"One" process, different grammatical mechanisms*

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The full range of palatalization processes can be modelled within Bidirectional Phonology and Phonetics (Boersma 2011), which provides a unified framework for understanding sound change. Several types of palatalization are analyzed as outcomes of evaluating phonetic, phonological, or morphological representations under different functional pressures. Both articulatory and auditory factors may influence palatalization at different points in its life cycle.

1 Introduction

Boersma (1998) was a radical departure from the architecture and the representations inherited from the SPE (Chomsky & Halle 1968), a project combining the insights from research on articulation (e.g., Browman & Goldstein 2008) and acoustics and perception (e.g., Lindblom 1986, 1990; Bladon & Lindblom 1981; ten Bosch 1991) with Optimality Theory (McCarthy & Prince 1993a, 1993b; Prince & Smolensky 1993) and functional approaches (Passy 1891; Martinet 1955; cf. Jun 1995; Flemming 1995). In particular, two insights allow us to look at phonological processes through a completely different lens: (a) that phonological processes of language can be represented as effects of evaluations at multiple different levels of representation, and (b) that these multiple representations use different features which are subject to different constraints, appropriate given the nature and role of this particular representation in the holistic architecture of the model. In this paper, I will argue that the variation in effects of palatalization across and within languages can be explained as processes occurring at different levels of representation, satisfying different functional pressures.

I also attempt to connect different types of palatalization processes with different stages of the life cycle of a phonological process (cf. Kiparsky 1995; Janda 2003; Bermúdez-Otero 2007), drawing examples primarily from Polish and Russian. The life-cycle of a phonological process was discussed most extensively in the works of Bermúdez-Otero (e.g., Bermúdez-Otero 2007, 2015), but

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assuming the model of Bidirectional Phonology and Phonetics (Boersma 2011) we end up with a different definition of subsequent stages.

1.1 Theoretical background: representations and the minimal unit of phonological analysis

Early generative phonology treated all sound changes the same and only with time did some nuances in the rule's nature or status have been more or less successfully and/or systematically addressed (for example, if a rule is exceptionless or sensitive to morphological information). For example, Lexical Phonology (Kiparsky 1982; Rubach 1984; Mohanan 1986) gained explanatory power over the SPE type approaches by attributing the impact of morpheme or word boundaries to the general architecture of phonological module and differentiating between cyclic, lexical, and post-lexical rules. This insight was initially overlooked at the advent of OT.[1] At the same time progress has been made regarding the theory of the interaction of representations. First, Autosegmental Phonology (Goldsmith 1976), and then Feature Geometry (Clements 1985; Halle 1995; Clements & Hume 1995) refined our understanding of representations themselves. Mainstream phonology has maintained the general assumption that we operate with the same minimal units of phonological descriptions – features – at all levels of representation, and Feature Geometry has continued to be used in OT-style analyses. However, Feature Geometry seems to draw evidence from different types of processes, without distinguishing between lexical or post-lexical processes. This has potentially contributed to the development of multiple competing models.

Alternatives to the classical feature model were proposed, differing in the level of abstractness of the minimal phonological unit and whether this minimal phonological unit is articulatorily or acoustically/auditorily based. For example, Articulatory Phonology (Browman & Goldstein 1990, 2008) uses gestures as the counterparts of features, which are organized in scores. In this approach phonological processes are changes in the amplitude and temporal scope of the gestures, and the acoustic effect of articulation is secondary. Articulatory Phonology is exceptionally effective when describing coarticulatory effects and can account for processes which in other approaches would be dismissed as phonetics but leaves many processes traditionally believed to be phonological outside of phonology. In Articulatory Phonology, the minimal unit of phonological analysis is maximally physical. On the other pole of the spectrum is

[1] The insights from Optimality Theory and Lexical Phonology could be combined in approaches allowing for serial evaluation in OT, e.g., Derivational OT (Rubach 1997; Plapp 1999) and Stratal OT (Bermúdez-Otero 1999; Kiparsky 2000). These approaches, however, undermine one of the fundamental tenets of OT that all constraints are evaluated in parallel on output representations.

the Element Theory (e.g., Backley 2011), operating with elements. Despite the claim of the acoustic basis for the framework, the elements are only very loosely based in acoustics. Per definition then, Element Theory is not best equipped to account for processes, which initiate as coarticulation.

