Derived Environment Effects in OT*

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Revised May 29, 1998

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*I am grateful to Christina Bethin, Ed Keer, John Kingston, Alan Prince, Jerzy Rubach, and Lisa Selkirk for valuable comments on this article, and especially to John McCarthy for extensive discussion of the theory and constant encouragement. Thanks also to the UMass phonology grant group members: John Alderete, Paul de Lacy, Nancy Hall, Caroline Jones, Meredith Landman, and Jennifer Smith; visitors: Toni Borowsky, Patrik Bye, Mark Harvey; the participants of the Fall 1997 MIT-UMass Phonology Workshop (especially Arto Anttila, and Michael Kenstowicz); the audiences at WCCFL XVII (especially Ellen Kaisse, Douglas Pulleyblank, Curt Rice, Su Urbanczyk), and at GLOW 21/Phonology Workshop (especially Morris Halle, Ben Hermans, William Idsardi, David Odden, and Krisztina Polgárdi). This work was supported by the National Science Foundation under grant SBR-9420424.

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1. Statement of the Problem

The theory of Lexical Phonology limits cyclic rule application to derived environments which are created by either morpheme concatenation or prior rule application. This restriction to derived environments is achieved by imposing a condition on cyclic rule application, known as the Strict Cycle Condition (SCC) (Chomsky 1965; Kean 1974; Mascaró 1976; Kiparsky 1982; Rubach 1984), given in (1).

(1) Strict Cycle Condition (Kiparsky 1982, p.4)

a. Cyclic rules apply only to derived representations.

b. *Definition:* A representation ϕ is derived w.r.t. rule R in cycle j iff ϕ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j or the application of a phonological rule in cycle j.

This paper shows how these derived environment effects can be understood within the Optimality Theory framework (OT) by making use of local conjunction (Smolensky 1993, 1995, 1997). By conjoining a markedness constraint with a faithfulness constraint, the markedness constraint is active, causing a phonological process, only when the faithfulness constraint is violated. I will argue that this proposal captures all legitimate effects of the Strict Cycle Condition.

The interaction of Velar Palatalization and Spirantization in Polish (Rubach 1984) provides an example of an environment derived by prior rule application. In Polish, velars turn into postalveolars before front vocoids (see (2a)). In the very same environment, however, as (2b) shows, a voiced velar *g* also spirantizes and so turns into a voiced postalveolar fricative *ž*. But not all voiced postalveolar affricates *ǰ* spirantize in Polish. In particular, underlying *ǰ* makes it faithfully to the surface (see (2c)).

(2) Interaction of First Velar Palatalization and Spirantization in Polish (Rubach 1984)

a. First Velar Palatalization: /k, g, x/ → [č, ǰ, š]/ _ [-cons, -back]

kro[k]+i+ć	→	kro[č]+y+ć	‘to step’
kro[k]+ǐk+ɨ̌	→	kro[č]+ek (dim)	‘step’
stra[x]+i+ć	→	stra[š]+y+ć	‘to frighten’

b. Spirantization of *ǰ* derived from *g* by Palatalization:

wa[g]+i+ć	→	wa[ǰ]+i+ć	→	wa[ž]+y+ć	‘to weigh’
dron[g]+ǐk+ɨ̌	→	dron[ǰ]+ǐk+ɨ̌	→	dron[ž]+ek (dim)	‘pole’
śnie[g]+ǐc+a	→	śnie[ǰ]+ǐc+a	→	śnie[ž]+yc+a	‘snow-storm’

c. No Spirantization of underlying voiced postalveolar affricates *ǰ:*

bry[ǰ]+ǐk+ɨ̌	→	bry[ǰ]+ek (dim)	‘bridge’
ban[ǰ]+o	→	ban[ǰ]+o	‘banjo’
[ǰ]em+ɨ̌	→	[ǰ]em	‘jam’

The Polish data pose a question of why the same affricates behave differently in (2b) and (2c). Only derived *ǰ*'s spirantize. Rubach (1984) proposes that Spirantization in Polish is subject to the Strict Cycle Condition (SCC); it is restricted to apply only in a derived environment which is created by the application of a prior rule, First Velar Palatalization. Hence, *ǰ* spirantizes if and only if Palatalization has taken place. This is illustrated in (3):

(3) SCC Account of Polish (Rubach 1984)

	a. *derived ǰ*	b. *underlying ǰ*
UNDERLYING FORM	wa[g]+i+ć	bry[ǰ]+ĭk+ɨ̌
VELAR PALATALIZATION	wa[ǰ]+i+ć	does not apply
SPIRANTIZATION	wa[ž]+i+ć	blocked by SCC
Other rules	wa[ž]+y+ć	bry[ǰ]+ek

In OT (Prince and Smolensky 1993) the Polish case is problematic. As I will show in detail below, any constraint ranking that permits the affricate *ǰ* at the surface will do so regardless of its source, underlying or derived. Since *ǰ* is permitted in output forms of Polish, the markedness constraint against *ǰ* must be low-ranked. Because this markedness constraint is low-ranked, the output form in (3a) is expected to have the affricate *ǰ* and not the actual fricative *ž*.

As for faithfulness, output *ǰ* would violate only one faithfulness constraint (i.e., 'no palatalization'). In comparison, the actual output form with *ž* violates not only 'no palatalization', but also an additional faithfulness constraint - 'no spirantization'. So the actual output form in (3a) incurs a double violation of faithfulness. For faithfulness reasons therefore, it should never occur in Polish.

This paper offers an explanation of what forces this seemingly unmotivated double faithfulness violation. The main idea is that an otherwise low-ranked markedness constraint is activated when faithfulness is violated. In Polish, for instance, the markedness constraint against the affricate *ǰ* is activated only in segments that undergo palatalization. Therefore, only 'derived' *ǰ's* are ruled out. This activation of a markedness constraint by the violation of a faithfulness constraint is accomplished by locally conjoining the two constraints. The same is true in cases of morphologically-derived environments.

As was just noted, in my proposal I make use of the concept of local conjunction (LC), as put forth by Smolensky (1993). Generally speaking, a constraint formed by LC is violated if and only if all of its conjuncts are violated within a certain domain. The role of the domain is crucial to the concept of LC, and it will have important implications for my work.

LC has been employed previously for the analysis of a number of phonological phenomena. Among others see Alderete (1997), Itô & Mester (1996, 1998) for dissimilation as self-conjunction of markedness; Kirchner (1996) for chain-shifts as conjunction of faithfulness; Smolensky (1993), Itô & Mester (1996) for the Coda-Condition as LC; Smolensky (1995) for the Sonority Hierarchy; and Smolensky (1997) for the typology of Vowel Harmony. For a different understanding of LC see Hewitt & Crowhurst (1996), Crowhurst & Hewitt (1997), Crowhurst (to appear).

The remainder of this paper is organized as follows. Section 2 presents schematically the rule-based approach to environments derived by prior rule application and shows why this type of derived environment effect is problematic for OT. Section 3 develops a novel account of this type of derived environment effect by making use of LC. The LC account is illustrated with a number of case studies in section 4: Spirantization in Polish (§4.1), Diphthongization in Slovak (§4.2), Lenition in Campidanian Sardinian (§4.3) and Vowel Lowering in Tiberian Hebrew (§4.4). Section 5 applies the LC account to cases of environments derived by morpheme concatenation. Section 6 compares entailments of the LC account with two alternative accounts of derived environment effects, the original SCC from Mascaró (1976), Kiparsky (1982), and an underspecification account from Kiparsky (1993). Finally, section 7 contains the conclusions, where an alternative to LC is proposed.

2. ABC's of Phonologically-Derived Environments

This section begins by explaining rule interaction in cases of environments derived by prior rule application, called phonologically-derived environments (§2.1). It later shows why derived environments of this type are problematic for OT (§2.2).

2.1 Serial Rule Interaction

Let's begin with some observations about the Polish example (similarly for other cases of phonologically-derived environments: Slovak (Rubach 1993), Campidanian Sardinian (Bolognesi 1998), Hebrew (Prince 1975)). As we saw in (3), in Polish the voiced velar *g* palatalizes to the affricate *ǰ* and then spirantizes to the fricative *ž* (therefore, *g*→*ǰ*→*ž*), but underlying *ǰ*'s are not affected. Significantly and typically, the intermediate *ǰ* step is more similar to the input *g* than the output *ž* is to the input *g*, and the *ǰ*→*ž* process is context-free. These are three properties characteristic of phonologically-derived environments.

Generalizing, we can describe cases of phonologically-derived environments schematically as a language L' in which there are two rules, a rule changing /A/ to *B* following *D* (RULE 1: A→B/D_), and a context-free rule changing /B/ to *C* (RULE 2: B→C). RULE 2 is resticted by the SCC to apply only in a derived environment which is created by the application of RULE 1.

Therefore, in case of an underlying /B/, RULE 2 does not apply, and so *B* makes it to the surface. But in case of an underlying /A/, both rules apply and so underlying /A/ changes to surface *C*. This is shown in (4).

(4) Schematically (L')

		a. derived B	*b. underlying B*
UNDERLYING FORM		DA	DB
RULE 1:	A→B/D_	DB	does not apply
RULE 2:	B→C (context-free)	DC	blocked by SCC

The /A/ to *C* mapping that we observe in (4a) is shown in (5):

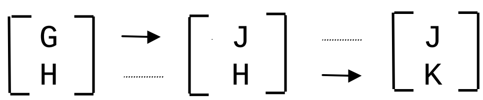
(5) Observed mapping

DA *DB* *DC*

This /A/ to *C* mapping presents a problem for OT. In terms of features, *B* is more similar to the input *A* than the actual output *C* is to the input *A*. To put it more concretely, one can imagine the following featural representations of segments *A*, *B* and *C*:

(6) Featural similarities between *A*, *B* and *C*

A *B* *C*



Notation used:

→ a change in feature

⋯⋯ no change

As (6) shows, *B* differs from *A* in only one feature (namely, G→J), whereas *C* differs from *A* with respect to two features (namely, G→J, and H→K). Therefore, as I will show in detail below, it is not clear what compels the /A/ to *C* mapping, since the /A/ to *B* mapping is more faithful and *B* is a possible output in L'.

