investigated further than can be achieved in this dissertation, and this is especially so because different frameworks must make different assumptions regarding opaque triggers.

5.3 Position of the palatalization trigger

As discussed in detail in Chapter 2, the palatalization trigger typically follows the target, in a CV pattern, although in a few cases the trigger precedes the target or there are further requirements in order for palatalization to take place (see section 2.7.1.1). The typical pattern where the trigger follows the target is not at all surprising, as palatalization is a type of assimilation. In many types of segmental assimilation, such as voicing assimilation, nasal-place assimilation, and vowel harmony, regressive assimilation (where the segment on the right influences the one to its left) appears to be the norm.

For example, Lombardi (1999) shows that consonants in a cluster assimilate in voicing to the following consonant which she attributes to a positional faithfulness constraint (in a C_1C_2 cluster, the C_2 is likely to be the onset of the following syllable, and onset faithfulness must be maintained, leading to the assimilation of the previous consonant). In many languages, including English, nasals assimilate to the place of articulation of the following consonant (the well known homorganic nasal rule): [i**m**pɔsɪbl̩] in+possible 'impossible', [i**ŋ**kɔmpətənt] in+competent 'incompetent', [i**n**tɔlərabl̩] in+tolerable 'intolerable' (Kager 1999). In addition, Hyman (2002) observes that, other things being equal, right-to-left (regressive) vowel harmony is much more common than left-to-right (progressive) harmony (Hyman 2002, p. 16) [80]. Browman and Goldstein (1995) discuss syllable position effects on gestural coordination, and find that onset consonants have a stronger phasing relationship with the nucleus vowel than coda consonants do; therefore, onset consonants are more likely to be affected by the following nuclear vowel than by a preceding vowel (even a nuclear one). The same left-to-right assimilation holds for vowels; for example, the vowel nasalization rule in English applies to vowels before nasal consonants in the same syllable, once again a following segment influencing a preceding one (Cohn 1993).

[80] In the case of retroflex consonants the reverse seems to be true: the consonant affects the vowel, but still in a regressive fashion: before articulating a retroflex consonant the tongue is already preparing for the retroflex gesture, changing the configuration of the vocal tract, which affects the preceding sound.

Therefore, it is not surprising that, while progressive palatalization does happen in some languages, regressive palatalization is most common (42 of 56 languages included in the detailed discussion have regressive palatalization—West Greenlandic and Kokota have palatalization but were not included in the detailed discussion because of unclear type of palatalization, full or secondary). In nine languages the trigger precedes the target, in two languages it can either precede or follow the target, and in three languages the trigger typically follows but it sometimes can precede the target (cf. Chapter 2, section 2.7.2.1). The question then is how the two coordination constraints which drive full and secondary palatalization, CV-COORD (center) and CV-COORD (release) can account for palatalization in languages where the palatalizing trigger precedes the target.

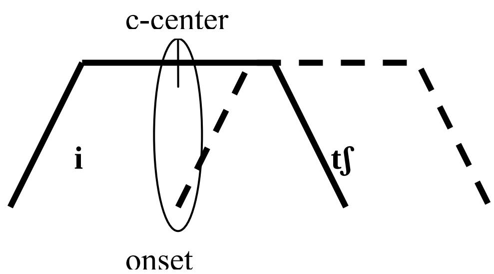
I propose that in languages with progressive palatalization the coordination constraints that drive palatalization are VC-COORD instead of CV-COORD, and that the landmark alignment for gestural coordination in VC-COORD constraints is different, since the vocalic gesture precedes that of the consonant. The assumption is that all languages have both types of constraints, but in those with progressive palatalization the VC-COORD constraints are ranked more highly. Of the nine languages where this is the case, eight have full palatalization and only one, Mongolian, has secondary palatalization. While I will not provide a full account of palatalization patterns utilizing VC-COORD constraints as I did with CV-COORD constraints in the earlier section, notice that replacing the type of coordination constraints (VC for CV) would produce the same overall patterns. In the diagrams below I present schematically how VC-coordination would produce full and secondary palatalization.

There are a few interesting facts to note about the cases of progressive palatalization. First, in all but one such case, Zoque, the trigger is maintained, so it appears on the surface, while for regressive palatalization the trigger can be “deleted”. In Zoque a preceding palatal glide triggers secondary palatalization on the consonant. However, in Zoque palatalization occurs in morpho-phonological contexts, and it expresses morphological information (e.g. /y-tatah/ → [t^jatah] ‘his father’). Not surprisingly, as discussed at various points in the dissertation, Hume (2002) treats the cases in Zoque as metathesis, while Sagey (1986) argues that it is palatalization with the glide surfacing as secondary articulation on the following consonant. Second, there tends to be full palatalization in this context. Once again, Zoque appears to be an exception, along with Mongolian, where there is secondary palatalization.

In full palatalization the preceding vocoid gesture is overlapped by the gesture of the following consonant, leading to the perception of a fully palatalized consonant. This is rather similar to what happens in full regressive palatalization, as there is a large overlap between the vocoid and the consonantal gesture in both cases, regardless of whether the vocoid follows or precedes the consonant. Thus, full progressive palatalization is defined and represented as below.

(9) *Full palatalization*: VC-COORD (center)

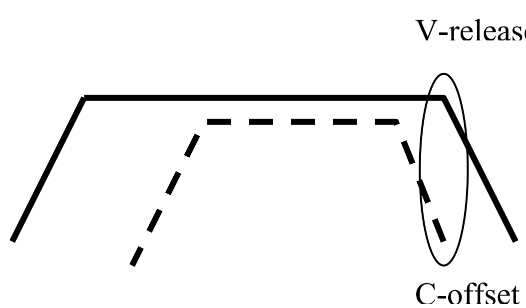
Align the onset landmark of the consonantal gesture (dotted line) *with the center landmark of the preceding vocoid gesture* (solid line).