In this context, Boersma's Bidirectional Phonology and Phonetics (Boersma 2011), offers a unique comprehensive framework to work with sound processes of different nature. In the subsequent sections, I will discuss a number of palatalization processes which differ in output and scope, and these differences may be directly explained assuming that the processes necessarily involve different grammatical mechanisms at different levels of representation. Phonetic level palatalization will be discussed in Section 2, and phonological palatalization in Section 3. I address the issue of the posterior articulation in Section 4, and the 'depalatalization' of palatalized sounds and the morphological mechanism of palatalization maintenance in Section 5.

2 Phonetic palatalization

Under the classical view that we have one set of universal phonological features, a lot of the debate concentrated on the issue of the phonetic grounding of the features, in particular, whether they are anchored in articulation or perception. The acoustic effect may be perceived only if it is articulated. Therefore, I believe all palatalization processes start with a particular articulatory configuration as a coarticulation: the tongue gesture characteristic of the front vowel partly overlaps with an adjacent consonant. An example of such an entirely articulatorily-driven phonetic level palatalization comes from Polish. In Polish, consonants followed by [i] and [j] are secondarily palatalized, as in [vʲina] *wina* 'guilt', [pʲisat͡ɕ] *pisać* 'to write', [pʲjana] *piana* 'foam', [tʲik] *tik* 'nervous tic', [sʲinus] *sinus* 'sine', [ʂʲintoizm] *Szintoizm* 'Shinto religion', [zʲ+integrovat͡ɕ] *zintegrować* 'to integrate, Perf.', [zʲ # igwɨ] *z igły* 'from a needle', etc. (cf. Dłuska 1983; Rubach 1984; Sawicka 1995; Wiśniewski 1997; Cavar 2004; Stolarski 2010; Lorenc et al. 2023). Following Rubach (1984), I will call this effect Surface Palatalization. Surface Palatalization is non-categorical, with stronger palatalization before [i] than before [j] (Stolarski 2010). It occurs anywhere the environment is met within a prosodic phrase, disregarding word or morpheme boundaries of any type, see the examples above. It does not render a phonemic distinction.[2]

[2] Many analyses (e.g., Szober 1957; Rubach 1984) recognize palatalized labials (/Pʲ/, where P = labial consonant) as underlying phonemes. However, in surface terms, the palatalized labial is then always followed by [j] in modern Standard Polish, so there is no surface level contrast between a palatalized labial and a non-palatalized labial.

I will adopt the approach in which palatalization is driven by the need to advance the tongue root before the front vowel and the dorsum fronting is a mechanical consequence of the advancement of the tongue root (Cavar 2004; Cavar et al. 2020; Cavar & Lulich 2021). Articulatory evidence indicates that the palatalization gesture in the consonant in Surface Palatalization is the strongest towards the very end of the consonant, directly before the beginning of the vowel. This is different from the phonemic palatalization (e.g., in prepalatals), where the raising and fronting of the tongue dorsum is the strongest at the beginning of the prepalatal consonant, and the advancement of the tongue root begins often as early as at the beginning of the preceding vowel (Cavar et al. 2020). Assuming then that the tongue root advancement in Surface Palatalization is already present at the beginning of the consonant, and that the gesture of the dorsum is visible shortly after the root has advanced, the gestural representation would be as shown in Tableau 1:

Tableau 1: Gestural representation of [tʲik]/tik/ *tik* 'nervous tic' showing the effect of Surface Palatalization in Polish

	/t/	/i/	/k/
tongue tip	closed	open	
dorsum	open	narrow	closed
tongue root	advanced		
velum	closed		
lips	spread		
glottis	wide	narrow	wide

The coarticulatory effect may be modelled in terms of the interaction of articulatory constraints on the phonetic articulatory representation, involving constraints from the *SYNC family (cf. Boersma 1998: 154–155), where the raising and fronting gesture of the dorsum and the advancement of the tongue root fails to synchronize with the jaw lowering and lip opening (for the articulation of the vowel). Cavar and Charles (2024) argued that the tongue root gesture always precedes the tongue dorsum gesture. As the dorsum fronting is a consequence of tongue root advancement, the position of the dorsum will be regulated by a constraint from the IMPLY family (Boersma 1998: 157).

