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Perspectives on palatalization

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In this article we provide a discussion of the definition of palatalization as a phonological phenomenon, its crosslinguistic variation, phonetic or functional grounding and phonetic (un)naturalness of palatalization, and theoretical approaches to palatalization patterns. After providing this background to the collection of articles in this special issue of *Glossa* we will give an overview of the contributions collected here.

Keywords: Phonology; palatalization; typology

1 Introduction

This paper surveys palatalization from various angles. We first discuss potential definitions of palatalization and will then provide a typological overview of palatalization across the world's languages, i.e., we will review in how far such patterns vary in the choice of triggers, targets and outputs. Then we will discuss the phonetics of palatalization and palatalization. From this we move on to theoretical repercussions of palatalization patterns for theories of phonological representation. Finally we link the papers of this special issue to the issues raised in the preceding sections.

The phonological phenomenon this special issue focuses on is widely attested in the world's languages and probably the most common phonological assimilatory process, maybe only second to nasal place assimilation, varying immensely in its phonological and morphological conditions cross-linguistically. Phonetically this phenomenon also shows a wide range of variation and it is not quite clear which patterns and processes should be subsumed under palatalization.

Some patterns show a palatal segment as the output in the presence of an adjacent palatal trigger. Consider the German *ach/ich* alternation (see e.g. Wiese 1996), in which we find a non-palatal fricative in the vicinity of a non-palatal vowel, i.e., [ax], and a palatal fricative in the vicinity of a palatal vowel, i.e., [ɪç], as in the following examples.

- (1) *German*
- | | | | |
|---------|------------------------|------------|-----------------------------|
| [bu:x] | <i>Buch</i> 'book' | [by:çə] | <i>Bücher</i> 'books' |
| [floχt] | <i>Flucht</i> 'escape' | [flyçtlɪŋ] | <i>Flüchtling</i> 'refugee' |
| [ho:x] | <i>hoch</i> 'high' | [høçstəns] | <i>höchstens</i> 'at most' |
| [lɔχ] | <i>Loch</i> 'hole' | [lœçə] | <i>Löcher</i> 'holes' |
| [baχ] | <i>Bach</i> 'stream' | [bæçə] | <i>Bäche</i> 'streams' |

In each example we see a velar or uvular fricative (depending on the tenseness of the preceding vowel) in the context of a back vowel on the left, and a palatal fricative if there is an unlauded and therefore front (or palatal) vowel on the right.

However, in many patterns it is only either the trigger or the result that is palatal. The output of the process varies considerably, while in the example above the fricative is articulated with a palatal place of articulation, the target might as well just have a secondary palatal articulation added or it might undergo a change in manner of articulation and place of articulation but not become palatal, as when /t/ or /k/ are realized as [tʃ] or [kʃ].

Under a broad definition that requires only either the trigger or the result to be palatal, some spirantization processes are included in the typology, such as t-assibilation (/t/ → [s]/_/i/). However, some such processes happen also in the presence of non-palatal vowels, as in Woleaian (Tawerilmang & Sohn 1984; Hall & Hamann 2006). Likewise, Bantu labial palatalization doesn't involve a palatal trigger. It changes a labial into a palatal in the presence of another labial (see Bennett & Braver 2015 and references there).

Very often the palatal trigger is only present at an abstract level of analysis and deleted or coalesced with the target at the surface, as in English post-lexical palatalization (e.g., *miss you* [mɪʃu:]).

There is wide variation in which segments act as triggers, as targets and which segments are the outputs of palatalization processes. This diversity will be discussed more thoroughly in the sections on typology and on phonetics.

After discussing such complicating matters, Bateman (2011: 589–590) divides palatalization into two types, full and secondary palatalization, with the following definitions.

(2) Definition (Bateman 2011: 549f)

Full palatalization: A consonant changes its primary place of articulation and often its manner of articulation, while moving toward the palatal region of the vocal tract when adjacent to a high and/or front vocoid.

Secondary palatalization: A consonant acquires a secondary palatal articulation when adjacent to a high and/or front vocoid.

This definition excludes a few of the options mentioned above. Spirantization, as in /t/ → [s] is excluded because it doesn't move the target towards the palatal area. Southern Bantu labial palatalization is excluded because it doesn't have a palatal vocoid as a trigger.

Many Norwegian dialects also show a form of palatalization that is not triggered by a high/front vocoid. Coronal consonant clusters and coronal geminate stops, nasals, and laterals are realized as palatals (Hanssen 2010). Many Italian palatals derive historically from combinations of dorsal and coronal consonants. In expressive palatalization (Kochetov & Alderete 2011; Urek 2016a) consonants are realized with full or secondary palatalization also without any overt trigger. All these instances of palatalization are excluded by this definition.

Unless we interpret Bateman's definitions to describe conditions at an abstract level of representation any palatalization process in which the trigger disappears is excluded as well. A literal interpretation of these definitions would lead to surprising analytic decisions. Consider the Italian verbal paradigm below.