For progressive secondary palatalization, the situation is different from that in regressive palatalization. In the latter the vocoid follows the consonant, and the V-gesture onset landmark is aligned with the release landmark of the preceding C-gesture, creating the effect of secondary palatal articulation. In the former case, however, the alignment cannot be the same, as the vocoid precedes the consonant. What appears to take place instead is that the vocoid gesture extends past the gesture of the consonant, thus appearing both before and after the consonant and also creating a secondary palatal articulation (see Gafos 1999).

(10) *Secondary palatalization*: VC-COORD (release)

Align release landmark of V-gesture (solid line) with the offset landmark of the following C-gesture (dotted line).



For those few languages where the trigger can both precede and follow the target, or where the presence of a palatalizing trigger alone is not enough to trigger palatalization (cf. section 2.7.1.1), there must be independent factors that play a role in gestural coordination. At this time I leave such cases for future study.

5.4 Trigger "fate"

A challenging issue arises when the palatalization trigger is opaque—not pronounced on the surface. As described in section 2.7.3 of chapter 2, while most palatalizing triggers are overt, some are not (particularly the palatal glide, or non-nuclear vowels). From a gestural standpoint this indicates that temporally the vocoid gesture is fully overlapped by the consonantal gesture and that its only surface realization is in the palatalization of the consonant. However, morphological and prosodic factors also appear to play an important role in determining whether a palatalizing trigger will appear overtly. I only provide a brief discussion of these factors below and suggest some ways that they could be integrated into the gestural account of palatalization. A detailed study and further investigation is necessary to fully understand and account for cases of opaque triggers, particularly how such cases can be analyzed in an OT framework.

Of the 56 languages included in the detailed discussion of palatalization, some trigger is 'deleted' in 19 languages[81] (see Appendix 4). In sixteen of these, glide or non-nuclear vowel triggers are 'deleted'. This suggests that prosodic factors are

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[81] In an additional language, Luganda, it is unclear whether the palatal glide trigger is deleted or maintained.

important: triggers are not deleted when needed to serve as syllable nuclei. However, when a syllable nucleus is provided otherwise, either by the addition of a V-initial affix (Dhivehi, Ikalanga), or by an already contiguous vowel (Greek, Mandarin, Mangap-Mbula, Western Shoshoni) the trigger vowel does not need to surface and is 'absorbed' into the target consonant. In the other three languages the situation is as follows. In Amharic (Ethio-Semitic, Ethiopia) and Romanian (Romance, Romania) the trigger *i* is deleted when it is a word-final suffix. In Romanian this has been treated as desyllabified *i* of the 2sg present indicative and the nominal plural marker (Chitoran 2002a). In Amharic this is the *–i* suffix of the the 2nd person feminine singular in the jussive, imperfect, and imperative, which also occurs in final position, where it is normally absorbed ('deleted'; Bender 1976). Finally, in Tswana (Southern Bantu, Botswana) the initial glide in palatalizing suffixes is often deleted, although this is obscured by the diachronic factors discussed in Chapter 3.

On the other hand, in 14 of the 19 languages in which the trigger is deleted, palatalization occurs in morpho-phonological contexts, suggesting that the presence of palatalization alone is sufficient to indicate the morphological information supplied by the trigger. This is particularly clear in the above-mentioned Amharic and Romanian. In only five languages does palatalization occur in phonological contexts—Yimas, Mandarin, Greek, Mangap-Mbula, and Western Shoshoni—and the last four of these are overlapping with the above languages where prosodic information seems important. In Yimas (Sepik-Ramu, Papua New Guinea), which shows full palatalization, both *i* and *j* are optionally maintained or deleted (Foley 1991).

Finally, since the disappearance of the palatalizing trigger suggests full temporal overlap, which would be possible with full palatalization even in the absence of morphological or prosodic factors, it is important to also look at whether these languages show full or secondary palatalization. As it turns out, 14 of the 19 languages have full palatalization, and five have secondary palatalization. Of these five, two are Mangap-Mbula and Mandarin, for which I have suggested above that prosodic factors may be important, and the other three, Hungarian, Shilluk, and Zoque, all show palatalization in morpho-phonological contexts—which suggests that there is an additional cue to allow for the recovery of the deleted palatalizing trigger.

To summarize, it appears that either a morphological or a (suprasegmental) phonological explanation exists when a palatalizing trigger does not appear on the surface. Although this type of opacity would be difficult to implement in an independent OT framework, Articulatory Phonology in OT stands in a better position to provide an explanation for it. As palatalization, and other phonological processes, results from the temporal overlap of adjacent gestures, it seems reasonable that full temporal overlap of these gestures could lead to the obscuring of the vocalic gesture (hence the 'deleted' trigger). What is less clear is how secondary palatalization can lead to the obscuring of the trigger, since secondary palatalization is characterized by the synchronization of the consonantal release landmark (at least for the more common regressive palatalization) with the onset of the vocoid gesture. This implies that the vocoid gesture cannot be completely overlapped with the consonantal gesture. However, it is possible that in addition to temporal overlap the vocoid gesture is shortened (reduced in temporal magnitude) due to the prosodic or morphological factors discussed here, in which case it could not be realized on the surface. To take one example, Yimas, where the trigger is optionally deleted or maintained, we might say that the degree of temporal overlap is variable for palatalization: it could be large, in which case full palatalization would result, and the trigger gesture would still be realized as a separate sound, or it could be complete, in which case the trigger would no longer be realized as a separate sound.

5.5 Conclusion

In this chapter I showed that the gestural account of palatalization employed to explain the patterns of palatalization targets in chapter 4 extends to the patterns of palatalization triggers. As the best trigger gesture is [palatal] and [narrow], all of the other triggers have gestures which aim to stay close to these two features. Thus, if a sound associated with a gesture with a more distant value for either the constriction degree [narrow] or the constriction location [palatal] is a palatalization trigger in a language, then it makes sense that any gestures with closer values for these tract variables (TBCL and TBCD) will also be a trigger. I also showed that while being both [palatal] and [narrow] is best, these two properties are not equal: being [palatal] alone is better than being [narrow] alone. This explains the rarity of high back vowel palatalization triggers and the abundance of languages where only front vowels trigger palatalization.

