ALTERNATING ENVIRONMENT IN THE ANALYSIS OF DERIVED-ENVIRONMENT EFFECTS[1]

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1. Introduction.

Phonological literature is replete with examples of processes which do not apply across-the-board, whenever the structural description is met, but whose application is restricted to the so-called derived environment. The notion of derived environment has been defined in Kiparsky (1973) as in (1).

(1) Derived environment; Kiparsky (1973), cited after Rubach (1984)
a. Two segments are separated by a morphological boundary.
b. A segment is created in the course of phonological derivation, i.e. it is not present at the underlying level but rather it is derived by applying a rule.

A classical example of the derived environment effect comes from Finnish, where /t/ changes to [s] before [i] as in (2a). Yet, not all [i]s trigger spirantization: morpheme-internal /t/s are not changed to [s] before surface [i]s, compare (2b).

(2) Derived environment effects in Finnish
(a) Rule applies at a morpheme boundary

halu[t]+a	halu[t]+koon	halu[t]+en	halu[s]+i	‘want’
pie[t]+æ	pie[t]+køøn	pie[t]+en	pike[s]+i	‘pitch’
filma[t]+a	filma[t]+koon	filma[t]+en	filma[s]+i	‘film’

(b) Rule doesn’t apply morpheme-internally

[ti]la	‘room’
æi[ti]	‘mother’
mæ[ti]	‘roe’
sil[ti]	‘however’
limonaa[ti]	‘lemonade’
val[ti]on	‘public’

Additionally, the rule applies morpheme-internally, but only if the trigger is not underlying but instead derived via an earlier applied rule, as in (3):

[1] I would like to thank Alexis Lanham, Michaela Rose, and Heather Rice for their comments on the earlier version of this paper.

(3) Finnish: derived environment via application of an earlier rule.
(a) Rule applies morpheme-internally if the trigger is not underlying
vete+næ 'water' essive sg. ve[si] 'water' nom. sg.
(b) Earlier rule /e/ → [i] creating the surface trigger for spirantization.
mæke+næ 'river' essive sg. mæki 'river' nom. sg.

Whereas these kind of effects received a lot of attention and a framework-motivated account within Cyclic and Lexical Phonology, the distinction between across-the-board and derived-environment phenomena escapes a systematic, broadly-recognized account within Optimality Theory (Prince and Smolensky, 1993; McCarthy and Prince, 1986/1996; McCarthy 2002; henceforth OT).

In this article I offer a new systematic approach to explain derived environment effects without reference to derivations, which can be incorporated into an OT-type analysis. However, the solution does not crucially rely on OT theory-internal concepts and can be adopted by any output-oriented phonological approach.

In section 2, I will review the classical approach to the derived environment within the Cyclic and Lexical Phonology framework. Section 3 discusses some earlier approaches to the derived environment within OT, most importantly that of Łubowicz (1998, 2002), and section 4 offers an alternative approach. In section 5 the non-derivational approaches are evaluated and tested against the palatalization data from Polish. Section 6 develops additional details connected with the concept of the alternating environment and finally section 7 provides the summary of the findings.

2. Derived Environment, Cyclic and Lexical Phonology

It is often assumed that most palatalization processes in Polish apply across morpheme boundaries only; that is, they apply only if the target is stem-final and the trigger is suffix-initial, and the adjacency is due to morpheme concatenation.

(4) Example of morpheme-boundary palatalization

lip+a	li[p^{j}j]+e	'linden, Nom. versus Loc.Sing.'
ry[b]+a	ry[b^{j}j]+e	'fish'
la[t]+o	le[ʨ]+e	'summer'
ra[d]+a	ra[ʥ]+e	'advice'
ra[s]+a	ra[ɕ]+e	'race'
ra[z]	ra[ʑ]+e	'one time'
kro[k]	kro[tš]+ek	'step, Dimin.'
móz[g]	móż[dž] + ek	'brain, Dimin.'

This condition on the application of palatalization in Polish has been formally expressed in terms of the derived environment in Rubach (1984) who applied this notion to account for the lack of palatalization in forms such as those in (5):

(5) No palatalization morpheme-internally (the potential target of palatalization is indicated by square brackets)

[b]ez	'without'
[p]est+k+a	'seed/stone inside the fruit'
[t]en	'this'
[d]entyst+a	'dentist'
[s]er	'cheese'
[z]e+rw+a+ć	'to pick up, tear off'
[k]elner	'waiter'
[g]erber+a	'kind of flower'

Notice that any explanation referring to co-phonologies, where palatalization would apply in the native vocabulary and not in the vocabulary of foreign origin/loan words, cannot be a solution, since all the listed words in (4)-(5) are native to Polish.

The analysis with the framework of Cyclic and Lexical Phonology was that palatalization applies only across a morpheme boundary because it is cyclic, and cyclic rules are subject to the Strict Cycle Condition, as below:

(6) Strict Cycle Condition (Kiparsky, 1982, 4)
Cyclic rules apply only to derived representations.
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.

Thus, in the examples in (5) palatalization will apply because the relevant sequence of a target consonant followed by a palatalizing front vowel ([e, i]) is created by morpheme concatenation.

3. OT and Derived Environment

In OT, we still have to account for the derived environment effects though we cannot refer to the notion of derivation, at least not in main stream OT, which excludes the possibility of a serial derivation[2]. In the following, some OT approaches to the derived environment effects will be presented and evaluated and it will be demonstrated why another solution of the derived environment problem needs to be proposed.

[2] An alternative would be to accept serial evaluation in OT (Kiparsky, 2000, Rubach, 2000, 2003)

3.1. Root versus general faithfulness

One solution is to propose that satisfaction of faithfulness constraints for the roots is cross-linguistically more important than for the non-root morphemes (McCarthy & Prince, 1995). Thus, a constraint ranking as in (7) is claimed to hold universally:

(7) Root-Faithfulness >> Faithfulness

Within this approach, the blocking of a markedness constraint morpheme-internally may be easily accounted for by the ranking of a markedness constraint higher than the general faithfulness constraint, and lower than the root-faithfulness:

(8) Root-faithfulness >> Markedness >> Faithfulness

Kager (1999) illustrates this mechanism in the example of nasal substitution in Indonesian (Pater, 1999). In verbs prefixed by /məN–/, the nasal consonant of the prefix is coalesced with the consonant of the stem when it is a voiceless consonant, leaving a nasal with the articulation place of the voiceless consonant, e.g.:

(9) Indonesian nasal substitution (Kager, 1999, 59)

məN+pilih > məmilih	'to choose, to vote'
məN+tulis > mənulis	'to write'
məN+kasih > məŋasih	'to give'

The data in (9) is accounted for by a constraint ∗NC̥ (no nasals followed by voiceless consonants). However, as observed by Pater (1999), the nasal substitution does not occur morpheme–internally. Pater proposes a root particular version of Linearity-IO, as defined in (10).

