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Derived Environment Effects in Optimality Theory*

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Abstract

The Strict Cycle Condition (SCC) permits phonological rules to apply only in derived environments. The notion of a derived environment, and consequently the phenomena attributed to the SCC, are problematic in Optimality Theory (OT). This article argues that OT can be extended to accommodate SCC effects by using local constraint conjunction. By locally conjoining a markedness constraint with a faithfulness constraint, the markedness constraint is active only when the faithfulness constraint is violated. The predictions of this approach are compared to the SCC and found to be superior in several respects.

Keywords

Optimality Theory

Lexical Phonology

Polish

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1. Introduction

The theory of Lexical Phonology limits cyclic rule application to derived environments which are created by either prior rule application (phonologically derived environments) or morpheme concatenation (morphologically derived environments). 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: 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 derived environment effects can be understood within the Optimality Theory framework (OT) of Prince and Smolensky (1993) by making use of local constraint conjunction, which was originally introduced for other reasons by Smolensky (1993, 1995, 1997). The proposal is that a markedness constraint is conjoined with a faithfulness constraint, so that the markedness constraint is active, able to compel a phonological alternation, only when the faithfulness constraint is violated. I will argue that this proposal captures all legitimate effects of the Strict Cycle Condition leading to different and arguably superior predictions.

This paper is organized as follows. Section 2 discusses spirantization in Polish as an example of an environment derived by prior rule application and shows why this type of derived environment effect is initially problematic for OT. Section 3 presents the proposal, developing a novel account of this type of derived environment effect that makes use of local conjunction (LC). The LC account is illustrated with spirantization in Polish (§3.1) and lenition in Campidanian Sardinian (§3.2). Section 4 extends the LC account to cases of environments derived by morpheme concatenation. Section 5 compares entailments of the LC account with alternative theories of derived environment effects. Finally, section 6 contains the conclusions.

2. Phonologically-Derived Environments: Statement of the Problem

The interaction of Velar Palatalization and Spirantization in Polish provides an example of an environment derived by prior rule application (Rubach, 1984). 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* (/g/→*ž*, */g/→*ǰ*). Crucially, *ǰ's* that are present underlyingly make it to the surface (see (2c)).[1]

(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]+i̷+ć	'to step'
kro[k]+ĭk+i̷	→	kro[č]+ek	'step' (dim.)
stra[x]+i+ć	→	stra[š]+i̷+ć	'to frighten'

b. Palatalization and Spirantization of underlying /g/:

va[g]+i+ć	(→	va[ž]+i+ć)	→	va[ž]+i̷+ć	'to weigh'
dron[g]+ĭk+i̷	(→	dron[ǰ]+ek)	→	drõw̃[ž]+ek (dim)	'pole'
śńe[g]+ĭc+a	(→	śńe[ǰ]+ic+a)	→	śńe[ž]+i̷c+a	'snow-storm'

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

bri̷[ǰ]+ĭk+i̷	→	bri̷[ǰ]+ek	'bridge' (dim.)
ban[ǰ]+o	→	ban[ǰ]+o	'banjo'
[ǰ]em+i̷	→	[ǰ]em	'jam'

The Polish data raise a question: why does underlying /g/ in (2b) undergo both palatalization and spirantization? If it only palatalized it would turn into surface *ǰ* and surface *ǰš* exist in Polish (2c). In response, Rubach (1984) proposes that Polish has a rule of Spirantization (/ǰ/→ *ž*) that is subject to the SCC: it is restricted to apply only in a derived environment which is created by the prior application of the rule of 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	va[g]+i+ć	br̩[ǰ]+ǐk+r̩
VELAR PALATALIZATION	va[ǰ]+i+ć	does not apply
SPIRANTIZATION	va[ž]+i+ć	blocked by SCC
Other rules	va[ž]+r̩+ć	br̩[ǰ]+ek

It seems clear that Rubach's analysis reflects a real insight, an insight that other theories of phonology need to capture. Yet SCC effects like this one are initially problematic for OT. To show this, I will first lay out some representational assumptions, and then I will discuss the constraints and their interaction. Following Clements (1989, 1991) and Hume (1992), I assume that front vowels are coronal. In palatalized sequences the coronal node of the vowel extends to the preceding velar, and so IDENT(coronal) is violated. (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.) Furthermore, I follow Rubach (1992) in assuming that Polish affricates are strident stops, [-continuant, strident]. Thus, spirantization involves a change from [-continuant] to [+continuant], violating IDENT(continuant). In this section I discuss spirantization only. Velar palatalization is itself subject to a morphologically-derived environment and is discussed separately in section 4. [2]

We now have the background to see why the Polish case is initially problematic in OT. There are two basic approaches one might take. One approach would be to ban *ǰ* from outputs generally. But, as I will show in detail below, this general prohibition on *ǰ* will affect all *ǰ's*, whether underlying or derived. Another approach would be to permit *ǰ* generally, but then there

is no way to prohibit derived *ǰ's*. Either way we run into a ranking paradox or a grammar that doesn't work.

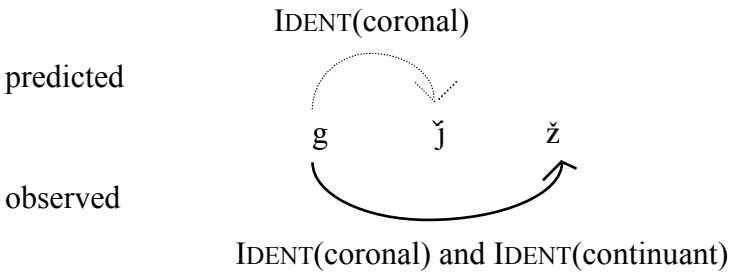
To see the problem, let us examine the second of these approaches in more detail. As we recall from (3), underlying *g* changes to surface *ž* (it palatalizes and spirantizes), but underlying *ǰ* is unaffected (it does not spirantize). Since there are *ǰ*'s at the surface in Polish, the markedness constraint against them (*ǰ) must be ranked below the faithfulness constraint that stops *ǰ* from changing into a fricative:

(4) IDENT(continuant) >> *ǰ

But because *ǰ is low-ranked, both underlying /ǰ/ and *ǰ's* that come from underlying /g/ should make it to the surface. To put it concretely, we expect **vaǰić* in (3a), with the affricate *ǰ*, and not *važić*, with the actual fricative *ž*. In other words, there is nothing to stop *ǰ* from surfacing as an output in Polish regardless of its source.

Another way to look at this problem is in terms of faithfulness. Mapping underlying /g/ to output *ǰ* would violate only one faithfulness constraint, IDENT(coronal). (Recall that Polish affricates are strident stops, according to Rubach (1992).) In comparison, the actual output form with *ž* violates not only IDENT(coronal), but also an additional faithfulness constraint, IDENT(continuant). This is shown in (5).

(5) Faithfulness violations in Polish



The mapping /g/→*ž* incurs a double violation of faithfulness, while the mapping /g/→*ǰ* violates only one faithfulness constraint. The challenge for OT, therefore, is to explain why the mapping with double violation of faithfulness is optimal.

3. The Proposal: Local Conjunction of Markedness and Faithfulness

3.1 Spirantization in Polish

Let's compare the two mappings formally on the example of an underlying form /ro**g**+ek/ ('horn'). The competing candidates are *roǰek* with an affricate (the predicted output) and *rožek* with a fricative (the actual output). As shown in the following tableau, the constraint ranking established so far wrongly chooses as optimal the candidate that incurs a lesser violation of faithfulness, that is, the one with an *affricate* in the output form *(*roǰek)*.

(6) /g/ in the input - wrong result [3]

/ro**g**+ek/	IDENT(coronal)	IDENT(continuant)	*ǰ
a. ☜ ro**ǰ**ek	*		*
b. ☞ ro**ž**ek	*	**!*!**	

Candidate (a) violates the low-ranked markedness constraint *ǰ, but because this constraint is low-ranked it does not rule out this candidate. Both candidates violate IDENT(coronal), since they both palatalize. But the actual output form *ro**ž**ek,* candidate (b), in addition fatally violates the high-ranked faithfulness constraint IDENT(continuant).

To choose candidate (b) as optimal, the force of the additional faithfulness violation that it incurs, IDENT(continuant), must be rendered irrelevant. Intuitively, it seems that in Polish, though the markedness constraint *ǰ is low-ranked, the affricate *ǰ* cannot surface if it is a result of palatalization. What this amounts to in OT terms is that the low-ranked markedness constraint *ǰ is activated if and only if there is a change from /g/ into a coronal, that is when IDENT(coronal) is violated.

I propose that the markedness constraint against voiced postalveolar affricates (*ǰ) is activated by the violation of the faithfulness constraint IDENT(coronal). This activation of a markedness constraint by the violation of a faithfulness constraint is achieved by locally conjoining them. Local constraint conjunction (LC), which was proposed by Smolensky (1993 et. seq.), is a way of combining constraints. The formal definition of LC is given in (7) below.

(7) Definition of LC (Smolensky, 1993)

The Local Conjunction of C_1 and C_2 in domain D, $[C_1 \& C_2]_D$, is violated when there is some domain of type D in which both C_1 and C_2 are violated. [4]

Let's work through this definition. The locally conjoined constraint is of the form $C=(C_1,C_2, D)$, where C_1 and C_2 are constraints and D is the domain in which C_1 and C_2 are conjoined. Then C is violated if and only if C_1 and C_2 are both violated somewhere in domain D. In other words, the locally conjoined constraint is violated if and only if all of its conjuncts are violated within a single domain. Generally speaking, LC is used to activate constraints that are by themselves dominated in the grammar of a particular language, and so they are otherwise either partially or totally inactive, their force having been vitiated by higher-ranked constraints. LC makes the otherwise low-ranked constraint active by requiring obedience to it when a violation of another constraint occurs within the same domain. The role of the domain is crucial to the concept of LC, and will have important implications below. [5]

In Polish and in other cases of phonologically-derived environments, the domain for LC of the markedness constraint and the faithfulness constraint is a segment. In Polish, then, the markedness constraint *ǰ and the faithfulness constraint IDENT(coronal) cannot be violated together within the same segment. The locally conjoined constraint is ranked above IDENT(continuant), so that it can compel violation of IDENT(continuant):

(8) $[*ǰ \& \text{IDENT(coronal)}]_{\text{Segment}} >> \text{IDENT(continuant)} >> *ǰ$

To put it differently, the markedness constraint *ǰ is low-ranked, but its conjunction with the faithfulness constraint IDENT(coronal) is high-ranked. As a result, a violation of the faithfulness constraint activates the low-ranked markedness constraint. Because of this conjunction of constraints ranked above IDENT(continuant), there are no surface *ǰ's* except those already present in the input form.[6]

Let us now apply these ideas to the Polish data. When there is a voiced stop in the input, as in (9), the markedness constraint is activated by the violation of IDENT(coronal), and so the locally conjoined constraint selects candidate (b), notwithstanding the double violation of faithfulness.