- (3) *Italian*
- | | |
|------------|-------------|
| le[dʒ:e]re | 'to read' |
| le[g:o] | '(I) read' |
| le[dʒ:a]mo | '(we) read' |

The infinitive here counts as a case of full palatalization since there is a following palatal vocoid present, while the first person plural form is not considered palatalization, since there is no palatal vocoid in the form. However, there is one present at an abstract level,

as one can see from other verbs, e.g. *credere* ‘to believe’, the first person plural of which is *cre[dj]amo*. One can thus assume that the input for ‘we read’ is /leg: + iamo/ and there is a palatal present that causes affrication and fronting of the dorsal stop and disappears (for more on palatalization in Italian, see Krämer 2009).

While the disappearance of the trigger usually leads to full palatalization, Baltazani et al. (this issue) report on a hybrid process in Greek, which they term strengthened palatalization, that also results in the loss of the triggering vocoid.

Kochetov (2011: 1666) opens his overview article with an extremely similar, but slightly more permissive, definition of the term palatalization: “The term ‘palatalization’ denotes a phonological process by which consonants acquire secondary palatal articulation or shift their primary place towards or close to the palatal region. This *usually* [our emphasis] happens under the influence of an adjacent front vowel and/or a palatal glide.” Given this definition, the triggerless palatalization patterns discussed above are considered unusual, but are still cases of palatalization.

Alternatively, one could focus on the characteristic element of consonant-vowel interaction. Usually the trigger is a vocoid and the target a consonant. This is, no doubt, one aspect of palatalization that makes it interesting for the development of feature theories. However, for a definition of the phenomenon this would, again, result in a very narrow focus.

Palatalization processes have been formally analyzed in various ways, as we will see in Section 4. What very many have in common is that they see the process as feature spreading. If we choose a feature, say, [coronal] in Unified Feature Theory (Clements & Hume 1995) or the element |I| (see Tifrit & Voeltzel as well as Nasukawa, this issue, for element theoretic approaches) we arrive at a different phenomenology of palatalization again, because this would presumably locate the processes above that have a trigger in a class with vowel harmony of the Finno-Ugric type, i.e., palatal harmony.

From an optimality theoretic perspective one could follow the methodology of Pater (1999) who identified a markedness constraint, *NÇ, and then shows how this in interaction with various standardly assumed faithfulness constraints produces different repair strategies for inputs that have the marked structure. Kochetov (this issue) proposes a constraint *CJ and explores its typological limits (see as well Collins & Krämer, for a discussion of anti-palatalization as well as deletion and epenthesis as means to satisfy otherwise palatalization inducing constraints). The constraint can be invoked for some of the patterns mentioned above but not all of them. Furthermore its violation can be avoided in a range of ways, i.e. by deleting one of the two segments, inserting another segment between them, swapping their order etc. Intuitively the term palatalization would get semantically overstretched. In analogy to Pater’s *NÇ effects one could talk about *CJ effects rather than a uniform phenomenon labeled with a term based in phonetic terminology.

2 Typological variation

Both full and secondary palatalization show a large degree of cross-linguistic variability, as revealed by a number of typological studies (e.g. Chen 1973; Bhat 1978; Hall & Hamann 2006; Bateman 2007; Kochetov 2011). At the same time, not all possible triggers, targets and outputs are cross-linguistically equally likely.

While place-changing palatalization may affect segments at any place of articulation, non-labials are cross-linguistically preferred undergoers of the process (Bateman 2007; Kochetov 2011). Labial targets of full palatalization are exceedingly rare, although not unattested. For instance, Bateman (2007) reports the data from the Moldavian dialect of Romanian, where labials alternate with palatal/palatalized coronals and velars when

underlyingly followed by the plural suffix *-i*. The same process also applies in verbs before overt or underlying front-vowel-initial suffixes.

(4) Full palatalization of labials in Moldavian (Bateman 2007: 95–97)¹

a. Labial palatalization in nouns

<i>Singular</i>	<i>Plural</i>	
[bolnav]	[bolnəʒʲ]	‘sick (person)’
[kartof]	[kartofʲ]	‘potato’
[psalm]	[psalnʲ]	‘psalm’
[plop]	[plokʲ]	‘poplar tree’

b. Labial palatalization in verbs

/rəzb-i/	→	[rəzɡʲi]	‘to overcome’
/dorm-i/	→	[dornʲi]	‘to sleep’

It is, however, a matter of debate whether cases like those illustrated in (4) in fact constitute true full palatalization. For Moldavian, Bateman (2007; with a reference to Ionescu 1969 and Avram 1977) argues convincingly that what synchronically looks like full labial palatalization is actually a result of hardening of the palatal glide which was present after the labial consonant at some stage, followed by the deletion of the labial segment. This account is backed up by the data from other Romanian dialects, where forms containing a labial followed by a palatalized consonant are still preserved.

(5) Diachronic development of Moldavian labial palatalization (Bateman 2007: 101)

rəzbi → rəzbji → rəzbji → rəzbgʲi → rəzɡʲi ‘to overcome’

It is, however, not clear whether all attested cases of full labial palatalization can receive a similar diachronic explanation. For instance, Ohala (1978) argues that no intermediate stages are necessary to account for full labial palatalization in Southern Bantu languages. Instead, he proposes that the change from labials to coronals in this language group is grounded in misperception of secondarily palatalized labials as dentals (quoting a confusability study by Lyublinskaya 1966) and could be achieved in one step. However, as pointed out in Bateman (2007), accounts that view full labial palatalization as phonetically natural leave the cross-linguistic rarity of the process unexplained.

