Deriving the Derived Environment Constraint in non-derivational phonology*

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Gregory K. Iverson. 2004. Deriving the Derived Environment Constraint in non-derivational phonology. *Studies in Phonetics, Phonology and Morphology*. 10.1. 1–21. A challenge to optimality theory has been to find motivated mechanisms that will impose general grammatical limitations equivalent to those uncovered in derivational frameworks. Proponents of optimality theory have struggled in particular to accommodate predictions of the Derived Environment Constraint (Kiparsky 1973), a widely tested principle that is shown here to play a key role in the staged development of contrasts in second language phonology. The paper concludes that the most straightforward implementation of the Derived Environment Constraint within optimality theory is the approach of Y. Cho (2002), which is to introduce a top-ranked "Lexical Faithfulness" constraint (FAITH-LEX) to the effect that optimal candidates may deviate from their input representations just in case these are not also lexical representations. Yet without explicit incorporation of the notion of contrast to limit FAITH-LEX to structure-preserving domains, the optimality theory rendition of the Derived Environment Constraint remains empirically inadequate. A solution lies in the "No Specification" (*SPEC) proposal for lexicon optimization recently advanced by J. Kim (2002): Redundant features must be absent in the underlying representation. **(University of Wisconsin-Milwaukee)**

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1. Background

At the University of Wisconsin–Milwaukee over the past few years, Fred Eckman and I have conducted a number of short studies bearing on similarity and difference in interlanguage phonology. In this paper I will review one of the key findings from this work, which is that the Derived Environment Constraint (Kiparsky 1973a, 1982) explains a particular staging sequence in the acquisition of second language phonology. I will then describe some of the ways in which this staging might be explained within the framework of optimality theory, focusing on some new findings in the analysis of Korean palatalization. I will suggest that a workable alternative to the current constraints-only description of phonological patterning is a model in which general limitations are placed on the operation and function of phonological instructions, i.e., a model

* Portions of this paper are adapted from Eckman, Elreyes & Iverson (2001, 2003).

of rules motivated and governed by constraints. Within the optimality theory paradigm, however, the alternative which most closely approximates the successes of the derivational approach is the lexical faithfulness proposal of Y. Cho (2002), although this still needs to be tempered by the familiar notion of contrast, i.e., the distinction between structure-building and structure-preserving phonological functions.

Proceeding from the point of view that the role of phonological constructs relating to phonemic contrast is crucial to the explanation of interlanguage sound substitutions, Eckman and I investigated the kind of substitution phenomenon which in the literature has been termed ALLOPHONIC SPLIT, viz., the phonemicization of two sounds that are allophones of one phoneme in the native language but which represent separate phonemes in the target language. The result of this kind of conflict between the native and target systems, we have found, is a tiered stage of learning in which speakers exhibit control over the contrast first in basic environments, but only later in relevant intermorphemic contexts, as summarized in (1):

(1) Allophonic Split
If sounds which are allophones of one phoneme in a learner's native language correspond to separate phonemes in the target language, then in positions where the target sound conflicts with the native language pattern, the contrast will be acquired in tautomorphemic contexts before it is in heteromorphemic contexts.

The task of the learner here, then, is to split native language allophones into separate target language phonemes, as confronts native speakers of Korean, for example, acquiring the English contrast between alveolar /s/ and postalveolar /š/. In Korean, [s] and [š] are allophones of the same phoneme, because [š] occurs only before the vowel [i] (or the palatal glide [y]), [s] in other syllable-initial environments. In English, these sounds are not in complementary distribution except before /r/, where only [š] occurs (*shrimp, *srimp*), and, for many speakers, before /l/ (*slip, *shlip*) and the nasals (*snip, *shnip; small, *shmall*), where only [s] occurs, as is the case before stops as well (*spit, *shpit*); but before vowels [s] and [š] stand in contrast (*sea, she; so, show*, etc.). Hence a Korean speaker learning English must learn to factor the Korean prevocalic allophones [s] and [š] into the separate English phonemes /s/ and /š/. What Eckman and I found is that the particular acquisitional staging that splits native language allophones into target language phonemes can be explained by a principle that grew out of the theory of lexical phonology and morphology (and its antecedents) and which seems to have a firm

basis in language learning, viz., the Derived Environment Constraint listed in (2).

(2) Derived Environment Constraint
Structure-preserving obligatory rule applications are restricted to derived environments.