Tableau 2 represents the evaluation of the articulatory phonetic form shown in square brackets. While the auditory form (in double square brackets) and the surface phonological form (between the forward slashes) are also represented as outputs in the tableau, only articulatory constraints are included, to demonstrate the articulatory mechanism of palatalization. The winner does not violate *SYNC or IMPLY and is optimal from the articulatory perspective.

(1) *SYNC(tip:closed|open; dorsum:open back|narrow front), or short *SYNC(tip, dorsum): do not synchronize the tongue tip closure with the dorsum fronting
*SYNC(tip:closed|open; root:retracted|advanced), or short *SYNC(tip, root): do not synchronize the tongue tip closure with the advancement of the tongue root
IMPLY(root:retracted|advanced, dorsum:open back|narrow front), or short IMPLY(root, dorsum): the advancement of the tongue root implies the fronting of the dorsum

Tableau 2: Evaluation of the phonetic articulatory representations showing the effect of Surface Palatalization in Polish

/ti/	IMPLY	*SYNC (tip, root)	*SYNC (tip, dorsum)
/ti/ [[ti]][ti]		*!	*
/ti/ [[t̪i]][t̪i]	*!		*
☞/ti/ [[tʲi]][tʲi]			

The optimal articulatory representation from Tableau 2 also does not impede the perception of the phonological representation. This is shown in Tableau 3, where CUE constraints defined in (1) are included, which are responsible for the evaluation of the match between the gradient auditory phonetic representation and the categorical phonological surface representation.

(2) */t/ [[HIGHESTF2]]: Do not categorize a segment with a highest F2 as /t/
*/t/ [[HIGHF2]]: Do not categorize a segment with a high F2 as /t/

Tableau 3a shows the ranking where the CUE constraint blocks palatalization. As there is no phonemic contrast between /t/ and /tʲ/, the [[tʲ]] realizations with [HighestF2] may be categorized as instances of /t/, as in Tableau 3b, and the promotion of the articulatory constraint will induce the effect of Surface Palatalization.

3 Palatalization in the phonological representation

Surface Palatalization in Polish does not affect perception negatively, in that it does not cause confusion with other consonantal categories. However, even though the sounds produced in Surface Palatalization are auditorily similar to the allophones produced in other contexts, the process generates acoustic effects, such as an increase in F2 in the transition after the consonant and/or adding an

Tableau 3: Surface Palatalization as an effect of the evaluation of the phonetic articulatory, phonetic auditory and surface phonological representation.

(a) Grammar does not allow Surface Palatalization

/ti/	*/t/ [[HIGHESTF2]]	*SYNC	*/t/ [[HIGHF2]]
☞/ti/ [[ti]][ti]		*	*
/ti/ [[tʲi]][tʲi]	*!		

(b) Grammar favors Surface Palatalization

/ti/	*SYNC	/t/ [[HIGHESTF2]]	*/t/ [[HIGHF2]]
/ti/ [[ti]][ti]	*!		*
☞/ti/ [[tʲi]][tʲi]		*	

occasional friction in stops. Such auditory effects may, in general, enhance the perception of [i] or [j] in the consonantal context, but in the long term they may contribute to the acoustic differentiation of the allophones and ultimately lead to phonologization (understood as recategorization of the surface phonological representation, cf. Kiparsky 1995; Janda 2003). Interestingly, Bermúdez-Otero (2007: 504) defines phonologization as a stage when "some physical or physiological phenomenon gives rise to a new cognitively controlled pattern of phonetic implementation through a coordination failure" and "manifests itself as Neogrammarian sound change (i.e., regular gradient change) […]". This would have to happen at the level of the phonetic representation in Boersma's approach, i.e., Boersma's model dictates a slightly different scenario that the one proposed by Bermúdez-Otero.