The various types of palatalization trigger patterns were modeled utilizing different permutations of OT constraints which are grounded in the gestural properties of the sounds involved in palatalization, the triggers and the targets. Furthermore, each constraint is motivated by the generalizations uncovered as a result of the typological survey. Of course, there are still issues which require further study. These include investigating the articulatory distinction between *i* and *j* as palatalization triggers (section 5.1), the gestural coordination in progressive versus regressive palatalization (section 5.2), and the role of morphological, prosodic, and perhaps other factors in the overt realization of the palatalization trigger (section 5.4).

CHAPTER 6

CONCLUSION

In this final chapter I sum up the main contributions of this dissertation and outline some questions and issues for further research which arose along the way and which I leave for future research.

Of previous crosslinguistic studies of palatalization (Bhat 1978, Hall 2000 on phonemic systems), Bhat's (1978) is the largest, and all subsequent researchers refer to his study as a point of departure in exploring palatalization. The current study contributes to this body of work in several significant ways. First, it is a study based on a balanced language sample. As emphasized in chapter 2, a balanced sample is crucial to the establishing of generalizations that might be called universal (if absolute universals in language are truly possible). Second, it is an in depth look at two processes, full and secondary palatalization, in 58 languages, and in addition this is also the first study that distinguishes between palatalization in morphological vs. phonological contexts. Doing so is significant. For example, the behavior of the labials which appear to be fully palatalized is only observed in morphological contexts. Furthermore, the study has confirmed the general claim that full labial palatalization is rare, and it has also shown that there are no significant differences regarding coronal and dorsal consonants (c.f. Chen 1973), unless one considers the fact that there are more languages which show coronal palatalization (although not significantly fewer languages which show dorsal palatalization).

The most important contribution of this thesis is the account of labial palatalization in general, and of 'full labial palatalization' in particular. This is the first study that explains the general dependency of labial palatalization on the palatalization of coronal and dorsal consonants. As discussed in detail in chapter 3, what has been referred to as full palatalization of labials is in fact not palatalization at all. I demonstrated that alternations of labials with palato-alveolars (or some other palatalized lingual sounds) are the synchronic reflexes of diachronic changes which involved hardening of a palatal glide following the labial, and subsequent labial deletion.

I argued that other approaches to palatalization fail to explain why palatalization takes place and why we would obtain the implicational relationships among palatalization targets and triggers (Sagey 1986, Clements 1989, Lahiri and Evers 1991, Hume 1994, Clements and Hume 1995). The formal account of palatalization that I proposed has greater explanatory power because it makes crucial reference to the oral articulators and how they interact during speech production. This account has implications for Articulatory Phonology and the extent to which gestures can interact, as well as for Optimality Theory and the types of constraints that can be used in conjunction with gestures.

Regarding AP, the analysis of full palatalization demonstrates that gestures must be allowed to blend (create a new gesture), whereas stronger versions of AP only allow gestures to temporally overlap, but not to change. In addition, referring to the tongue and the lips as separate articulators in using the framework of Articulatory Phonology is the most fruitful way to explain the palatalization patterns. Thus, this work brings supporting evidence for Browman and Goldstein's (1989) suggestion that a Tongue node is necessary (to subsume tongue tip, blade, and body).

This work has also raised a variety of questions and issues that are left for future research. I briefly discuss some of these here, and notice that they are primarily concerned with a language-by-language investigation of particular phenomena.

The first issue regards the potential articulatory distinction between the palatalization triggers *i* and *j*. In chapter 5 I presented evidence for their acoustic distinction and also distinction in degree of constriction, and I suggested that an articulatory difference in terms of constriction location may also exist in some languages. This would appear to be motivated by the fact that *i* and *j* behave asymmetrically with respect to palatalization, and since for a palatalization trigger being [palatal] is more crucial than being [narrow], it is possible that a difference exists in some languages with respect to the palatality of the high front vowel versus the glide. An articulatory study with speakers of languages where *i* and *j* show asymmetric behavior would be necessary to determine if this is indeed the case.

The second issue regards the distinction between a secondarily palatalized velar, a fronted velar, and velar palatalized to a palatal stop. As discussed in the dissertation, there is not always agreement as to how these sounds should be transcribed, even in English (is a fronted velar *k* always a *c*, or is it more like a *k*, but not quite palatal and not quite velar? Where is the line between velar and palatal drawn?). In a related vein, the distinction between a secondarily palatalized consonant and a consonant followed by a palatal glide should be investigated, on a language by language basis. It may be the case that the distinction is very clear in some languages, but not in others. This is why some cases of Zoque have been treated as secondary palatalization (Sagey 1986), or as metathesis (Hume 2002).

Third, I would like to test the prediction made in chapter 5 regarding the potential secondary palatalization of labials by the trigger *u*. The palatalization study revealed that *u* does not trigger palatalization on dorsal consonants, but it does on coronals. My explanation for this was that there is no compelling reason for *u* to trigger any kind of palatalization on dorsals given the gestural properties of velars and *u*. However, there does not seem to be an a priori reason for *u* not to trigger secondary palatalization on labials. Thus, the prediction is that in a language where *u* triggers palatalization on labials and coronals, dorsals are also expected to palatalize, but before a different trigger, namely *i*, in line with the trigger hierarchy (if *u* then *i*).

In conclusion, while there are still residual issues to be worked out as outlined above, the gestural account of palatalization employed in this thesis not only explains why palatalization occurs in the first place (it is the result of CV-coordination), but also why we would obtain the implicational relationships for place of articulation and palatalization triggers (by relating them to the major oral articulators and gestural properties).