2.2 OT Parallelism

In OT, instead of serial rule ordering, outputs are accounted for by the interaction of two families of constraints: markedness and faithfulness. Therefore, the first step to solve the puzzle of L' is to determine the language-particular constraint rankings.

But this is problematic. Any constraint ranking that conspires against *B* will affect all such outputs, both underlying and derived. Similarly, any ranking that allows *B* will do so regardless of its source, underlying or derived. So either of the two alternatives results in a ranking paradox.

Let us examine the second of these alternatives in detail. Since *DA* is ruled out in L' (see (4a)), the markedness constraint disfavoring *DA* (written *DA) must outrank the faithfulness constraint prohibiting the change from /A/ to *C* (written F(A→C)). With the opposite ranking, *DA* would freely occur in L'. Also, since *B* exists in L' (see (4b)), the faithfulness constraint against the change from /B/ to *C* (F(B→C)) must compel violation of the markedness constraint ruling out *B* (*B). In this way, *B* outputs are allowed in L'. The rankings are given in (7).

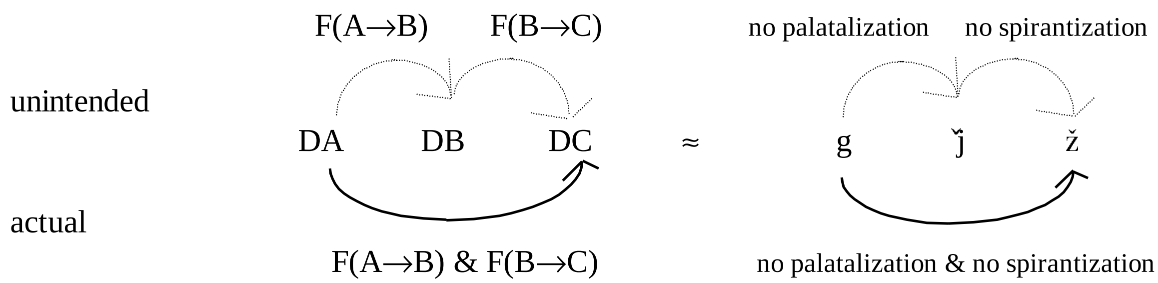
(7) Constraints in L'

DA is ruled out:	*DA >> F(A→C)
B exists:	F(B→C) >> *B

But due to the low rank of *B, the expected output form in (4a) is *B* and not the actual output *C*. In other words, there is nothing to stop *B* from surfacing as an output in L'.

To put the matter differently, the actual /A/→*C* mapping is problematic, because it violates two faithfulness constraints: F(A→B) and F(B→C). But there is a more harmonic unintended mapping in L', namely /A/→*B*, which violates only one faithfulness constraint, F(A→B). This is shown in (8):[1]

(8) Faithfulness Violations in L' (& in Polish for comparison)



So the actual /A/→*C* mapping is less harmonic, because it incurs a double violation of faithfulness. The challenge for OT, therefore, is to explain why the less harmonic mapping is taking place in L'.

To illustrate what I have just noted, I will now show that the constraint rankings in (6) choose the wrong mapping as optimal:

(9) /DA/ in the input - wrong result

/DA/	*DA >> F(A→B) , F(B→C)		F(B→C) >> *B	
a. DA	*!			
b. ☜ DB		*		*
c. ☞ DC		* !*!	!*!	

The faithful parse, candidate (a), is ruled out due to *DA. Candidate (c), the actual mapping, fails on faithfulness. Candidate (b), the unintended mapping, emerges as optimal. It fares better on faithfulness than its competitor (c), as it violates only one faithfulness constraint, F(A→B). It violates markedness *B, but *B cannot rule it out, as it is low-ranked in L'. So how is candidate (c) optimal?

[1]A faithfulness constraint of the form F(A→B) militates against the featural disparity which is incurred by the mapping from *A* to *B*. As (6) shows, in L' it means: do not change a feature G into J, because that's precisely how *A* and *B* differ. Similarly, a constraint F(B→C) militates against the change from *B* to *C*. In L' it means: do not change a feature H into K, because that's how *B* and *C* differ. Finally, a segment *A* differs from *C* in both G and H features, and so incurs a violation of both F(A→B) and F(B→C) constraints.

3. The Proposal: Local Conjunction [Markedness & Faithfulness]$_{Seg}$

To choose the candidate with double violation of faithfulness as optimal, the force of the additional faithfulness violation that it incurs, F(B→C), must be rendered irrelevant. Intuitively, it seems that the low-ranked markedness constraint *B is activated if and only if there is a change from *A* to *B*. This is the case when *B* is not already in the input.

I propose that this activation of the markedness constraint *B by the violation of the faithfulness constraint F(A→B) is achieved by locally conjoining them. The domain for LC of these constraints is the segment which violates F(A→B), namely segment *A*. In other words, the markedness constraint (*B) and the faithfulness constraint (F(A→B)) cannot be violated together within the same segment. (The conjoined constraint has nothing to say about violation of its two conjuncts within different segments.) The locally conjoined constraint is ranked above F(B→C), so that it nullifies its force:

(10) **[*B & F(A→B)]$_{Seg}$ >> F(B→C) >> *B**

In other words, the markedness constraint *B is low-ranked, but its conjunction with the faithfulness constraint F(A→B) is high-ranked. Consequently, *B is only relevant when there is a change from *A* to *B*, that is, when the faithfulness constraint (F(A→B)) is violated.

When /A/ is in the input, as shown in (11), *B is activated by the violation of F(A→B). Thus the conjoined constraint favors the less faithful mapping /DA/→*DC* over the more faithful one /DA/→*DB*.

(11) /A/ in the input

/DA/	[*B & F(A→B)]$_{Seg}$	F(B→C)
a. DB	*!	
b. ☞ DC		*

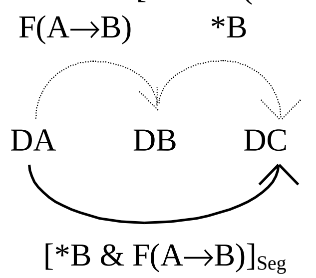
Yet, when /B/ is in the input, there is no change from *A* to *B*, so F(A→B) is not violated, and therefore the conjoined constraint has no force. In this case the faithfulness constraint F(B→C), which outranks *B, is decisive, and so the faithful parse *DB* comes out as optimal.

(12) /B/ in the input

/DB/	[*B & F(A→B)]$_{Seg}$	F(B→C)	*B
a. DC	√	*!	
b. ☞ DB	√		*

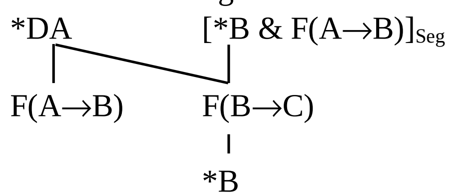
Consequently, as illustrated in (13), the mapping /DA/→*DC* is forced by the locally conjoined constraint:

(13) The Role of [*B & F(A→B)]$_{Seg}$



The conjoined constraint compels the otherwise problematic double faithfulness violation. Thus there is no *B* in the output unless it is already present in the input. The ranking that has been established is in (14) and a summary tableau is in (15):

(14) Established Ranking



(15) Summary Tableau

/DB/	*DA	[*B & F(A→B)]$_{Seg}$	F(A→B)	F(B→C)	*B
a. ☞ DB					*
b. DC				*!	
/DA/	*DA	[*B & F(A→B)]$_{Seg}$	F(A→B)	F(B→C)	*B
a. DA	*!				
b. DB		*!	*		*
c. ☞ DC			*	*	

Generalizing, *B is only relevant when F(A→B) is violated, and this is so when *B* is not in the input. That is the effect of local conjunction.

4. Applications in Phonologically-Derived Environments

In this section the proposal is applied to Polish (§4.1), Slovak (§4.2), Campidanian Sardinian (§4.3) and Hebrew (§4.4).

4.1 Spirantization in Polish

In Polish, as shown in the introduction, First Velar Palatalization creates a derived environment for Spirantization. The voiced postalveolar affricate *ǰ* turns into a fricative *ž* only in segments that undergo palatalization. Otherwise, the affricate *ǰ* is faithfully parsed in the output.[2]

In this section I will discuss spirantization only. Velar palatalization is itself subject to a morphologically-derived environment and is discussed separately in section 5. Following Clements (1989, 1991) and Hume (1992), I assume that front vowels are coronal. First Velar Palatalization, therefore, involves spreading of the coronal node from the vowel to the preceding velar, and so incurs a violation of IDENT(coronal). From an OT perspective, spirantization takes place only when IDENT(coronal) is violated.[3]

I follow Rubach (1992) in assuming that Polish affricates are strident stops: [-continuant, strident]. Spirantization involves a change from [-continuant] to [+continuant]. Since there are *ǰ*'s at the surface in Polish, the markedness constraint against them (*ǰ) must be ranked below a faithfulness constraint against spirantization (IDENT(continuant)):

(16) IDENT(continuant) >> *ǰ

This constraint ranking, when faced with the input /ro**g**+ek/, wrongly chooses as optimal the candidate that incurs a lesser violation of faithfulness, that is, the one with a voiced postalveolar *affricate* in the output form *(*ro**ǰ**ek)*. The candidate with a voiced postalveolar *fricative* (*rožek*) is wrongly ruled out, because it diverges from the input in both place and manner of articulation. This is illustrated in (17).

(17) /g/ in the input - wrong result

/rog+ek/[4]	IDENT(cor) ,	IDENT(cont)	IDENT(cont)	>> *ǰ
a. ☜ ro**ǰ**ek	*			*
b. ☞ rožek	*	!*!	!*!	

Why then is *rožek* (with palatalization and spirantization) optimal?

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[2] I postulate that spirantization is an automatic process, except when OCP would be violated: mia[zg]+a 'pulp' ~ mia[žǰ]+y+ć (and not mia[žž]+y+ć) 'to squash', ró[zg]+a 'brain'~ ró[žǰ]+ek (and not ró[žž]+ek) (dim.gen.pl)).