(9) /g/ in the input

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

Yet, when 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.

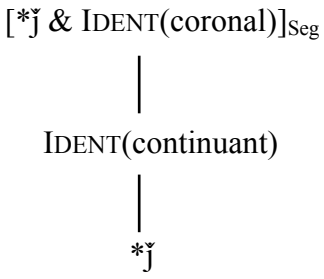
(10) /ǰ/ in the input

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

Consequently, the mapping /*g*/→ *ǰ* is forced by the locally conjoined constraint. 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) (shown in (5)).

The ranking that has been established is presented in (11).

(11) Established ranking



By virtue of this ranking, *ǰ is only relevant when IDENT(coronal) is violated, and this is so when *ǰ* is not in the input. That is the effect of local conjunction.

There are three significant observations to be made about the Polish example. These observations are important because they hold of other cases of phonologically-derived environments, such as lenition in Campidanian Sardinian discussed in section 3.2, as well as vowel lowering in Tiberian Hebrew (Prince, 1975), and diphthongization in Slovak (Rubach, 1993).

First, in each of the cases of phonologically-derived environments, segments are allowed to surface faithfully if they are underlying but cannot arise as a result of a phonological alternation. To illustrate it, let's look again at the Polish example. As we saw in (2), in Polish underlying *ǰ*'s

are allowed on the surface but *ǰ*'s that would be a result of palatalization are banned. This is accounted for by means of a high-ranked locally-conjoined constraint *ǰj and IDENT(coronal). The markedness constraint *ǰj is low-ranked but is activated when faithfulness, IDENT(coronal), is violated.

Second, the actual mapping in cases of phonologically-derived environments (in Polish, /g/→*ʒ́*) incurs a seemingly unmotivated double violation of faithfulness. At the same time there is a more faithful hypothetical mapping (/g/→*ǰ)* which violates one faithfulness constraint less. We know that because the featural composition of a voiced velar stop (*g*) is more similar to a voiced postalveolar affricate (*ǰ*), than it is to a voiced postalveolar fricative (*ʒ́*). Thus, a change from /g/ to *ǰ* would result in a more faithful mapping and should be preferred for faithfulness reasons, as the discussion of (6) emphasized. The challenge for OT is to explain what forces the less faithful mapping to take place, and the proposal here is that the locally-conjoined markedness and faithfulness constraint is responsible.

Third, in each legitimate case of phonologically-derived environments, the markedness constraint that results in the unmotivated faithfulness violation (in Polish, the spirantization constraint) is context-free. The context-free property of the markedness constraint allows the domain for LC in cases of phonologically-derived environments to be a single segment. It is enough to look at the segment itself to evaluate the context-free markedness constraint.

In summary, there are three characteristics of phonologically-derived environments: (i) the special status of underlying segments, (ii) the seemingly unmotivated double violation of faithfulness in the actual mapping, and (iii) the context-free property of the phonological alternation that adds an unmotivated faithfulness violation. The LC proposal takes into account

these three characteristics and accounts for each of them using the general tools of OT. In this way the LC proposal provides a general account of all legitimate cases of phonologically-derived environments. The idea is straightforward; an otherwise low-ranked markedness constraint is activated, resulting in a phonological alternation, only when a faithfulness constraint is violated within the same segment. In the next section I illustrate the LC proposal with another case of phonologically-derived environment, lenition in Campidanian Sardinian.

3.2 Lenition in Campidanian Sardinian

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

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

dɛɔ [f]uɛɖ:ɔ [s]ɛmprɛ	→	dɛu [v]uɛɖ:u [z]ɛmpri	'I speak-1sg always'
s:u [s]egretario	→	s:u [z]ɛɣrɛt:aɾiu [7]	'the secretary'
s:a [f]amil:ia	→	s:a [v]amil:ia	'the family'

In the same environment, however, the voiceless stops /p, t, k/, and the affricate /tʃ/ also lenite:

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

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

Interestingly, the voiced stops /b, d, g/, when preceded by a vowel, do not undergo lenition. They remain unaffected:

(14) No lenition of voiced stops postvocalically: [8]

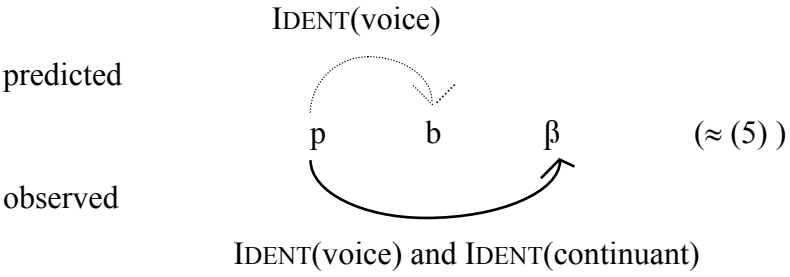
bɔʒɛ [b]ɛl:a	→	bɔʒi [b]ɛl:a	'voice beautiful'
dɛ [g]ɔma	→	dɛ [g]ɔma	'of rubber'
dɔn:ia [d]ɔminɣu	→	don:ja [d]ominɣu	'every Sunday'

The interaction of voicing and lenition in Campidanian displays the three characteristics of phonologically-derived environments that were discussed at the end of section 3.1: (i) the special status of underlying segments, (ii) the seemingly unmotivated double faithfulness violation, and (iii) the context-free property of the relevant markedness constraint. I will now show how it matches the three characteristics.

To begin with, voiced stops surface faithfully when they are underlying but they cannot be a result of a phonological alternation, such as voicing. Therefore, to avoid "derived" voiced stops, voicing is always accompanied by lenition (/p/→β, */p/→b).

Secondly, the mapping that we observe in Campidanian incurs the seemingly unmotivated double faithfulness violation. The input voiceless stop turns into a voiced fricative in the output. Since *p* differs from *β* in both voicing and continuancy, the mapping /p/→*β* violates both IDENT(voice) and IDENT(continuant). At the same time there is a more harmonic hypothetical mapping /p/→*b* which would violate only one faithfulness constraint, IDENT(voice):

(15) Faithfulness violations



LC of markedness and faithfulness will explain why the less harmonic mapping is taking place in Campidanian.

Finally, as in all other cases of phonologically-derived environments, the markedness constraint that results in an unmotivated faithfulness violation, here a constraint that bans voiced stops, is context-free. All voiced stops that are the result of the voicing process undergo lenition. In OT terms lenition takes place whenever IDENT(voice) is violated.

We now come to the analysis. Since voiced stops are in the inventory of Campidanian, the markedness constraint against voiced stops (*VOICED/STOP) (see ft. 2) must be ranked lower than

a faithfulness constraint against lenition (IDENT(continuant)) and below a faithfulness constraint against a change in voicing (IDENT(voice)). This is a general way of ensuring that voiced stops make it to the surface, if present underlyingly. They cannot lenite or devoice. Also, since voicing takes place, a constraint against voiceless obstruents postvocalically (*V/VOICELESS) (for a detailed account of lenition see Kirchner (1998)) must outrank faithfulness to the input voice specification (IDENT(voice)). This is illustrated in (16).

(16) Constraints and their rankings

a. There are voiced stops in the inventory

IDENT(continuant), IDENT (voice) >> *VOICED/STOP

b. Postvocalic Voicing takes place

*V/VOICELESS >> IDENT(voice)

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 *β* loses, as it incurs a double violation of faithfulness:

(17) /p/ in the input - wrong result [9] (*s:u βãi* 'the bread')

/su: **p**ani/	*V/VOICELESS	IDENT(voice)	IDENT(continuant)	*VOICED/STOP
a. s:u **p**ãi	***!**			
b. ☜ s:u **b**ãi		*		*
c. ☞s:u **β**ãi		*	**!*!**	

Candidate (a) does not undergo postvocalic voicing, and so fatally violates *V/VOICELESS. Candidate (c), the actual output, loses on IDENT(continuant), and candidate (b), the unintended mapping, is the winner. Candidate (b) violates a markedness constraint against voiced stops, but this markedness constraint is low-ranked in the grammar of Campidanian, and so does not rule out candidate (b). Similarly to the Polish case (compare 6), the violation marks incurred by the actual output (17c) are worse than the violation marks incurred by the unintended mapping (17b).

To choose candidate (c) as optimal, I propose that *VOICED/STOP is activated in segments that violate IDENT(voice). In that way, it is activated in forms where the voiced stop is not in the input. Activation is accomplished by locally conjoining *VOICED/STOP with IDENT(voice), and ranking the combined constraints above IDENT(continuant):

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

This ranking is illustrated in the tableaux below:

(19) /p/ in the input

/s:u **p**ani/	[*VOICED/STOP & IDENT(voice)]$_{Seg}$	IDENT(continuant)	*VOICED/STOP
a. s:u **b**ãi	*!		*
b. ☞s:u **β**ãi		*	

(20) /b/ in the input (*sa: βia* 'the road')

/s:a **b**ia/	[*VOICED/STOP & IDENT(voice)]$_{Seg}$	IDENT(continuant)	*VOICED/STOP
a. ☞ sa: **b**ia	√		*
b. sa: **β**ia	√	*!	

In tableau (19) I only consider candidates that satisfy *V/VOICELESS, that is the ones that have a voiced segment following a vowel. Candidate (19a) loses, because it violates the locally conjoined constraint. It has a voiced stop in the output which is a result of IDENT(voice) violation. Candidate (19b) wins, because it satisfies the high-ranked locally-conjoined constraint. It violates IDENT(voice), but does not incur a violation of *VOICED/STOP within the same segment. This way a candidate with a double violation of faithfulness (19b) becomes optimal. In case when the voiced stop is already in the input (tableau (20)), 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 a lesser violation of faithfulness, candidate (20a), becomes the winner.

Summarizing, as a result of locally conjoining the markedness constraint *VOICED/STOP with a faithfulness constraint IDENT(voice), the markedness constraint against voiced stops is activated in segments that undergo voicing. This forces the fell-swoop from an input voiceless stop to a voiced fricative in the output. Otherwise, when there is no violation of IDENT(voice), the markedness constraint is inactive and so underlying voiced stops make it to the surface. That is the effect of a high-ranked locally conjoined constraint.