Within non-labial consonants, obstruents are more likely targets than sonorants (with coronals outnumbering dorsals), with stops being more frequently affected than fricatives and affricates. As for sonorants, nasals undergo palatalization more often than laterals, while rhotics are the most rare to palatalize (Bateman 2007: 56).

Several asymmetries have also been identified for the outputs of place-changing palatalization. Kochetov (2011) reports that in his sample of 64 languages belonging to 17 language families, sibilant palatalization outputs are more commonly attested than non-sibilants. Besides, while palatal stops occur as outputs of full palatalization (as in /k/ → [c]), palatalization resulting in alveolar segments may only produce sibilants.

Palatalization triggers were also found to exhibit a number of distributional asymmetries. While front vocoids are much more likely to trigger palatalization than non-front ones, high back and central vowels [u, ɨ, ʉ] are also attested as triggers (Bhat 1978: 54–55; Bateman 2007: 62–63; also Kochetov 2011: 1672). It was also observed that high front vocoids, [i, j], are much more likely to trigger the process than lower front vowels (Bhat

¹ The actual phonetics of these palatalized labial stops is controversial. While most sources transcribe them as above there is also good reason to transcribe them as palatals, as Kochetov (2011) does. A careful phonetic study is needed to clarify this issue. We would like to thank Nicoleta Bateman and Alexei Kochetov for discussing these issues with us.

1978; Bateman 2007; Kochetov 2011). In addition, two implicational relations among palatalization triggers have been uncovered (Chen 1973; Bateman 2007: 64):

- (6) a. If lower front vowels trigger palatalization, then so will higher front vowels (Chen 1973; Bateman 2007: 64);
 b. If high back/central vowels trigger palatalization, then so will high front vowels (Bateman 2007).

Position of palatalization trigger with respect to the target is also subject to some cross-linguistic variation. The trigger may either precede or follow the target, with the latter scenario being slightly more common (see Bhat 1978; Bateman 2007; Kochetov 2011). In the majority of cases, the trigger is immediately adjacent to the target of palatalization. However, in a handful of cases palatalization can apply over intervening segments that are not themselves targeted. For instance, Bateman (2007: 79) discusses data from Karok and Western Shoshoni, in which the trigger and the target can be separated by a consonant, as in *haintseh* ~ [hámtʃih] ‘friend’. Kochetov (2011: 1673), with reference to Rose (1997), provides an example from Harari, where palatalization can apply over one or more syllables, as in /kitəbi/ → [kitʃəbi].

3 The phonetics of palatalization and functional grounding

Despite its typological variability, palatalization is often regarded as a natural process motivated by the interplay of acoustic, articulatory and perceptual factors, which have been the topic of a large body of work. In a number of studies, it has been claimed that palatalization is primarily motivated by the acoustic similarity between its targets and outputs in the context of front vocoids. Thus, it was shown, for instance, that [ki] and [ti] strings have similar formant transitions (Chang et al. 2001; Plauché 2001 and references therein); similarly, Ohala (1978) shows that F_2 transition of palatalized labials is more similar to that of dentals than to that of plain labials. Further, it was demonstrated that the turbulent noise created when a plosive is released into a high vocoid is comparable in duration to the release noise characteristic of affricates and fricatives, which may explain the propensity of full palatalization to output sibilants (Kim 2001; Ćavar & Hamann 2003; Hall et al. 2006). Interestingly, Guion (1998: 30) also reports the effect of vowel height, such that velars are acoustically more similar to postalveolar affricates before higher front vowels than before lower ones, which reflects the implicational hierarchy of palatalization triggers uncovered by Bateman (2007) and Chen (1973).

The fact that listeners may pick up on these acoustic similarities was confirmed in a number of stop confusion studies that found a robust tendency for non-coronal stops to be misidentified as coronals when followed by front high vowels (Winitz et al. 1971; Chang et al. 2001; Plauché 2001 and references therein). In addition, Guion (1998) reports significant confusion rates between velar plosive [k] and postalveolar affricate [tʃ] when followed by a high front vowel, especially when the signal was degraded by noise. Similarly, Chang et al. (2001) report higher than chance confusion rates of aspirated [k^{hi}] tokens as [tʃ^{hi}], when the former was degraded to filter out the characteristic mid-frequency spectral peak of the velar.

Some studies also emphasize the role of articulatory factors in palatalization. Thus, Bateman (2007) argues that acoustic and perceptual facts alone are unable to account for the rarity of full labial palatalization (cf. Ohala 1978). She proposes instead that the cross-linguistic facts receive a straightforward explanation if palatalization is seen primarily as the result of temporal overlap between vocalic and consonantal articulatory gestures. She argues that the temporal overlap of two gestures employing the same articulator, i.e. the tongue, but aiming at different constriction locations may result in gestural blending,

where the actual output is shifted with respect to the target (as is the case of full palatalization). However, if two gestures employing different articulators, i.e. the lips and the tongue, overlap to a considerable degree, no blending occurs – which correctly predicts the rarity of full labial palatalization. Importantly, secondary palatalization of labials is still predicted and attributed to a minimal temporal overlap between the articulatory gesture executing a labial closure and the gesture executing a front vowel.