One might wonder why only voiced affricates spirantize. As suggested to me by John Kingston, one way to explain this fact is to compare voiced and voiceless stop closures. Voiced stops typically have shorter closures than voiceless stops. (It is difficult to maintain voicing throughout a stop, and so the closure has to be short.) But because the voiced stop closure is so short, speakers do not always achieve complete closure, and so the result is a fricative (Ohala 1983, Kingston 1998).

[3]Since *g* is not specified for coronal, this analysis of palatalization is presented under the assumption that IDENT(coronal) is violated even when an input segment is not specified for coronality.

[4]This is a simplified input form. According to Rubach (1984), the input is: /-g+ĭk+ɨ̆/.

To choose the candidate that incurs a double violation of faithfulness as optimal, I propose that the markedness constraint against voiced postalveolar affricates (*ǰ) is activated only when IDENT(coronal) is violated. This activation of the markedness constraint by the violation of a faithfulness constraint is accomplished by locally conjoining them within the domain of a segment:

(18) **[*ǰ & IDENT(coronal)]$_{Seg}$ >> IDENT(continuant) >> *ǰ**

Because of this conjunction of constraints ranked above IDENT(continuant), there are no surface *ǰ's* except those already present in the input. The relevant tableaux are given in (19).

(19) Illustration

a. /g/ in the input

/rog+ek/	[*ǰ & IDENT(coronal)]$_{Seg}$	IDENT(continuant)	*ǰ
a. ro**ǰ**ek	*!		*
b. ☞ rožek		*	

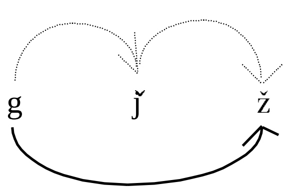
b. /ǰ/ in the input

/banǰ +o/	[*ǰ & IDENT(coronal)]$_{Seg}$	IDENT(continuant)	*ǰ
a. ☞ ban**ǰ**o	√		*
b. banžo	√	*!	

When there is a voiced stop in the input, as in (19a), the markedness constraint is activated by the violation of IDENT(coronal), and so the locally conjoined constraint chooses candidate (b), with double violation of faithfulness, as the optimal candidate. When, however, the affricate *ǰ* is already in the input, and so there is no violation of IDENT(coronal), then the locally-conjoined constraint has no force. In this case, candidate (a), with no spirantization, becomes the winner.

As a result, the markedness constraint *ǰ emerges via local conjunction with a faithfulness constraint, the violation of which is incurred when *ǰ* is not in the input:

(20) IDENT(cor) *ǰ

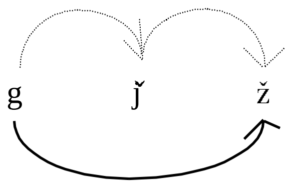


(≈ (13))

[*ǰ & IDENT(cor)]$_{Seg}$

The local conjunction of *ǰ and IDENT(coronal) compels the otherwise problematic double faithfulness violation. The optimal candidate with the fricative *ž* violates both IDENT(coronal) and IDENT(continuant):

(21) IDENT(cor) IDENT(cont)



(≈ (8))

IDENT(cor) & IDENT(cont)

The ranking that has been established is presented in (22).

(22) Established Ranking

[*ǰ & IDENT(coronal)]$_{Seg}$
|
IDENT(continuant) (≈ (14))
|
*ǰ

4.2 Diphthongization in Slovak

The interaction of Vowel Lengthening and Diphthongization in Slovak (Kenstowicz and Rubach 1987; Rubach 1993, 1995) provides yet another example of an environment derived by prior rule application. In Slovak, some affixes cause lengthening. I assume that they come with a floating μ in the input, which associates to the vowel in the output and causes it to lengthen. Consequently, as shown in (23), root vowels lengthen in the presence of those affixes.

(23) Vowel Lengthening

p[i]v+μ	→	p[i:]v (Gen. pl.)	'beer'
r[u]k+μ	→	r[u:]k	'hand'
l[a]n+μ	→	l[a:]n	'cable'

In the very same environment, however, as shown in (24), mid vowels (and æ) diphthongize.

(24) Diphthongization of mid vowels (and æ) in the lengthening contexts

č[e]l+μ	→	č[e:]l	→	č[ie]l	'forehead'
š[o]p+μ	→	š[o:]p	→	š[uo]p	'shed'
m[æ]s+μ	→	m[a:]s	→	m[ia]s	'meat'

But not all long mid vowels diphthongize in Slovak. In particular, the underlying long mid vowels make it faithfully to the surface:

(25) No Diphthongization of underlying long mid vowels

dc[e:]r+a	→	dc[e:]ra	'daughter'
m[o:]d+a	→	m[o:]da	'fashion'
baz[e:]n	→	baz[e:]n	'pool'

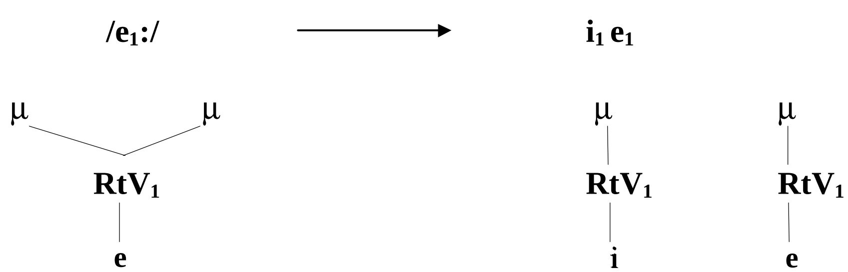
The Slovak data pose a question of why the same vowels behave differently in (24) and (25). Only derived long mid vowels diphthongize. Rubach (1993) proposes that Diphthongization in Slovak is subject to the Strict Cycle Condition (SCC); it is restricted to apply only in a derived environment which is created by the application of a prior rule, Vowel Lengthening. Hence, long mid vowels diphthongize if and only if Vowel Lengthening has taken place. This is illustrated in (26):

(26) SCC Account of Slovak (Rubach 1993, 1995)

	a. derived e:	*b. underlying e:*
UNDERLYING FORM	č[e]l+μ	dc[e:]r+a
VOWEL LENGTHENING	č[e:]l	does not apply
DIPHTHONGIZATION	č[ie]l	blocked by SCC

Before presenting an OT account of Slovak, let me make explicit the representational assumptions that I adopt. Following the proposals of McCarthy and Prince 1986, 1987, Hayes 1988, and Hyman 1985, I represent long vowels as consisting of a single root node doubly-linked to two different moras. This is the so-called One-Root Theory of Length, where length is expressed by mora count associated with a particular root node.[5] Following the standard assumptions (McCarthy & Prince, Hayes & others), I assume that moras contribute to segmental weight. Thus when a short vowel undergoes lengthening, it gains a mora in the output, and consequently differs in weight from the input short vowel. Diphthongization in my account consists of the breaking of a root node associated with the input long vowel. This is represented below:

(27) Diphthongization in Slovak (rising diphthongs)



The second element of the rising diphthong is featurally identical to its input correspondent. The first element of the diphthong, however, turns into a front high vowel. (As Rubach notes in some dialects it becomes a front glide *j*.)

[5]An alternative to a One-Root Theory of Length is a Two-Root Theory of Length (Selkirk 1988), where a long vowel consists of two root nodes, and thus it is the root count that represents length. I will not entartain this alternative in my analysis.

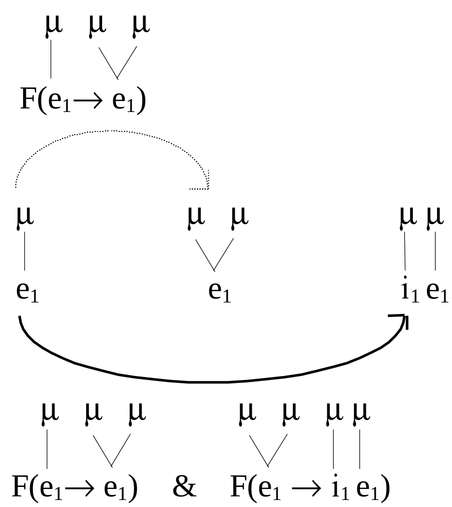
From an OT perspective diphthongization in Slovak takes place only when WT-IDENT is violated. Otherwise, the nonperipheral long vowels (i.e., i:, u:, æ:) make it faithfully to the surface.[6]

But this is initially problematic. In terms of faithfulness, the actual č[e]l→*č[ie]l* mapping, as represented in (26a), violates two faithfulness constraints, 'no lengthening' (F(μ→μμ)) and 'no diphthongization' ($F(e_1{:}\rightarrow i_1e_1)$). But there is a more harmonic hypothetical mapping, č[e]l→*č[e:]l*, which violates only one of those faithfulness constraints, namely F(μ→μμ). This is shown in (28).

(28) Faithfulness violation

hypothetical

actual



So the actual mapping in Slovak incurs a double violation of faithfulness, just as in all other cases of phonologically-derived environments.

Since long mid vowels are permitted as output forms in Slovak, the markedness constraint against them must be low-ranked. But because this markedness constraint is low-ranked, the expected output form in (28) is the long mid vowel [e:] and not the actual diphthong [ie].

The following are constraint rankings in Slovak:

(29) Constraint-rankings

•WT-IDENT >> *LONG	Vowel length is contrastive
•MAX-μ >> WT-IDENT	WT-IDENT is violated in lengthening contexts
•*MIDLONG	Nonperipheral long vowels are marked (Flemming 1997)[7]
•INTEGRITY >> *MIDLONG	There are nonperipheral long vowels in Slovak[8]

[6] WT-IDENT is violated when an input segment gains (or loses) a mora in the output.

[7] For notational convenience, I refer to nonperipheral vowels as mid. This is a simplification which bears no effect on the outcome of the analysis.

[8] INTEGRITY is a constraint against diphthongization (McCarthy & Prince 1995).