3.3 Typological Implications

Inherent to Optimality Theory is language typology. The central question that needs to be asked of any OT analysis is what languages are predicted by various re-rankings of the proposed constraints. In this section I examine ranking permutations involving the local conjunction constraint of markedness and faithfulness proposed so far.[10]

When establishing ranking permutations, free permutations may be limited by universally fixed (non-permutable) rankings. One general claim concerning local constraint conjunction is that conjoined constraints universally outrank their component parts, thus the locally conjoined constraint $[F\&*M]_D$ dominates its components, markedness *M and faithfulness F, in all grammars (Smolensky 1995 et seq.). Predicted grammars are given in (21).

(21) Predicted Grammars

a. Derived environment effect

$[F\&*M]_D$ >> IDENT(M) >> *M

b. Normal application

*M >> IDENT(M)

c. Blocking in all environments

IDENT(M) >> $[F\&*M]_D$ >> *M

The ranking in (a) is a general schema for derived environment effects. The marked segment M surfaces in some environments in the language (IDENT(M) >> *M) but is ruled out when faithfulness F is violated in a local domain ($[F\&*M]_D$ >> IDENT(M)). As argued in this paper,

faithfulness violation implies a derived environment effect. Thus, according to this ranking, M-type segments are not allowed in derived environments. The ranking in (b), on the other hand, presents a case where the marked segment is banned from all environments due to the high ranked markedness *M (*M >> IDENT(M)). In this case, the ranking of the locally conjoined constraint $[F\&*M]_D$ is irrelevant since markedness is active in all environments. Finally, the ranking in (c) is a case where the marked segment is admitted to all environments. Faithfulness to M, IDENT(M), outranks both the locally-conjoined constraint and antagonistic markedness. We have seen now that LC theory can account for the range of attested behaviors: derived environment effect, normal application and blocking in all environments.

4. Extension to Morphologically-Derived Environments

Thus far I have argued that local conjunction of a faithfulness constraint and a markedness constraint accounts for phonologically-derived environments. In this section I extend this theory to cases of derived environments created by morpheme concatenation. The key observation is that all legitimate cases of morphologically-derived environments always involve misalignment of stem and syllable edges. In terms of Correspondence Theory (McCarthy and Prince, 1995), stem-syllable misalignment is a faithfulness violation, because proper alignment is required by the correspondence constraint ANCHOR. The analysis then proceeds in a way closely parallel with the account of phonologically-derived environments: by locally conjoining a markedness constraint with the faithfulness constraint ANCHOR, the markedness constraint is active only in domains where stem and syllable are misaligned. This proposal, I will argue, subsumes all genuine effects of the SCC with morphologically-derived environments.

I begin by presenting the rule-based account of morphologically-derived environments in section 4.1. I then present the theory of morphologically-derived environments based on local conjunction of markedness and faithfulness (ANCHOR) constraints in section 4.2. In section 4.3 I discuss cases of opacity involving palatalization to account for the full range of palatalization data from Polish. Finally, in section 4.4 I discuss the differences between the misalignment approach and the Strict Cycle, and I propose a reanalysis of an apparent counterexample to the misalignment approach, the process of Vowel Raising in Basque.

4.1 Rule-Based Account

In this section I summarize a rule-based account of SCC effects with morphologically-derived environments, using as an example First Velar Palatalization in Polish (after Rubach, 1984). In Polish, velars palatalize before front vocoids (see (2a)), but there is no Palatalization when the trigger and target of the process are tautomorphemic:

(22) No Velar Palatalization in tautomorphemic sequences (cf. (2a))

[ke]f'ir	'kefir'	[ke]lner	'waiter'	[k'i]śel	'jelly'
[ge]nc'jana	'gentian'	a[ge]nt	'agent'	[g'i]ps	'plaster'
[x'i]g'jeńistka	'hygienist'	[x'i]stor'ja	'history'	[xe]m'ik	'chemist'

To account for this lack of palatalization in tautomorphemic sequences, Rubach (1984) postulates that First Velar Palatalization is a cyclic rule and therefore subject to the SCC;

accordingly, it is restricted to apply only across a morpheme boundary. This is shown by the derivation in (23).

(23) The role of the SCC (Rubach, 1984)

Cycle 1	[xe]mik	'chemist'
	blocked by SCC	FIRST VELAR PALATALIZATION
Cycle 2	xemi[k+ĭ]k	WFR: dim.
	xemi[č+ĭ]k	FIRST VELAR PALATALIZATION
	xem'i[č+e]k	Other rules

First Velar Palatalization cannot apply on Cycle 1, because the *xe* sequence is tautomorphemic. But on Cycle 2 the *k+ĭ* sequence is heteromorphemic, so that First Velar Palatalization can (and in fact must) apply. [11]

4.2 Morphologically-Derived Environments in OT

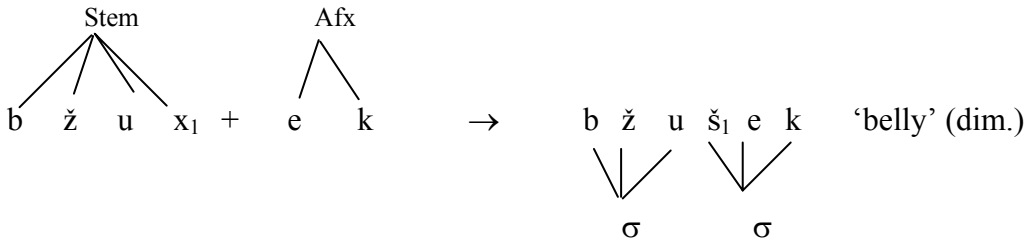
The fact that a process is restricted to apply only across a morpheme boundary initially seems problematic for OT. Within the OT framework, there are ways to restrict phonological alternations to salient positions only (i.e., initial syllables, onsets, roots as opposed to affixes), either by means of positional faithfulness (Beckman, 1995, 1997) or contextual markedness (Zoll, 1996), but none of these hold of tautomorphemic vs. heteromorphemic sequences. In other words, none of these alternatives allows a phonological alternation to be blocked tautomorphemically, but to apply in heteromorphemic sequences within the same language.

In order to show this problem concretely using the Polish data, I must first describe the constraints relevant to First Velar Palatalization. I call the markedness constraint against the sequence of a velar followed by a front vowel PAL. Following Clements (1989, 1991) and Hume (1992), I postulate that velars are specified as [dorsal] and front vocoids are [coronal, dorsal]. Therefore, PAL militates against the sequence [dorsal][coronal, dorsal]. In palatalized sequences, a coronal node is shared by the front vowel and the preceding velar, and so the faithfulness constraint that is violated is IDENT(coronal) (see section 2).

We now have the background to see why the Polish derived environment effect is problematic for OT. There are two ways to approach the data, but neither is successful. We could rank PAL above IDENT(coronal) and demand palatalization everywhere. But then palatalization would take place in tautomorphemic sequences. Alternatively, we could rank IDENT(coronal) above PAL, and block palatalization everywhere. But then palatalization would be blocked in heteromorphemic sequences.

Since palatalization takes place in heteromorphemic sequences only, there must be a difference between heteromorphemic and tautomorphemic sequences to force palatalization in heteromorphemic sequences only. The crucial observation is that in each case palatalization affects a stem-final consonant before a vowel-initial suffix. Since the suffix starts with a vowel, the final consonant of the stem belongs to the syllable contributed by the palatalizing suffix. This results in misalignment (Prince and Smolensky, 1993; McCarthy and Prince, 1993ab) of the right edges of the stem and a syllable.

(24) Stem-syllable misalignment in Polish palatalization[12]



As (24) shows, the rightmost segment of the stem is not syllable-final. This misalignment, I will argue, is a general property of all cases of morphologically-derived environments. (This leads to a different range of predictions than the standard Strict Cycle approach. The implications of this account are explored in section 4.4.)

In Correspondence Theory (McCarthy and Prince, 1995), the stem-syllable misalignment illustrated in (24) violates the constraint ANCHOR (McCarthy and Prince, 1995), which is defined as follows:

(25) 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.

R-ANCHOR(Stem; σ) is violated in (24) because the input x_1, which is stem-final, stands in correspondence with output $š_1$, which is not syllable-final. Because it is formulated in correspondence-theoretic terms, ANCHOR is a faithfulness constraint, unlike its predecessor ALIGN (McCarthy and Prince, 1993).

We now have the tools we need to apply the LC theory to First Velar Palatalization. In every instance of velar palatalization, there is a violation of R-ANCHOR(Stem; σ). Only the segment that incurs a violation of stem-syllable anchoring (the stem-final segment before a vowel-initial

suffix) undergoes palatalization. So what this means is that a violation of R-ANCHOR(Stem; σ) is a necessary condition for palatalization to take place. We can go even further and say that anchoring activates palatalization, thereby establishing a close parallel between morphologically- and phonologically-derived environments.

To capture this observation, I propose that the local violation of R-ANCHOR(Stem; σ) activates an otherwise low-ranked markedness constraint PAL. Formally, PAL is locally conjoined with R-ANCHOR(Stem; σ). The combined constraint is ranked above IDENT(coronal), so that it is able to compel violation of IDENT(coronal) and force palatalization. The constraint ranking is in (26).

(26) $[\text{PAL} \;\&\; \text{R-ANCHOR(Stem; σ)}]_D$ >> IDENT(coronal) >> PAL

PAL and R-ANCHOR(Stem; σ) are conjoined within a local domain D. The domain restriction is discussed later in this section. For now let's assume that D is such that segments violating R-ANCHOR(Stem; σ) undergo palatalization.

Since palatalization is activated by the violation of R-ANCHOR(Stem; σ), stem-final segments palatalize when followed by a front-vowel suffix, because they incur a violation of R-ANCHOR(Stem; σ).[13] There is no palatalization of a segment that satisfies R-ANCHOR(Stem; σ), such as tautomorphemically. This is illustrated in (27) and (28):

(27) Palatalization heteromorphemically (Stem-Finally)

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

(28) No palatalization tautomorphemically

/[x$_1$emik]$_{Stem}$ /[14]	[PAL & R-ANCHOR(Stem; σ)]$_D$	IDENT(coronal)	PAL
a. ☞ x$_1$e.mik.	√		*
b. š$_1$e.mik.	√	*!	