Appendix 1. Language sample (117 languages, 86 genera)

Language	Genus	Area	Palatalization
Indonesian	Sundic (Indonesia)	Austronesia	Fronting
Karachay	Ponto-Caspian (Russia)	Eurasia	Fronting
Nepali	Indo-Aryan/Northern zone (Nepal)	Eurasia	Fronting
!Xóõ Bushman	Khoisan (Namibia)	Africa	NO
Andoke	Isolate (Colombia)	South America	NO
Arosi	Central-Eastern Oceanic (Solomon Islands)	Austronesia	NO
Babungo	Bantoid/Ring/North (Cameroon)	Africa	NO
Bali-Vitu	Western Oceanic/Meso Melanesian (Papua New Guinea)	Austronesia	NO
Bashkir	Turkic/Western (Russia-Europe)	Eurasia	NO
Bilua	East-Papuan (Solomon Islands)	Australia new Guinea	NO
Bisayan dialects	Central Philippine (Philipines)	Austronesia	NO
Bislama	English-based creole/Pacific (Vanuatu)	Australia New Guinea	NO
Canela-Krahô	Macro-Ge (Brazil)	South America	NO
Capanahua	Panoan (Peru)	South America	NO
Catalan	Romance/Ibero-Romance(Spain)	Eurasia	NO
Chamorro	Western MP/Chamorro (Guam)	Austronesia	NO
Cocopa	Hokan/Esselen-Yuman (Mexico)	North America	NO
Dholuo	Nilotic (Kenya)	Africa	NO
Djingili	West Barkly (Australia)	Australia New Guinea	NO
Duuŋidjawu	Australian (Southeastern Queensland)	Australia New Guinea	NO
Evenki	Tungus / Northern (China)	Eurasia	NO
Ewondo	Bantoid/Northwest (Cameroon)	Africa	NO
Finnish	Uralic/Finnic (Finland)	Eurasia	NO
Halkomelem (Musqueam)	Salishan(Canada)	North America	NO
I'saka	Papuan (Papua New Guinea)	Australia New Guinea	NO
Imbabura Quechua	Quechuan (Ecuador)	South America	NO
Javanese	Sundic (Indonesia-Java and Bali)	Eurasia	NO
Kannada	Dravidian/Southern /Kannada (India)	Eurasia	NO
Kashmiri	Dardic (India)	Eurasia	NO

Kilivila	Papuan Tip/Peripheral (Papua New Guinea)	Austronesia	NO
Lavukaleve	East-Papuan (Solomon Islands)	Australia New Guinea	NO
Loniu	Manus (Papua New Guinea)	Austronesia	NO
Ma'di	Central Sudanic (Uganda, Sudan)	Africa	NO
Manchu	Tungus /Southern (China)	Eurasia	NO
Mangarayi	Gunwingguan (Australia)	Australia New Guinea	NO
Masalit	Mabang (Sudan)	Africa	NO
Maung	Yiwaidjan (Australia)	Australia New Guinea	NO
Misantla Totonac	Totonacan (Mexico)	North America	NO
Mokilese	Ponapeic-Trukic/Ponapeic (Micronesia)	Austronesia	NO
Mong Njua (Green Miao)	Hmong-Mien (Laos, SW China, N. Vietnam)	Eurasia	NO
Mundari	Munda (India)	Eurasia	NO
Nengone	Central-Eastern Oceanic (New Caledonia)	Eurasia	NO
Noon	Cangin (Senegal)	Africa	NO
Ostyak	Yenisei Ostyak (Russia)	Eurasia	NO
Palauan	Western MP/Palauan (Palau and Guam)	Austronesia	NO
Pashto	Iranian/Eastern (Iran, Pakistan)	Eurasia	NO
Pirahã	Mura (Brazil)	South America	NO
Ponapean	Ponapeic-Trukic/Ponapeic (Micronesia)	Austronesia	NO
Puluwat	Ponapeic-Trukic/Trukic (Micronesia)	Austronesia	NO
Punjabi/ Panjabi	Iranian/Central zone (India)	Eurasia	NO
Rapanui	Central-Eastern Oceanic/ Central Pacific (Chile)	Austronesia	NO
Rotuman	West-Fijian Rotuman (Fiji)	Austronesia	NO
Sedang	Mon-Khmer (Vietnam)	Eurasia	NO
Tagálog	Meso- and Central Philippine (Philippines)	Austronesia	NO
Tamil	Dravidian /SouthernTamil-Kodagu(India)	Eurasia	NO
Tulu	Dravidian/Southern(India)	Eurasia	NO
Usarufa	Trans-New Guinea/Eastern (Papua New Guinea)	Australia New Guinea	NO
Woleaian	Ponapeic-Trukic/Trukic (Micronesia)	Austronesia	NO
Yidiɲ	Yidinic (Australia)	Australia New Guinea	NO
Amharic	Semitic (Ethiopia)	Africa	YES
Apalai	Carib/Northern (Brazil)	South America	YES
Basque	Basque (Spain)	Eurasia	YES
Breton	Celtic (France)	Eurasia	YES

Bulgarian	Slavic/South (Bulgaria)	Eurasia	YES
Carib	Carib (Guiana)	South America	YES
Coatzospan Mixtec	Oto-Manguean/Mixtec (Mexico)	North America	YES
Dakota	Siouan (USA)	North America	YES
Dhivehi	Maldivian (Republic of Maldives)	Eurasia	YES
Eastern Ojibwa	Algonquian (Canada)	North America	YES
Ejagham	Bantoid/Ekoid (Nigeria)	Africa	YES
English	Germanic (USA)	Eurasia	YES
Fanti	Akan (Ghana)	Africa	YES
Fongbe	Atlantic Creoles/Gbe (Benin and Togo)	Africa	YES
Hausa	Chadic (Nigeria)	Africa	YES
Hungarian	Uralic /Ugric (Hungary)	Eurasia	YES
Ikalanga	Bantoid/Shona (Zimbabwe, Botswana)	Africa	YES
Japanese	Japanese (Japan)	Eurasia	YES
Karok	Hokan (USA)	North America	YES
Kayardild	Tangic (Australia)	Australia-New Guinea	YES
Kokota	Western Oceanic/Santa Isabel/Central (Solomon Islands)	Austronesia	YES
Korean	Isolate (Korea)	Eurasia	YES
Koromfe	Gur (Burkina Faso)	Africa	YES
Limlingan	Non-Pama-Nyungan (unclassified) (Australia??)	Australia-New Guinea	YES
Luganda	Bantoid/Nyoro Ganda (Uganda)	Africa	YES
Luvale	Bantoid/Chowke-Luchazi (Zambia)	Africa	YES
Mandarin	Sino-Tibetan/Chinese (China)	Eurasia	YES
Mangap-Mbula	Western Oceanic/Vitiaz (Papua New Guinea)	Austronesia	YES
Maori	Oceanic (New Zealand)	Austronesia	YES
Marathi	Indo-Aryan/Southern zone (India, Israel)	Eurasia	YES
Mina	Chadic/Biu-Mandara (Cameroon)	Africa	YES
Modern Greek	Greek(Greece)	Eurasia	YES
Mongolian (Halh dialect)	Mongolian (Mongolia)	Eurasia	YES
Mwera	Bantoid/Yao (Tanzania, East Africa)	Africa	YES
Navajo	Athapaskan-Eyak (USA)	North America	YES
Nishnabemwin	Algonquian (Canada)	North America	YES
Nkore-Kiga	Bantoid (spoken in??)	Africa	YES
Nupe	Nupoid (Nigeria)	Africa	YES
Polish	Slavic/West (Poland)	Eurasia	YES
Romanian	Romance (Romania)	Eurasia	YES