Let us return to our example of palatalization and the question of its phonologization. The surface phonological representation is constructed of phonological categories. How a child acquires categories has been discussed in, for example, Boersma et al. (2003). Boersma et al. (2003) modeled learning phonological categories as driven by distributional evidence from the auditory input. The learner of the language hears that in some words the sound has systematically higher F2 (and perhaps other cues are also systematically present). This triggers learning: re-ranking of the CUE and WARP constraints (and by a feedback loop supports articulatory differentiation). So, hearing systematically different F2 transition for /t/ before /i/ versus before /a/ will ultimately lead to formation of two discrete categories /tʲ/ (before /i/) and /t/ (elsewhere).[3] Learners

[3] One of the reviewers asks why two categories do not phonologize in Surface Palatalization in Polish. I can stipulate that this is due to high density of the consonantal inventory in Polish. The phonetic coarticulation in Polish is not strong enough to support the phonological restructuring (certain degree of *PRECISION dominates certain degree of *COORD, cf. Tableau 6). It remains

also receive feedback from the environment if they fail to recognize an auditory signal as an instance of a category – when they cannot match the underlying phonological representation of the given word with the correct semantic representation.

As soon as the language user has two categories to map to at the phonological surface representation, a restructuring of the surface phonological representations will occur. When the speaker can map an auditory representation either onto /t/ or /tʲ/ in the phonological surface representation, as in Tableau 4, the choice will always be for the category which is auditorily closer.

Tableau 4: Phonological-phonetic interaction with restructuring in the surface phonological representation

|ti|	*SYNC	*/t/ [[HIGHESTF2]]	*/tʲ/ [[HIGHESTF2]]
|ti|/ti/ [[tʲi]][tʲi]	*!	*	
☞ |ti|/tʲi/ [[tʲi]][tʲi]			*

Once surface phonological category contains a /tʲ/, the learner cannot fail to notice the systematic mismatch between the surface and underlying representations, see Tableau 5a, which prompts the learner to promote the structural constraint PAL, and demote faithfulness constraints. I use the constraint PAL because I assume it encodes directly a difference in representation and not its phonetic realization. PAL in Cavar (2004) was defined as a dimension of a phonemic contrast realized by [HighestF2] or [HighF2] and/or [Friction].

Tableau 5: Re-ranking of structural and faithfulness constraints

(a) Mismatch between the surface and underlying representations

|ti|	*SYNC	*/t/ [[HIGHESTF2]]	IDENT[PAL]	PAL
|ti|/ti/ [[tʲi]][tʲi]	*	*	* →	
V |ti|/tʲi/ [[tʲi]][tʲi]				* ←

(b) Phonology with a phonological palatalization process

|ti|	*SYNC	*/t/ [[HIGHESTF2]]	PAL	IDENT[PAL]
|ti|/ti/ [[tʲi]][tʲi]	*	*	*	
☞ |ti|/tʲi/ [[tʲi]][tʲi]				*

minimal because any higher level of coarticulation would make the sound too similar to another phonemic category: the palatalized dentals (e.g., /tʲ/) would be too similar to existing prepalatals (e.g., /t͡ɕ/), all that in the presence of the third series of coronal phonemes - the non-palatalized posteriors (e.g., /t͡ʂ/). The forms with miscategorized sounds would systematically violate semantic constraints, cf. the discussion in Section 5.

I would like to argue that Russian i-Palatalization is a case of phonological palatalization as discussed above. Russian palatalization in the context of /i/ and /j/, seemingly looks very similar to the Polish Surface Palatalization. However, while this is still an articulatorily regular process, it produces a categorical distinction. This type of palatalization in Russian remains regular and obligatory in the context of the high front vowel /i/ and the glide /j/. An apparent exception may be word-initial /i/, preceded by a word ending in a non-palatalized consonant (e.g., [brɑtˠ # ɪvɑn+ə] *брат Ивана* 'Ivan's brother', as compared to [ivɑn] *Иван* 'Ivan, proper name'). In these cases, instead of secondary palatalization on the preceding consonant, the vowel is retracted. Rubach (2000) uses such examples to argue for Derivational OT (DOT). In particular, two OT evaluations, one at the lexical level, taking care of the word-internal palatalization, and another, with a potentially different constraint ranking, at the phrase level, responsible for automatic, across-the-board processes. While one can perhaps argue that [i] stem-initially is for historical reasons underspecified and, consequently, does not trigger palatalization, it would be difficult to propose a parallel analysis for [j], which, like [i], fails to trigger palatalization across a morpheme or word boundary (e.g., [ɑtˠ+jezd]/[ɑtˠ+jest] *отъезд* 'departure', [[pʲidzɑ̨kˠ #jelʲt͡sɨnə] *пиджак Ельцина* 'Yeltsin's jacket'). The conclusion can be that the i-Palatalization in Russian is not operating at the phrase level but instead at the word level, where the prefixes are treated as separate words, thus, it is phonological. Nevertheless, given the induced modification of the vowel, the surface generalization that [i] cannot be produced directly after a non-palatalized consonant holds exceptionless. The process is also typically a subject to transfer in L2 of native speakers of Russian.