In tableau (27) the locally-conjoined constraint is relevant, because the palatalizing segment is input stem-final, and only a segment in this morphological location can violate anchoring. Recall that with no violation of anchoring, there is no violation of the locally-conjoined constraint. Candidate (27b) violates the locally-conjoined constraint, because the stem-final segment in this candidate is unanchored and unpalatalized. Its competitor (27a) becomes the winner. Its stem-final segment, though unanchored, is palatalized and so satisfies the locally-conjoined constraint.

The situation is different in tableau (28). Here the high-ranked locally-conjoined constraint has no force, because there is no violation of R-ANCHOR(Stem; σ). Therefore, lower-ranked constraints are decisive. Candidate (28b) palatalizes the velar, and so fails on IDENT(coronal). Candidate (28a) is the winner. This candidate does not incur a violation of IDENT(coronal). It violates PAL, but PAL is ranked lower than IDENT(coronal), and so is irrelevant in this case.

The same analysis extends straightforwardly to cases like (29), where palatalization occurs between suffixes (rather than between a root and a suffix).

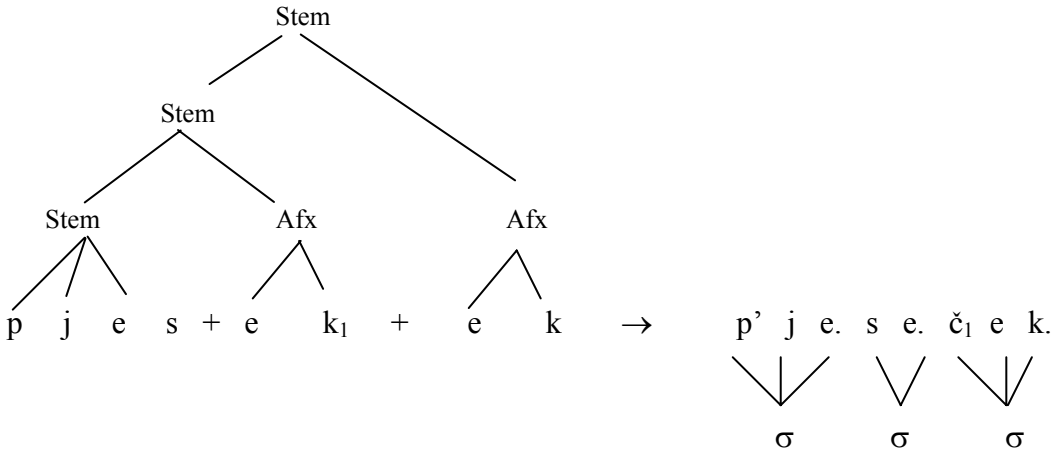
(29) Palatalization across edges of suffixes

/pjes+ek$_1$+ek/ → p'je.se.[č$_1$]ek 'dog' (double dim.)

/vor+ek$_1$+ek/ → vo.re.[č$_1$]ek 'bag' (double dim.)

In each case it is the final velar of the first diminutive suffix that palatalizes. I will follow McCarthy and Prince (1993) in assuming that the stem is a recursive category, and therefore every right suffix edge is a stem boundary. A consequence of this view is that if the right suffix edge violates anchoring, it must palatalize, just like the rightmost segment of the innermost stem does:

(30) Violation of stem-syllable anchoring among suffixes 'dog' (double dim.)



Therefore, strict cycle effects among suffixes are a natural consequence of the LC theory of morphologically-derived environments.

As examples (27-30) illustrate, segments that violate R-ANCHOR(Stem; σ) (stem-final segments) must palatalize. This is equivalent to saying that PAL must be satisfied in segments that are unanchored. We have also seen that if there is no violation of R-ANCHOR(Stem; σ)

within the word, there is no palatalization. (This was shown in (28)). There is a third possibility we have left out, but that we should also consider. These are cases where there is a violation of R-ANCHOR(Stem; σ) within the word, but the segment that could palatalize is not the one that violates anchoring. Tableau (31) shows this problem formally.

(31) Palatalization nonlocally - wrong result (*kelnera* 'waiter' (masc. gen.))

/[$k_1$elner]$_{Stem}$ + a/	[PAL & R-ANCHOR(Stem; σ)]	IDENT(coronal)	PAL
a. ☞ $k_1$el.ne.ra.	*!		*
b. ☞ $č_1$el.ne.ra.		*	

The addition of a vowel-initial suffix incurs a violation of anchoring of the stem-final segment /r/. This segment does not palatalize since the suffix is not a high front vowel.[15] But there is a sequence within the stem, the initial sequence /ke/, which would palatalize if the locally-conjoined constraint was evaluated nonlocally. Candidate (b) would be the winner.

To explain why the *ke* sequence escapes palatalization, we need to impose a domain condition on constraint conjunction. Crucially, the velar stop *k* does not palatalize because it is not the segment that violates R-ANCHOR(Stem; σ). This is shown in the tableau below.

(32) No palatalization nonlocally

/[$k_1$elner]$_{Stem}$ + a/	[PAL & R-ANCHOR(Stem; σ)]$_D$	IDENT(coronal)	PAL
a. ☞ $k_1$el.ne.ra.	√		*
b. $č_1$el.ne.ra.	√	*!	

Both candidates in (32) satisfy the high-ranked locally-conjoined constraint since it now has the domain argument. Candidate (b) loses on IDENT(coronal). Candidate (a) is the winner, because it fails to palatalize and so satisfies IDENT(coronal).

To ensure that only segments violating R-ANCHOR(Stem; σ) can palatalize, I propose that the domain for the locally-conjoined constraint is the domain of adjacent segments:

(33) [PAL & R-ANCHOR(Stem; σ)]$_{AdjSeg}$ >> IDENT(coronal) >> PAL

The domain cannot be smaller than adjacent segments, because PAL requires two adjacent segments to be evaluated (for a discussion of the domain condition see ft. 5).

To complete the picture, we now combine the results of this section with the previous section by examining the behavior of underlying stem-final /g/. When followed by a front vocoid, stem-final underlying /g/ palatalizes, violating IDENT(coronal), and spirantizes, violating IDENT(continuant), and so changes to surface *ž*.

(34) Palatalization and Spirantization of stem-final /g/ (recalled from (2b))

va[g]+i+ć	→	va[ž]+i̶+ć	'to weigh'
dron[g]+ǐk+i̶	→	drõw̃[ž]+ek	'pole' (dim.)
ro[g]+ǐk+i̶	→	ro[ž]+ek	'horn' (dim.)

As argued in section 3, spirantization in segments that palatalize (violate IDENT(coronal)) is due to a high-ranked locally-conjoined constraint [*j & IDENT(coronal)]$_{Seg}$. This locally-conjoined

constraint disallows *ǰ's* in segments that palatalize. Such segments cannot end up as *ǰ's* and so choose to spirantize:

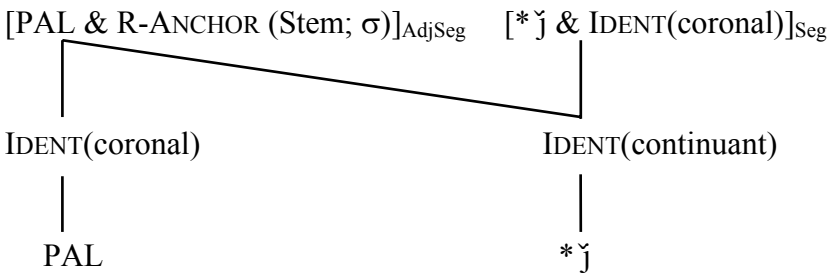
(35) Palatalization and Spirantization of stem-final /g/ (recalled from (9))

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

So we know that IDENT(continuant) is always violated in segments that violate IDENT(coronal).[16] But why is there violation of IDENT(coronal) in the first place? When analyzing these cases in section 3 we took it for granted that IDENT(coronal) is violated, because we did not have the tools to account for it. We now have those tools: palatalization is forced by a high-ranked locally-conjoined constraint [PAL & R-ANCHOR(Stem; σ)]$_{AdjSeg}$. This constraint demands palatalization of a segment that violates anchoring, such as stem-final /g/ in /ro**g**+ek/.

As for the ranking of [PAL & R-ANCHOR(Stem; σ)]$_{AdjSeg}$ relative to faithfulness constraints, we have established that it must outrank IDENT(coronal), because otherwise palatalization would be blocked. (This was shown in (26-28).) In addition, because the /g/ to *ž* mapping involves a violation of IDENT(continuant), it is also crucial that [PAL & R-ANCHOR(Stem; σ)]$_{AdjSeg}$ outranks IDENT(continuant), since otherwise, a candidate with output *g* would be the winner. The constraint ranking that has been established for Polish is in (36) and a summary tableau which shows the two types of locally-conjoined constraints at work is in (37):

(36) Established ranking for Polish (Section 3.1 & 4.2)[17]



(37) Summary tableau

/ro**g**+ek/	[PAL & R-Anchor]$_{AdjSeg}$	[*ǰ & IDENT(coronal)]$_{Seg}$	IDENT (coronal)	IDENT (continuant)	PAL
a. ☞ro**ž**ek			*	*	
b. ro**ǰ**ek		*!	*		
c. ro**g**ek	*!				*

The fully faithful candidate (37c) is ruled out because it fails to palatalize a segment that violates anchoring. Candidate (37b) fails because it does not spirantize a segment that also palatalizes. Candidate (37a) is the winner, because it satisfies both of the high-ranked locally-conjoined constraints. It is less faithful than either of its competitors, violating IDENT(coronal) and IDENT(continuant), but these constraints are lower-ranked, and so are irrelevant in this case.

To conclude, in this section I have observed that in Polish First Velar Palatalization only segments that violate stem-syllable anchoring can palatalize. To capture this observation, I have proposed that a local violation of anchoring activates an otherwise low-ranked markedness constraint. I argued that the LC/Anchoring account of morphologically-derived environments is a natural extension of the general LC schema developed in section 3.