However, the natural-rule view of palatalization is challenged by numerous recent findings. First, palatalization is not necessarily assimilatory. Cases where palatal alternations apply productively in the absence of any obvious phonological trigger are well attested: such is, for instance, expressive palatalization that applies in diminutive morphology, sound symbolism, baby talk and child-directed speech (Kochetov & Alderete 2011). Second, even in cases where palatalization rules that operate in a given language can be viewed as assimilatory, a more detailed examination may uncover complex morphological conditioning, seemingly unmotivated gaps and a considerable degree of variability, which has led some to question the central and causal role of phonetics in palatalization (Gussmann 2001; 2004).

4 Palatalization and phonological theory

As palatalization is very commonly attested across languages and usually regarded as a typical example of a phonetically natural assimilatory process, it is also seen as a process that should be relatively easily accommodated by a phonological model (Hyman 1975: 156–161). However, a large degree of diversity, both cross-linguistically and within individual languages, posed considerable challenges for formal phonological accounts striving to provide a unified analysis of all processes subsumed under this cover term.

Any formal analysis of palatalization necessarily concerns itself with a number of fundamental – and as of yet controversial – issues in phonology. For instance, palatalization has been crucial in informing models of subsegmental representation. Being a consonant-vowel interaction, it served as one of the main sources of evidence for the nature, constituency and affiliation of phonological features (Chomsky & Halle 1968; Clements 1985; Hume 1992; Clements & Hume 1995; Halle, Vaux & Wolfe 2000; Calabrese 2005; Morén 2006). Palatalization has also sparked considerable interest in computational accounts, where attempts were made to explain asymmetries and implications through universal restrictions on the computational component, e.g., fixed rankings (Rubach 2003).

In SPE formalism (Chomsky & Halle 1968), a phonological representation of an utterance was a two-dimensional matrix, with rows labeled by universal features, and columns labeled by the consecutive segments of that utterance. Each binary-valued phonological feature reflected an articulatory characteristic, e.g. location or degree of stricture, active articulator involved, etc. While the features themselves and their definitions are well familiar, some points relevant to the analysis of palatalization have to be emphasized. First, all vowels (except for retroflex ones) were specified as [–coronal], because they are produced “with the blade of the tongue in the neutral position” (Chomsky & Halle 1968: 304). Second, all vowels were [–anterior], because they are produced without constriction in the oral cavity. Third, features [high], [low] and [back], which reflected the displacement of the body of the tongue relative to its neutral position (in vowels, as well as in consonants), had a dual role. In [–coronal, –anterior] consonants, these characterized the primary place of articulation; in [+anterior] and/or [+coronal] consonants, these characterized secondary (“subsidiary”) articulations like palatalization, velarization and pharyngealization (Chomsky & Halle 1968: 305–306). Thus, palatalized consonants were treated as [+high, –back]. The fact that the same set of features was used to define

the place of articulation and the height in vowels, and the secondary articulation of the [+anterior] and/or [+coronal] consonants made it possible to straightforwardly capture secondary palatalization in the context of high vowels as an assimilatory process involving [+high], as shown below:

$$(7) \quad \begin{array}{l} t \quad \rightarrow \quad t^j \quad / ____ i \\ [+anterior] \quad \rightarrow \quad [+high] \quad / ____ [+high, -consonantal] \end{array}$$

Place-changing palatalization of velars, on the other hand, could be represented as the assimilation of [-back] triggered by front vowels, as in (8):

$$(8) \quad \begin{array}{l} k \quad \rightarrow \quad c \quad / ____ e \\ [-anterior] \quad \rightarrow \quad [-back] \quad / ____ [-back, -consonantal] \end{array}$$

There are, however, three problems with this account, also noted and discussed in Kochetov (2011). First, palatalization of labials and coronals and that of velars is treated as two distinct processes, the former involving [+high], and the latter [-back]. Second, it predicts that [+back] vowels cannot trigger palatalization of velars, and that [-high] vowels cannot trigger palatalization of coronals, even though such cases are attested (see Kochetov 2011). Although it has to be noted that this is clearly reminiscent of the tendency first identified in Bhat (1978), whereby coronals are more readily palatalized by high vowels and velars are more likely to be affected by front vowels. Finally, velars with a secondary palatal articulation, i.e. [k^j, g^j], cannot be distinguished from palatal stops [c, ʃ] in this model, as both have to be represented as [+high, -back]. This in turn entails that velars are predicted to never undergo secondary palatalization, which is contrary to fact (Bateman 2007).