This principle presupposes that phonological rules—or constraints, too, for that matter, under the optimality-theoretic assumption of "harmonic serialism" (McCarthy 2000)—fall into two groups: those that result in segments which are found in the phonemic inventory (structures which already exist in the lexicon), and those that result in novel segments which are not part of the phonemic inventory of the language. The former type is called "structure-preserving" because it engenders substitutions among existing structures rather than create new ones. In primary languages, this kind of rule has been found to apply only to "derived" forms, to words whose relevant portions have been modified by other rules or which are built-up out of separate morphemes. Rules which produce segments that are not part of the phonemic inventory, on the other hand, do not require the forms to which they apply to be derived or morphologically composite in any relevant way, and so apply "across-the-board", within as well as between morphemes. As generalized here, the Derived Environment Constraint, which grew out of the pioneering work of Kiparsky (1973a) and the earlier Revised Alternation Condition, is, I think, one of the chief discoveries in modern formal phonology.

To reiterate, the Derived Environment Constraint holds that structure preserving or lexical rules may apply only to configurations that are crucially derived, as through a process of affixation.[1] One of the most frequently cited examples of a rule evincing Derived Environment Constraint effects, illustrating with a familiar example, is Trisyllabic Laxing in English, so named because it has the effect of making a stressed vowel short, or lax, if it is in the third syllable from the right end of the word. This rule accounts for well-known alternations in vowels such as those in

[1] Based on the analysis of primary language data relating to rules with lexical as well as postlexical functions, Iverson (1992, 1993) makes the more general case that not only are lexical rules constrained to apply just in derived environments, as in conventional lexical phonology, but so are the applications of all structure preserving rules, whether functioning lexically or postlexically. The effect of this narrower limitation, which is adopted here as the operative version of the Derived Environment Constraint, is that obligatory neutralizing rule applications in any part of the grammar may not affect basic lexical items—were they to do so, recovery of the underlying structure of the morpheme would be confounded, as was argued so persistently during the "abstractness controversy" of the 1970's.

the word pairs listed in (3).

(3) s[eɪ]ne s[æ]nity
div[aɪ]ne div[ɪ]nity

The stressed vowel in each of the unsuffixed words in (3) is tense, but is pronounced as lax when the word it is in consists of a stem followed by the two-vowel suffix *-ity*. The word in (4a), on the other hand, exemplifies that the rule applies only in so-called derived environments (when an affix has been appended, not when the word itself consists of just the stem), and the word in (4b) exemplifies that only particular suffixes (*-ity* but not *-able*) will trigger Trisyllabic Laxing.

(4) a. n[aɪ]ghtingale *n[ɪ]ghtingale
b. n[oʊ]table *n[ɔ]table

The core idea behind the Derived Environment Constraint is thus that obligatory structure-preserving operations are restricted to apply only to configurations that are derived through processes of affixation or word formation, or the application of another rule, but they may not affect basic lexical entries. If such rules were to apply to unmodified lexical items without affixes, there would be no trace left in terms of crucial alternations which support the recovery of underlying representations. For example, if the neutralizing Trisyllabic Laxing rule in English were to apply in nonderived contexts, i.e., within single-meaning structures like *nightingale*, there would be no basis for recovery of the fact that the first vowel in this word is tense /i/ (> [aɪ]), not lax /ɪ/, since the form would always be pronounced with the incorrect lax vowel. The Derived Environment Constraint, then, is fundamentally a condition on the recoverability, or learnability, of words and their parts: applying neutralizing rules to nonderived forms would make the lexical representation essentially unlearnable because there would be no alternations from which the learner could acquire the phonemic representation.

To relate this point to the acquisition of second languages: in a learning situation in which the native grammar affiliates segments as allophones of one phoneme which are distinguished as members of different phonemes in the target language, extension of the native language rule relating these allophones into the learner's interlanguage does not result in any change in the rule's allophonic status for a speaker who has not yet acquired the target language contrast. That is, the interlanguage rule still is not structure-preserving for a learner at this early stage, and so will continue to apply in basic as well as derived environments in the interlanguage,

with the learner erring across-the-board on target language words that exhibit the contrast. A first-stage Korean learner of English thus would be predicted to err consistently on target language words containing a /si/ sequence, pronouncing *receive* as [rəšiv] and the words *messy* and *meshy* both as [mɛši].