(10) RootLinearity-IO
The output reflects the precedence structure of the input segments of the root, and vice versa.

Further, the data of nasal substitution are accounted for by a ranking as in (11):

(11) Blocking of the root-internal fusion
RootLin-IO >> ∗NC[-vd] >> Linearity-IO

A ranking in (11) may correctly predict the surfacing of nasal + voiceless consonants morpheme-internally, see tableau (12):

(12) Fusion in Indonesian: example
a. Blocking of root-internal fusion

Input: /ə$m_1p_2$at/	RootLin-IO	*NC[-vd]	Linearity-IO
a.☞ ə$m_1p_2$at		*	
b. ə$m_{1,2}$at	*!		*

a. Fusion occurs

Input: /məN_1+$p_2$ilih/	RootLin-IO	*NC[-vd]	Linearity-IO
a. mə$m_1p_2$ilih		*!	
b. ☞ mə$m_{1,2}$ilih			*

Unfortunately, this solution is not applicable to Polish palatalization. To account for Polish data one would have to postulate, on the one hand, a markedness constraint forbidding sequences of non-palatalized consonants followed by front vowels (alternatively, the constraint would have to refer to the sequences of features), and on the other hand, a faithfulness constraint referring to the features of the target consonant, for instance as in (13) below.

(13) Constraints in Polish
Pal (Palatalization)
A consonant followed by a front vowel has to be palatalized.
Ident[anterior]-IO
The value of feature [+/-anterior] in the input is reflected in the output.

Further, following the logic of the ranking in (8), one would expect that a ranking as in (14) should explain the presence of palatalization at a morpheme boundary, and no palatalization when the target and the trigger are not separated by a morpheme boundary:

(14) RootIdent[anterior]-IO >> Pal >> Ident[anterior]-IO

The ranking in (14) would indeed explain why there is no palatalization morpheme-internally, compare (15a), but then one would have to explain why palatalization does happen to the stem-final segments: it is a stem consonant that undergoes palatalization that is, violates faithfulness, as illustrated in (15b).

(15) The application of root-faithfulness in Polish
a. No palatalization morpheme-internally

Input: /ten/	RootIdent[anterior]-IO	Pal	Ident[anterior]-IO
☞ a. ten		*	
b. tɕen	*!		*

b. Root-faithfulness block palatalization at a morpheme boundary

Input: /rad+e/	RootIdent[anterior]-IO	Pal	Ident[anterior]-IO
☜ a. rade		*	
☞ b. radʑe	*!		*

3.2. Derived environment constraint.

Another proposal was made by Polgardi (1998), who proposes a Derived Environment Constraint, as below:

(16) Derived environment constraint (DEC, quoted after Blaho, in press)
No changes are allowed within a single analytic domain.

Further, it is stipulated that constraints responsible for across-the-board effects, i.e. generalizations which are always true irrespective of the presence/absence of morphological boundaries, are ranked higher than DEC. On the other hand, for derived environment effects, DEC dominates the particular constraint.

Blaho (in press) demonstrates that this approach cannot account for pre-sonorant voicing in Slovak. She argues that Polgardi's solution encounters problems "every time when phenomena displaying diverse sensitivity to derived environments are regulated by the same set of constraints". In a similar way, DEC would account for the lack of palatalization inside the morpheme in Polish, as in (17a), but it would also wrongly predict that the morpheme-final target of palatalization should not be palatalized, compare (17b):

(17) DEC in Polish

a. Morpheme-internal palatalization is blocked.

Input: /ten/	DEC	Pal
☞ a. ten		*
b. tɕen	*!	

b. Morpheme-final palatalization

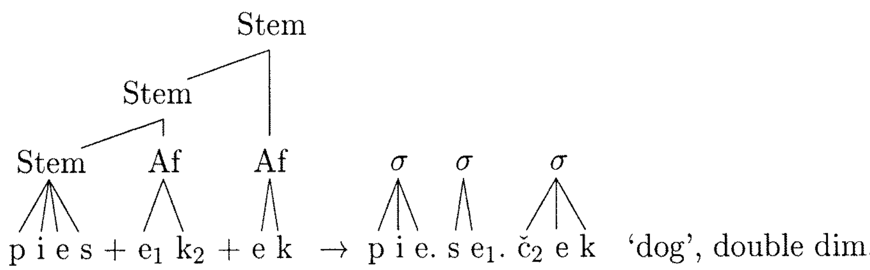
Input: /servis+e/	DEC	Pal
☜ a. servise		**
☞ b. serviɕe	*!	*
c. ɕerviɕe	*!*	

The ranking of DEC over Pal would correctly predict lack of palatalization morpheme internally, because the form with palatalization, e.g. candidate b. in (17a), changes the underlying feature specifications. In (17b), candidate a. does not violate DEC because there is no change within the morpheme, however, this is not the winner that one would expect. The actual winner is candidate b., which violates DEC ones (features of one segment within the morpheme have been changed). Thus, Polgardi's DEC without any additional mechanism to differentiate between morpheme-internal and morpheme-final segments, does not account for the data.

3.3. Local conjunction with Anchor

Another approach has been proposed by Łubowicz (1998, 2002). She observes that since the relevant palatalizing suffixes in Polish are always vowel-initial and since a preceding consonant will always syllabify as an onset for the suffix-vowel, the constraint which requires the rightmost edge of the stem in the input to correspond with the rightmost edge of the syllable in the output (cf. also Łubowicz, 2002:26) will always be violated in forms with palatalization. This is illustrated in (18):

(18) Violation of stem: syllable anchoring among suffixes (Łubowicz, 1998:24)



In (18), the [k_2] of the first affix is treated as stem-final. It will be syllabified as an onset of the final syllable if we add another suffix –ek. Thus, the right edge of the stem ([$č_2$]) does not correspond on the surface to the right edge of the syllable, which is [e_1].