The crucial ranking is the one where the faithfulness constraint against diphthongization (INTEGRITY) outranks the markedness constraint against nonperipheral long vowels *MIDLONG. With an opposite ranking, there would be no nonperipheral long vowels in Slovak. The ranking of MAX-μ above WT-IDENT simply asserts that it is more important to preserve a mora from the input, than it is to be faithful to the input vowel length.

The constraint ranking, as illustrated in the tableau (30), wrongly chooses *č[e:]l* (the candidate with lengthening) as the optimal candidate. The actual *č[ie]l* (with lengthening and diphthongization) is ruled out.

(30) /e/ in the input - wrong result

/če_1l+μ/	MAX-μ >>	WT-IDENT	INTEGRITY	INTEGRITY>>	*MIDLONG
a. če_1l	*!				
b. ☜ če:$_1$l		*			*
c. ☞či_1e_1l		*	!* !	!*!	

Candidate (a) fails on high-ranked MAX-μ. Candidate (b), the hypothetical mapping, fares better on faithfulness than its contestant, candidate (c), the actual mapping, and so turns out victorious. Markedness against nonperipheral long vowels (*MIDLONG) cannot rule out candidate (b), as it is low-ranked in Slovak, given the fact that there are nonperipheral long vowels independently in the language. The query then is how to get *č[ie]l* (with lengthening and diphthongization) as the optimal candidate?

To choose the candidate that incurs a double violation of faithfulness as optimal, I propose that the markedness constraint against nonperipheral long vowels (*MIDLONG) is activated only when WT-IDENT is violated. In that way, *MIDLONG is only relevant in forms where the nonperipheral long vowel is not in the input. This activation of a markedness constraint by violation of a faithfulness constraint is accomplished by locally conjoining them within the domain of a segment.

(31) **[*MIDLONG & WT-IDENT]$_{Segment}$ >> INTEGRITY >> *MIDLONG**

Because of this conjunction of constraints ranked above INTEGRITY there are no long nonperipheral vowels, unless present in the input form. The relevant tableaux are given in (32).

(32) Illustration of LC

a. /e/ in the input[9]

/če_1l+μ/	[*MIDLONG & WT-IDENT]$_S$	INTEGRITY	*MIDLONG
a. če:$_1$l	*!		*
b. ☞ či_1e_1l		*	

[9]Candidates not considered in (32a): *čel* which violates undominated MAX-μ; *či:l* which violates IDENT(mid). IDENT(mid) outranks INTEGRITY, and so this candidate is less harmonic than *čiel*.

b. /e:/ in the input[10]

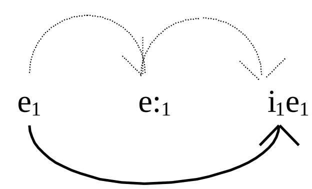
	/dce:$_1$r+a/	[*MIDLONG & WT-IDENT]$_S$	INTEGRITY	*MIDLONG
a.	☞ dce:$_1$r+a	√		*
b.	dci$_1$e$_1$r+a	√	*!	

When there is a nonperipheral short vowel in the input, as in (32a), *MIDLONG is activated by the violation of WT-IDENT, and so LC rules out *č[e:]l*. When, however, the nonperipheral long vowel is already present in the input form, as in (32b), there is no violation of WT-IDENT. The conjunction therefore has no force. *MIDLONG is low-ranked and INTEGRITY makes the choice between candidates. The candidate where diphthongization does not take place is the winner.

In other words, the markedness constraint *MIDLONG emerges via local conjunction with an appropriate faithfulness constraint (WT-IDENT), the violation of which is incurred when the input vowel is short. The role of the relevant constraints and their conjunction is shown in (33).

(33) The Role of LC

WT-IDENT *MIDLONG



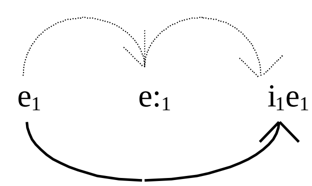
(≈ (13))

[*MIDLONG & WT-IDENT]$_{Segment}$

The local conjunction of *MIDLONG and WT-IDENT compels the otherwise problematic double faithfulness violation. The winning candidate violates both WT-IDENT and INTEGRITY, which is illustrated in (33).

(34) Faithfulness Scale

WT-IDENT INTEGRITY



(≈ (8))

WT-IDENT & INTEGRITY

[10]Other failed candidates not considered in (32b): a candidate where shortening takes place *dcera* which violates high-ranked MAX-μ; a candidate with a high long vowel *dci:ra* which violates low-ranked IDENT(mid).

The constraint ranking that has been established for Slovak is given in (35).

(35) Established Ranking[11]

MAX-μ   [*MIDLONG & WT-IDENT $]_S$

WT-IDENT   INTEGRITY   (≈ (14))

*MIDLONG

The markedness constraint *MIDLONG is low-ranked and so it has nothing to say by itself. It is only relevant when the faithfulness constraint (WT-IDENT) is violated. In other words, it is only relevant in forms where the nonperipheral long vowel is not in the input. Otherwise, there is no violation of WT-IDENT and so there is no way to activate the markedness constraint. Therefore, due to local conjunction, there are no long nonperipheral vowels unless present underlyingly.

4.3 Lenition in Campidanian Sardinian[12]

The interaction of voicing and lenition in Campidanian Sardinian presents yet another example of a phonologically-derived environment (see Bolognesi 1998). In Campidanian, voiceless fricatives /s, f/ undergo voicing when preceded by a vowel and so turn into their voiced counterparts:

(36) Postvocalic Voicing: /s, f/ → z, v/V_

s:u [s]egretario	→	s:u [z]egretario	'the secretary'
s:a [f]amil:ia	→	s:a [v]amil:ia	'the family'

In the same environment, however, voiceless stops /p,, t, k/, and the affricate /tʃ/ in addition spirantize:

(37) Lenition of voiceless stops /p, t, k/ and the voiceless affricate /tʃ/:

bɛl:u [p]iʃ:i	→	bɛl:u [b]iʃ:i	→	bɛl:u [β]iʃ:i	'nice fish'
s:u [t]rintadus	→	s:u [d]rintaduzu	→	s:u [δ]rintaduzu	'thirty-two'
dɛ [k]uat:ru	→	dɛ [g]uat:ru	→	dɛ [γ]uat:ru	'of four...'
s:u [tʃ]ɛlu	→	s:u [ʤ]ɛlu	→	s:u [ʒ]ɛʁu	'the heaven'

Interestingly, voiced stops /b, d, g/, when preceded by a vowel, do not undergo lenition. They either remain unaffected, or in some dialects optionally delete:

[11] Additional rankings are: WT-IDENT >> *MIDLONG (there are nonperipheral long vowels in Slovak) and IDENT (mid) >> INTEGRITY (better diphthongize than change the quality of the nonperipheral vowel).

[12] Campidanian Sardinian is spoken in Southern Sardinia. For a detailed discussion see Bolognesi (1998).

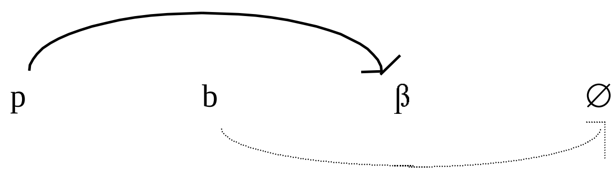
(38) No lenition of voiced stops postvocalically:

s:a [b]ia	→	s:a [b]ia	'the road'
s:u [g]atu	→	s:u [g]at:u	'the cat'
dɔn:ia [d]ɔminiɣu	→	don:ja [d]ominiɣu	'every Sunday'

So the question is why do only derived voiced stops spirantize? And why is there no spirantization of underlying voiced stops?

In OT terms lenition takes place only when IDENT(voice) is violated. Otherwise, the voiced stop remains unaffected. (In all dialects of Campidanian, the voiced stop makes it faithfully to the surface and in some dialects it also optionally deletes.) So the mapping that we observe in Campidanian is from the input voiceless stop to a voiced fricative. There is also this optional mapping from the input voiced stops to a null segment. I mark the latter mapping with a dotted line.[13]

(39) Observed mappings in Campidanian:



The mapping marked with a solid line is initially problematic. Since there are voiced stops in the inventory of Campidanian, then why do voiceless stops spirantize? They could simply undergo voicing, and turn into a voiced stop. This hypothetical mapping from a voiceless stop to a voiced stop would violate only one faithfulness constraint, IDENT(voice), whereas the actual mapping from a voiceless stop to a voiced fricative violates not only IDENT(voice), but also IDENT(continuant).

In terms of constraint rankings, since voiced stops are in the inventory of Campidanian, the markedness constraint against voiced stops must be ranked lower than a faithfulness constraint against lenition. Also, since voicing takes place, a constraint calling for voicing must outrank faithfulness to the input voice specification. This is illustrated in (40).

(40) Constraints and their rankings:

*V/VOICELESS >> IDENT(voice)		Voicing takes place
IDENT(continuant) >> *VOICED/STOP		There are voiced stops in the inventory

But this constraint ranking, when faced with /p/ in the input, wrongly chooses a candidate with lesser violation of faithfulness as optimal. The actual output with a voiced fricative loses, as it incurs a double violation of faithfulness:

[13] This latter mapping is irrelevant to out concerns in this paper, and so I do not discuss it further here. I take it to be an instance of maximal lenition, lenition to a null segment.

(41) /p/ in the input - wrong result

/su: pani/	*V/VOICELESS >> IDENT(voice), IDENT(cont)		IDENT(cont) >> *VOICED/STOP	
a. s:u [p]ãi	*!			
b. ☜ s:u [b]ãi		*		*
c. ☞s:u [β]ãi		* !* !	!*!	