Roviana	Western Oceanic/New Georgia/West (Solomon Islands)	Austronesia	YES
Sanuma	Yanomam (Brazil, Venezuela)	South America	YES
Sentani	Trans-New Guinea/Central and Western (Indonesia (Papua))	Australia-New Guinea	YES
Shilluk	Nilotic (Sudan)	Africa	YES
Sirionó	Tupí-Guaraní (Bolivia)	South America	YES
So	Kuliak (Fringe Cushitic, may be independent family)	Africa	YES
Somali	Cushitic (Somalia)	Africa	YES
Swahili	Bantoid/Central (Tanzania)	Africa	YES
Tiwa	Australian, Aboriginal (Northern Australia)	Australia-New Guinea	YES
Tohono O'Odham	Uto-Aztecan/Tepiman (USA)	North America	YES
Tswana	Bantoid/Sotho-Tswana (Botswana)	Africa	YES
Turkish	Turkic /Southern (Turkey)	Eurasia	YES
Watjarri	Wadjari (Australia)	Australia-New Guinea	YES
West Greenlandic	Eskimo-Aleut/Inuit (Greenland)	North America	YES
Western Shoshoni	Uto-Aztecan/Numic (USA)	North America	YES
Yagua	Peba-Yaguan (Peru)	South America	YES
Yimas	Sepik-Ramu (Papua New Guinea)	Australia-New Guinea	YES
Zoque	Mixe-Zoquean (Mexico)	North America	YES

Appendix 2. Palatalization patterns for each language

The shaded cells indicate that there is no palatalization at that place of articulation, parentheses mean optional palatalization, and a question mark indicates that for that place of articulation there is enough evidence to suggest that full palatalization is what takes place, but this is still unclear[1].

Table 1. Total palatalization (all languages)

	Labial				*Coronal*				*Dorsal*			
	Full		*Secondary*		*Full*		*Secondary*		*Full*		*Secondary*	
	mp	*p*	*mp*	*p*	*mp*	*p*	*mp*	*p*	*mp*	*p*	*mp*	*p*
Bulgarian				x				x		x		
Fanti				x				x		x		x
Luganda										x		
Nkore-Kiga										x		
Roviana										x		
Dakota									x			
Mwera									x			
Somali									x			
Apalai						x						
Basque						x						
Coatzospan-Mixtec						x		x				
English						x						
Fongbe						x						
Karok						x						
Korean					x	x						
Mina					x	x						
Mandarin				x		x		x	impossible			
Nupe				(x)		x		(x)				(x)
Sentani						x		x				
Tohono O'Odham						x	x					
Western Shoshoni						x						
Yimas						x						
Amharic (Addis Ababa)					x							

[1] The case included here is different from those in Andoke and Kashmiri, which were excluded from the palatalizing group, and also different from Kokota and West Greenlandic, which were included in the palatalizing group, but excluded from the detailed discussion. In Maori *t* palatalizes to *tç* before *i* and before final devoiced *i* and *u* (Bauer 1993). This may be acoustic effect of vowel devoicing, but it is not clear (Arvaniti 2006, personal communication).

Dhivehi					x							
Ikalanga					x							
Luvale					x							
Marathi					x							
Nishnaabemwin					x							
Yagua			x		x		x				x	
Breton						x				x		
Carib				x		x		x		x		
Greek (SM, C)						x				x		
Japanese						x				x		
Maori						x?				x		
Sanuma						x				x		
Amharic (Gonder)			(x)		x	x	(x)			x		
Amharic (Menz)				x	x			x		x		x
Amharic (Gojjam, Wello)				x	x	x		x		x		x
Hausa					x				x			x
Romanian (Standard)			x		x		x		x		x	x
Polish			x	x	x			x	x		x	x
Zoque			x		x						x	
Swahili					x				x			
Romanian (Moldavian)	~~x~~		x		x		x		x		x	x
Tswana	~~x~~				x				x	x		
Ejagham												x
Kayardild												x
Koromfe												x
Limlingan												x
Sirionó												x
So												x
Mangap-Mbula								x				
Tiwa								x				
Watjarri								x				
Hungarian							x					
Eastern Ojibwa								x				x
Navajo								x				x
Turkish								x				x
Mongolian				x				x				x
Shilluk			x				x				x	

Table 2. Full palatalization only (all languages)

	Labial		*Coronal*		*Dorsal*	
	Full		*Full*		*Full*	
	mp	*p*	*mp*	*p*	*mp*	*p*
Bulgarian						x
Fanti						x
Luganda						x
Nkore-Kiga						x
Roviana						x
Dakota					x	
Mwera					x	
Somali					x	
Apalai				x		
Basque				x		
Coatzospan-Mixtec (Women's speech)				x		
English				x		
Fongbe				x		
Karok				x		
Korean			x	x		
Mina			x	x		
Mandarin				x	impossible	
Nupe				x		
Sentani				x		
Tohono O'Odham				x		
Western Shoshoni				x		
Yimas				x		
Amharic (Addis Ababa)			x			
Dhivehi (Maldivian)			x			
Ikalanga			x			
Luvale			x			
Marathi			x			
Nishnaabemwin			x			
Yagua			x			
Zoque			x			
Breton				x		x
Carib				x		x
Greek (Standard Modern, Cypriot)				x		x
Japanese				x		x
Maori				x?		x
Sanuma				x		x
Amharic (Gonder)			x	x		x
Amharic (Menz)			x			x