Łubowicz (1998:24) postulates in her analysis the R-ANCHOR(Stem; δ) constraint, as quoted in (19). Then she proceeds to analyze the derived environment problem in terms of local conjunction of R-ANCHOR(Stem; δ) and a constraint inducing palatalization (in her approach understood as an articulatory spreading):

(19) R-ANCHOR(Stem; δ)
The rightmost segment of a stem in the input has a correspondent at the right edge of a syllable in the output.

The following constraints were used in the analysis in Łubowicz (1998) but not specifically defined:

(20) Constraints used in Łubowicz (1998)
(a) PAL (yields adjoining of feature Coronal to the preceding consonant).
(b) R-ANCHOR(Stem; δ) & Pal understood as “palatalize when R-ANCHOR(Stem; δ) is violated”.

A local conjunction is a macro-constraint which conjoins the conditions of two sub-constraints. It is violated when both of its member-constraints are violated within the same domain, for instance, by the same segment (Smolensky, 1993)[3]. Thus, when either the first or second constraint is violated, or when neither of them is violated, the conjunct is not violated either, see the table (21) below.

[3] Since local conjunction is always ranked higher than any of the two sub-constraints, the effect of the local conjunction is such that a violation of any given constraint is a worse offence when the other constraint in the conjunction is violated too. On the other hand, the two constraints may be separately low-ranked and exert little effect on the phonology of a language, unlike their conjunction.

(21) Local conjunction, as adopted in Łubowicz (1998)

	Conjunction: R-ANCHOR(Stem; δ) & Pal	R-ANCHOR(Stem; δ)	Pal
i.	non-violated	violated	non-violated
ii.	non-violated	non-violated	violated
iii.	non-violated	non-violated	Non-violated
iv.	violated	violated	violated

A summary is provided in (21) above, of when the conjunction is violated and when it is satisfied. In case i., when the stem edge does not correspond to the syllable edge (derived environment) and when palatalization does take place, there is no violation of a conjunct. In case ii. when the stem edge does correspond to the syllable edge (non-derived environment) and when palatalization does not occur, the correct output is also obtained. In case iv. when the stem edge does not correspond to the syllable edge (derived environment) and palatalization does not occur, there is a violation of the conjunct.

An example analysis of the Polish data is provided in (22):

(22) Palatalization

Input: /kas+e/	R-ANCHOR(Stem; δ) & Pal	R-ANCHOR(Stem; δ); Pal
a. kase	*!	* *
☞ b. kaɕe		*!

Notice that situation iii., when both members of the conjunct are satisfied, should in principle deliver a correct output, assuming the definition of Local Conjunction as adopted in Łubowicz (1998). Yet, this does not correspond to the surface facts: the segments which morpheme–internally vacuously satisfy Anchor may not undergo palatalization.

(23) No palatalization morpheme-internally

Input: /ten/	R-ANCHOR(Stem; δ) & Pal	Pal
☞ a. ten		*
☜ b. tɕen		

That local conjunction is not violated in candidate b. in (23) is an unwelcome effect, because if local conjunction is not violated, candidate a. is disqualified as a result of a violation of the lower ranked Pal, and the predicted winner does not correspond to the actual winner.[4]

[4] Łubowicz (2002) excludes candidates with morpheme-internal palatalization by ranking Ident[coronal] above Pal. Thus, candidate (b) [tɕen] violates the faithfulness constraint, and the winner is candidate (a) [ten]. This ranking is, however, problematic for the analysis of palatalization triggered by morpheme-initial yers, compare (28).

The actual tableau for the Polish data should be as below:

(24) Actual surface forms in Polish with respect to the two constraints

	Local Conjunction surface true or not	R-ANCHOR(Stem; δ)	Pal
i.	desired surface result	violated	non-violated
ii.	desired surface result	non-violated	violated
iii.	wrongly not expected	non-violated	non-violated
iv.	not expected	violated	violated

That is, the relationship between the two constraints is rather that of a Logical Inequivalence (exclusive OR), where the expression is true only if one of the sub-expressions is true, but not if both sub-expressions are true[5].

To exclude case iii. of Local Conjunction, cf. tableau (18) above, from the discussion, Łubowicz argues (1998: 24-25):

> "Since Palatalization is activated by the violation of anchoring, there is no Palatalization of a segment that vacuously satisfies anchoring, such as tautomorphemically. Only stem final segments can palatalize, precisely because only such segments can incur a violation of anchoring (. . .) The locally conjoined constraint is only relevant when the palatalizing segment is stem final (. . .) Otherwise, the conjoined constraint has no force, and so lower ranked constraints are decisive."

It seems that this argumentation is equal to saying that some candidate is not evaluated with respect to a particular constraint, because there is no way this candidate can violate the given constraint, that is, it would always be vacuously satisfied. I am not aware of other formal applications of the distinction between vacuous and non-vacuous application of a rule/constraint/generalization.

A more serious problem for the account proposed by Łubowicz comes from Polish data involving yer-initial suffixes.

Yers were historically full vowels in Common Slavic. There were two types of yers, those that triggered palatalization (marked as "ь" in Slavic literature), and those that did

[5] Crowhurst and Hewitt (1997) proposed a typology of constraint interaction based on the principles of Boolean logic, and assumed that the cases like the ones discussed in (17), that is Local Conjunction as defined in Smolensky (1993) correspond to logical disjunction, (i.e. inclusive OR; a statement is false only iff both sub-statements are false). On the other hand, a logical conjunction is true only iff both sub-statements are true, that is, it is false in all other cases. They did not discuss cases of type (24). The interaction of constraints in Polish seems to correspond to logical relation of inequivalence (i.e. exclusive OR; the statement is true if either of the two sub-statements is true, but it is false if both of them are true, or if both are false.)