To choose candidate (c) as optimal, I propose that *VOICED/STOP is activated in segments that violate IDENT(voice). In that way, *VOICED/STOP is only relevant in forms where the voiced stop is not in the input. Concretely, I propose the following ranking:

(42) **[*VOICED/STOP & IDENT(voice)]$_{Segment}$ >> IDENT(continuant) >> *VOICED/STOP**

This ranking is illustrated in the tableaux below:

(43) Illustration of LC

a. /p/ in the input

/s:u pani/	[*VOICED/STOP & IDENT(voice)]$_S$	IDENT(cont)	*VOICED/STOP
a. s:u [b]ãi	*!		*
b. ☞s:u [β]ãi		*	

b. /b/ in the input

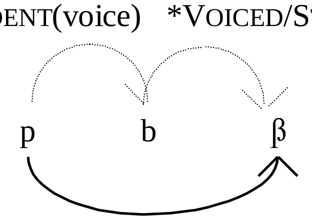
/s:a bia/	[*VOICED/STOP & IDENT(voice)]$_S$	IDENT(cont)	*VOICED/STOP
a. ☞ sa: [b]ia	√		*
b. sa: [β]ia	√	*!	

The locally conjoined constraint is only relevant when voicing takes place (43a). In case when the voiced stop is already in the input, there is no violation of IDENT(voice) in the input-output mapping, and so there is no way to activate the markedness constraint. The candidate with lesser violation of faithfulness, candidate (a), becomes the winner.

As a result of locally conjoining the markedness constraint *VOICED/STOP with a faithfulness constraint IDENT(voice), voiced stops are avoided when voicing takes place. This forces the fell-swoop from the input voiceless stop to a voiced fricative in the output:

(44) The Role of LC

IDENT(voice) *VOICED/STOP



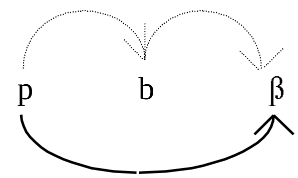
(≈ (13))

[*VOICED/STOP & IDENT(voice)]$_{Segment}$

The local conjunction of *VOICED/STOP and IDENT(voice) compels the otherwise problematic double faithfulness violation. The winning candidate violates both IDENT(voice) and IDENT(continuant).

(45) Faithfulness Scale

IDENT(voice) IDENT(continuant)



(≈ (8))

IDENT(voice) & IDENT(continuant)

Summarizing, this double violation of faithfulness is forced by activating the markedness constraint against voiced stops in segments that undergo voicing. Otherwise, the markedness constraint militating against voiced stops is inactive. That is the effect of a high ranked locally conjoined constraint.

4.4 Vowel Lowering in Tiberian Hebrew

As discussed in Prince (1975), nonlow vowels in Tiberian Hebrew alternate between high and mid variants. In particular, high vowels are never an output of lengthening rules. Alan Prince has suggested to me that this pattern could be regarded as an SCC effect; there are no long high vowels, unless present underlyingly. Hence, the following mappings take place in Tiberian Hebrew:

(46) Mappings in Tiberian Hebrew

Underlying long high vowels	High vowels in a lengthening context
i: → i:	i → e:
u: → u:	u → o:

These alternations are illustrated in (47).

(47) Lengthening in Tiberian Hebrew[14]

Lengthening Process	Lengthened form	Gloss	Short form	Gloss
Pre-Tonic Lengthening	š[i]m+o:t → š[e:]m+ót̲	'names'	šimká:	'your names'
Tone-Lengthening	s[i]pr → s[é:]p̄er	'book'	sip̄r-í:	'my book'
	y[i]bk → y[é:]b̲k	'let him weep'	yib̲ké	'he will...'
	s[u]bb → s[ó:]b̲	'go around'	subb-í	'for me to...'
	ḥ̥[u]qq → ḥ̥[ó:]q	'statute'	ḥ̥uqqí:m	'statutes'

Lengthening Process		Expected form	Lengthened form	Gloss	Category
Guttural Lengthening	brk	*b[i]rrák̲	b[e:]rák̲	'he blessed'	Pi'ēl
	brk	*b[u]rrá:k̲	b[o:]rák̲	'he was blessed'	Pu'al
	ḥ̥ŕš	*ḥ̥[i]rré:š	ḥ̥[e:]rré:š	'deaf'	Adj. Def.
	nḥ̥t	*y[i]nḥ̥á:t̲ *y[i]ḥ̥ḥ̥á:t̲	y[e:]ḥ̥á:t̲	'he marched down'	Verb I-n

The LC account presented in this paper accounts for the above mappings in a uniform way. Since there are long high vowels in Hebrew, the markedness constraint that militates against long high vowels (*HIGHLONG) must be low-ranked. But this low-ranked markedness constraint is activated when faithfulness to length (WT-IDENT) is violated - i.e., when lengthening takes place. Therefore, long high vowels are never a result of lengthening.[15]

This activation of the markedness constraint (*HIGHLONG) by the violation of the faithfulness constraint (WT-IDENT) is achieved by locally-conjoining them. The relevant ranking is in (48).

(48) **[*HIGHLONG & WT-IDENT]$_{\text{Segment}}$ >> IDENT (high) >> *HIGHLONG**

As a consequence, there are no long high vowels unless present underlyingly.

[14]For a detailed description of the above processes see Prince (1975).

[15]The markedness constraint *HIGHLONG is independently motivated. Long high vowels are avoided in Yawelmani (see Archangeli 1984, McCarthy 1998 and references cited there).

5. LC Account of Morphologically-Derived Environments

So far I have argued that local conjunction accounts for phonologically-derived environments. In this section I extend the LC account to cases of derived environments by morpheme concatenation. I observe that cases of morphologically-derived environments always lead to violation of stem:syllable anchoring. Therefore, I propose that this violation of anchoring activates the relevant markedness constraint.

5.1 Rule-Based Account

In this section I give a rule-based account of SCC effects with morphologically-derived environments. As an example I use First Velar Palatalization from Polish (after Rubach 1984).

As we saw in (2), First Velar Palatalization turns velars into postalveolars before front vocoids. But there is no Palatalization when the trigger and target belong to the same morpheme:

(49) No Velar Palatalization in tautomorphemic sequences

[ke]fir	'kefir'	[ke]lner	'waiter'	[k'i]siel	'jelly'
[ge]ncjana	'gentian'	a[ge]nt	'agent'	[g'i]ps	'plaster'
[x'i]gienistka	'hygienist'	[x'i]storia	'history'	[xe]tera	'shrew'(person)

Rubach (1984) postulates that First Velar Palatalization is a cyclic rule and therefore subject to the SCC; it is restricted to apply only across a morpheme boundary. This is shown schematically in (50).

(50) The Role of SCC (Rubach 1984)

Cycle 1	xemik	
	blocked by SCC	VELAR PALATALIZATION
Cycle 2	xemik+ǐk	WFR: dimin.
	xemič+ǐk	VELAR PALATALIZATION
	xem'ič+ek	Other rules

Consequently, Velar Palatalization is allowed to apply only when the trigger and target of the process are heteromorphemic, that is after word formation rules on cycle two.

5.2 More on First Velar Palatalization

Before explaining why First Velar Palatalization is restricted to apply only when the trigger and target of the process are heteromorphemic, I will discuss the process of palatalization in more detail. As we saw in (2), First Velar Palatalization takes place before front vocoids, and due to palatalization input velars turn into postalveolars. I assume the following feature specifications of the relevant segments:

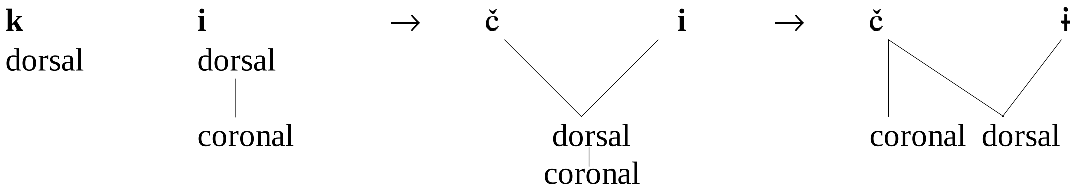
(51) Feature representations

high front vowel *i*:	[coronal, dorsal]
high mid vowel *ɨ*:	[dorsal]
mid front vowel *e*:	[coronal, dorsal, pharyngeal]
velars:	[dorsal]
postalveolars:	[dorsal, coronal]

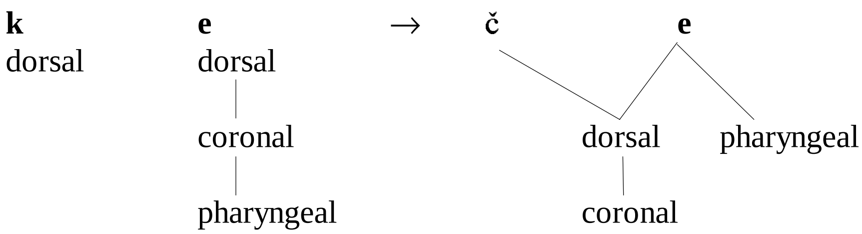
Assuming these featural representations, palatalization involves the following mappings:

(52) Mappings in First Velar Palatalization

a. Palatalization before *i*



b. Palatalization before *e*



In each case [coronal] spreads onto the preceding velar, and so the input velar becomes postalveolar in the output. Interestingly, the high front vowel *i* in addition loses its input [coronal] specification, gives it up entirely to the preceding velar, and therefore turns into a high mid vowel *ɨ* in the output. In case of a front mid vowel *e*, however, [coronal] is preserved on the output vowel, and so there is nothing happening to the vowel itself. But why do only high front vowels lose their coronality?

One way to explain this fact is to say that the target of palatalization is actually to transfer [coronal] to the preceding velar entirely, and that is what triggers *coronal transfer* in (52a). But because there are no mid central vowels in the inventory of Polish, the target cannot be achieved in (52b), and so we're doing our best by just spreading coronal onto the velar, and preserving coronal on the mid vowel *e*.

In Optimality Theory the inventory of a language is shaped by the interaction of faithfulness and markedness constraints. Since mid central vowels are marked in the inventory of some languages, a markedness constraint against mid central vowels has been postulated. In case of Polish, this constraint is high-ranked, so that, regardless of the input vowel specification, there are no mid central vowels in the inventory. On the other hand, since there are high central vowels in the output forms of Polish, then the markedness constraint against them must be ranked lower than faithfulness. This is shown in (53).