Amharic (Gojjam, Wello)			x	x		x
Hausa			x		x	
Romanian (Standard)			x		x	
Polish			x		x	
Swahili			x		x	
Romanian (Moldavian)	x		x		x	
Tswana	x		x		x	x

Table 3. Secondary palatalization only (all languages)

	Labial		*Coronal*		*Dorsal*	
	Secondary		*Secondary*		*Secondary*	
	mp	*p*	*mp*	*p*	*mp*	*p*
Ejagham						x
Hausa						x
Kayardild						x
Koromfe						x
Limlingan						x
Sirionó						x
So						x
Coatzospan-Mixtec (Women's speech)				x		
Mangap-Mbula				x		
Sentani				x		
Tiwa				x		
Watjarri				x		
Hungarian			x			
Tohono O'Odham			x			
Eastern Ojibwa				x		x
Navajo				x		x
Turkish				x		x
Bulgarian		x		x		
Carib		x		x		
Mandarin		x		x	impossible	
Amharic (Gonder)	(x)		(x)			
Zoque	x				x	
Polish	x	x		x	x	x
Amharic (Menz)		x		x		x
Amharic (Gojjam, Wello)		x		x		x
Fanti		x		x		x
Mongolian		x		x		x
Nupe		(x)		(x)		(x)
Romanian (Standard)	x		x		x	x
Romanian (Moldavian)	x		x		x	x
Shilluk	x		x		x	
Yagua	x		x		x	

Appendix 3. Full and secondary palatalization at the same place of articulation within a single language. Only relevant consonants are shown.
MP indicates morpho-phonological contexts, P phonological contexts, FV front vowel.

Language	Coronal		Dorsal		Labial	
	Full	Secondary	Full	Secondary	Full	Secondary
Amharic (Gojjam, Wello) (P)	t’ d	s r	k k’ g	h		
Amharic (Gonder)	s (MP) others	s (optional, P)				
Amharic (Menz)	d (MP) others	d r (P)	k k’ g	h		
Carib	s (y)	t d r				
Coatzospan Mixtec (women’s speech)	*t nd* before *i e*	*t nd* before *ɨ u*				
Fanti			x→ ʃ/_nasalized FV	x→ x^j/_non-nasalized FV		
Hausa			w→ j	k g k͡		
Mandarin	dental affricates and *s*	others				
Nupe	fricatives, affricates	plosives (free variation)		plosives (free variation)		plosives (free variation)
Polish			1st, 2nd velar pal.; j-pal	surface velar pal. (MP) phrase level pal. (P)		
Romanian (Moldavian)	s z l	ʃ ʒ n l r	MP	P	MP (verbs) P ?	MP (nouns, other)
Romanian (standard)	s z l	d t ts ʃ ʒ tʃ dʒ l r n	k g (MP)	k g (P) h (MP)		
Sentani	n j	d				
Tohono O’Odham	t d	n				
Tswana					k k^h x (P) x, ŋ (MP)	
Yagua	s	t n r				

Appendix 4. Trigger fate

Language	Trigger maintained	Comments	Trigger deleted	Comments
Hungarian	(t^j, d^j, n^j) j	in post lexical (phonological) palatalization	j	in lexical (morphological) palatalization
Korean	i, y		j, hi, hj	
Luganda	i		j	unclear
Luvale	i		j	
Mandarin	i, y	nuclear V	j, ɥ	pre-nuclear vowels (become glides)
Shilluk			j	
Yagua			j	
Yimas	j, i	optionally	j, i	optionally
Zoque	j	before *t* in non-initial clusters	j	
Nishnaabemwin	i	nuclear V	i, j	non-nuclear V
Polish	i, e		j	
Swahili	i	unless in i+V seq.	j	part of -ja suffix, -a is maintained
Dhivehi			i	before V-initial affix
Greek	i, e	nuclear V	i	non-nuclear V
Ikalanga			i, e	via glide formation before another V
Mangap-Mbula			i	*i* triggers pal. if another vowel follows, which is maintained
Western Shoshoni	i, ai		i	if second member of vocalic cluster (optional)
Amharic	e, i		i	depending on dialect and context
Romanian (Moldavian)	i, e	if *i* comes from raised *e*	i, *j	final *i*, if desyllabified
Romanian (Standard)	i, e		i	final, if desyllabified
Tswana	-w, le-		j→ w	diachronic implications

Note: In Yagua the phonological process described is sometimes interpreted as metathesis, other times as palatalization. I interpret it as palatalization in which case the palatal glide triggers secondary palatalization and is deleted. Further evidence for this interpretation lies in the fact that the glide also triggers full palatalization of *s*. If interpreted as metathesis, the palatal glide would not be deleted, and something else would have to be said about *s* (Payne and Payne 1990).