not, which leads researchers to conclude about their actual phonetic quality (palatalizing yers are assumed to have been front vowels). In the argument here, I refer to the palatalizing yer. Later in the historical development all yers neutralized with other surface vowels in certain specified positions (if another yer followed in the next syllable), and in all other positions they have been surface-deleted. The process of neutralization gave in different modern Slavic languages different surface effects. In Polish, both the palatalizing and non-palatalizing yers surface as [e], and this process is referred to as Yer Lowering (e.g. Rubach, 1984). Yet, in spite of the surface neautralization, one has to distinguish between the regular vowel [e] and the yers in synchronic terms, because otherwise there is no way to account for the pattern of the occurrence and deletion of the yer. One way to represent yers is as floating features without a timing slot in the input (Rubach, 1986; no X-slot in older theories or no root-node in feature geometry). Synchronically, underlying yers need to be assumed in Polish in morphemes displaying surface vowel-zero alternation and in the cases when there is palatalization without a surface trigger, for instance as in (25)

(25) [e]-zero alternation in Polish (original spelling)

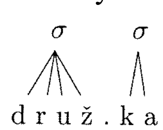
dróż+ek	dróż+k+i	‘path’ Gen.Sg vs Nom.Pl.
pień	pni+a	‘stump’ Nom.Sg. vs Gen.Sg.
krocz+k+u	krocz+ek	‘step’ Dim. Gen. Sg. vs Nom. Sg.
śpiew+acz+k+a	śpiew+acz+ek	‘singer’ Fem. Nom. vs. Gen. Sg.
głos	głoś+n+y	‘voice’ vs ‘loud’
giez	gz+y	‘gadfly’, Nom. Sg. – Nom. Pl.
iskier	iskr+a	‘spark’, Gen. Pl. – Nom. Sg.
sen	sn+u	‘dream’, Nom. Vs Gen. Sg.

Łubowicz (2002:265) assumes that her model makes a general prediction “that a C-C boundary will not in general trigger derived environment effects because it does not result in stem-syllable misalignment.” However, palatalization in Polish applies in some cases also when stem-syllable alignment is not violated, as is illustrated in (26):

(26) drog+a ‘way’ dró[ž]+k+a
UR: /dróž +ьk+a/ ‘way, diminit.’ for ь=palatalizing yer

If the surface syllabification is considered, according to the definition given by Łubowicz (1998:24), the Anchor constraint is not violated because, in the absence of a surface nucleus, the final segment of the stem syllabifies as a coda to the syllable containing other segments of a given morpheme. Example (27) illustrates the most likely surface syllabification:

(27) Surface syllabification of forms containing a yer



Since Anchor is not violated it does not eliminate the form without palatalization. Ident[coronal] which guaranteed that no palatalization occurs morpheme-internally, blocks palatalization also in the words like in (25), see (28)

(28) ANCHOR analysis for ***dróżka***

/drog+ьk+a/	ANCHOR & Pal	Ident[coronal]	Pal
☜a. drogka			*
☞b. drožka		*!	

To refer to Anchor violation, one would have to refer to the underlying representation, or input. First, one would have to assume that there is syllabification on the input already, stored in the lexicon. Second, we would have to evaluate the input – which goes against the theorem of Richness of the Base, for example, as defined in Kager (1999):

(29) Richness of the Base (Kager, 1999:19)
No constraints hold at the level of underlying form.

Summing up, the solution in terms of Anchor constraint does not cover a set of data involving yers. Łubowicz (2002:37) has to invoke an independent mechanism here and explains the cases as in (26) in terms of faithfulness to a sympathetic candidate (McCarthy 1999) Apart from the fact that an independent mechanism needs to be invoked to account for a subset of data, Sympathy Theory has been a target of criticism itself. It seems that the choice of the selector constraint and, consequently, of the sympathetic candidate is not independently justified. For a general critique of Sympathy Theory, see e.g. Kager (1999).

4. An Alternative Proposal to the Derived Environment Problem

In what follows, I propose an alternative solution to the derived environment problem. This idea was inspired by Timberlake (1978) who distinguished between alternating versus non-alternating environments in language change. What differentiates the morpheme-boundary environment from a stem internal environment on the surface is the fact that in the across-the-morpheme environment different sequences of neighboring segments may occur: throughout the paradigm and within a word family. Let us, for example, consider the paradigm of *sinus* 'sinus':

(30) Paradigm of *sinus* 'sinus'
Nom. [sinus], [sinusɨ]
Gen. [sinusa], [sinusuv]
Dat. [sinusovi], [sinusom]
Acc. [sinus], [sinusɨ]
Instr. [sinusɛm], [sinusami]
Loc/Voc. [sinuɕe], loc. pl. [sinusax]
Dimunitive [sinuɕik], etc.

Whereas after s_1 of [$s_1$inus_2] – throughout all the forms of the paradigm – the sequence of the following segments is [-inu], s_2 is followed by a number of various segment sequences. This might account for a different status of the segments: s_1 will not palatalize, s_2 will undergo palatalization. Let us define formally the alternating versus uniform environment.

(31) Alternating environment: definition
For A – which is a target, B – a potential trigger, C – an adjacent segment, an environment is alternating when there is more than one surface realization of the underlying sequence of A, B, (C) within the set of morphologically related surface forms.

In other words, when deciding if the given environment is alternating or uniform, one considers the syntagmatic relationship between any segment and the adjacent segments to see if the syntagmatic relationship remains unchanged paradigmatically. An alternating environment refers to morpheme-boundary environments, where A and B belong to a separate morpheme, as in (32).

(32) Environment

Non-alternating	Alternating
AB+C, AB+D	A+B(C), A+(C)

for A = target, B = environment, C, D = adjacent segments

An alternating environment would encompass also the cases of the derived environment without a morpheme boundary, i.e., where it has been created via the application of earlier rules within the framework of cyclic/lexical phonology, or using OT formalism, when the generalization holds for only those surface candidates where the trigger is unfaithful to the input anyway:

(33) Phonologically derived environment
(a) Deletion/Epenthesis: ABC versus AC
(b) Feature change: ABC versus ADC

The difference in the application of certain constraints in the alternating versus non-alternating environments may be motivated by the learning strategies characteristic to the human cognitive system. In a uniform environment, we have no positive evidence for the application of any constraint the representation obeys. An alternating environment, in contrast, makes the generalization more salient; it is more obvious that there is some requirement on the surface form depending on the properties of the environment, since the same word may surface with different environments.