(53) Vowel Inventory of Polish
*MIDCENTRAL >> IDENT(coronal) >> *HIGHCENTRAL

Since, as I suggested above, the output of palatalization is to transfer [coronal] entirely to the preceding velar, I propose that a constraint against multiple linkage of coronal, NOMULTIPLE(coronal) must be high-ranked. In particular I suggest that it dominates the markedness constraint *HIGHCENTRAL, and that's what forces *coronal transfer* in case of high vowels. But since in case of mid vowels, [coronal] remains on the vowel, and at the same time is linked to the preceding velar, thus violating NOMULTIPLE(coronal), I propose that *MIDCENTRAL must outrank NOMULTIPLE(coronal). The constraint ranking is given in (54) and the relevant tableaux are in (55).

(54) *MIDCENTRAL >> NO MULTIPLE(coronal) >> *HIGHCENTRAL

(55) Coronal Transfer

a. Palatalization before *ɨ;* [coronal] transfer takes place

/ k i / dorsal dorsal coronal	NO MULTIPLE (coronal)	*HIGHCENTRAL
1. č i dorsal coronal	*!	
☞ 2. č ɨ coronal dorsal		*

b. Palatalization before *e;* [coronal] transfer is blocked

/ k e / dorsal dorsal coronal pharyngeal	*MIDCENTRAL	NO MULTIPLE (coronal)
☞1. č e dorsal pharyngeal coronal		*
2. č ə coronal dorsal pharyngeal	*!	

Generalizing, we aim to satisfy NO MULTIPLE(coronal), but only if the markedness constraint against the resulting segment is low-ranked. Otherwise, coronal is multiply linked in the output form to both the consonant and the vowel.

Another way to explain this asymmetry between high and mid vowels with respect to *coronal transfer* is to say that we opt for more optimal perceptual distance between adjacent segments. The postalveolar and the front high vowel *i* are too close perceptually, and so the vowel undergoes retraction. The mid vowel *e* and the postalveolar are perceptually distinct enough, and so there is no need for making them even more distinct. Therefore, [coronal] remains on the mid vowel *e* in the output. [16]

In the next section I account for the morphological restriction on the process of palatalization.

5.3 The Theory of Morphologically-Derived Environments

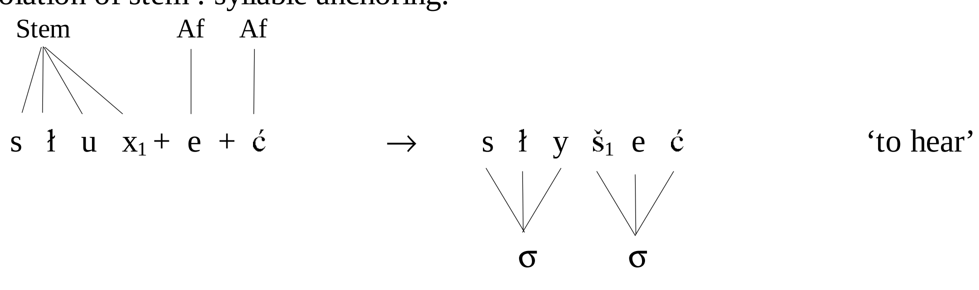
The fact that a process is restricted to apply only across a morpheme boundary initially seems problematic for OT. Since there are instances of velars that do not palatalize before front vowels, the markedness constraint calling for palatalization, PAL, must be ranked below a faithfulness constraint militating against a change in coronality, IDENT (coronal). This is shown in (56).

(56) IDENT(coronal) >> PAL[17]

But with this ranking, there should be no palatalization whatsoever.

To force palatalization when the target of the process is input stem final, I note that the addition of a palatalizing suffix always results in violation of stem:syllable anchoring. Since the palatalizing suffix starts with a vowel, the final consonant of the stem becomes the onset of the syllable contributed by the palatalizing suffix. Therefore, the rightmost segment of the input stem does not coincide with the right edge of the syllable in the output. This is illustrated in (57).

(57) Violation of stem : syllable anchoring.



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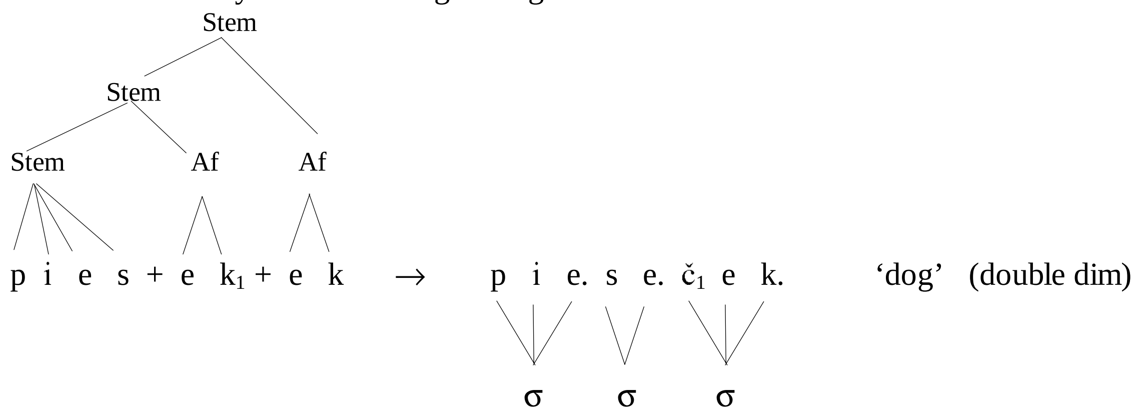
[16] The perceptual account needs more evidence, but it could be a way to go.

[17] PAL militates against having velars before front vocoids (PAL = *[DORSAL][CORONAL, DORSAL].)

Similarly, a violation of anchoring may occur at a suffix : suffix boundary. Following McCarthy and Prince (1995), I take it that the stem is a recursive category, and therefore every right suffix edge is a stem boundary. A consequence of this view is that there may be strict cycle effects among suffixes:

(58) Violation of stem : syllable anchoring among suffixes



I propose that this violation of stem:syllable anchoring activates the markedness constraint demanding palatalization. Consequently, only input stem final segments may palatalize. This leads to a different range of predictions that the standard Strict Cycle approach to morphologically-derived environments. The implications of the anchoring account are explored in §5.4.

Formally, I propose the constraint calling for palatalization is locally conjoined with the constraint guarding stem:syllable anchoring. The relevant anchoring constraint is given in (59) and the constraint ranking is in (60).

(59) R-Anchor(Stem; σ) - the rightmost segment of a stem in the input has a correspondent at the right edge of a syllable in the output.[18]

(60) **[PAL & R-Anchor(Stem; σ)]$_{AdjacentSegments}$ >> Ident(coronal) >> PAL**

The two constraints are conjoined within the domain of adjacent segments. Therefore, only a segment that violates stem:syllable anchoring undergoes palatalization when followed by a front vowel.

Since Palatalization is activated by the violation of anchoring, there is no Palatalization of a segment that vacuously satisfies anchoring, such as tautomorphemically. Only stem final segments can palatalize, precisely because only such segments can incur a violation of anchoring. This is illustrated in (61ab).

[18] Anchoring is a correspondence constraint, therefore faithfulness, replacing the MCat:PCat Alignment constraints of McCarthy and Prince (1993). For an extensive discussion of anchoring see McCarthy and Prince (1995); Benua (1997); McCarthy (1997).

(61) The Role of LC

a. Palatalization heteromorphemically

/[xemik$_1$]$_{Stem}$ + ek/	[PAL & R-ANCHOR (Stem; σ)]$_{AdjSeg}$	IDENT(cor)
a. ☞ xe.mi.č$_1$ek.		*
b. xe.mi.k$_1$ek.	*!	

b. No Palatalization monomorphemically

/[x$_1$emik]$_{Stem}$ /[19]	[PAL & R-ANCHOR (Stem; σ)]$_{AdjSeg}$	IDENT(cor)	PAL
a. ☞ x$_1$e.mik.	√		*
b. š$_1$e.mik.	√	*!	

The locally conjoined constraint is only relevant when the palatalizing segment is stem final (as in (61a)). Otherwise, the conjoined constraint has no force, and so lower-ranked constraints are decisive (this is shown in (61b)). [20]

The constraint ranking that has been established for Polish in sections 4.1 & 5.3 is in (62):

(62) Established Ranking for Polish (Section 4.1 & 5.3)

[PAL & R-ANCHOR (Stem; σ)]$_{AdjSeg}$ [*ǰ & IDENT(cor)]$_{Seg}$

IDENT(cor) IDENT(cont) (≈ (14))

PAL *ǰ

To conclude, the LC account of morphologically-derived environments shows in what way faithfulness between morphological and prosodic categories activates a phonological process.

5.4 Further Consequences

My account of morphologically-derived environments makes two novel predictions. First, it predicts that the trigger and target of a process that is resticted to apply across a morpheme boundary must be adjacent. This requirement follows from the domain condition on local conjunction. Second, my account shows that it is not the mere presence of the morpheme boundary that matters, but violation of stem:syllable anchoring. By means of local conjuction, violation of stem:syllable anchoring activates a markedness constraint, causing a phonological process. In case when there is no violation of anchoring the phonological process is blocked. These two predictions of my account turn out to be true of all Palatalization processes in Slavic

[19] According to Rubach (1984), the full underlying form is: /xemik+ɨ̆/.

[20] There are surface forms in Polish that do not show violation of anchoring (e.g. xemič+k+a). But in each case there is a failed candidate emitted by Gen which incurs violation of anchoring and therefore shows palatalization (e.g. xemič+ĭk+a). Palatalization in the actual output is then due to faifthulness to this failed candidate (as in McCarthy's 1998 Sympathy proposal).