A morphologically-derived environment as defined by the SCC is not the same as an anchoring violation. My claim that a violation of anchoring is a necessary condition for morphologically-derived environments significantly narrows down the set of legitimate cases of morphologically-derived environments in comparison with the SCC. The differences in predictions between the SCC account and the LC/Anchoring account will be discussed in §4.4. Before comparing the two accounts, however, it is necessary to discuss another issue that relates to palatalization, cases of opacity involving palatalization. Opacity, though not directly relevant to the focus of this section, is nonetheless important in the analysis of Polish.[18]

4.3 Opacity of Palatalization

In some situations, the stem-final velar does not palatalize, even though on the surface it is followed by a front high vowel *i*. The front vowel is a result of vowel-consonant dissimilation called Fronting (Rubach, 1984) or Vowel Adjustment (Gussmann, 1980). Cases of this sort are known as counter-feeding opacity and are illustrated below:

(38) Counter-feeding opacity (Rubach, 1984: 151-61)

a. Masc. nonpersonal nom. pl.:

/...k+i̇/ → kro[k'+i] 'steps'

/...k+i̇/ → p'jeseč+[k'+i] 'dogs' (dim.)

b. Fem. nom. pl and fem. gen. sg.:

/...g+ɨ/ → no[g'+i] 'legs'

/...k+ɨ/ → xem'ič+[k'+i] 'chemist'

c. Derived imperfective suffix /ɨv/

/...x+ɨv.../ → wɨ+słu[x'+iv]+a+ć 'to listen'

/...k+ɨv.../ → wɨ+kšɨ[k'+iv]+a+ć 'to shout out'

An OT account of opacity has been proposed by McCarthy (1999). McCarthy argues that opacity results from a high-ranked inter-candidate faithfulness constraint. Under his account among the set of output forms emitted by *Gen* is a designated failed candidate (a sympathetic candidate, denoted by the symbol ❀) that best satisfies a particular faithfulness constraint (the selector constraint). The actual output must resemble this sympathetic candidate with respect to a property (or set of properties) determined by inter-candidate faithfulness constraints (sympathetic constraints indicated with a ❀ symbol). When high-ranked, such faithfulness constraints result in transmitting properties of the failed candidate to the actual output form. In the analysis of Polish, I will employ McCarthy's proposal.

Cases of counter-feeding opacity (shown in (38)) are problematic for the OT account developed in this paper, because according to the ranking in (26), the stem-final velar should palatalize. Palatalization is demanded by the high-ranked locally-conjoined constraint, [PAL & R-ANCHOR(Stem; σ)]$_{\text{AdjSeg}}$ (see section 4.2). To explain why there is no palatalization, I propose that the actual output in cases of this type is faithful to a sympathetic candidate (i.e., ❀*krok+ɨ*) in which there is no palatalization because the vowel following the velar is central and not front.

This sympathetic candidate is chosen on IDENT(back) since its suffix vowel agrees in backness with the corresponding input vowel. The lack of palatalization in the sympathetic candidate is retained in the actual output via inter-candidate faithfulness, ❀IDENT(coronal). The inter-candidate faithfulness constraint outranks the locally-conjoined constraint and therefore, despite surface stem-syllable misalignment, palatalization is blocked. No additional mechanisms are needed to account for cases of this type.

In addition to the opacity shown in (38), there are cases, where palatalization takes place even though it should not based on the surface form. These cases are known as counter-bleeding opacity and they fall under two categories: the ones where there is no vowel following the palatalized (postalveolar) segment (see (39a)), and the ones where there is a vowel following but it is not a front vowel (see (39b)). Examples in (39a) involve deletion of the underlying yer, whereas the ones in (39b) represent vowel retraction after hard coronals (Rubach, 1984; Gussmann, 1980).

(39) Counter-bleeding opacity (Rubach, 1984: 184-189, 201-08)

a. Yer deletion

/...k+ĭk../	→	xem'i[č+k]+a	'chemist' (fem.nom.)
/...k+ĭk.../	→	p'jes+e[č+k']+i	'dogs' (double dim.)

b. Vowel retraction

/...k+i.../	→	kro[č+ɨ]+ć	'to step'
/...k+i.../	→	le[č+ɨ]+ć	'to treat'
/...x+i.../	→	pu[š+ɨ]st+ɨ	'fluffy'

Both cases satisfy the PAL constraint, and so under the constraint ranking proposed so far, there is nothing here that forces palatalization.

To explain why palatalization takes place when the palatalized segment is not followed by a vowel on the surface (39a), I propose that the actual output is faithful to the sympathetic candidate in which the suffix-initial yer vowel is not deleted (❀*xemič+ĭk+a*) and in which the velar thus palatalizes. The sympathetic candidate is chosen by a faithfulness constraint, DEP-V, militating against vowel deletion. The actual output retains palatalization from this sympathetic candidate via high-ranked inter-candidate faithfulness (❀IDENT(coronal)).

Similarly, to explain palatalization when the stem-final velar is followed by a central vowel on the surface (39b), I propose that the actual output is faithful to the sympathetic candidate in which the suffix vowel agrees in backness with the input vowel (❀*kroč+i+ć*). This sympathetic candidate is chosen on a faithfulness constraint IDENT(back). Palatalization is carried over to the actual output via faithfulness to the sympathetic candidate (❀IDENT(coronal)).

To conclude, in this section I have discussed cases of opacity involving palatalization, thereby covering the full range of data from First Velar Palatalization in Polish. In the next section I will discuss the differences in predictions between the LC/Anchoring theory (introduced in § 4.2) and the SCC proposal. I will argue that the predictions of the Anchoring account are empirically more adequate than those of the SCC.

4.4 Misalignment and Morphologically-Derived Environments

My account of morphologically-derived environments in Polish is based on the observation that only stem-final segments palatalize. These segments are special, because they can incur a stem-syllable anchoring violation. I have proposed that this violation of anchoring is what activates the relevant markedness constraint. The LC/Anchoring proposal is a natural extension of the theory of phonologically-derived environments introduced in section 3. Just like in cases of phonologically-derived environments, the markedness constraint is activated by a local violation of a faithfulness constraint, which in cases of morphologically-derived environments is stem-syllable anchoring.

The predictions of my proposal differ significantly from the standard SCC, because the set of legitimate cases of morphologically-derived environments predicted by my proposal constitutes a narrow subset of all the logically possible cases predicted by the SCC. The SCC says that the presence of any morpheme boundary under any phonological conditions is able to create a derived environment. Therefore, if α is the trigger and β is the target of a phonological process subject to a morphologically-derived environment, it is enough that α and β belong to two different morphemes for this phonological process to take place. There is no other phonological relation required to hold between α and β.

The theory of morphologically-derived environments based on LC of markedness and anchoring is more restrictive than the SCC. It is not enough that α and β belong to two different morphemes. Crucially, α and β must be adjacent, because of the domain condition on local conjunction. In addition to the adjacency relation between α and β, the target of the process, α ,

(or the trigger of the process, β) must incur a violation of stem-syllable anchoring. It must be input stem-final, but non-syllable-final in the output. Because α and β must be adjacent, and because α (or β) must be stem-final in the input and non-syllable-final in the output, it follows that α and β must belong to the same syllable in the output form. So, in addition to the adjacency requirement between α and β, a prosodic relation must hold between them.

These locality and prosody requirements significantly narrow down the set of possible cases of morphologically-derived environments, and by that, I argue, provide a superior match between the theory and the facts. Since misalignment and adjacency are necessary conditions for derived environment effects to occur, this predicts that a C-V stem-affix boundary can trigger derived environment effects. This turns out to be true of all the numerous Palatalization processes in Slavic (Rubach, 1984, 1995)[19], Polish Iotation (Rubach, 1984; Rubach and Booij, 1990), Affrication in Korean (analyzed in Kiparsky, 1993, modifying Iverson and Wheeler, 1988). In all of those cases, the root-final consonant syllabifies over onto the affixal vowel, violating the faithfulness constraint RIGHT-ANCHOR which then activates an otherwise low-ranked markedness constraint in the domain of adjacent segments.

Apparent counterexamples, such as Finnish Consonant Gradation (Bye, 1999; Kiparsky, 1993), Tri-syllabic Shortening (Chomsky and Halle, 1968; Halle and Vernaud, 1987; Myers, 1987), or Icelandic u-Umlaut (Anderson, 1969; Kiparsky, 1984; Orešnik, 1977; Ottósson, 1988) have been already reanalyzed in the literature. Bye (1999) accounts for Finnish Consonant Gradation in terms of the local conjunction of markedness and anchoring constraints developed in this work, thus providing additional support for the proposal. Myers (1987) provides an analysis of Tri-syllabic shortening as closed-syllable shortening fed by stress-induced re-syllabification. Re-syllabification takes place only at stem-affix boundary and thus accounts for

the seemingly derived environment nature of this process. Finally, Kiparsky (1993) discusses a proposal by Ottósson (1988) where Icelandic u-Umlaut is driven by a difference between epenthetic and non-epenthetic vowels. Only non-epenthetic u's trigger umlaut. (For an OT analysis, see Karvonen and Sherman (1998).)

The LC proposal makes an interesting prediction with respect to a C-C stem-affix boundary. It predicts that a C-C boundary, unlike a V-C boundary, will not in general trigger derived environment effects because it does not result in stem-syllable misalignment. As pointed out to me by an anonymous reviewer, this predicts, for example, that no language should apply nasal assimilation (a C-C process) only in morphologically-derived environments. This would be a language with /benba$_{Rt}$/→*benba* (no assimilation root-internally) vs. /ben$_{Rt}$+ba$_{Sfx}$/→*bemba* (assimilation across the C-C boundary). This, as far as I know, is a good prediction of the proposal. I do not know of any language that works this way.[20]

Lastly, since locality is a necessary condition for derived environment effects to occur, cases of long-distance root-affix harmony are not predicted to show derived environment effects under this proposal. Vowel Assimilation in Basque (Hualde, 1989) represents a tentative counter-example. In the rest of this section I propose a reanalysis of Vowel Raising in Basque. The account I present generalizes to all cases of vowel harmony, where harmony takes place in affixes, but is blocked in roots.

As noted by Hualde (1989), in Basque word-final /a/ raises to *e* when preceded by a high vowel. Hualde calls this process Vowel Assimilation and formalizes it as follows:

(40) $a \rightarrow e \; / \; \underset{[+high]}{V} \; C_o ___ \;]$

This process, which I will call Raising, applies in word-final vowel-final suffixes, but is blocked in roots and in non-(word/vowel) final suffixes. This is illustrated in (41-43) from Hualde (1989).

(41) Vowel raising in suffixes of the form +(C)a

a. lagun+[a]	→	laɣun[e]	'the friend'
b. aīri+k[a]	→	aīrik[e]	'throwing stones'
c. bi+n[a]	→	biɲ[e]	'two by two'

(42) No raising of root-final /a/

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

(43) No raising in non-final suffixes

a. aīri+k[a]+da	→	aīrik[a]ra	'throwing of a stone'
b. čakur+[a]+k	→	čakur[a]k	'dog' (erg.)