Once the learner begins to acquire the target language contrast, however, the status of the native language rule becomes structure-preserving in the interlanguage grammar, and thus subject to the Derived Environment Constraint, because the rule now substitutes one phoneme for another rather than merely specifying allophones. This means that the rule now may no longer apply in all contexts, but rather is restricted to derived environments, i.e., across a morpheme boundary. At some later point, of course, the rule can be expected to be eliminated from the interlanguage altogether as the learner's speech becomes more and more target-like. The predicted stages of acquisition for a Korean speaker learning the English contrast between alveolar /s/ and postalveolar /š/ are as laid out in (5):

(5) Stage I, NO CONTRAST: The learner does not make the target language contrast at all, applying the native language rule in both derived and basic contexts (a Korean learner pronounces the pairs *sea–she* and *messing–meshing* homophonously, as [ši] and [mɛšɪŋ];
Stage II, PARTIAL CONTRAST: The learner makes the contrast in some words, applying the native rule only in derived contexts (a Korean learner pronounces *sea–she* correctly but errs by producing *messing–meshing* homophonously);
Stage III, CONTRAST: The learner makes the contrast in all word types, applying the native rule in neither derived nor basic contexts (a Korean learner says the pairs *sea–she* and *messing–meshing* correctly);
Excluded: The learner makes the contrast in some words, applying the native rule only in basic contexts (a Korean learner says the pair *sea–she* homophonously, but says *messing–meshing* correctly).

2. An interlanguage study

Eckman and I conducted a cross-sectional study testing for the existence of the three stages predicted in (5) and the absence of the excluded stage.[2]

[2] We also conducted a longitudinal study to test the two training implications of the hypothesis, predicting that a learner who is taught to make a split between native language allophones only in a derived environment will generalize this learning to the basic environment, but a learner who is trained to make the contrast in a basic context

For this hypothesis to be supported, we needed to be able to attest only three kinds of behavior among learners: (i) those who make the relevant contrast (between [s] and [š] for Korean speakers) in both basic and derived contexts, (ii) those who make the contrast in basic environments but who may not make it in derived environments, and (iii) those who have not (yet) acquired the contrast in either context. We should not have been able to find, according to the hypothesis, a learner who makes the contrast in derived environments but lacks it in basic words.

We elicited pronunciations of English words from sixteen English as a Second Language learners, seven of whom were native speakers of Korean. The subjects were given directions and examples for an exercise designed to elicit English words exhibiting the contrast being investigated in both a derived and a basic environment. Words exhibiting the contrast in a basic environment were monomorphemic lexical items, whereas words exhibiting the contrast in a derived environment contained a suffix, either the progressive "ing" or the adjectival ending "y". The exercise was constructed so that the pictures contained a cue indicating which of the two suffixes was to be added to the word being pictured (this avoided any spelling influences as well). For example, if the subject was shown a picture of some grass on one page, and a definition of grass on the facing page, the subject was to produce the word *grass*. If the picture and definition presented to the subject also contained the cue "adjective" on the page below the picture and the definition, then the subject was to produce the adjectival form of *grass*, namely, *grassy*. So the subjects produced two kinds of baseline words: those containing the sounds in question in a basic context, without a suffix, and those with the sound in a derived context, with the addition of a suffix.

All seven of the Korean subjects achieved accuracy of 80% or better over the contrast between /s/ and /š/ in basic contexts, thus meeting, in this environment, the performance criterion we established for having acquired the contrast. Three of the Koreans were Stage III learners who evinced the contrast in both derived and basic environments, whereas the other four showed the contrast only in basic contexts during the initial baseline measures, but shortly thereafter evidenced it in derived environments, too.

In sum, the results from the cross-sectional study depict interlanguage grammars that are at either Stage II, having the relevant contrast in only basic environments, or Stage III, evincing the contrast in both derived and basic contexts. None of the interlanguage grammars we analyzed showed

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will not necessarily extend it to derived environments. Results (confirming the hypothesis) are reported in Eckman, Iverson & Alreyes (2001, 2003).

the contrast only in derived environments. The results therefore confirm the staging laid out in (5), which in turn showcases the role played by the Derived Environment Constraint in the acquisition of second language phonemic contrasts.

3. Implications

The pattern of sound substitutions in second language acquisition reviewed here indicates that target language contrasts between sounds which are allophones of a single phoneme in the native language are incorporated into interlanguages progressively, not at once, following a path laid out by consideration of the Derived Environment Constraint. As expressed in (2), this modernized version of the Revised Alternation Condition (Kiparsky 1993, Iverson 1987, 1993) is a chief player to determine staging in the acquisition of second language phonemic contrasts. Phonology now has come to be widely construed as a "constraint" rather than "rule" based enterprise, however, and thus it is instructive to see how the learnability and derived environment effects uncovered here in second language acquisition would be expressed in optimality theory. Efforts persist up to the present to integrate the predictions of the Derived Environment Constraint into this framework, which is based on hierarchically interacting constraints (in tableaux) rather than sequentially structured rules (in derivations). A general challenge to monostratal optimality theory, in fact, has been to find mechanisms that implement equivalent limitations to those established in the derivational framework of the theory of lexical phonology and morphology (Kiparsky 1982, 1985).[3] With respect to the Derived Environment Constraint, proposals to do this have ranged from stipulated feature underspecification (Inkelas 1998, reprising Kiparsky 1993) and arbitrary "constraint conjunction" (Łubowicz 2002) to a suggestion by Y. Cho (2002) reintroducing the "lexical redundancy rule" formulated by Kiparsky (1982) (cf. also Anttila & Cho 1999 and Burzio 2000). Proponents of optimality theory have thus struggled repeatedly to accommodate the predictions of the Derived Environment Constraint, which has been taken at face value here in a derivationally oriented discussion of staged learning in second language phonology.