In the end, markedness requirements may be blocked by the faithfulness constraints in the uniform environment more likely than in the alternating environment, cf. Anderson (1981). Thus, whereas other solutions are more abstract (e. g. they employ theoretical concepts such as affix, stem, syllabification), the concept of the alternating versus uniform environment refers to surface sequences of segments, and might be psychologically grounded.

Formally, to distinguish between the alternating and uniform environment in OT, a constraint Uniform is postulated:

(34) Uniform ABC
A sequence of segments A, B, (C) is realized on the surface in a uniform way throughout a paradigm and morphologically related word forms, where A, B, C are adjacent segments out of which A is a potential target of a generalization, and B a potential trigger.

For example, in the word [$s_2$inus$_2$ax], cf. (30), the sequence [$s_1$in−] satisfies Uniform because it is rendered uniform throughout the paradigm. In contrast, [−$s_2$ax] violates uniform because, first, [s_2] may be followed by a different sequence of segments [−ɨ], [−ami], [−Ø], and, second, [s_2] itself may correspond to another segment which differs in the featural make-up, i. e. [ɕ], see (30). A constraint limited to the alternating environment may be formally expressed as disjoint with Uniform, see (35):

(35) Constraint X ABC ∨ Uniform ABC
Logical Inequivalence "Constraint XABC ∨ Uniform ABC" is satisfied when either Constraint XABC is satisfied, or Uniform ABC is satisfied.

The effect of the inequivalence in (35) is such that any given Constraint X is activated by the alternating environment. This is illustrated in (36):

(36) Palatalization in Polish
a. Morpheme-internally

Input: /sinus/	Uniform ∨ Pal	Pal	Uniform
☞ a. sinus		*	
b. ɕinus	*!		

b. Palatalization across a morpheme boundary

Input: /kas+e/	Uniform ∨ Pal	Pal	Uniform
☞a. kase		*	*
b. kaɕe	*!		*

The relation of Uniform and Pal in Polish is that of a logical inequivalence, that is, it is violated if either both sub-constraints are violated, or if both constraints are satisfied. The relation is also local, i.e. must apply to the same segment. If in (36a) morpheme-internal sequence [si] is in a uniform environment, it does not violate Uniform. Candidate (b) satisfies Pal, and thus, logical inequivalence Uniform ∨ Pal is violated. In (36b) the potential target of palatalization, i.e. the consonant followed by a front vowel, appears in an alternating environment, thus, it violates Uniform. Consequently, the segment must be palatalized for the logical equivalence to be satisfied.

5. Comparison of Łubowicz (1998, 2002) and the proposal here.

Since the solution based on the difference between stem-particular and general faithfulness constraints (Pater, 1999) cannot be applied in Polish, we concentrate in this section on the comparison of Łubowicz's solution and the one proposed in this paper. We first analyze in detail the data from Polish, and proceed with the comparison of general predictions.

5.1. Coronal Data in Polish.

Apart from the earlier mentioned problem with the lack of anchor-violation by yer-triggered palatalization (cf. section 3.3), in Polish there are a few more examples which might potentially constitute a problem to Łubowicz's proposal. Consider the forms in (37):

(37) Morpheme-internal yers trigger palatalization

a.	płó[tn]o	płó[ʨen]+n+y	'cloth' n. – 'cloth' Adj.
b.	o[ɕem]	ó[sm]+y	'eight' – 'eighth'
c.	kro[ɕen]	kro[sn]+a	'loom' Gen. Pl. – Nom. Pl.

Let us assume that palatalization in words in (37) is not underlying, but must come from a process of palatalization triggered by a vowel (the alternatives are discussed later on). It seems also that the correct analysis of these facts requires an assumption that it is the deletion of an underlying vowel rather than vowel epenthesis (compare e.g. Gussmann, 1980; Rubach, 1986). Since the same sequences of consonants may appear with or without vowels as well, we would not be able to state the conditions for vowel insertion, see (38):

(38) No need for vowel epenthesis

dr:	cedr 'cedar'	puder 'powder'
zł:	wiózł 'drove', 3 rd sg. masc.	węzeł 'node'
sł:	rósł 'grew', 3 rd sg. masc.	suseł 'ground-squirrel'
ɕm:	ta[ɕ]m 'tapes' gen. pl.	ta[ɕ]emka 'ribbon'

Thus, for words such as *płócienny* in (37), one would like to assume an underlying form like /płutьn+ьn+ɨ / (where ь stands for a palatalizing yer).

Notice that the palatalized consonant does not appear at the edge of the stem; it satisfies the conditions of the derived environment because palatalizing morpheme-internal [e] is derived by Yer Lowering (Rubach, 1984; second case of the derived environment), but local conjunction with ANCHOR constraint does not obtain the correct output here – palatalization cannot apply. On the other hand, [ʨ] of płó[ʨen]+n+y appears in an alternating environment, in that on the surface it is sometimes followed directly by a consonant, sometimes by a surfacing yer.

One could try to analyze the data in (37) in a different way. In the following paragraphs the alternatives are reviewed and discarded.

(37a) might be analyzed as having an underlying palatalized coronal, which in forms where the coronal is followed by a coronal nasal consonant undergoes depalatalization. In fact, a rule of depalatalization of prepalatal affricates before coronal continuants were postulated both by Gussmann (1978) and Rubach (1984), as it was claimed that there are no words containing surface strings like [ʨl, ʥl, ʨn, ʥn, ʨr, ʥr]. A counterexample to this statement of the rule is word *ćlamać* [ʨ]lamać – Warsaw coll. 'eat slowly'. It is difficult to say whether the rule is to be stated in a more restrictive way, or rather the lack of some sequences in the native vocabulary is merely an accidental gap, or the generalization should be viewed in diachronic terms.