To account for these generalizations, Hualde (1989) proposes that Raising is a non-cyclic rule restricted to apply in a morphologically-derived environment. The evidence that Raising is subject to a derived environment condition comes from the fact that there is no Raising in morpheme-internal contexts like (42). The evidence that Raising is non-cyclic, in turn, comes

from the fact that there is no Raising in non-final suffixes, as in (43). Hualde proposes that Raising applies after all suffixation has been completed, that is after word formation rules when interaction with morphology is no longer possible.[21] In (44) I show sample derivations for the three cases mentioned above.

(44) Sample derivations (after Hualde, 1989)

	a. Raising in final suffixes	b. No raising in non-final suffixes
	[[aīi]ka]	[[[čakur]a] k]
	'throwing stones'	'dog sg erg'
Stratum I	aīi	čakur
Suffixation of /-a/, /-ka/	aīika	čakura
Suffixation of /-k/	–	čakurak
Output of morphology	aīika	čakurak
Vowel Raising	aīike	S.D. not met

c. No raising in roots

[eliša]

'church'

Stratum I	eliša
Suffixation Rules	–
Output of morphology	eliša
Vowel Raising	blocked by the SCC

In (44a) Vowel Raising takes place because the structural description of the rule is met. The target low vowel /-a/ is in a word-final suffix and is preceded by a high vowel *i* which belongs to the root morpheme. In (44b) Raising is blocked, however, because the /-a/ suffix is not word-final at the stage when the rule applies. (Recall that vowel raising is non-cyclic.) Finally, in (44c) there is no Raising, because the trigger and target of the rule are tautomorphemic and so the derived-environment condition is not met.

Hualde (1989) classifies Vowel Raising as a rule subject to a morphologically-derived environment. This explains why Raising applies only to word-final suffixes, but is blocked in roots. But if this is an instance of a morphologically-derived environment effect, the LC/Anchoring theory should be able to account for it. It is clear, however, that the LC schema does not capture the Basque data. In Basque, there is no violation of anchoring of the stem-final segment, and so there is no way to activate the markedness constraint resulting in raising. Therefore, we must seek a different explanation for vowel raising in Basque.

What we have to account for is blocking of raising in roots as opposed to affixes. Disharmonic roots are common in vowel harmony processes, and there is a proposal to deal with

this phenomenon, based on the notion of positional faithfulness as in Beckman (1995, 1997) and McCarthy and Prince (1995). The restriction of raising to affixes 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.[22] 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 universal ranking of these constraints is given in (45).

(45) $\text{IDENT}_{\text{ROOT}}$(low) >> $\text{IDENT}_{\text{AFFIX}}$(low) [23]

Furthermore, I assume that a constraint prohibiting sequences of a word-final low vowel /a/ preceded by a high vowel, call it RAISING, is ranked between the two faithfulness constraints: [24]

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

So raising takes place in affixes, because the markedness constraint RAISING dominates $\text{IDENT}_{\text{AFFIX}}$(low). But in roots raising is blocked due to the higher-ranked $\text{IDENT}_{\text{ROOT}}$(low). This is illustrated in (47) and (48) below.

(47) Raising in affixes

/lagun+a/	$\text{IDENT}_{\text{ROOT}}$(low)	RAISING	$\text{IDENT}_{\text{AFFIX}}$(low)
a. ☞laɣune	✓		*
b. laɣuna	✓	*!	

(48) No raising in roots

/eliša/	IDENT$_{ROOT}$(low)	RAISING	IDENT$_{AFFIX}$(low)
a. ☞eliša		*	
b. eliše	*!		

In tableau (47), candidate (b) loses on RAISING, because it fails to raise the affix. Candidate (a) undergoes raising, and so comes out as the winner. The situation is different in tableau (48). Here conditions for raising are met in the root, but not in the affix. Root-Identity comes into play. Candidate (a), with no raising wins, because it avoids violation of IDENT$_{ROOT}$(low).

In my account RAISING demands raising of the word-final vowel only. It does not apply to non-final suffixes as in (43b). The relevant tableau is given below.

(49) No raising in non-final suffixes

/čakur+a+k/	IDENT$_{ROOT}$(low)	RAISING	IDENT$_{AFFIX}$(low)
a. ☞čakurak	✓	✓	
b. čakurek	✓	✓	*!

The suffix *a* is non-final and, therefore, the markedness constraint RAISING is vacuously satisfied. Candidate (b) loses since it incurs an unnecessary violation of Affix-Identity. Candidate (a) is the winner.

To conclude, vowel raising in Basque can be straightforwardly reanalyzed in terms of ROOT and AFFIX faithfulness. It no longer falls under the scope of a morphologically-derived environment. Rather it adds strength to the claim that roots are positions which license more contrast, and so ROOT FAITHfulness is ranked higher than AFFIXFAITHfulness.[25]

5. Comparison with Previous Approaches

This section compares the LC theory of derived environment effects with alternative approaches in Lexical Phonology (§5.1) and Optimality Theory (§5.2).

5.1 Approaches Within the Lexical Phonology Model

The alternative Lexical Phonology approaches that will be discussed here are the original Strict Cycle Condition (SCC) (Mascaró, 1976; Kiparsky, 1982) and Kiparsky's (1993) underspecification account. I will show that the predictions of the LC account differ radically from the original SCC, but are very similar to Kiparsky's later underspecification model. This similarity holds even though the LC account and the underspecification account are based on very different theoretical premises.

I begin by listing five basic claims made by the SCC. I then explain them and compare them with the predictions of Kiparsky's underspecification theory and the LC theory. The five basic claims of the SCC are as follows:

(50) Basic claims of the SCC

a. Strict correlation between derived environment effects and cyclicity.

b. Existence of rules subject to both phonologically- and morphologically-derived environment effects.

c. Morpheme boundary as a sufficient condition for a morphologically-derived environment.

d. Phonologically-derived environment as a result of a derived context.

e. Phonologically-derived environment as a result of vacuous rule application.

The first entailment of the SCC has to do with the correlation of derived environment effects and cyclicity. Under the SCC, non-derived environment blocking is equated with cyclic rule application. What this means is that all and only cyclic rules are blocked from applying in non-derived environments. So the SCC predicts that there will be no cyclic rules exempt from the derived-environment condition, nor will there be any non-cyclic rules subject to this requirement. Contrary to these predictions of the SCC, Kiparsky (1993) presents evidence that there is no necessary connection between cyclicity and derived environment effects. There are cases of cyclic rules that apply in non-derived environments, as well as cases of non-cyclic rules that are blocked in such environments. Kiparsky (1993) cites the example of Finnish Vowel Coalescence, a cyclic rule that applies in non-derived environments, and the example of the noncyclic (postlexical) ruki rule of Vedic Sanskrit that is blocked in non-derived environments. Kiparsky also cites Kaisse (1986) who shows that a noncyclic word-level rule of stop devoicing in Turkish is prevented from applying in non-derived environments.[26]

Reflecting this evidence, the underspecification model of Kiparsky (1993) predicts no correlation between non-derived environment blocking and cyclicity. Likewise, the LC account proposed here does not connect non-derived environment blocking with the cycle. Under the LC theory, the seemingly unmotivated double violation of faithfulness follows directly from local conjunction of otherwise lower-ranked markedness and faithfulness constraints, with no connection to cyclicity.[27] The lack of strict connection between cyclicity and derived environment effects is confirmed by the facts, both in Kiparsky (1993) and here. Above, we saw the example of lenition in Campidanian Sardinian which in the LP approach is recognized as non-cyclic (applies across word-boundaries) and nonetheless is subject to non-derived environment blocking.

The second claim of the SCC refers to the relation between phonologically- and morphologically-derived environment effects. 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 logically. Thus, the original SCC predicts that any rule can in principle be subject to both types of derived environment.[28] Unlike the SCC, Kiparsky's (1993) underspecification model and the LC model make no necessary connection between the two types of derived environment. In the underspecification account "NDEB (non-derived environment blocking) is a result of structure-building rules applying to maximally underspecified representations" (Kiparsky, 1993: 285). Whether a rule applies depends on the details of underspecification which may differ in the two types of derived environments. In the LC theory, on the other hand, where an otherwise low-ranked markedness constraint is activated by a violation of a faithfulness constraint, the faithfulness constraint is different in cases of phonologically- and morphologically- derived

environments. Thus, neither LC nor underspecification predict that there are phonological alternations subject to both types of derived environment effects. This prediction seems to be borne out by the facts; the only known apparent cases, Finnish assibilation and Sanskrit ruki (Kiparsky, 1973, 1982), have been reanalyzed by Hammond (1992).[29]

The third claim made by the SCC concerns the nature of morphologically-derived environments. The SCC predicts that the mere presence of a morpheme boundary is sufficient to create a morphologically-derived environment. Consequently, any cyclic rule whose trigger and target belong to different morphemes applies under such conditions. There is no requirement of locality between the trigger and target of the process, nor is there a requirement on the shape of the morphemes that come into contact. Kiparsky's (1993) underspecification model makes the same prediction.

Unlike the SCC and the underspecification account, the LC theory crucially makes two novel predictions with respect to morphologically-derived environments. First, it asserts that the trigger and target of a phonological alternation that occurs only across a morpheme boundary must be adjacent. This follows from the requirement that constraints be conjoined in the domain of adjacent segments. Secondly, the LC account asserts that it is not the mere presence of a morpheme boundary that matters but violation of anchoring. So it is not the case that the presence of any morpheme boundary activates a phonological alternation. It is crucial that the morpheme boundary brings about a violation of anchoring. The empirical consequences of these two predictions have been already addressed in section 4.4.

The last two claims of the SCC deal specifically with phonologically-derived environments. According to the SCC, a phonologically-derived environment can arise by a prior rule that either targets the segment (as in section 3) or alters its context (as below).

(51) Context-altered derived environment

UNDERLYING FORM	DBE	DBX
E→X/B_	DBX	does not apply
B→C/_X	DCX	blocked by SCC

Here, unlike the cases discussed in section 3, the earlier rule creates the context, rather than the target, for the later rule. Since the SCC makes no distinction between contexts and targets, it predicts that cases like this should exist. In fact, it even predicts that the same cyclic rule might sometimes be triggered by a derived context and sometimes by a derived target, depending on the details of the form being derived. Kiparsky's (1993) underspecification model makes these predictions as well.