Appendix 5. Palatalization targets and their outcomes

Table 1. Full palatalization

	Morpho-phonological	Phonological
	k→ tʃ (5) tʃ^{j} ʃ^{j} ʃ (2) (c)	k→ c (7) tʃ (8) ç (2) c^{j} c^{h} tʃ^{h}
	k'→ tʃ'	k'→ tʃ' (2)
	k^{h}→ tʃ^{h}	
		kw→ tʃ(^{w}) (Fanti)
	g→ dʒ (4) or tʃ dʒ^{j} ʒ^{j} ʒ (2) (ɟ)	g→ ɟ (5) dʒ (4)
		gw→ dʒ(^{w}) (Fanti)
DORSAL		nk→ ɲɟ (Cypriot Greek)
	ŋ → ɲ (Tswana)	ŋ→ ɲ (4)
		ŋ͡→ ɲ (Carib)
	x→ ʃ ʃ(w) ɕ (prepalatal, Polish)	x→ ç (3) x̺ (Carib) ʃ (2)
		ɣ→ ʒ ʝ (2)
	q→ tʃ	
	h→ ʃ(^{w})	h→ ç
CORONAL	t→ tʃ (13) c t^{Y}(alv-pal stop) tɕ (prepalatal affricate, Polish)	t→ tʃ (5) tç (Maori) c (2)
	t'→ tʃ' (5) (ejective)	t'→ tʃ' (2)
	t'→ tʃ' (tense t)	
	th→ tʃh	
	ts→ tʃ (2)	ts→ tç tʃ (4) (or ʒ W. Shoshoni) (or dʒ or ʒ--Sanuma)
		ts^{h}→ tç^{h}
		tts→ tʃʃ (čč, W. Shoshoni)
	d→ ɟ dʒ (10) tʃw (dʑ, dʒ Polish) d^{Y}(alv-pal stop)	d→ dʒ (7) ɟ
	dz→ dʒ	dz→ dʒ (2)
	dzh→ dʒh	
	s→ ʃ (12) ʃ^{j} ɕ (prepalatal fricative, Polish) (or tʃ, Yagua)	s→ ʃ (11) ç
	s'→ tʃ' (5) (ejective)	

	S→ ʃ (morphophoneme, Nishnaabemwin)	
		s’→ ʃ’ (tense s)
	z→ ʒ (10) dʒ ʒ^{j} ʑ (prepalatal fricative, Polish)	z→ ʒ (5)
	n→ ɲ (11) j n^{Y}(alv-pal stop)	n→ ɲ (7)
	nd→ nʒ ndʒ	
	N→ ʒ (reflex of PA *θ, Nishnaabemwin)	
	l→ j (9) dʒ (2) or tʃw	l→ ʎ (4) or ʝ
	r→ ʒ ʃ(w) or tʃh(w)	
		j (y)→ j (Carib; laminal semivowel, friction change)
		j→ dʒ (Sentani; prepalatal semivowel)
	p→ tʃ^{w} (Tswana)	
	ph→ tʃh^{w} (Tswana)	
	b→ dʒ^{w}w or dʒ or tʃ(^{w}) (Tswana)	
LABIAL	m→ ɲ(Ikalanga) m→ ɲ (Tswana-one ex.)	
	w→ j	
	f→ ʃ (Romanian, Moldavian)	
	v→ ʒ (Romanian, Moldavian)	

Table 2. Secondary palatalization

	Morpho-phonological	Phonological
DORSAL	k→ kʲ (3) tʃʲ ʃʲ	k→ kʲ (12) cʲ
		k’→ kʲ (ejective, Hausa)
		kk-→ kkʲ
		kp→ kpʲ
	g→ gʲ (2) dʒʲ ʒʲ	g→ gʲ (11)
		gb→ gbʲ
	ŋ→ ŋʲ	ŋ→ ŋʲ (2)
		ɣ→ ɣʲ
		x→ xʲ (4) ç (Tswana)
	h→ hʲ (4)	h→ hʲ (3)
	w→ wʲ	
	ʔ→ ʔʲ	
CORONAL	t→ tʲ (3) tsʲ	t→ tʲ (7)
	t̪→ t̪ʲ	t̪→ tʲ (2)
		tʰ→ tʰʲ (2)
	ts→ tsʲ	t͡s→ t͡sʲ
		tx→ txʲ
	tʃ→ tʃʲ	
	d→ dʲ (2) zʲ ʒʲ	d→ dʲ (7) (or tʲ--Sentani)
	d̪→ d̪ʲ	
	dʒ→ dʒʲ	
	s→ sʲ ʃʲ	s→ sʲ (4)
	ʃ→ ʃʲ (2)	ʃ→ ʃʲ
		ʃʃ→ ʃʃʲ
		z→ zʲ (2)
	ʒ→ ʒʲ (2)	
	n→ nʲ (6) nᵈʲ	n→ nʲ (6)
		n̪→ nʲ (2)
	l→ lʲ (3)	l→ lʲ (2)
		l̪→ lʲ
		ɮ→ ɮʲ
		ɫ→ lʲ wʲ (Polish)

	r→ r^j (3) d^j (Yagua)	r→ r^j (7) d^j (Carib)
	c→ c^j (Shilluk)	c^h→ c^{hj}
	ɟ→ ɟ^j (Shilluk)	
	ɲ→ ɲ^j (Shilluk)	
		j→ j^j (lamino-dental semivowel, Watjarri)
LABIAL	p→ p^j (6) p→ k^j (Romanian, Moldavian)	p→ p^j (8)
		p^h→ p^{hj} (2)
	b→ b^j (6) b→ g^j (Romanian, Moldavian)	b→ b^j (8)
	m→ m^j (6) m^{bj} m→ n^j (Romanian, Moldavian)	m→ m^j (6)
	w→ β^j (Yagua)	w→ w^j (3)
	f→ f^j (4)	f→ f^j (5)
	v→ v^j (3)	v→ v^j (3)

Appendix 6. Intermediate stages of ‘labial palatalization’ in Bantu (Guthrie 1970)

Table. 1 Intermediate stages in the palatalization of PB *p

Group	Language	PB	Meaning	Form	
Tumbuka	Tumbuka	*-píà-	‘new’	-pɕa	
Senga-Sena	Nyungwe			-psa	
Lenje-Tonga	Ila			-pya	
Bemba	Bemba (Wemba)			-pya	
Chopi	Tonga			-phya	
Nyanja	Maŋanja	*-pí-	‘become hot’ or ‘become burnt’	-pɕ-	
Bemba	Bemba (Wemba)			-py-	
Yao	Yao			-py-	
Umbundu	Mbundu			-py-	
Bemba	Bemba (Wemba)	*-píà-	‘burnt grass’	umu|pya	
Nyanja	Cewa (Peta)			lu|pŝa	
Shona	Manyika			ru|ps̯a	
Yao	Yao			u|pya	
Tumbuka	Tumbuka	*-píágid-	‘sweep’	-pɕeɽ-	
Nyanja	Cewa (Peta)			-pŝel-	
Yao	Yao			-pyāɟil-	
Kikuyu-Kamba	Kamba	*-pí̧ú	‘knife’	o|βyo	
Nyika-Taita	Kauma			ki|fyu	
Nyanja	Maŋanja	*-pí̧yò	‘kidney’	im|pɕo	
Yao	Yao			lu|pyo	
Luba	Luba-Katanga			lu|fyo	
Sotho-Tswana	S. Sotho (Suthu) (Lesotho, S.A.)	*-pú-	‘dry up’	-pɕh-	
Sotho-Tswana	S. Sotho (Suthu) (Lesotho, S.A.)	*-pùànj-	‘pound’ (verb)	-pɕhatl’	‘smash’