The treatment of place-changing palatalization in the SPE framework is also not uncomplicated, especially in cases where the process is accompanied by assibilation, as in /k/ to [tʃ]. The fact that non-retroflex vowels were specified as [-coronal] precluded the possibility of treating velar coronalization in the context of front vowels as strictly assimilatory. Assibilation could not be represented as assimilatory either, because all non-obstruents were non-strident. This necessitated that additional mechanisms – so-called “marking conventions” – were employed to capture place-changing palatalization. Marking conventions were defined as a universal set of statements that determine which feature values are marked and which are unmarked in a given context. Changes that result in unmarked feature specifications are less costly for the grammar: marking conventions apply automatically, and therefore changes resulting in the unmarked feature specifications don't need to be referred to in the rule. Marking conventions can be overruled – as in when a rule needs to assign a marked feature value – but this can only be done at an extra cost, as it will necessitate stating a rule that makes reference to more features. Consider, for example, a case of First Velar Palatalization, turning velar consonants /k, g, x/ into alveopalatal stridents [tʃ, dʒ, ʃ] respectively before front vocoids, which in SPE can be formalized as shown below (Chomsky & Halle 1968: 422):

$$(9) \quad \text{First velar palatalization in SPE} \\ [-ant] \rightarrow [-back, +cor, +delayed\ release, +strident] / ____ [-consonantal, -back]$$

As Chomsky & Halle (1968: 422) note, while the change from [+back] to [-back] is expected in this context, and is clearly assimilatory, the change of other feature specifications mentioned in the rule cannot be due to assimilation. Instead, the change from [+back] to [-back] activates a set of linked marking conventions given below,

which, applying successively, will give rise to a postalveolar affricate (Chomsky & Halle 1968: 424):

(10) SPE marking conventions

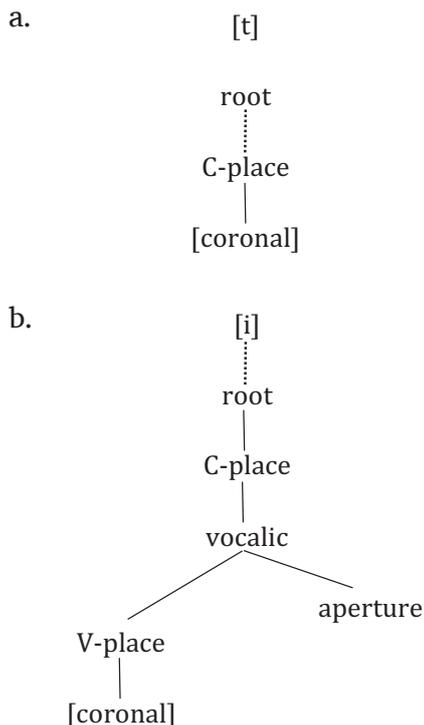
[u cor]	→	[+cor]	/ [____, -back, -ant]
[u del rel]	→	[+del rel]	/ [____, -ant, +cor]
[u strid]	→	[+strid]	/ [____, +del rel, +cor]

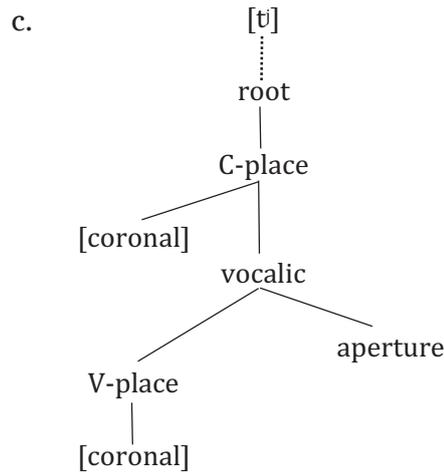
According to the universal marking conventions given in (10), the unmarked value of [\pm coronal] for [-back, -anterior] consonants is [+coronal]; unmarked [-anterior, +coronal] consonants, in turn, are [+delayed release], while unmarked [+coronal, +delayed release] consonants are [+strident]. Thus the least “costly” result of velar fronting is an alveopalatal affricate, rather than palatal or palato-alveolar plosive.

To sum up, the analysis of palatalization advanced in SPE faced two major challenges: first, the proposed universal feature specifications were not sufficient to account for all attested patterns; second, additional formal mechanisms – marking conventions – had to be invoked to account for the full range of palatalization processes.

A number of problems inherent in the SPE analysis persisted in later autosegmental treatments of palatalization. The analysis of palatalization couched within a family of Unified Feature Theories (UFT; Clements 1985; 1991; Hume 1992; Clements & Hume 1995) departs from SPE not only in that it uses geometric representations, but also in terms of features that it employs. The crucial property of UFT is that the place of articulation of both consonants and vowels is characterized by the same set of unary features comprising [labial], [coronal] and [dorsal]. Another major innovation of UFT is segregation of consonant and vowel place features to separate nodes, termed C-place and V-place node respectively. The segregation of vowel and consonant features allows to straightforwardly represent consonants with secondary articulation as having V-place features in addition to C-place features. Thus, for instance, palatalized consonants would have a [coronal] feature dominated by the V-place node in this model.

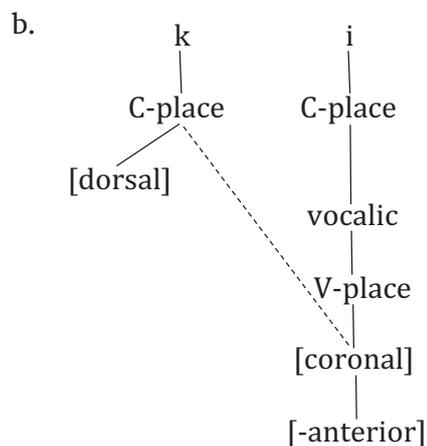
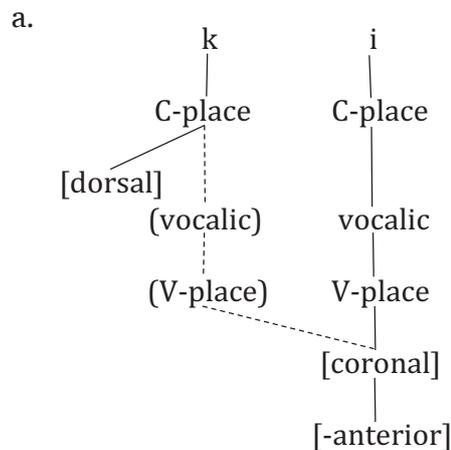
(11) Palatals in Unified Feature Theory