Contrary to the SCC and the underspecification account, the LC account predicts no phonologically derived environment effects when the faithfulness and markedness constraints are violated within different segments because the domain for local conjunction of faithfulness and markedness is a segment**.** In fact, cases of derived environments of this type are regarded as problematic, as shown in Hammond (1992).[30] It is important to note that in all cases of phonologically-derived environments presented in this work, the markedness constraint that incurs the unmotivated violation of faithfulness is context-free. Because of that it would be impossible for the relevant markedness and faithfulness constraints to be violated non-locally. The context-free property of the particular markedness constraint allows the domain for LC to be a segment.

Finally, under the original SCC, a phonologically-derived environment can arise by vacuous rule application. The basic idea is that even if a rule does not effect an observable change, it has "derived" the environment sufficiently to trigger application of a later cyclic rule. Mascaró (1976) cites the processes of Vowel Lowering and Mid Vowel Reduction in Catalan in support of this view.

Contrary to the SCC, in the underspecification account of Kiparsky (1993) derived environment effects cannot arise by vacuous rule application. In support of this claim, Kiparsky reanalyzes the apparent cases of vacuously derived environments from Mascaró (1976). Similarly, in the LC account, if there is no violation of faithfulness, there is no activation of the conjoined markedness constraint. As a result, the locally-conjoined constraint of markedness and faithfulness would be satisfied under such circumstances and would play no role.

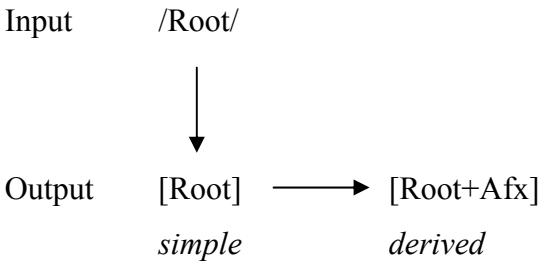
To conclude, the predictions of the LC account differ radically from the original SCC, but are in general similar to the underspecification model of Kiparsky (1993). The LC account and Kiparsky's underspecification account agree in predictions with respect to three out of the five claims described in (50). This similarity between the two theories holds even though the LC account and the underspecification account are theoretically distinct. It is important to note that in cases where the LC account and Kiparsky's account disagree (claims (50c-d)), evidence strongly supports the predictions of the LC theory.

5.2 Approaches Within OT

I now discuss two other approaches to NDEB within the framework of Optimality Theory, Burzio (1997; 2000) and Polgárdi (1998). I first discuss Burzio's approach and then turn to the proposal by Polgárdi. [31]

In his account, Burzio assumes the following model of faithfulness:

(52) Burzio's model (cf. Benua, 1997)



The derived output form stands in an OO-faithfulness relation to a simple form and the simple output form stands in an IO-faithfulness relation to its input. Crucially, there is no IO relation for a derived form and therefore this form vacuously satisfies any IO- faithfulness constraint.

Burzio distinguishes three types of derived environments, morphologically-derived environments, phonologically-derived environments and a new type which I will call "TETU blocking". To account for morphologically-derived environments, Burzio proposes faithfulness constraints that refer to segmental strings in addition to faithfulness constraints that refer to individual segments (feature classes). As an example he uses Finnish Assibilation, where an alveolar voiceless stop turns into a corresponding sibilant when followed by a high front vowel (t→s/_i). This alternation does not target underlying tautomorphemic /ti/ sequences and therefore

it is known as a case of a morphologically-derived environment. Due to assibilation, simple *tilat* alternates with derived *tilas+i*. The final *t* assibilates but the initial *t*, which is followed by tautomorphemic *i*, surfaces unchanged. To explain this, Burzio proposes that a markedness constraint against the *ti* sequence (**ti*) outranks output faithfulness to *t* (OO-FAITH-T) but is itself dominated by faithfulness to the sequence *ti* (OO-FAITH-TI). What this means is that when the *ti* sequence is already present in the simple form, it resists assibilation in a corresponding derived form. Conversely, when the *ti* sequence is not present in the simple form, hence part of it is added by an affix, it undergoes assibilation in a corresponding derived form. The ranking is in (53).

(53) Faithfulness to sequences

OO-FAITH-TI >> *TI >> OO-FAITH-T

Burzio goes on to generalize this account to phonologically-derived environments.

Burzio's account is problematic as it significantly enriches the theory of faithfulness. Now there exist not only faithfulness constraints that refer to individual segments (feature classes) but also faithfulness constraints that refer to strings of segments. One might ask why faithfulness constraints referring to strings of segments are needed in the theory other than to account for morphologically-derived environments. If there is no other usage of this type of faithfulness constraints, we should avoid introducing them altogether. Unlike faithfulness to strings of segments, the local conjunction mechanism discussed in this paper has a much broader usage (see ft. 4 for references).

Another question one might ask concerning Burzio's approach is what strings of segments there are faithfulness constraints to. This type of faithfulness constraint is presumably limited to only those strings that describe marked configurations, that is the ones against which there are markedness constraints. If that were not the case, the factorial typology of possible constraints would enlarge significantly, as we would have faithfulness to any string, and by ranking permutation we would predict unattested languages. As an illustration, consider the ranking in (54). In this ranking there is a string faithfulness constraint IO-FAITH-Kü without a corresponding markedness constraint *Kü.

(54) Faithfulness without markedness

IO-FAITH-Kü >> *ü >> IO-FAITH-RND

This ranking leads to an unlikely prediction. It describes a language where front rounded vowels are present only after velars, due to the string faithfulness constraint IO-FAITH-Kü, and are neutralized elsewhere, due to the high-ranking of the markedness constraint *ü.

Besides the morphologically- and phonologically-derived environments, Burzio recognizes a new type of derived environment called TETU blocking.[32] One of the examples that Burzio presents is vowel shortening in English (i.e., div[aj]n ~ div[i]n+ity; m[aj]grate ~ im+m[i]grant). Burzio accounts for vowel shortening by proposing that a markedness constraint against long vowels, *V:, is ranked below IO-faithfulness to length and above corresponding OO-faithfulness. Therefore, we have the following ranking:

(55) TETU blocking

IO-FAITH >> *V: >> OO-FAITH

According to Burzio's model of faithfulness, this is a TETU ranking. In non-derived forms, we are faithful to underlying vowel length due to high-ranked IO-FAITH and so if there are long vowels in the input form, they are preserved on the surface. But in derived forms there is no IO-faithfulness relation (see (52)), because there is no input for derived forms, and so the markedness constraint becomes top priority and always has to be obeyed (for a tableau see Burzio 2000: 65-73). Consequently, there are no long vowels anywhere in a derived form.

Although the TETU blocking mechanism may be appropriate for English vowel shortening, it does not generalize (nor was it intended to generalize) to the morphologically- and phonologically-derived environment effects studied in this article. The TETU mechanism predicts that a phonological alternation applies anywhere within a derived form, regardless of where the morpheme boundary is. But we have seen that in morphologically-derived environments a phonological alternation applies locally to a morpheme boundary and it is not the case that adding a morpheme boundary triggers an alternation anywhere within a derived form. Consider a hypothetical example from Polish, where simple *kibic* 'fan' alternates with derived *kibic+em* 'fan (inst.)'. Adding a morpheme boundary to *kibic* does not result in palatalization of *k*, even though the *ki* sequence is militated against by a markedness constraint which in Polish is activated in derived environments. The key observation is that the markedness constraint is activated only locally to a morpheme boundary. Our theory of NDEB should be able to capture this insight formally (see section 4 for discussion).

Let's now turn to the account of NDEB proposed by Polgárdi (1998). To explain non-derived environment blocking, Polgárdi proposes a DERIVED ENVIRONMENT CONSTRAINT, defined as follows.

(56) DERIVED ENVIRONMENT CONSTRAINT (DEE) (Polgárdi, 1998: 69)

No changes are allowed within a single analytic domain.

As Polgárdi puts it "this constraint requires an intervening analytic domain boundary between the trigger and target for a particular neutralization process to apply" (Polgárdi, 1998: 68). Analytic domains are "roughly equivalent to morphological derivation" (Polgárdi, 1998: 77). When this constraint is ranked above a particular markedness constraint, a phonological alternation is blocked from applying in morphologically non-derived environments.

This is problematic for two reasons. First, in order to evaluate this constraint, it is necessary to refer directly to the trigger and target of a phonological alternation. But in OT, unlike rule-based phonology, there is no a priori notion of a trigger or a target and therefore we cannot refer to them directly in the formulation of constraints. Whether a given segment undergoes or triggers an alternation follows from the interaction of markedness and faithfulness constraints in a particular grammar. Secondly, within this account there is no requirement of locality between the trigger and target of a phonological alternation nor is there any mention of anchoring violation. Rather for a given alternation to take place, it is enough that the trigger and target belong to two different analytic domains. But, as we have seen in this article, an approach of this type predicts a number of unattested cases of morphologically-derived environments and therefore creates a mismatch between the theory and the facts (see the discussion in section 4.4).

6. Conclusion

In this paper I have argued that the local conjunction of a markedness and faithfulness constraint enables OT to handle all actually observed 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. Depending on the choice of the faithfulness constraint, this accounts for both phonologically- and morphologically-derived environment effects.

All cases of phonologically-derived environments involve a seemingly unmotivated double faithfulness violation. I postulated that this double violation of faithfulness is forced by the high-ranked locally-conjoined constraint. The domain for LC in cases of a phonologically-derived environment is a segment.

(57) Phonologically-derived environments

a. In Polish:

$[*\check{j}\ \&\ \textsc{Ident}\,(\text{coronal})]_{\text{Seg}} >> \textsc{Ident}(\text{continuant}) >> *\check{j}$

b. In Campidanian Sardinian:

$[*\textsc{Voiced/Stop}\ \&\ \textsc{Ident}(\text{voice})]_{\text{Seg}} >> \textsc{Ident}(\text{continuant}) >> *\textsc{Voiced/Stop}$

I then went on to argue that all cases of morphologically-derived environments involve a violation of stem-syllable anchoring. 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 an alternation subject to a morphologically-derived environment. This is illustrated in (58).

(58) Morphologically-derived environment

[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 effects, although it accounts for both of them in a similar way. This as well as other predictions of the LC account were emphasized in section 5.1, where implications of the LC account were compared with the original SCC and an underspecification model of Kiparsky (1993). The predictions of the LC theory are significantly different from the SCC model, but show numerous similarities with a theoretically distinct Kiparsky's later underspecification account. Thus, one can conclude that work on non-derived environment blocking virtually since Kiparsky (1982) consistently supports the results achieved by the LC account developed in this work.