(Rubach 1984, 1995), Polish Iotation (Rubach 1984; Rubach & Booij 1990), as well as Affrication in Korean (analyzed in Kiparsky 1993 modifying Iverson & Wheeler 1988). The apparent counterexamples, such as Icelandic u-Umlaut (Anderson 1969; Kiparsky 1984; Orešnik 1977; Kiparsky 1993; van Oostendorp 1998), Finnish Consonant Gradation (Kiparsky 1993, Bye (to appear)), Tri-syllabic Shortening (Halle and Vergnaud 1987; Myers 1987) or Vowel Assimilation in Basque (Hualde 1989) can be analyzed differently.

Reanalyses of Icelandic u-Umlaut, Finnish Consonant Gradation and Tri-syllabic shortening have been already proposed in the literature (see the references cited above). Therefore, in the rest of this section I propose a reanalysis of Vowel Assimilation in Basque.

As noted by Hualde (1984), in Basque word-final /a/ raises to *e* when preceded by a high vowel. This process is blocked in roots. It only applies in suffixes and clitics. This is illustrated in (63) (from Hualde 1989).

(63) A. Vowel Raising in suffixes of the form -(C)a

a. gišon+[a]	→	gišon[a]	'the man'
lagun+[a]	→	lagun[e]	'the friend'
b. pelota-k[a]	→	pelotak[a]	'throwing a ball'
ar̄i-k[a]	→	ar̄ik[e]	'throwing stones'
c. bat-n[a]	→	batn[a]	'one by one'
bi-n[a]	→	biɲ[e]	'two by two'

B. No Raising of root-final /a/

a. eliš[a]	→	eliš[a]	'church'
b. mug[a]	→	muɣ[a]	'limit'

C. Vowel Raising of clitic-final /a/, after reduction of vowel sequences

a. buru-a d[a]	→	burur[e]	'it is the head'
b. baso-a d[a]	→	basur[e]	'it is the forest'

D. No Raising in non-final suffixes (a), unless what follows is a clitic (b).

a. ar̄i-k[a]	→	ar̄ik[e]	'throwing stones'
ar̄i-k[a]-da	→	ar̄ik[a]ra	'throwing of a stone'
b. lagun-[a] da	→	laɣun[e]ra	'it is the friend'

To account for these generalizations, Hualde (1989) proposes that Vowel Assimilation only targets word final vowels. It is a non-cyclic rule subject to the SCC. It applies after all suffixation has been completed and is restricted by the SCC to apply only across a morpheme boundary.

Therefore, there is no assimilation in non-final suffixes as in (63D) and in morpheme-internal contexts as in (63B).[21]

It is clear that the LC/Anchoring account of morphologically-derived environments presented in the previous section would not work for the Basque data. In Basque, there is no violation of anchoring of the stem final segment. Therefore, I suggest a different explanation for the blocking of Vowel Assimilation in roots (as in 63B). In particular, I propose that the restriction of assimilation to affix-like entities (63A,C) follows from the difference in ranking between ROOTFAITH and AFFIXFAITH. As suggested by McCarthy and Prince (1995), universally ROOTFAITH dominates AFFIXFAITH. In other words, it is more important to be faithful to the input feature specification within roots than within affixes. In Basque the relevant feature specification is height. The constraint IDENT(low) is subdivided into $\text{IDENT}_{\text{ROOT}}$(low) and $\text{IDENT}_{\text{AFFIX}}$(low). The relative ranking of these constraints is in (64).

(64) $\text{IDENT}_{\text{ROOT}}$(low) >> $\text{IDENT}_{\text{AFFIX}}$(low)

Furthermore, I assume that a constraint calling for raising of a word final /a/ if preceded by a high vowel, call it RAISING, is ranked between the two faithfulness constraints:

(65) $\text{IDENT}_{\text{ROOT}}$(low) >> RAISING >> $\text{IDENT}_{\text{AFFIX}}$(low)

So raising takes place in affixes, because the markedness constraint calling for raising dominates $\text{IDENT}_{\text{AFFIX}}$(low). But in roots raising is blocked due to the higher-ranked $\text{IDENT}_{\text{ROOT}}$(low).

To conclude, Vowel Assimilation in Basque can be straightforwardly reanalyzed in terms of ROOT and AFFIX faithfulness. It no longer falls under the scope of morphologically-derived environment and therefore, it does not present a problem for my account of this type of derived environment effect.

6. Comparison with Previous Approaches

This section compares predictions made by three alternative accounts of non-derived environment blocking (NDEB) effects: the original SCC account (Mascaró 1976, Kiparsky 1982), an underspecification account (Kiparsky 1993), and the LC account developed in this work. The predictions of my account differ radically from the original SCC, but are very similar to the underspecification model of Kiparsky (1993). This similarity holds even though the LC account and the underspecification account are based on very different theoretical premises.

The predictions of these three approaches are compared with respect to five basic claims made by the SCC: derived environment effects and the cycle, the two types of derived environment effects, the nature of morphologically-derived environments, phonologically-derived environments by altering the context, and phonologically-derived environments by vacuous rule application.

[21] Furthermore, Hualde (1989) proposes that clitic groups are formed at a different stage than suffixes, and therefore a nonfinal suffix when followed by a clitic may undergo raising (as in 63Db).

6.1 Entailments of the original SCC

To begin with, the SCC, as presented in (1), predicts that all and only cyclic rules are blocked from applying in non-derived environments. In this way, the SCC equates non-derived environment blocking (NDEB) with cyclicity.

Second, under the SCC the two distinct types of derived environment, the one resulting from prior rule application (i.e., phonological) and the one resulting from morpheme concatenation (i.e., morphological), are always united. This implies that a rule subject to the first type of derived environment will be subject to the second type and vice versa, if evidence is available.

Third, the SCC predicts that it is the mere presence of a morpheme boundary that creates a morphologically-derived environment. Consequently, any cyclic rule of which the trigger and target belong to different morphemes applies under such conditions.

Fourth, according to the SCC, a phonologically-derived environment can arise by a prior rule that either targets the segment (as in §4) or alters its context (as below).

(66) Context altered derived environment

UNDERLYING FORM	DBX
$E \rightarrow X/B\_$	does not apply
$B \rightarrow C/\_X$	blocked by SCC

As (66) shows, the later rule can apply if and only if its context has been derived by the prior rule. This means that the two rules in this special feeding relation do not necessarily have to target the same segment.

Finally, under the SCC, a derived environment can arise by vacuous rule application. Mascaró (1976) gives an example of 'Vowel Lowering' and 'Mid Vowel Reduction' in Catalan in support of this view.

The SCC account, however, encounters empirical difficulties, and so alternatives have been postulated. One of them is the underspecification account proposed by Kiparsky (1993).

6.2 Comparison with Kiparsky (1993)

The account of Kiparsky (1993) crucially makes use of the notion of radical underspecification (Archangeli 1984), binarity, and structure-building vs. structure-changing mode of rule application. In this underspecification account 'NDEB is the result of structure-building rules applying to underspecified representations' (Kiparsky 1993: 285).

Contrary to the SCC, the underspecification model of Kiparsky (1993) makes no necessary connection between cyclicity and NDEB. The only necessary condition for rules to be subject to NDEB is that they are obligatory neutralization rules of the structure-building type.

Unlike the SCC, the underspecification model makes no necessary connection between the two types of derived environment. It no longer requires that there exists a rule subject to both types of derived environment effects, though certainly it does not undermine this possibility.

As in the SCC account, Kiparsky (1993) predicts that morphologically derived environment can arise by adding any morpheme boundary. The necessary condition is that the rule is of the structure-building type and it applies to an underspecified representation.

Moreover, similarly to the SCC, Kiparsky (1993) predicts derived environment effects by a prior rule targeting the context and not necessarily the same segment. Finnish Assibilation is given as an example of such a rule.

Finally, contrary to the SCC, in the underspecification account derived environment effects cannot arise by vacuous rule application. In support of this claim, Kiparsky (1993) reanalyzes the apparent cases of vacuously derived environment: 'Catalan Vowel Lowering', and 'Catalan Mid Vowel Reduction'.

6.3 Comparison with Local Conjunction

This paper offers yet another account of derived environment effects, this time within the framework of OT. The predictions of the LC account presented in this work differ radically from the original SCC account. However, the predictions are similar to the underspecification model of Kiparsky (1993), although the LC account and the Underpecification account are theoretically distinct.

- **No connection with the cycle.** Just like Kiparsky's 1993 underspecification model and in contrast to the SCC, the LC account does not connect NDEB with the cycle. The special feeding order between rules follows directly from local conjunction of otherwise lower-ranked constraints.

  In section 4.3 we've already seen an example of a rule which applies across word boundaries (postlexically), and is subject to non-derived environment blocking. The Strict Cycle approach could not handle this case. In fact, other work on derived environment effects has rejected the cyclic basis for NDEB (see Hualde 1989, Kaisse 1986, Kiparsky 1993 and others).[22] As shown in the literature, there are cyclic rules not subject to NDEB, as well as noncyclic and postlexical rules that apply only in a derived environment. To name just a few, Kiparsky (1993) gives an example of Finnish Vowel Coalescence, a cyclic rule, applying freely in a non-derived environment. Kaisse (1986) further shows that a noncyclic word-level rule of stop devoicing in Turkish is prevented from applying in a non-derived environment. Finally, Kiparsky (1993) argues that the postlexical ruki rule in VedicSanskrit must be subject to NDEB, so that it does not apply morpheme-internally.

[22] For a comprehensive review see Kiparsky (1993).

- **No necessary connection between the two types of derived environment effects**. Unlike the SCC and similarly to the underspecification model of Kiparsky (1993), though within a different framework, the LC account makes no necessary connection between the two types of derived environment. In fact, it has not been proved that there exists a rule subject to both types of derived environment effects. (Two apparent cases, Finnish assibilation and the Sanskrit ruki rule (Kiparsky 1973, 1982), are analyzed differently in Hammond 1992.)

  In the LC account the two types of derived environment are accounted for in a similar way. In both cases the faithfulness constraints activating the relevant markedness constraints involve correspondence, although they demand correspondence of different categories. In cases of phonologically-derived environments the faithfulness constraints are of the IDENT (Feature/Weight) type and so they guard feature/weight identity, whereas in cases of morphologically-derived environments they are of the ANCHOR (MCat, PCat) family and so demand correspondence between input morphological and output prosodic categories.