The configurations in (11) lead to two further predictions: first, that V-place features can spread across consonants, but C-place features cannot spread across vowels (Clements 1985); second, the fact that vowels and consonants share the same set of place features predicts the existence of *cross-category assimilations*, or cases where some (place) feature spreads from vocoids to consonants or vice versa (Clements 1991). Given that both coronal consonants and front vowels are specified for the feature [coronal], the representation of secondary palatalization in UFT is straightforward. It can be captured as the assimilatory process by which the V-place [coronal] feature spreads from the front vowel to the adjacent consonant, as shown in (12a) below:

(12) Full and secondary palatalization in UFT (Clements & Hume 1995: 294–295)



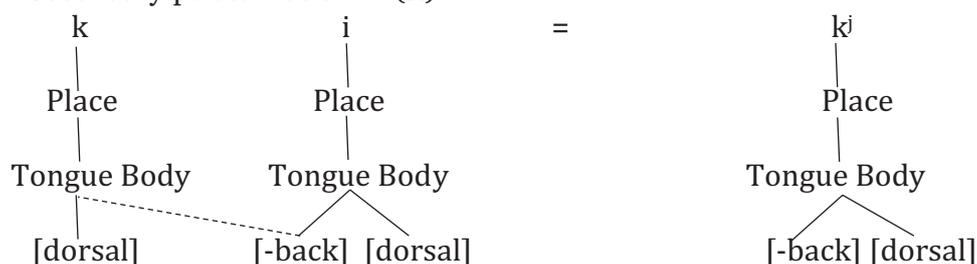
Full, or place changing, palatalization, is also represented as an assimilatory process, but its representation requires additional mechanisms. The analysis advocated in Hume (1992) proposes that in case of place-changing palatalization triggered by front vowels V-place-[coronal] the feature of the trigger spreads directly to the C-place node of the target, as shown in (12b) (this configuration is referred to as cross-planar spreading). An alternative treatment of place-changing palatalization is proposed in, e.g., Clements (1991), and Clements & Hume (1995): here, feature spreading is restricted to a given plane (as shown in (12a)), but may be optionally followed by *tier promotion*, by which a V-place feature is promoted to the C-place node, where it replaces the original place feature. Under this view, full palatalization involves two steps: feature spreading, and feature promotion. In turn, the representation of cases where the change of place resulting from the assimilation of V-place[coronal] is accompanied by the change of manner, was also somewhat problematic. For instance, Hume (1992: 189) attributes the change in manner to “redundancy rule assignment determined on a language specific basis”, which is reminiscent of the marking conventions of SPE.

Another family of representational theories that developed in parallel with UFT was (Revised) Articulator Theory ((R)AT; Sagey 1986; Halle 1992; 1995; Halle, Vaux & Wolfe 2000). The major conceptual difference between the two groups of theories lies in the choice regarding the primary source of evidence for grouping phonological features into higher-level constituents. While Clements (1985) and much subsequent work elaborating his proposal explicitly stated that decisions regarding such grouping should be made solely based on the evidence from phonological processes, and not on *a priori* assumptions about the architecture of the articulatory system, (R)AT followed a different path, in allowing evidence outside the domain of phonology proper to have a say in determining the architecture of phonological representations. This had consequences for the treatment of palatalization, because within this group of theories vowels and consonants could not be construed as a natural class, so in order to formalize the affinity between front vocoids and coronal consonants additional theoretical mechanisms were required.

In order to distinguish between primary and secondary articulations of consonants (the distinction captured by C-place and V-place nodes in UFT), (R)AT formally differentiates between major and minor articulator features (Halle et al. 2000; Halle 2003). Major articulator features are privative, and indicate the main active articulator implementing a sound. Thus, for consonants produced with a stricture formed by the tongue blade the major articulator is [coronal], and so on. Importantly, all vowels are [dorsal], because their production crucially involved the tongue body (Halle 2003). Minor articulator features, which are binary, indicate either a secondary articulation involved in the production of the sound, or the configuration of the major articulator. For instance, labialized velars are [dorsal, +round], while front vowels are [dorsal, –back].