Optimality theory, as is now cliché, rests on a series of ranked, violable constraints whose interaction leads to the selection of the "optimal"

[3] Kiparsky (2000) shows what a multi-tiered of leveled form of optimality theory would be like, reintroducing morphological and phonological strata familiar from the theory of lexical phonology, and from which this serial model of optimality theory then differs rather little.

candidate from among an open set of possible realizations of the underlying representation. This familiar model is sharply challenged by derivational properties which are theoretically unavailable to it, "opacity" in particular. A variety of fixes, in addition to "sympathy theory" (cf. Itô & Mester 1999, 2001 on German [ç] ~ [x] alternations, described rather differently by Iverson & Salmons 1993), have been put forward in order to accommodate this kind of interaction, i.e., the superficial contradiction of one grammatical statement via the invocation of another. The credibility of these modifications to the theory still awaits assessment, but it is clear that derived environment effects are quite beyond the capacity of classical optimal theory to capture. One proposal to bring this major finding of modern phonological inquiry into the fold of optimality has been developed by Łubowicz (2002).

Łubowicz reviews the (first) palatalization of velars in Polish, noting that palatalization takes place in morphologically derived environments (/xemik + ek/ → [xemiček] 'chemist'-diminutive) but not in morpheme internal contexts ([k'isiel] 'jelly'). This classic derived environment effect cannot be characterized within conventional optimality theory. Łubowicz (2002:256) writes:

(6) "There are two ways to approach the data, but neither is successful. We could rank [the palatalization markedness constraint] PAL above [the feature faithfulness constraint] 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."

Łubowicz proposes to solve this problem by providing optimality theory with the descriptive equivalent of a derived environment effect in morphologically composite environments via the mechanism of "local conjunction". This device marries a markedness constraint, such as PAL, with a faithfulness constraint, in this case the correspondence constraint guarding stem:syllable anchoring. The idea behind stem:syllable anchoring is that the edge segments of a morphological stem should "align with" the edges of its syllables. And there typically is a violation of stem: syllable anchoring when a palatalization-inducing vowel is appended as a suffix to a consonant-final stem, because the (restructured) syllable edge no longer lines up with the edge of the stem. This violation can be exploited, Łubowicz argues, to capture the morphological derived environment effect if the stem:syllable anchoring constraint is conjoined with the palatalization constraint (within a local domain D). The right-

anchoring correspondence constraint is as in (7); locally conjoined with palatalization, its ranking relative to the others is as in (8).

(7) 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.

(8) $[\text{PAL} \,\&\, \text{R-ANCHOR(Stem;}\sigma\text{)}]_{\text{D}}$ >> IDENT(coronal) >> PAL

The theory then provides for the special interpretation that a violation of stem:syllable anchoring will activate its local conjunct, viz., palatalization. When anchoring is not violated, palatalization is not activated, remaining subordinate to the identity faithfulness constraint. But in morphologically derived contexts, stem:syllable anchoring is violated (with different syllabic affiliation at the juncture between morphemes than internally), triggering the locally conjoined markedness constraint, PAL. The reason that palatalization does not take place in tautomorphemic environments, then, is because no violation of anchoring occurs to trigger the markedenss constraint PAL, i.e., morpheme-internal syllable structure is lexically faithful.

This arrangement is not quite the same as to invoke the Derived Environment Constraint, however. Apart from the technicalities of local conjunction and just how the violation of a correspondence constraint is construed to activate a markedness constraint, the chief difference between the two approaches is that the specification of local conjunction is a language-specific matter, whereas the Derived Environment Constraint is understood to hold for all cases in all languages, without being specified for any individual grammar. This is a very substantial difference, of course.