Whereas for (37a) one could in principle refer to the depalatalization rule postulated by Gussmann (1978) and Rubach (1984), (37b) cannot be analyzed with an underlying palatalized sound, as there is no depalatalization of continuants, see (39a), and there is no depalatalization before labial sonorants, see (39b) :

(39) a.	gło[ɕn]y	'loud'
	mro[ʑn]y	'frosty'
	[ɕl]epy	'blind'
	[ʑl]e	'bad, Adv.'
	[ɕr]oda	'Wednesday'
	[ʑr]ebię	'foal'
b.	[ʨm]a	'moth'
	wie[ʥm]a	'witch'

Alternatively, we could assume that the forms in (37b) (o[ɕ]em - ó[s]m+y) have to be analyzed as a lexicalized alternation, with two underlying representations. Similarly, we can postulate two underlying representations for the examples in (37c). Then forms like *krosien* would have to be analyzed as having two underlying allomorphs. In this case [ɕ] in *krosien* would have to be lexical, but forms like głos – gło[ɕ]ny (UR /głos+ьn+ɨ/ , (where the trigger of palatalization never surfaces) can and will be analyzed as containing an underlying /s/ palatalizing before the front yer, only because the morpheme boundary is there. In other words, forms like kro[ɕ]en and gło[ɕ]ny will have to be analyzed by means of different theoretical mechanisms.

Summing up, I assume that the analysis of words as in (37) is correct with an underlying dental being palatalized, as shown in (40)[6]:

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[6] It is assumed here that the surfacing of the yer is regulated by high-ranked prosodic constraints (Lower yer if followed by another yer) which are not included in tableau (39).

(40) A morpheme-internal yer triggers palatalization

a.

Input: /płutьn+ьn+ɨ /	*tɕn	Pal ∨ Uniform	Pal Uniform
☞ a. płutɕennɨ			*
b. płutennɨ		*!	* *

b.

Input: /płutьn+o /	*tɕn	Pal ∨ Uniform	Pal Uniform
a. płutɕno	*!		*
☞ b. płutno		*	* *

Consequently, this is another subset of data not covered by Łubowicz's solution.

In conclusion, as far as the alternating condition solution proposed here is concerned, it makes different predictions from the Anchor solution. It does not make an à priori distinction between the environment at the morpheme boundary and the cases where the target segment finds itself in an alternating environment due to requirements of other higher-ranked constraints.

One has to admit that there is a very limited number of examples of the type listed in (37), containing coronal consonants, and the arguments are not very compelling. A more convincing set of data offers morpheme-internal Velar Fronting (Rubach, 1984), which is discussed in the following section.

5.2. Velar Data in Polish.

As to velar stops, e-initial morphemes in Polish trigger either deep palatalization to post-alveolar affricates [tš, dž], e.g. like in kro[k] – kro[tš]+ek, or they cause so-called Surface Velar Palatalization (c.f. Rubach, 1984), as in (41):

(41) Surface Velar[7]

krok	kro[c]+em	'step'	Nom. Versus Inst. Sing.
bra[k]	bra[c]+em	'lack'	
wyso[k]+a	wyso[c]+ej	'tall'	'adj. Nom. Versus Gen. Sing. Fem.'
	wyso[c]+emu		'adj. Dat.Sing. Masc.& Neut.
dłu[ɟ] + a	dłu[ɟ] + ej	'long'	adj. Nom. Vs Gen. Sing. Fem.
	dłu[ɟ] + emu		adj. Dat. Sing. Masc. & Neut.

In fact Polish has no sequences [k] + e where the two sounds would be separated by a morpheme boundary, velar stops have to be surface palatalized before a front

[7] In fact the generalization is broader, embracing also sequences with a high front vowel, but this is irrelevant for our argument and is not going to be discussed.

vowel. On the other hand, there is no such requirement for morpheme-internal sequences, as demonstrated in (42) below:

(42) No Surface Velar

[g]eografi+a	'geography'
[k]elner	'waiter'

Interesting for us is the data where the front vowel appears morpheme-internally but still triggers Surface Velar. Rubach (1984: 176-177) notes that there is a "systematic relationship" between palatalized velars and underlying yers. Underlying yers, if they surface, they surface as a front mid vowel and trigger secondary palatalization (Surface Velar Palatalization) on the velar stops, as in (43):

(43) yer-zero alternation: a yer lowers to a mid front vowel and triggers Surface Velar; quoted from Rubach (1984: 177)

[ɟez]	[gz+ɨ]	'gadfly', Nom. Sg. – Nom. Pl.
szczy[ɟew]	szczy[gw]+a	bird art, Nom. Sg. – Gen. Sg.
szwa[ɟer]	szwa[gr]+a	'brother-in-law', Nom. Sg. – Gen. Sg.
is[cer]	is[kr]+a	'spark', Gen. Pl. – Nom. Sg.
cu[cer]	cu[kr]+u	'sugar', Nom. Sg. – Gen. Sg.
cer[cev]	cer[kv]+i	'orthodox church', No. Sg. – Gen. Sg.

There are no cases in Polish where a morpheme-internal yer would surface after a velar, and the velar would not be palatalized.

In (43) the morpheme-internal sequences are treated like the sequences at the morpheme boundary. This is predicted by the definition of the alternating environment that I proposed in section 4. Throughout the paradigm, we observe alternations with respect to the sequences in question between the presence versus absence of a surface vowel. Consequently, the examples in (43) may be analyzed in the same way as sequences at the morpheme boundary.

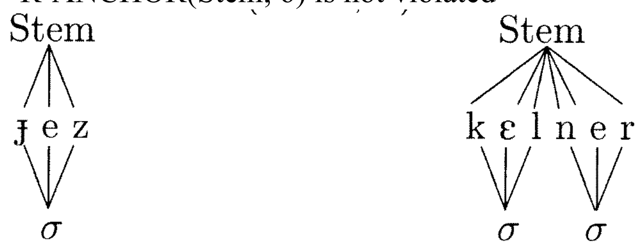
Since it is an alternating environment, the prediction is that surface agreement for place of articulation will have to be obeyed as in the case of the morpheme boundary context. The prediction is borne out.

Notice that in the discussed case, the solution to the derived environment problem offered by Łubowicz (1998) makes wrong predictions. Łubowicz argues that palatalization occurs on the consonant C_1, if this consonant C_1 is stem final but not syllable final, which is formally expressed by a disjunction, repeated here as (44).

(44) R-ANCHOR(Stem; δ)
The rightmost segment of a stem in the input has a correspondent at the right edge of a syllable in the output.

If we compare the words with and without a yer morpheme internally, we see that they do not differ in terms of syllabification.