Just as with previous approaches, the representation of secondary palatalization within this model is rather straightforward, and involves the spreading of [–back] from a vowel to a consonant, as shown below:

(13) Secondary palatalization in (R)AT



What is more problematic is the treatment of place-changing palatalization, by which velars surface as anterior or posterior coronals in the context of front vowels. Since both the target and the trigger in this case are specified as [dorsal], it is not immediately clear how a [coronal] segment can be the result of such interaction. Coronalization of vowels in the context of coronal consonants cannot be represented as spreading for the same reason. Halle et al. (2000: 401), with a reference to Calabrese (1993), solve this problem by proposing a special set of rules that they dub “equivalency relations” (cf. marking conventions in Chomsky & Halle 1968). Thus, there is an equivalency relation between [dorsal, –back] vowels and [coronal] consonants, such that vowels that get a [coronal] feature as a result of assimilation are automatically re-written as [dorsal, –back]. Conversely, [dorsal, –back] consonants are converted to coronals. Notably, as Halle et al. (2000: 401) point out, equivalency relations are not automatic. If this were the case, a configuration like that in (13) could never surface. Rather, as they put it, the adoption of equivalency rules is not obligatory, though “favored over adoption of other rules”. It means, then, that in some sense full palatalization of velars is less costly for the grammar than secondary palatalization (despite the fact that the former involves two steps).

The introduction of Optimality Theory (OT; Prince & Smolensky 1993) brought with it a focus on factorial typology, i.e. the idea that every possible permutation of universal markedness and faithfulness constraints must yield an attestable phonological grammar. Conversely, grammars judged as unattestable (which in practice usually meant unattested) must be impossible to express via constraint permutation. As a consequence, many constraint-based analyses of palatalization were constructed with an explicit goal to account for the findings of typological surveys (Chen 1996; Rose 1997; Rubach 2000; 2003; Kurisu 2008; 2009, among others).

Thus, cross-linguistic regularities – including those independently explainable by acoustic/perceptual and articulatory factors – were taken by some to reflect the innate restrictions on the constraint set. For instance, the apparent absence of languages where labials undergo palatalization to the exclusion of consonants at other places of articulation (see, e.g., Bateman 2007) has motivated proposals explaining the typological gap by the existence of a universally fixed ranking of markedness constraints as shown in (14) (Chen 1996: 171; Rose 1997: 48; Kurisu 2009: 445).

(14) Palatalizability Hierarchy (from Kurisu 2009: 445; also Rose 1997)

*Lab^j >> *Dors^j >> *Cor^j

The universally fixed hierarchy in (14) captures the intuition that consonants at certain but not other primary places of articulation are inherently more compatible with, or susceptible to, palatalization (an asymmetry which is usually explained as motivated by various phonetic factors, see Kurisu (2009) and Rose (1997) and the discussion in the previous section). It also reflects the implicational relationship between palatalization targets that is evident from a number of typological studies, namely that palatalization of labials implies palatalization of coronals and dorsals, while the languages in which the reverse is true are as of yet unattested. Incorporating a fixed ranking as that in (14) in OT grammar renders languages where labials are palatalized to the exclusion of other places of articulation impossible: since markedness constraints that form a fixed hierarchy cannot be permuted, the insertion of a palatalization-inducing constraint (abbreviated here as PAL) may only yield one of the four scenarios illustrated below:

- (15) Factorial typology of palatalization (following Kurisu 2008; 2009)
- | | | |
|----|---|--|
| a. | *Lab ^j >> *Dors ^j >> *Cor ^j >> PAL | No palatalization |
| b. | *Lab ^j >> *Dors ^j >> PAL >> *Cor ^j | Palatalization of coronals |
| c. | *Lab ^j >> PAL >> *Dors ^j >> *Cor ^j | Palatalization of dorsals and coronals |
| d. | PAL >> *Lab ^j >> *Dors ^j >> *Cor ^j | Palatalization of labials, dorsals, and coronals |

Thus, the factorial typology in (15) excludes three types of scenarios: one where only labials undergo palatalization, one where only labials and coronals do, to the exclusion of dorsals, and one where only dorsals palatalize to the exclusion of labials and coronals. The fixed constraint ranking as a formal device raises two immediate questions: First, it is a conceptual issue whether the explanation for cross-linguistic patterns should be hard-wired in phonological computation (see Hale et al. 2006; Hale & Reiss 2008). Second, it is a question of descriptive adequacy of implicational hierarchies such as that proposed in (15). Given that unattested does not equal unattestable, and that the number of languages that has so far been examined is a mere fraction of currently existing languages, which, in turn, is a small portion of possible languages, the empirical basis for the fixed hierarchy in (15) is rather limited. In fact, apparent counterexamples can be found in the typological survey by Bateman (2007: 44, 50), who found that two out of three “impossible” scenarios are, in fact, attested: First, dorsals do palatalize to the exclusion of other places of articulation. Second, languages where labials and coronals undergo secondary palatalization to the exclusion of dorsals do exist.

5 Overview

This special of *Glossa* unites a selection of papers that address a range of palatalization patterns in different languages and they look at them from very different perspectives, methodologically, and theoretically.

Baltazani et al. (2016) investigate palatalization patterns in Greek dialects and propose to add a third category to the division of palatalization processes into full and secondary palatalization – a process they label strengthened palatalization. Both traditional palatalization types, full and secondary, are generally triggered by a present front vocoid (though see the discussion in section one above or the contribution by Tifrit & Voeltzel), which may or may not disappear in the process. In strengthened palatalization in Greek dialects, the trigger disappears and Baltazani et al. discuss various implications of a coalescence and a deletion analyses. In addition to arguing for a phonological motivation for their third type of palatalization they provide acoustic phonetic evidence that the output of the process is different from the other two, which are also attested in varieties of Greek.