The situation with e-Palatalization in Russian is different: e-Palatalization remains regular across a morpheme boundary, and like i-Palatalization does not trigger palatalization across word boundary. However, a number of newer borrowings also show no palatalization in the context of /e/ word-internally: [kɑfˠɛ] *кафе* 'coffee shop', [kəmpʲjutʲɪr] or [kəmpʲjutˠɛr] *компьютер* 'computer', [flʲe̯skə] or [flˠɛ̯skə] *флешка* 'flashdrive'. That is, /ɛ/ may now show up outside of its normal allophonic environment, i.e., after /ʂ, ʐ, t͡s/. This can be interpreted in two ways. Under one interpretation, we deal with an ongoing phonemic split between the tense /e/ following a palatalized consonant and the laxer /ɛ/ (parallel to the already existing phonemic contrast between /i/ and /ɨ). The borrowings are then nativized with /ɛ/ because it does not trigger palatalization and the speaker wants to preserve the foreign word's original quality of being non-palatalized. Another interpretation would be to assume that e-Palatalization in Russian is on the way to lexicalization, cf. Section 5.

4 Retraction

Apart from the increase in F2 in the transition after the consonant and adding an occasional friction on stops, we often observe the retraction of the major place of articulation in palatalization processes: from dental to alveolar and ultimately into the postalveolar area. There is evidence that the tendency operates by itself, without affrication. For example, the palatalized anteriors in Russian are often alveolar, that is retracted in comparison to their non-palatalized dental counterparts (Bolla 1981; Kedrova et al. 2008). Cavar (2026) shows that Russian /tʲ/ may be articulated with or without concavity behind the primary place of articulation: concavity shows up in the apical articulations, lack of concavity is visible in tip-down articulations.

However, categorical retraction is usually accompanied by friction, so palatalized stops evolve to affricates (and then often simplify to fricatives). In Polish, there is a synchronic process of Coronal Palatalization (e.g., Rubach 1984; Cavar 2004), where morpheme-final dentals alternate with prepalatals if the following morpheme starts with /i/ (no exceptions), and before many morphemes starting with /e/.[4] Historically, the modern prepalatals were palatalized dentals/alveolars (like in Russian) and the category shifted to the prepalatal area in the 13th century (Stieber 1952; Carlton 1991) or between the 10th and 12th century (Długosz-Kurczabowa & Dubisz 1993).

The shift to prepalatal cannot be easily accounted for in a traditional featural approach without assuming that front vowels are not only [coronal] but also [-anterior]. Cavar (2026) proposes that the raising of the tongue tip and the secondary palatalization are anti-synergistic (cf. Phonological Potentials model in Moisik et al. 2021). The formation of concavity through lowering the tongue behind the tongue tip most likely involves the contraction of the oblique longitudinal muscle (Wrench 2024). In secondarily palatalized dentals, the activation of the oblique longitudinal would occur in addition to the contraction of the posterior genioglossus, the muscle responsible for the tongue root advancement and the shift of the tongue mass forward. The oblique longitudinal would form the lowering behind the tongue tip, and the posterior genioglossus would push the mass of the tongue towards the same area. This can be expressed using a constraint from the *COORD family (Boersma 1998: 156). Eliminating the contraction of the oblique longitudinal would eliminate the concavity and the need for the apical articulation. The laminal contact shifts the place of articulation backwards to the alveolar area and beyond. As it is difficult to form a stop in the posterior area, constraint from the *PRECISION family is postulated, cf. (3).