Still, it might be useful to see how this modification of optimality theory would attempt to accommodate the staging of second language phonological learning laid out in (5) for Korean learners of English. Assuming a markedness constraint PAL militating against sequences of /si/, it is clear that PAL must be ranked superior to IDENT(anterior) (an identity faithfulness constraint calling for anterior segments to be realized as anterior), because in Korean /s/ palatalizes before /i/ both within and between morphemes, i.e., across-the-board. This is the ranking given in (9).

(9) PAL >> IDENT(anterior)
(Stage I: *sea* = *she* [ši], *messing* = *meshing* [mɛšɪŋ])

Presumably this would be the ranking of constraints which Stage I

learners of English convey to their interlanguage grammars, producing the pairs *sea–she* as [ši] and *messing–meshing* as [mɛšɪŋ], in which the pressure to have coronals be palatalized preceding the vowel /i/ is greater than that calling for anterior segments to be true to their base anteriority. Stage III speakers, however, would have learned to suppress palatalization altogether, yielding the reverse ranking in (10) and so producing the fricatives in *sea–she* and *messing–meshing* much as they are in the English target language.

(10) IDENT(anterior) >> PAL
(Stage III: *sea* ≠ *she, messing* ≠ *meshing*)

Stage II learners, by contrast, evince a derived environment effect with respect to interlanguage palatalization. They pronounce the pair *sea–she* correctly, but continue to palatalize in *messing,* merging it with *meshing*. For speakers at this stage of learning, the local conjunction version of optimality theory would arrange constraints as in (11).

(11) $[\text{PAL} \,\&\, \text{R-ANCHOR(Stem;}\sigma)]_{D}$ >> IDENT(anterior) >> PAL
(Stage II: sea ≠ she, messing = meshing [mɛšɪŋ])

This would operate analogously to Polish, then, in the manner Łubowicz describes. The question, though, is by what mechanism of learning did Stage II learners acquire the locally conjoined palatalization/ anchoring constraint? Merely listening to the ambient input of native speakers is not sufficient to motivate it, for native speakers of English don't palatalize /s/ either in *sea* or *messing*. Nor is there any sense in which (11) represents a generalization or simplification of the native language pattern of constraints as expressed in (10) — rather, it is a complication, with repeated specification of the markdeness constraint PAL, once before the faithfulness constraint IDENT(anterior) and once after it.

Indeed, the issue is even more complex when one takes into account that Korean also palatalizes coronal stops before /i/ in the next morpheme (Iverson 1993). But this is a neutralizing process in the language and for that apparent reason is restricted to derived environments, as the phonemic stop–affricate distributions in (12a-c) exemplify in comparison with the allophonic fricative pattern of (12d).

(12) a. /tat-/ 'close' [tat˺t'a] (indic.) [tǎji] (noun)
/tot-/ 'rise' [tot˺t'a] (indic.) [tǒji] (noun)
/pat^{h}-/ 'field' [pat^{h}ɯl] (obj.) [pač^{h}i] (subj.)

b.	[madi]	‘knot’ (< /mati/)		c.	[čipˀ]	‘house’	
	[pət^{h}i]	‘endure’			[č’ǐjə]	‘tear’	(imp.)
	[t^{h}i]	‘dust’			[čǐjə]	‘bark’	(imp.)
d.	/os-/	‘cloth’	[os~~ɨ~~l] (obj.)		[oši]	(subj.)	
	[ši]	‘poem’	*[si]				
	[šikan]	‘time’	*[sikan]				
	[š’i]	‘seed’	*[s’i]				

It thus turns out that the ranking of optimality theoretic constraints in (11) actually would be appropriate for Korean, but only for the cases in which the effect of palatalization is neutralizing. For all other cases, i.e., when it is allophonic, the requisite configuration would have to be as in (9), and it is far from obvious how a constraint grammar could accommodate this distinction, with ranking one way in cases where the effect is allophonic, but with superordinate local conjunction of a correspondence constraint and a suppressed markedness constraint in cases where the effect is neutralizing.[4] The derivational approach, on the other hand, takes note of the universality of the Derived Environment Constraint given in (2), and recognizes but one palatalization process whose varying restricted and across-the-board effects are predicted by the principle, not stipulated via multiple rankings which in any event would have to be sensitive to the neutralizing versus allophonic character of their outputs.