- **Morphologically-derived environments.** Unlike the SCC and the underspecification account, the LC makes no connection with cyclicity or structure-building mode of rule application. Rather, it makes two novel predictions. First, it predicts that the trigger and target of a process that is restricted to apply across a morpheme boundary must be adjacent. This follows from the requirement that constraints be conjoined in some local domain. Secondly, it predicts that it not the mere presence of a morpheme boundary that matters but violation of anchoring. These two predictions seem to be empirically more adequate than those of previous approaches (see §5.4).

- **No derived-environment effects when the prior rule alters the context**. Contrary to the SCC and the underspecification account, the LC account predicts no derived environment effects when the prior rule targets the context. In the LC account, the structure of the double faithfulness loop is restricted by the locality condition on constraint conjunction. Since the domain for LC is a segment, the LC account predicts no derived-environment effects when the faithfulness and markedness constraints are violated within different segments (in support of this view see discussion in §7.2). In fact, the cases of a derived environment by a prior rule altering the context are regarded as problematic, as shown in Hammond (1992).[23]

- **Derived environment cannot arise by vacuous rule application**. In the LC account, unlike Mascaró (1976), a derived environment cannot arise by vacuous rule application. In the LC account of derived environment effects the particular markedness constraint is activated by a violation of the relevant faithfulness constraint. In the case of vacuous rule application, however, there is no violation of faithfulness, and so there is no way to activate the markedness constraint. As a result, the markedness constraint is satisfied vacuously and local conjunction has no force. In fact, the purported cases of vacuously derived environment were also argued against in the underspecification account of Kiparsky (1993).

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[23] In Hammond (1992) see in particular the analysis of Finnish Assibilation drawing on Keyser and Kiparsky (1984); McCarthy and Prince (1990). Estonian Lowering and Sanskrit Ruki Rule are also discussed.

To conclude, the predictions of the LC account differ radically from the original SCC, but are very similar to the underspecification model of Kiparsky (1993). This similarity holds even though the LC account and the underspecification account are based on very different theoretical premises. Thus, one can conclude that work on non-derived environment blocking virtually since Kiparsky (1982) consistently supports the results achieved by local conjunction.

7. Conclusions

In this section I first summarize the proposal presented in this paper (§7.1) and then offer a somewhat different conceptualization of local conjunction (§7.2).

7.1 Summary

In this paper I have argued that the local conjunction of a markedness and faithfulness constraint enables OT to handle all cases of derived environment effects. A markedness constraint is low-ranked in the particular grammar, whereas its conjunction with a faithfulness constraint is high-ranked. Violation of the faithfulness constraint thus activates the markedness constraint. This accounts for both phonologically- and morphologically-derived environment effects.

In section 2 I showed that all cases of phonologically-derived environments involve a seemingly unmotivated double faithfulness violation. In section 3 I postulated that this double violation of faithfulness is forced by the high-ranked locally-conjoined constraint. I argued that the domain for LC in cases of a phonologically-derived environment is a segment.

(67) Phonologically-derived environments

In Polish:	[*ǰ & IDENT (coronal)]$_{Segment}$	>> IDENT(continuant)>>	*ǰ
In Slovak:	[*MIDLONG & WT-IDENT]$_{Segment}$	>> INTEGRITY	>> *MIDLONG
In Sardinian:	[*VoicedStop & IDENT(voice)]$_{Segment}$	>>IDENT(continuant)>>	*VoicedStop
In Hebrew:	[*HIGHLONG & WT-IDENT]$_{Segment}$	>> IDENT(high)	>> *HIGHLONG

Furthermore, in section 5 I argued that all cases of morphologically-derived environments involve a violation of stem:syllable anchoring. I proposed that this violation of anchoring activates the relevant markedness constraint. The domain for LC in cases of a morphologically-derived environment consists of adjacent segments, which explains why only stem final segments may undergo palatalization. This is illustrated in (68).

(68) Morphologically-derived environments

In Polish: [PAL & R-ANCHOR(Stem; σ)]$_{Adjseg}$ >> IDENT(coronal) >> PAL

To sum up, in this paper I have shown that the LC proposal accounts for both phonological- and morphological derived environment effects. The LC account, unlike the SCC account, makes no necessary connection between the two types of derived environment, although it allows to account for both of them in a similar way. This as well as other predictions of the LC account were emphasized in section 6, where the implications of the LC account were compared with the original SCC and an underspecification model of Kiparsky (1993).

7.2 Alternative to LC

LC, as formulated in Smolensky (1993, 1995) raises two basic questions:

(i) What constraints can be conjoined?

(ii) What is the domain for constraint conjunction?

In the rest of this section I examine each of these questions in turn. I also propose an alternative to LC which motivates the locality condition for constraint conjunction.

(i) What constraints can be conjoined?

Hewitt & Crowhurst (1996) and Crowhurst & Hewitt (1997) propose that only constraints that share a fulcrum (an argument) can be conjoined. Though I adopt a somewhat different conceptualization of local conjunction than they do, my work supports this view. In Slovak and Hebrew the shared argument of the two conjoined constraints is length; in the case of Polish Spirantization it is coronality; and in the palatalization processes it is a segment. This is illustrated below.

(69) Shared Argument

Type of derived environment	Language	Markedness constraint	Faithfulness constraint	Shared Argument
Derived environment by prior rule application	Slovak	* μ μ (both linked to) V, linked to [mid]	F (μ linked to V → μ μ linked to V)	μ μ linked to V
	Polish	* [-cont] linked to [coronal dorsal] linked to [+voice]	F (∅ → [coronal])	[coronal]
	Campidanian Sardinian	*[+obstruent] linked to [-continuant] linked to [+voice]	F([-voice]→[+voice])	[+voice]
	Tiberian Hebrew	* μ μ (both linked to) V, linked to [high]	F (μ linked to V → μ μ linked to V)	μ μ linked to V
Derived environment by morpheme concatenation	Polish Velar Palatalization	*dorsal || dorsal coronal	R-ANCHOR(Stem, σ)	segment

(ii) What is the domain for constraint conjunction?

I propose that the domain for LC is the smallest domain within which both of the locally-conjoined constraints can be evaluated. In cases of phonologically-derived environments the relevant markedness and faithfulness constraints can be assessed within a single segment, and so the segment is the domain of LC. In cases of morphologically-derived environments, however, the ANCHORING constraint is still evaluated within a segment, but the markedness constraint requires two adjacent segments to be evaluated, and so the domain for LC is the window of two adjacent segments. It remains to be determined why these two kinds of conjunctions have exactly these domains.

In the rest of this section I will show that the locality condition for the evaluation of the conjoined constraint follows naturally from a somewhat different conceptualization of LC. In particular, I will show that the mechanism of LC, which forbids the two conjuncts from being violated within the same local domain, follows from perceiving the two conjuncts as a specific single constraint.

•**LC as Markedness-sub-Faithfulness**. Specifically, I propose that in cases of LC one of the conjoined constraints *sets up a domain of evaluation (or 'activation')* for the other. This is a different sense of domain from the one discussed so far. It consists of segments that violate one of the conjoined constraints.

In particular, in cases of LC of markedness and faithfulness, it is the faithfulness constraint that sets up a domain of evaluation (or 'activation') for the markedness constraint with which it is conjoined. Hence, I argue that the locally conjoined constraint can be seen as a specific markedness constraint which is only relevant for those segments that violate relevant faithfulness constraint (call it MARK-sub-FAITH). The violation of the relevant faithfulness constraint thus establishes a domain of activation for this specific markedness constraint. When faithfulness is satisfied, this markedness constraint is obeyed vacuously, and when faithfulness is violated, it can be obeyed or violated non-vacuously depending on the output configuration.

This MARK-sub-FAITH constraint stands in the relation Specific to General with respect to the non-relativized MARKEDNESS. The set of candidates that violate MARK-sub-FAITH is smaller than the set of candidates that violate MARKEDNESS. Therefore, for this constraint to be active at all it has to outrank general MARKEDNESS. (One can easily see a parallel with specific faithfulness constraints, such as: FAITH-sub-NOUN or FAITH-sub-ONSET, which are evaluated only within the domain pointed out by the subscript and stand in the relation Specific to General with respect to their non-relativized counterparts).[24] Schematic rankings are given in (70) and the role of specific markedness for Slovak is illustrated in (71).

(70) Schematic Ranking for Slovak

	MARK-sub-FAITH1	**>> FAITH2**	**>> MARKEDNESS**
In Slovak:	*MIDLONG$_{\text{WT-IDENT}}$	>> INTEGRITY	>> *MIDLONG

(71) The role of MARK-sub-FAITH in Slovak

/če$_1$l+μ/	*MIDLONG $_{\text{WT-IDENT}}$	INTEGRITY	*MIDLONG
a. če:$_1$l	*!		*
b. ☞či$_1$e$_1$l		*	
/dce:$_1$r+a/	*MIDLONG $_{\text{WT-IDENT}}$	INTEGRITY	*MIDLONG
c. ☞ dce:$_1$r+a	√		*
d. dci$_1$e$_1$r+a	√	*!	

[24]For a detailed discussion of specific faithfulness constraints see Selkirk (1994); Beckman (1995, 1997); Smith (1997) and others.

So the specific markedness constraint is violated only when there is a mid long vowel in the output which is a result of lengthening (this is shown in 71a). In case of an output mid long vowel which is already present in the input, as in (71c), this specific markedness constraint is satisfied vacuously. There is no violation of faithfulness to set it active.

The alternative to LC, as discussed above, explains why the two constraints, markedness and faithfulness, have to be locally conjoined. Namely, the specific markedness constraint is only activated when the relevant faithfulness constraint is violated within the same segment. Otherwise, this markedness constraint is inactive. Hence, the 'local' part of LC is playing a crucial role in the evaluation of this specific markedness constraint.

To sum up, in this section I have presented a different conceptualization of LC as a specific single constraint. It shows how the mutual dependency between the two conjoined constraints might be based on general premises of OT.

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