Tswa-Ronga	Tswa			-phyanhl	‘smash’
Sotho-Tswana	Pedi	*-puany-	‘pound’	-pçhany-	‘smash’
Nyanja	Cewa (Peta)			-pçany-	‘smash’
Shona	Zezuru			-pxany-	‘smash’
Nyanja	Maŋanja	*-píù	‘red’	pçu	

Table 2. Intermediate stages in the palatalization of PB *b

<table>
<tr><th>Group</th><th>Language</th><th>PB</th><th>Meaning</th><th>Form</th></tr>
<tr><td>Sotho-Tswana (N. Sotho)</td><td>Pedi</td><td>*-bí́á́</td><td>‘cord, strap’</td><td>le|βza</td></tr>
<tr><td>Umbundu</td><td>Mbundu (Nano)</td><td></td><td></td><td>u|βja</td></tr>
<tr><td>Tswa-Ronga</td><td>Tswa</td><td>*-bíád-</td><td>‘plant’</td><td>-bz̯al-</td></tr>
<tr><td>Kaonde</td><td>Kaonde</td><td></td><td></td><td>-βjāl-</td></tr>
<tr><td>Bemba</td><td>Bemba (Wemba)</td><td></td><td></td><td>-βjāl-</td></tr>
<tr><td>Bena-Kinga</td><td>Hehe</td><td></td><td></td><td>-ʋjāl-</td></tr>
<tr><td>Ruanda-Rundi</td><td>Ruanda</td><td>*-bį́ád-</td><td>‘bear’ (child)</td><td>-bɟār-</td></tr>
<tr><td>Ruanda-Rundi</td><td>Ha</td><td></td><td></td><td>-vzār-</td></tr>
<tr><td>Sotho-Tswana</td><td>S. Sotho (Suthu) (Lesotho, S. A.)</td><td>*-búà</td><td>‘dog’</td><td>m̄|pʃ’a</td></tr>
<tr><td>Shona</td><td>Manyika</td><td></td><td></td><td>im|bɣa</td></tr>
<tr><td>Chopi</td><td>Copi</td><td></td><td></td><td>m|bjwa</td></tr>
<tr><td>Maka-Njem</td><td>Mvumbo</td><td>*-bų́à
*-mbį́à</td><td>‘dog’</td><td>mbʑi</td></tr>
<tr><td>Maka-Njem</td><td>Niëm and Bajuɛ</td><td></td><td></td><td>mpįɛ</td></tr>
<tr><td>Ruanda-Rundi</td><td>Ruanda</td><td>*-búéd-
*-búíd-</td><td>‘tell’</td><td>-bgīr-</td></tr>
<tr><td>Ruanda-Rundi</td><td>Rundi</td><td></td><td></td><td>-bɣīr-</td></tr>
<tr><td>Tswa-Ronga</td><td>Tswa</td><td></td><td></td><td>-bjel-</td></tr>
<tr><td>Chopi</td><td>Copi</td><td></td><td></td><td>-gel-</td></tr>
</table>

Appendix 7. A case of apparent labial-palatalization: Ikalanga (Narrow Bantu, Zimbabwe)

It has also been proposed that labials fully palatalize in Ikalanga. However, Mathangwane (1999) uses the term palatalization to refer to “those changes caused by a palatal element, which could be either the front vowels /i, e/ or a palatal glide /j/. As a result, some of the segments derived by this process are palato-alveolar affricates (e.g. /t͡ʃ, d͡ʒ/) and the palatal nasal /ɲ/ while others have an alveolar place of articulation (e.g. / t͡s^{hw}, n͡dz^{w} /)” (p. 91). Therefore, the only labial that would qualify as being fully palatalized in Ikalanga is *m*, which palatalizes to *ɲ*. For *p, mb*, and *ʋ* the outcome is not palatalization. These sounds become alveolar affricates with labial release when the final vowel is *i* or *e* and the diminutive suffix *–ana* is attached. Some examples are provided below.

(1) Labial alternation in Ikalanga (Mathangwane 1999):

semé	se**ɲ**áná	‘small basket’
lu-límí	lu-lí**ɲ**áná	‘small tongue (uvula)’
kópi	ko**t͡s^{hw}**-áná	‘small cup’
fúpi	fu**t͡s^{hw}**-áná	‘shorter’
d̪ope	d̪o**t͡s^{hw}**-aná	‘small mud’
ŋ-kómbe	ŋ-kó**n͡dz^{w}**-áná	‘small water vessel’
simbe	si**n͡dz^{w}**-aná	‘small coal’
d̪áʋí	d̪a**d͡z^{w}**-áná	‘small branch (of tree)’

According to Mathangwane (1999), with the exception of velar palatalization, palatalization in Ikalanga is a fairly recent development when compared to other Bantu languages such as Tswana and Zulu. Proto-Bantu velar stops **k* and **g* became *tʃ* and *dʒ*, respectively, in Ikalanga: *-kéŋgid-a → tʃéndʒéla 'be wise' (Mathangwane 1999, p. 93). She further states that this type of process is common and can be seen in some changes of Proto-Bantu labials which are now alveolar affricates in Ikalanga:

(35) Proto-Bantu labials and their reflexes in Ikalanga (Mathangwane 1999):

*-pía	ts^{hw}á	'new'
*-biad-a	dz^{w}ál-a	'plant'

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