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[1] The intermediate step shown in (2b) is a convenient way of representing the discrepancy in the underlying-surface mapping and has no formal status in the OT approach taken in this paper.

[2] One might wonder why only voiced affricates spirantize. As suggested to me by John Kingston (p.c.), 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] In the tableau I consider only candidates that satisfy the constraint demanding palatalization, which is discussed in section 4. As for the notation, I use '☜' and '☞' in opposite ways: '☞' marks the observed output form which according to the constraint ranking in (6) is non-optimal, whereas '☜' points to a candidate that does not surface as the output, but is optimal according to the constraint ranking.

The input form is simplified for clarity. According to Rubach (1984), the input is /-g+ĭk+ɨ/. This simplification has no effect on the outcome.

[4] LC has been employed previously for the analysis of a number of other phonological phenomena. Among others see Alderete (1997), Ito and Mester (1998) for dissimilation as self-conjunction of markedness; Alderete (1999) for transderivational non-identity effects as local conjunction of an antifaithfulness constraint and anchoring; Kirchner (1996) for chain-shifts as conjunction of faithfulness; Smolensky (1993), Ito and Mester (to appear) for the Coda-Condition; Smolensky (1995) for the Sonority Hierarchy; and Smolensky (1997), Bakovic (2000) for the typology of Vowel Harmony. For a different understanding of LC see Hewitt and Crowhurst (1996), Crowhurst and Hewitt (1997), Crowhurst (1998).

[5] There are limits on what constraints can be conjoined and in what domains. Hewitt and Crowhurst (1996), and Crowhurst and Hewitt (1997) propose that only constraints that share a fulcrum (an argument) can be conjoined. Though I adopt a somewhat different conceptualization of LC than they do, my work supports this view.

As for the domain, I propose that it 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 for LC.

[6] There are cases in Polish where *ǰ's* that are a result of palatalization do not spirantize. In all instances where spirantization fails, *ǰ's* are preceded by a postalveolar fricative *ž* (i.e., *musk* 'brain' - *muž̌ǰ+ek* 'dim.', *drob'jask* 'trifle' - *drob'jaž̌ǰ+ek* 'dim.', *m'jazg+a* 'pulp' - *m'jaž̌ǰ+ɨ+ć* 'to squash'). I postulate that spirantization is blocked here because it would incur a violation of an OCP constraint which in the grammar of Polish dominates the locally-conjoined constraint.

[7] The medial *t* in the loan word *zɛɣrɛt:arʹu* in (12) is not lenited. According to Bolognesi, word-internal post-vocalic obstruents in loan-words regularly fail to lenite or voice and instead undergo gemination (i.e., *s:u ɣomput:ɛ* 'the computer', *su: ðas:i* 'the taxi') (Bolognesi, 1998: 33). Bolognesi reports that geminates in Campidanian resist voicing and lenition (i.e., *mak:u* 'crazy', *tup:a* 'bush', *mat:a* 'tree') (Bolognesi, 1998: 149).

[8] In all dialects of Campidanian, the voiced stop makes it faithfully to the surface and in some dialects it also optionally deletes. This mapping is not discussed further here. I take it to be an instance of maximal lenition, lenition to a null segment (cf. Kirchner, 1998).

[9] This is a stratified constraint ranking. There is no relative ranking between *V/VOICELESS and IDENT(continuant). No matter how these constraints are ranked w.r.t. each other, candidate (b) is the winner.

[10] I would like to thank an anonymous reviewer for comments on this point.

[11] The forms in (22) are all borrowings. (I am grateful to Christina Bethin for this challenge.) This does not weaken the argument that First Velar Palatalization is restricted to heteromorphemic sequences only. As argued in Rubach (1984), these words are fully integrated into the grammatical (morphological, inflectional, prosodic) system of the language as a whole. When the same word contains a tautomorphemic and heteromorphemic sequence that could undergo palatalization, only the heteromorphemic sequence does (i.e., /xemik+ǐk/→ *xem'ič̌+ek*, **šem'ič̌+ek*). This shows that these cases are not just exceptions to First Velar Palatalization (see (23)).

[12] The underlying representation is simplified for expository reasons. The same applies to other examples in this section, (27)-(30).

[13] The violation of R-ANCHOR(Stem; σ) is forced by a dominant constraint ONSET .

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

[15] The liquid *r* is a coronal, so if followed by a front high vowel across a morpheme boundary, it would turn into a postalveolar fricative *ž* by coronal palatalization.

[16] Recall that this is restricted to only the voiced /g/ (see ft. 2).

[17] The markedness constraint *ǰ must also be ranked below IDENT(coronal), because *ǰ* could be avoided by depalatalization, and that does not happen (see section 3).

[18] Accounts of opacity in parallel OT include McCarthy (1999), Goldrick and Smolensky (1999), and Ito and Mester (to appear).

[19] In Polish, for example, the other palatalization processes, besides first velar palatalization, include: (a) second velar palatalization (i.e., *polak* 'Pole' - *polac+ɨ* 'nom. pl.'); (b) coronal palatalization (i.e., *gwos* 'voice' - *gwoś+ik* 'dim.'); (c) affricate palatalization; (d) labio-velar palatalization; (e) adjectival and nominal strident palatalizations (those are all discussed in detail in Rubach, 1984).

[20] In response to the LC proposal put forth in this paper, Inkelas (1999) discusses vowel raising in a dialect of Uyghur (Orgun, 1994, 1996) as a possible counter-example. As reported by Inkelas, in Uyghur the rightmost vowel of the stem raises in a non-final open syllable (i.e., /qazan+i/ → *qazɨni*, /bala+lar/ → *balɨlar*). This is seemingly problematic for the LC proposal, since raising sometimes occurs when there is no stem-syllable misalignment (i.e., /bala+lar/ → *balɨlar*). (Since only a limited amount of data is available from this dialect based on fieldwork by Orgun, in what follows I discuss the same process in standard Uyghur (Hahn, 1991ab; Vaux, 2000.))

In addition to data presented in Inkelas and Orgun, Hahn (1991ab) reports that in Uyghur there is a much stricter correlation between syllable quality and raising. It is not only the case that there is no raising in closed syllables (/ömäz+din/ → *ömäzdin*), but stressed open syllables do not raise (/bina:+da/ → *binádа*) (Hahn, 1991a: 55). In addition, it is not the case that raising is only restricted to the rightmost vowel in the morpheme. Hahn observes that there can be raising word-initially if the vowel undergoing raising is shorter in duration from what is expected. Hahn refers to those cases as underlength (Hahn, 1991a: 56-57). Some examples are *dimäk* /dä-/, *yimäk* /yä-/. Based on this evidence, Hahn concludes that raising is representative of a general process of vowel reduction that is restricted to medial open unstressed syllables (with the additional assumption that initial syllables may undergo raising in case of underlength). Since vowel raising in Uyghur represents a well-motivated process of vowel reduction rather than a special case of a derived environment effect, it does not present a problem for the LC/Anchoring account developed here.

[21] Hualde (1989) also discusses clitic groups. I will leave this complication aside for the purposes of this article.

[22] Evidence for high-ranked root faithfulness includes among others: (a) resolution of stress clash, where root stress "wins" over affix stress (Alderete, 1999); (b) restrictions on segmental inventories, where root inventory is a superset of affix inventory (see laryngealized stops in Cuzco Quechua (Parker, 1997), Arabic pharyngeals (McCarthy and Prince, 1995), clicks in Zulu and Xhosa (Doke, 1990; Beckman, 1997)); (c) harmony processes where affixes harmonize with roots and not vice versa (see palatal and labial harmonies in Turkish, Finnish, Hungarian and other Uralic and Altaic languages (Ringen, 1997; Ringen and Vago, 1995; Steriade, 1995).

[23] The same result would be achieved by ranking $\text{IDENT}_{\text{ROOT}}$ above a general IDENT.

[24] RAISING is an instance of a height-attraction constraint, for details of which see Kirchner (1996), Gnanadesikan (1997).

[25] An anonymous reviewer points out that there are cases where harmony is triggered by a particular feature value, whether it originates in root or affix, and those cannot be accounted for by ROOT-AFFIX faithfulness. This is known as dominant-recessive harmony. Certain features are dominant regardless of their locus of origin. For an OT analysis of dominant-recessive systems see Bakovic (2000). To explain why certain features are dominant while others recessive, Bakovic extends the LC account developed in this work to the realm of feature assimilation. Directionality in his account follows from the interaction of AGREE-type constraints with constraints from markedness and faithfulness families.

[26] For additional arguments against the cycle see Cole and Coleman (1992).

[27] In fact parallel OT (Prince and Smolensky, 1993), on which the LC account is based, rules out cyclicity. Candidates are evaluated in parallel by a set of universal constraints ranked on language-particular basis. For references to stratal approaches to OT see McCarthy (1999: 387-391).

[28] Of course, not every rule will necessarily present evidence of both types of derived-environment effects; this will depend on the details of the rule itself, other rules, and the morphology. The important point is that the SCC predicts that *some* rules should show both types of derived-environment effects, and *any* rule should if the external conditions are right.

[29] Hammond (1992) argues that neither Finnish Assibilation nor Sanskrit Ruki are triggered by the prior application of some other phonological process. Rather, in both cases what has been seen as prior application of a phonological process should be understood as part of the morphology.

[30] In Hammond (1992), see in particular the analysis of Finnish Assibilation, drawing on Keyser and Kiparsky (1984); McCarthy and Prince (1990). Hammond proposes that Finnish Assibilation is triggered by the addition of a nominative singular *–i* suffix rather than by the prior application of vowel raising as has been previously proposed. Estonian Lowering and Sanskrit Ruki Rule are also discussed.

[31] Another OT approach to NDEB, not discussed here, is Inkelas (1999). Inkelas' proposal was offered after this paper was completed. Inkelas discusses the LC theory introduced here and offers an alternative.

[32] TETU blocking is also known as The Emergence of The Unmarked (McCarthy and Prince, 1994, 1995; Alderete et al., 1999). TETU refers to situations where a given markedness constraint is ranked lower than some type of faithfulness but higher than some other type of faithfulness. Due to this peculiar ranking, the markedness constraint emerges (becomes active) when the higher-ranked faithfulness constraint is irrelevant.