(45) R-ANCHOR(Stem; δ) is not violated



If Surface Velar is induced by the conjunction of Palatalization with R-Anchor(Stem, δ), then the prediction would be that [ɟ]ez and [k]elner should be treated the same way, which is not borne out. The prediction of ANCHOR approach – assuming that there is no is no problem with the definition of the local conjunction as used by Łubowicz – is that the segment morpheme-internally will not undergo palatalization. It would be true for words with an underlying front mid vowel, but not for words with an underlying yer. The winner in (46a) should be candidate (a), but the true surface form corresponds to candidate (b).

(46) Analysis of a word with a morpheme-internal yer with an ANCHOR constraint.

a.

Input: /gьz+ь/	ANCHOR & Pal	Pal ANCHOR
☞ a. gez		*
☜ b. ɟez	*!	

b.

Input: /kelner/	ANCHOR & Pal	Pal ANCHOR
☞ a. kelner		*
b. celner	*!	

5.3. Spirantization.

Łubowicz (1998, 2002) demonstrates another example from Polish where derived environment effects are accounted for by the local conjunction solution. In Polish /g/ 'should' palatalize to [dž] (analogue to the palatalization of /k/ to [tš], and of /x/ to [š]), and it does – but only when preceded by an obstruent. When in an inter-vocalic position it will surface with an additional change of manner of articulation to fricative. Consider the forms below:

(47) Spirantization

móz[g] → mó[ždž]+ek	'brain – brain, dim.'
wa[g]+a → wa[ž]+y+ć	'weight – to weight'

A well known effect is that spirantization occurs only in conjunction with palatalization, that is, forms which can be claimed as having an underlying /dž/ (and not an underlying /g/) will not undergo spirantization, as demonstrated in (48):

(48) No Spirantization of underlying voiced postalveolar affricates

bry[dž]	brv[dž]+yk	'game of bridge'	(dim.)
ban[dž]+o		'banjo'	

Here, Łubowicz (1998, 2002) applies a conjunction of Ident[continuant] and *dž conjoined with constraint inducing palatalization, that is, local conjunction Pal & R-Anchor.

Assuming that Spirantization really applies in a derived environment, the alternating environment solution predicts that both in ro[ž]+ek and in bry[dž]+yk, we should expect spirantization to [ž], which is not the correct output. In this case we would have to admit an independent solution, like for example, the one suggested by Łubowicz.

(49) Alternating Environment approach to Spirantization

Input: /brɨdž+ɨk/	Spirantization ∨ Uniform	Spirantization	Uniform
☞ a. brɨdž+ɨk	*!	*	*
☜ b. brɨž+ɨk			*

Notice, however, that the two examples discussed above are probably the only two examples actually existing in Polish. [dž] itself is probably a minor phoneme in Polish, and appears especially seldom word-finally. Both words in (48) are borrowings, confined to certain registers of language, and they happen not to attach the 'right' palatalizing suffixes, except for the form 'bry[dž]+yk which potentially might be palatalized. Thus, it might be justified to assume here a kind of co-phonology effect, with particular faithfulness ranked over constraints inducing spirantization. Also, out of the two examples, example 2, 'ban[dž]o' does not decline in Polish, and thus, [dž] is not really in an alternating environment, although some native speakers might assume a morpheme boundary there by analogy with other Polish neuter nouns. Thus, it is not uncontroversial to motivate the necessity of the use of local conjunction solution based on the existence of two borrowings which do not comply to more general patterns of the language.

From the discussion above one conclusion is clear, that is, different derived environment effects – even in the same language – require problem-specific conjunctions in Łubowicz's approach. Also, local conjunction is potentially unconstrained, in principle one can conjoin any two types of constraints, thus, the theory accepting local conjunction as a solution to the derived environment problem might erroneously overgenerate.

Above I argued that the exceptions to Polish spirantization in principle might be accounted for in a different manner, which is not to claim that local conjunction needs to be eliminated altogether.

5.4. Summary of general differences

One difference between the two approaches is the treatment of palatalization without the surface trigger. As discussed in section 3., Łubowicz's proposal cannot analyze the cases like [krotš+k+u] 'step, Gen. Sg., Dim.' (cf. krok – krotš+ek), where the underlying yer does not surface yet there is palatalization. Two sets of such words are repeated below.

(50) Words with yers

a.	krok 'step'	krotš+k+u Dim. Gen. Sg.	krotš+ek Dim. Nom. Sg.	
	drog+a 'way'	drož+k+a Dim. Nom. Sg.	drož+ek Dim. Gen. Pl.	
	ɕp^{j}jev + ak 'singer'	ɕp^{j}jev + atš + k + a Fem.	ɕp^{j}jev + atš + ek Gen. Sg.	
	głos 'voice'	głoɕ + n + ɨ 'loud'		
b.	[ɟez]	[gz+ɨ]	'gadfly', Nom. Sg. – Nom. Pl.	
	szczy[ɟew]	szczy[gw]+a	bird art, Nom. Sg. – Gen. Sg.	
	szwa[ɟer]	szwa[gr]+a	'brother-in-law', N. Sg. – Gen. Sg.	
	is[cer]	is[kr]+a	'spark', Gen. Pl. – Nom. Sg.	

Since there is no surface vowel, the final consonant of the morpheme is not reanalyzed on the surface as an onset for the attached palatalizing suffix, thus, an independent mechanism is needed to explain this kind of derived environment palatalization, as exemplified in (28) and (46), here repeated as (51).

(51) ANCHOR analysis for Polish

a. ANCHOR analysis for ***dróżka***

/drog+ьk+a/	ANCHOR & Pal	Ident[coronal]	Pal
☜a. drogka			*
☞b. drožka		*!	

b. ANCHOR analysis of *giez*

Input: /gьz+ь/	ANCHOR & Pal	Pal ANCHOR
☞ a. gez		*
☜ b. ɟez	*!	

On the other hand, the proposal made here correctly predicts that palatalization should apply. The target of palatalization appears in the alternating environment. Thus, it seems that the explanation of the derived-environment effect does not need to make reference to syllable structure.