Kochetov (2016) takes the investigation of the typological range of outputs of palatalization a step further. He explores the typological predictions that arise from optimality-theoretic constraint interaction. He starts out with glide strengthening in Kirundi, in which the glides in *Cj* as well as *mw* sequences are strengthened to *Cc* and *mŋ*, respectively. This pattern is accompanied by palatalization of non-labial *Cj* sequences, eg., a /tj/ to [tʃ] mapping. After observing that a constraint family that causes palatalization, such as *CG (violated by consonant-glide sequences) can also cause glide strengthening he takes a look beyond Kirundi and shows that a range of processes, such as epenthesis, metathesis, and deletion can ultimately be attributed to this constraint family, since they all emerge in avoidance of just such sequences. The study accounts for the patterns in Kirundi in Optimality Theory and proposes to account for the greater typological variation by simple constraint reranking in relation to one central markedness constraint (family), as in Pater’s (1999) seminal study of *NÇ effects.

Baltazani et al.'s and Kochetov's papers widen our understanding of the empirical scope of palatalization. While Kochetov's article represents a "classic" OT approach to some issues in the analysis of palatalization, especially the redefinition of the term itself by looking at it through the lens of an elaborate theory, the papers by Jurgec and Łubowicz represent theory-internal innovation driven by linguistic data. In these cases palatalization patterns are used as evidence in support of new theoretical proposals. Furthermore, both papers look at a very different aspect of palatalization patterns. While Baltazani et al. and Kochetov were mostly interested in variation in the output of the process, Jurgec (2016) looks at external factors that decide between application and blocking of palatalization. Łubowicz investigates morphologically conditioned phonological opacity in Polish palatalization and models the patterns insightfully in Contrast Preservation Theory (PC; Łubowicz 2012). Jurgec focuses on velar palatalization in Slovenian, which is optional in some forms, obligatory in others and categorically blocked in yet another group. He concludes that blocking is a long distance effect of a palatal segment somewhere else in the stem. Moreover, velar palatalization in Slovenian is triggered by certain suffixes that do not necessarily contain a palatal vocoid, while other suffixes that contain such a vocoid do not cause palatalization. Jurgec goes on to argue that the variation in the pattern is best accounted for using a Maximum Entropy model of OT (Wilson 2006; Hayes & Wilson 2008) with weighted and indexed constraints.

Łubowicz (2016) discusses the following allomorphy in Polish datives. Stems ending in coronals take a dative suffix that consists of a palatal vowel, *-e*, which causes palatalization of the coronals into pre-palatals. Stems that end in these pre-palatals take the dative suffix *-u* instead. She proposes that this suffix allomorphy is an effect of the preservation of the place contrast in the final consonants of the stems that would be neutralized in the dative if both groups of stems took the same suffix. PC theory differs from standard OT in that the grammar doesn't evaluate individual candidates but rather contrast scenarios, which are networks of forms.

Nasukawa and Tifrit & Voeltzel approach palatalization from Government Phonology. Nasukawa (2016) discusses two patterns found in Japanese, palatalization, which applies to coronals followed by front vowels and de-palatalization, which, unlike the pattern from Polish mentioned above, is a distributional restriction, evident from the absence of light diphthongs of a palatal glide followed by a palatal vowel. In Nasukawa's Precedence-free Phonology (Nasukawa 2011, 2014, 2015a; b), he analyses both processes as effects that emerge from head-dependent relations. An embedded palatal element needs the presence of a dominating $|H|$ element, the absence of this results in a build-up of structure above the embedding head and its presence and absence of $|I|$ in copying of the palatal element form a higher level tier.

Tifrit & Voeltzel (2016) reconstruct the history of French palatalization, providing a new analysis in Government Phonology 2.0 (Pöchtrager 2006). They are particularly interested in French second palatalization, which turned Latin dorsal stops preceding a low vowel into postalveolar fricatives and argue that the low vowel doesn't contain the palatalization inducing element $|I|$ and thus the cause for palatalization has to be found in the structure of the dorsal stops themselves. This leads them to an analysis of dorsals as containing an additional projection, i.e., a complex hierarchical structure.

One can categorize the studies by Nasukawa and Tifrit & Voeltzel as substance-free phonological approaches to palatalization phenomena. In her analysis of a selection of palatalization patterns in Latvian, Urek (2016b) contributes a third study of this type, though couched in a very different theoretical framework, combining the Parallel Structures Model of Feature Geometry (Morén 2003; 2006; Iosad 2012; Youssef 2013) with Optimality Theory. On the basis of four central palatalization patterns in Latvian,

a hitherto understudied language in the theoretical literature, she argues that segmental representations have to be substance-free, underspecified and language-specific, rather than universal.

Finally, a socio-phonetic study is contributed by Flores (2016), who investigates the use of a palatal fricative for Spanish /x/ in Chilean radio broadcasts. Chilean Spanish differs from other varieties of Spanish in that the palatal surfaces also next to the front mid vowel. The process is variable and after providing a phonetic analysis using center of gravity in the spectrum she links this measure of palatality with linguistic and sociolinguistic variables to determine if the phonological context or sociolinguistic features of the speaker or the audience correlate with the use of the palatal allophone.

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Competing interests

The authors declare that they have no competing interests.

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