[4] We will return to the issue of /e/ being an inconsistent trigger of the palatalization process in Section 5.

Tableau 6 shows how the interaction of constraints at the phonetic level plays out to achieve retraction to the prepalatal area. The highest ranked *SYNC is not shown as none of the candidates with palatalization would violate it, as shown in Tableaux 2 and 3. Tableau 6a shows the scenario where the retraction is blocked. Here the CUE constraint */t/ FRICTION eliminates a retracted affricate. Tableau 6b shows a grammar where retraction is possible. Here, *COORD is ranked lower than */t/ FRICTION and the *PRECISION constraints.

(3) *COORD(tip|closed, blade|open, dorsum|narrow), short *COORD: Do not lower the blade when the tongue tip is raised and the dorsum fronted and raised.
*/t/ FRICTION: Do not categorize a segment with Friction as /t/
*PRECISION(blade|closed|retracted), short *PRECISION: Do not form stops in the postalveolar are.

Tableau 6: Retraction to the post-alveolar area

(a) Grammar blocks retraction

/tʲ/	*PRECISION	*/t/ FRICTION	*COORD
☞/tʲ / [[tʲi]] [tʲi]			*
/tʲ / [[t͡ɕi]] [t͡ɕi]		*!	
/tʲ / [[t̠ʲi]] [t̠ʲi]	*!		

(b) Grammar allows retraction

/tʲ/	*COORD	*PRECISION	*/t/ FRICTION
/tʲ /[[tʲi]] [tʲi]	*!		
☞/tʲ / [[t͡ɕi]] [t͡ɕi]			*
/tʲ / [[t̠ʲi]] [t̠ʲi]		*!	

5 Depalatalization

Another broadly discussed palatalization process in Polish involves velars (Velar Palatalization, e.g., Rubach 1984; Cavar 2004). This is a process which in Modern Polish involves velars /k, g, x/ alternating with retroflex sibilants /t͡ʂɨ, d͡ʐ/ʐ, ʂ/ before vowels which need to be interpreted as underlyingly front. Synchronically, it is triggered by some morpheme-initial /e/s and before some morpheme-initial /ɨ/s. The latter environment is a vowel which is incompatible with inherently palatalized prepalatals in Polish (*Cʲɨ, where Cʲ = prepalatal or palatal consonants, cf. Cavar 2020). While synchronically the process makes little sense from the phonetic perspective, it used to be a regular phonetically driven palatalization.

The vowels which trigger the change synchronically were historically front and the current retroflexes developed as in (4):

(4) k(i) > kʲ > t͡ɕ >t͡ʃ > t͡ʂ

The voiced velar stop, and the voiceless velar fricative developed similarly, with voiced stops changing to voiced affricates (after a consonant) or further simplifying to fricatives after vowels, and the velar fricative – remaining a fricative. The last step in (4) (t͡ʃ > t͡ʂ), described in Slavic literature as 'hardening', happened in the 16th century (Rospond 1971), most probably as a part of a chain shift, in response to palatalized dentals pushing to more retracted articulation, as discussed in Section 4. Boersma and Hamann (2008) successfully modelled the evolution of the sibilant inventory with three sibilants in the coronal area: such a system always ends up with a system of places of articulation like in Polish, i.e., /s, ɕ, ʂ~ʐ/. Synchronically, the speaker learns the morphemes using the semantic information (cf. Boersma 2011). This is modelled formally by semantic constraints such as, for example, those in (5).

(5) *"POINTING" <t͡ɕi>: Do not match context "pointing" with the morpheme <t͡ɕi>
*"QUESTION" <t͡ɕi>: Do not match context "question" with the morpheme <t͡ɕi>

[[t͡ɕi]] *ci* 'those, Masc.Nom.Sg.' and [[t͡ʂɨ]] *czy* 'question particle' are actual Polish words. [[t͡ɕi]] should correctly be recognized as <t͡ɕi>, especially in a context when somebody is pointing at multiple men, it should not be recognized in the context when a question particle is expected, so *"QUESTION" <t͡ɕi> should outrank *"POINTING" <t͡ɕi> to secure correct perception. Learner mis-learning as well as adult speaker misperceptions lead to a communication break. Either case will trigger re-ranking of the lexical constraints, as in Tableau 7.