(52) Alternating Environment analysis for ***dróżka***

Input: /drog+ьk+a/	Uniform ∨ Pal	Pal Uniform
a. drogka	*!	* *
☞ b. drožka		*

Further, Łubowicz's solution makes another prediction, that there are no derived environment effects triggered non-locally. Łubowicz (2002) analyzes one potential counterexample: Vowel Raising in Basque (Hualde, 1989). She proposes a solution in terms of an independent mechanism, i.e. positional faithfulness (Beckman, 1995, 1997, McCarthy and Prince, 1995), similar like the approach to Indonesian nasal substitution discussed in the previous section. Thus, the existing counter-examples are not covered by Łubowicz's proposal.

In general, it seems that the relationship between syllable and stem edge is an artifact of the theory rather than a valid observation. There are apparently more counter-examples to the predictions made by Łubowicz's proposal. Apart from the Basque Vowel Raising, Blaho (in press) shows that Łubowicz's approach cannot be adopted for the derived environment effects applying to pre-sonorant voicing in Slovak because pre-sonorant voicing in Slovak takes place independently from the syllabification of the affected consonants. Thus, Łubowicz's solution does not seem to offer a general cross-linguistically applicable approach to derived environment effects.

The two approaches, that of Łubowicz (1998, 2002) and the one proposed here, would make different predictions in one more respect. Notice that Łubowicz's solution makes a principal distinction between the two kinds of the derived environment, morphological (by morpheme concatenation) and phonological. The derived environment of a morpheme boundary will be explained by a conjunction with ANCHOR constraint, and the environment derived resulting from a prior application of a rule will be expressed by a conjunction with faithfulness: a surface effect will only occur when the underlying feature is not faithfully rendered on the surface. The solution proposed here does not make an a priori distinction between two types of the environment consequently, the same surface effect might appear with or without surface morpheme boundary, as long as the environment is alternating. This has been illustrated by Polish Velar Fronting in sections 5.1. -- 5.2.

One can also ask about the external grounding of a Pal & ANCHOR conjunct: is it articulatory, acoustic, perceptual or psychological? What is the particular relation between triggering palatalization and the correspondence between the edge of a morpheme and its syllable affiliation on the surface? This relation seems rather arbitrary. On the other hand, the current proposal seeks external, independent grounding.

6. Further issues.

Timberlake (1972) shows the concept of alternating environment in a diachronic perspective, in particular, the influence of the uniform versus derived environment on the spreading of phonological change. He argues that phonological change is facilitated/spreads earlier and quicker in a uniform environment though one must bear in mind that it is different from our synchronic perspective. Most of his examples of facilitated phonological change in a uniform environment would be analyzed in synchronic terms rather as cases of the underlying representation equal to the surface representation, where there would be no "effect" to discuss. It might very well be the case that diachronically, alternating environment blocks the phonological change however, synchronically, once there is no variation in the realization in a uniform environment, the alternating environment will make salient the mental reality of the alternation, and thus, it will fossilize the effects which are no longer articulatorily conditioned.

In earlier sections, examples from Polish demonstrated that a uniform versus an alternating environment does not always coincide with a morpheme boundary. However, most of the cases of alternating environment are connected with different types of morphological boundaries. Thus, Timberlake (1972:325) sums up:

> "Boundaries express the degree of coalescence of a phonological context along the syntagmatic axis (Jakobson 1971:108). Alternation involves the comparison of a phonological context with other possible contexts in the paradigm of a word. Alternation expresses the degree of coherence of a phonological context along the paradigmatic axis (Kiparsky 1972: 206-13)."

Consequently, he argues that:

> "Just as there is a hierarchy of strength of boundaries, so there is probably a hierarchical gradation in strength of alternation. Forms in an inflectional paradigm are more closely related than forms in derivational paradigm. Accordingly, a sound change might develop earlier under derivational alternation than under inflectional alternation." (Timberlake, (1972:326)

Similarly, we might expect a gradation of effects of synchronic systems that is, we might observe that certain synchronic effects might occur only in the presence of only strong morphological boundaries as opposed to weak morphological boundaries, or they might be triggered by any type of alternating environment. Whereas Polish palatalization (both 1st Velar and Velar Fronting) seems to be triggered by any type of alternating environment, including an alternating environment without a morphological boundary, Slovak pre-sonorant voicing is applicable at a strong morpheme boundary only, when the target and the trigger are separated by a word boundary, compare the forms in (53) below (Blaho, in press).

(53) Slovak

a. No pre-sonorant voice assimilation

sestra	[st]	'sister'	
púzdro	[zd]	'case'	
tlak	[t]	'pressure'	
dla	[d]	'palm'	
mokrá	[k]	'wet'	
modrá	[d]	'blue'	

b. Pre-sonorant voice assimilation

vojaka	[k]	'soldier GenSg'	vojak ide	[g]	'the soldier goes'
lese	[s]	'forest LocSg.'	les je	[z]	'the forest is'
tlakom	[k]	'pressure InsSg.'	tlak je	[g]	'the pressure is'

Consequently, it seems that the notion of alternating environment requires further refinement, as to reflect the gradient nature of derived environment effects.

7. Summary.

There seems to exist a systematic distinction between processes which apply across-the-board and those which are limited to the derived environment, yet OT has not developed a systematic approach to derived environments effects. The solution in terms of the universal ranking of Stem-Faithfulness over general Faithfulness proposed by Pater (1999) cannot apply to Polish data because it does not explain why some stem consonants (stem-final) do alternate whereas some others (stem-internal) do not. The solution offered by Łubowicz (1998) in terms of conjunction of constraints with Anchor, basically relying on the relationship between the palatalization and morpheme and syllable edges, does not account for two sets of data. First, it does not cover the palatalization without the surface trigger. Second, it makes wrong predictions for morpheme-internal palatalization, which in earlier approaches has been regarded as the second case of derived environment, cf. the definition in (1), with the trigger derived not from the concatenation of morphemes but from the prior application of another rule.

The new proposal in terms of the alternating environment does not refer to derivation but instead refers to simple surface regularities. The solution is practically theory-independent because it does not rely on any OT-internal concepts, thus, it can be easily adopted in any output-oriented phonological theory. It is argued that a derived environment is actually an alternating environment, defined as the sequence which is not uniform throughout the paradigm. The prediction is that the two cases of derived environment, i.e. those which involve a morphological boundary, and those which are triggered by segments violating faithfulness, can be treated the same way. This seems to be a desired effect with respect to the Polish data.

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