This difference in function between the neutralizing and allophonic aspects of Korean palatalization has formed the basis of argumentation for separating them into independent (usually lexical versus postlexical) statements (e.g., Ahn 1998, Y. Cho 2002).[5] Ceteris paribus, of course, it is

[4] McCarthy (2002) draws a distinction in optimality theory between “Old” and “New” markedness constraints, which are identical except that Old holds over the input representation (actually, the “fully faithful candidate”) and New holds over other candidates in the set. Thus, for every markedness function, like PAL, there are two constraints available for ranked interaction with other constraints, $_{O}$PAL and $_{N}$PAL. Each of these, moreover, combines with both Input-Output and Output-Output faithfulness (or correspondence) constraints, so that there are actually four distinct forms of palatalization under this approach, known as comparative markedness: IO–$_{O}$PAL, IO–$_{N}$PAL, OO–$_{O}$PAL, OO–$_{N}$PAL. With four versions of palatalization available for varied constraint interaction, McCarthy (2002:21-24) shows that optimality theory as modified by comparative markedness can indeed accommodate the derived environment effect which is evident in the palatalization of Korean /t/ (analogously, in that of Polish /k/, etc.) without recourse to constraint conjunction, albeit at the price of quadrupling the inventory of markedness constraints. But even at that, the second language acquisition staging identified here for Korean learners of English vis-à-vis /s/ and /š/ remains as curious under the comparative markedness approach as it does under constraint conjunction.

[5] H. Kim (2001) has recently argued that t-palatalization in Korean is actually not

preferred that a unified generalization hold over all forms of coronal palatalization in the language, with segmental differences in function attributed to universal rather than language-specific limitations (viz., to the Derived Environment Constraint, as per Iverson 1993, Iverson & Wheeler 1998). Quite aside from this methodological point, surprisingly, a notable Derived Environment Constraint effect has recently been shown to obtain outside the domain of phonology per se, in speech production, a discovery which lends further support to the unified view of palatalization. Using electro-magnetic midsagittal articulography (EMA) and electro-palatography (EPG), T. Cho (1999, 2001) has found that Korean palatalization affecting /ti/ and /ni/ sequences evinces more variability in gestural timing when the sequences are heterormorphemic than when they are tautomorphemic, irrespective of structure preservation. That is, the coarticulation of palatalization is on average "stronger" between morphemes, "weaker" within. Measuring the degree of gestural overlap between segments in sequences of /ti/ and /ni/, T. Cho tested for electrode contact by the tongue at the "Front-Region" (dental, alveolar and postalveolar areas combined), the "Pal-Region" (postalveolar subset of the Front-Region), and the "i-Region" (the area contacted by the tongue body in production of the high front vowel /i/). What he found was that, whether the process is allophonic (affecting /ti/ and /ni/ morpheme-internally and /n+i/ inter-morphemically) or neutralizing (affecting /t+i/ inter-morphemically), the articulatory extent of coronal palatalization is measurably less when taking place within morphemes than when occurring between them. Specifically, the degree of gestural overlap is "…smallest for tautomorphemic /ti/, intermediate for tautomorphemic /ni/, and greatest for heteromorphemic /n+i/ and /t+i/."[6]

T. Cho did not evaluate s-palatalization or l-palatalization in Korean, neither of which is neutralizing, but the variation he found in palatalization among obstruent and nasal stops can be summarized as in (13).

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palatalization at all, but rather simply affrication. On her view, the coronal stops (/t/ and /t^h/) remain alveolar as they affricate before /i/ (/c/ and /c^h/), rather than retracting to postalveolar position (/č/ and /$č^h$/). This is a controversial claim, certainly, though the extent of postalveolarization in Korean affricates is audibly less than the common characterization of them as alveopalatal would imply. If valid, however, Kim's claim would support the formal separation of neutralizing t-affrication from allophonic s-, n-, and l-palatalization, as suggested by Ahn, Y. Cho and others.

[6] In fact, the gestural overlap is so small for tautomorphemic /ti/ that T. Cho finds no palatalization at all in these sequences, even instrumentally (contra assertions of Kiparsky 1993, Y. Cho 2002).

(13) Weak (or no) coarticulatory palatalization of /t/ within morphemes (T. Cho 2001)
/ti/ > [ti] /mati/ > [madi] 'knot' (with predictable medial voicing)
Moderate coarticulatory palatalization of /n/ within morphemes (allophonic)
/ni/ > [n^{j}i] /pani/ > [pan^{j} i] 'proper noun (name)'
Strong palatalization of both /t/ (neutralizing) and /n/ (allophonic) between morphemes
/t+i/ > [či] /mat+i/ > [mǎji] 'the eldest' (with predictable medial voicing)
/n+i/ > [ɲi] /pan+i/ > [paɲi] 'class' (subj.)