(At least) one more question remains. Velar Palatalization occurs before some morphemes, such as Diminutive +*ek*, for example, [krot͡ʂek] *kroczek* 'step, Dimin.', but we have only Surface Velar Palatalization before some others, such as Sg.Instr. +*em*, e.g., [krokʲem] *krokiem* 'step, Sg.Instr.'.[5] If Velar Palatalization does not have a straightforward phonological trigger, the learner will not be able to learn the ranking of the PAL constraint based on the input they receive, unless the process is conditioned by a presence of a particular morpheme. Then, the choice of the morphological representation would be due to a morphological structural constraint. For the purposes of this analysis, I propose the constraint

[5] The vowel in the Sg.Instr. ending historically was back and never triggered Velar Palatalization. When it fronted, Velar Palatalization was no longer triggered by phonetic factors.

*MORPH_K+E-PAL, which penalizes a combination of allomorphs, where the first one ends in a velar, and the second belongs to the set of palatalizing suffixes. At the level of morphology, the learner evaluates the combinations including the two allomorphs stored in the lexicon, e.g., {<krok>, <krot͡ʂ>}. Since the underlying form is a copy of the lexical form, only the underlying form with |t͡ʂ| can hold.

Tableau 7: Selection of a morpheme based on the semantic context

(a) Wrong winners lead to constraint re-ranking

	*"POINTING" <t͡ɕi>	*"QUESTION" <t͡ʂɨ>	*"POINTING" <t͡ʂɨ>	*"QUESTION" <t͡ɕi>
✓ "pointing" [[t͡ʂɨ]][t͡ʂɨ]			← *	
"question" [[t͡ʂɨ]][t͡ʂɨ]		*! →		
✓ "question" [[t͡ɕi]][t͡ɕi]				← *
"pointing" [[t͡ɕi]][t͡ɕi]	*! →			

(b) Correct ranking results from re-ranking

	*"POINTING" <t͡ʂɨ>	*"QUESTION" <t͡ɕi>	*"POINTING" <t͡ɕi>	*"QUESTION" <t͡ʂɨ>
"pointing" [[t͡ʂɨ]][t͡ʂɨ]	*!			
☞ "question" [[t͡ʂɨ]][t͡ʂɨ]				*
"question" [[t͡ɕi]][t͡ɕi]		*!		
☞ "pointing" [[t͡ɕi]][t͡ɕi]			*	

Tableau 8: Phonology with a phonological palatalization process

	*MORPH K+E-PAL	PAL	IDENT[PAL]
"step,Dim." <k+ek(Pal)> |ke|/t͡ʂe/	*!		
"step, Instr.Sg." <k+em> |k|/k/			
"step, Dim." <t͡ʂ+ek(Pal)> |t͡ʂe| /t͡ʂe/			

6 Conclusions

In this paper, examples of phonetic, phonological and morphological palatalization were analyzed. It was not my intention to systematically cover all the palatalization processes in any single language or the palatalization of any single group of sounds, but rather the goal was to test how different types of palatalization may be modelled within Bidirectional Phonology and Phonetics. The model of Bidirectional Phonology and Phonetics dictates a concrete interpretation of palatalization processes as progressing through the life cycle. I assume that all palatalization processes at their inception must be articulatorily-driven phonetic effects and auditory factors play a role in that they license (or do not licence) the articulatory variation. Once palatalization contrast is phonologized, the mechanism becomes phonological and the output of palatalization may divorce from its original phonetic basis. However, auditory factors remain important, in particular, those driving the consideration of the optimal inventory of phonological categories, as modelled in Boersma and Hamann (2008). Historical changes de-regularize the phonological context of the process, which may lead to re-interpretation of the palatalization as a morphological generalization (and further, lexicalization). Phonologized, morphologized and lexicalized palatalization processes continue to be subject to further evaluation at the level of the phonetic articulatory and auditory representations, pushing the phonemic categories resulting from palatalization on the evolution path that is seemingly arbitrary when evaluated from the perspective of the original phonetic forces triggering palatalization, but predictable and expected if we assume multiple representations operating with different features.

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