As T. Cho concludes, the coarticulatory effect of a following high front vowel on a preceding /t/ in Korean is salient intermorphemically precisely because it results in neutralization with the affricate /č/, whereas its phonetic effect within morphemes is so slight as to be generally not worth reporting.[7] In short, the intramorphemic palatalization of /t/ is hardly noticeable, even instrumentally, but t-palatalization between morphemes is cognitively very prominent, both because it is more extensive and because of the phonemic neutralization that it results in. The surprise that T. Cho has uncovered is that n-palatalization also shows a stronger effect between as compared to within morphemes, even though n-palatalization is invariably allophonic (because there is no palatal nasal phoneme in Korean with which the output of palatalization could be merged). This parallel in phonetics to the phonological operation of the Derived Environment Constraint is important confirmation of the fundamental status of the principle, whose full manifestation is realized, and recognized, only in the domain of phonology per se. But its functioning now where basic versus derived morphological information has been thought to be fully irrelevant, in the phonetics, is ontologically supportive of the Derived Environment Constraint as a core principle of phonological theory.

The Derived Environment Constraint, it would seem, then, is ingenerate in mentally structured articulation irrespective of considerations of structure preservation, for trace effects of an intermorphemic bias are observable even among nonneutralizing functions; but the constraint blossoms up to phonological prominence precisely when inducing cognitively apparent substitutions, i.e., when merging phonemes. It is thus not only the case that structure preserving operations are restricted to derived environments, per (2), but the very process of composite

[7] Y. Cho (2002) ascribes a weak palatalized quality to the stop in tautomorphemic /ti/ and /t^{h}i/ sequences; but cf. the preceding footnote.

derivation appears to unleash the articulatory force of natural phonological operations, like palatalization, whose morpheme-internal application is inhibited by the apparent desirability of maintaining a phonologically stable lexicon. This stability is not threatened by the occurrence of a measurable degree of palatalization in tautomorphemic /ni/ (as it would be in tautomorphemic /ti/) because no merger with other lexical sequences results, there being no palatal nasal phoneme in Korean; yet palatalization is nonetheless less extensive in tautomorphemic /ni/ than in heteromorphemic /n+i/, a fact which points conspicuously to a nascent form of the Derived Environment Constraint limiting the degree to which even allophonic adjustments take place.

The other side of the Derived Environment Constraint coin, then, is that phonological processes are stronger and more extensive in inter-morphemic (derived) environments than in intramorphemic (basic) ones, irrespective of whether they are structure preserving. From the perspective of the phonology proper, phonological processes are inhibited entirely in basic environments when they are structure preserving. But even when they are creating rather than maintaining structure, it turns out that the phonetic extent of their effect is appreciably diminished in nonderived environments.

This finding of a derived environment effect phonetically as well as phonologically makes, in my view, the proposal by Y. Cho (2002) the best candidate for reflecting the Derived Environment Constraint within optimality theory. Her idea is basically to adapt into optimality theory the Lexical Identity Rule first formulated by Kiparsky (1982), which made of each lexical entry a "rule" of the form, /xyz/ → /xyz/. That is, the mere listing of an entry in the lexicon would be construed as a rule rewriting the entry as itself. The Lexical Identity Rule, then, being more specific in its formulation in each case than any general rule in the lexical component of the phonology, would fall into an inclusion relation superordinate to the general rule, which, by the familiar Elsewhere Condition (Kiparsky 1973b), would be prevented from applying. For example, the structure of the Lexical Identity Rule as it rewrites the morpheme *nightingale* (/nightingale/ /nightingale/) would properly include (be more specific than) the general rule of Trisyllabic Laxing, thus blocking its application. But as a sequence of morphemes like *divine + ity* would come about through word formation, and so not be listed in the lexicon, there would be no lexical redundancy rule of the form /divine+ity/ /divine+ity/, hence Trisyllabic Laxing is free to apply. In this way, the Derived Environment Constraint was itself made to be derived, a consequence of interaction between the Lexical Identity Rule and the Elsewhere Condition.

Within optimality theory, Y. Cho's approach is similar, namely, to introduce a top-ranked "Lexical Faithfulness" constraint (FAITH-LEX) to the effect that optimal candidates may deviate from their input representations just in case they are not also listed as lexical items. Basic lexical entries, in other words, are immune to subordinate markedness constraints (Y. Cho 2002):

(14) FAITH-LEX: Output candidates must not be distinct from corresponding lexical entries.

With FAITH-LEX in place at the top of the constraint hierarchy, an output candidate satisfying the markedness constraint of Trisyllabic Laxing for a lexical entry like /nightingale/ would be *n*[ɪ]*ghtingale*, with a lax vowel in the trisyllabic environment. But this incurs a fatal violation of the faithfulness of candidate /nightingale/ to lexical entry /nightingale/, and so the optimal candidate for realization of /nightingale/ is that which is most faithful to the lexical item, viz., /nightingale/ itself. With respect to a composite structure like /divine+ity/, however, FAITH-LEX—though still top-ranked—is not violated by a candidate with a lax vowel in the trisyllabic environment, because there is no lexical entry of the form *div*[ɪ]*nity* that the input /divine+ity/ needs to be faithful to. Working in much the same fashion as the Lexical Identity Rule did in the context of lexical phonology, then, the high ranking of the FAITH-LEX constraint serves to select as optimal monomorphemic candidates which are phonologically indistinguishable from their lexical forms, just as, in a traditional derivational model, the Derived Environment Constraint blocks the tautomorphemic application of structure preserving rules.

Though this proposal would appear just to translate the Derived Environment Constraint into an optimality theoretic special faithfulness statement, there remains the key difference that the Derived Environment Constraint is limited to structure preserving applications of obligatory rules. Without explicit incorporation of the notion of phonemic contrast to limit FAITH-LEX to structure-preserving domains, the optimality theory account makes no distinction between candidates which are lexically faithful to phonemic representation versus to phonetic representation, a distinction which conventional optimality theory expresses, if at all, on a case by case basis via varying constraint rankings.[8] In the derivational idiom, Korean palatalization blocks morpheme-internally when neutraliz-

[8] For example, [spread glottis] would outrank feature faithfulness in allophonic aspiration, whereas feature faithfulness would outrank [spread glottis] in phonemic aspiration, as per Kirchner (2002).

ing but applies (with varying intensity) across-the-board when allophonic; but in optimality theoretic terms, the top-ranked FAITH-LEX constraint will select the wrong candidate whenever the property the candidate is being faithful to is noncontrastive. For example, the correct candidate [pan^{j} i] for /pani/ 'proper noun (name)' is not optimal because it fatally violates FAITH-LEX: its moderately palatalized [n^{j}] is not identical to lexical plain /n/. One way out of this difficulty, pursued by Y. Cho, would be to factor neutralizing palatalization and allophonic palatalization into separate markedness constraints, placing the latter in dominance over FAITH-LEX so as to implement allophonic palatalization at the expense of faithfulness. Apart from repetition of the generalization that coronals are palatalized before /i/, however, such fragmentation of the PAL constraint is not very appealing in light of the subtle unity underlying it which T. Cho has recently uncovered, namely, that the effect of both neutralizing and allophonic palatalization is more extensive between morphemes than within, and that intramorphemically it is near zero when defined on a phonemic distinction.

Another way out of the difficulty that these distributions present for optimality theory, however, would be to retain palatalization as a unified markedness constraint (PAL) subordinate to FAITH-LEX, with the general understanding that lexical representations are not specified one way or the other for noncontrastive features. Then Korean /n/ is neither palatalized nor nonpalatalized in underlying form, but rather is neutral with respect to this predictable difference, just as the Korean lone liquid phoneme is not specified for either lateral or central properties underlyingly (Iverson & Sohn 1994). In contradistinction to the conventional "Richness of the Base" hypothesis in optimality theory, this is precisely the "No Specification" (*Spec) proposal for lexicon optimization recently articulated by J. Kim (2002:40):

(15) *SPEC: Redundant features must be absent in the underlying representation.

J. Kim's position, quite aside from consideration of any Derived Environment Constraint effects, is that the lexicon should be the repository only of idiosyncratic information, not predictable properties—a widely held assumption to which we subscribe here as well. That being the case, candidate [pan^{j} i] would not violate FAITH-LEX with respect to lexical representation /pani/ 'proper noun (name)', because underlying /n/ is neither plain nor palatal, but is simply neutral with respect to secondary articulation. Candidate [maǰi] would violate FAITH-LEX with respect to lexical representation /mati/ 'knot', however, because affricated and

unaffricated stops are different phonemes in Korean, and hence lexically distinguished, so the optimal candidate is one which remains truer to the lexical form, [madi]. Candidate [mǎji] is optimal for /mat + i/ 'the eldest', conversely, because it incurs a violation of neither of the top-ranked constraints, FAITH-LEX and *SPEC. In tableau form, the array of rankings and constraints takes the shape of (16), which presupposes a phonemic inventory of Korean that includes coronal stops in contrast with palatalized affricates, all other coronals (the fricatives /s/ and /s'/, a nasal and a liquid) being phonemically neutral between alveolar and postalveolar or palatalized articulation. That is, the Korean coronal phoneme inventory includes /t/ (anterior), /č/ (nonanterior), /n/ and /s/ (neutral with respect to anterior), but excludes palatal */n^j, ɲ, š/.

(16) Unified Korean palatalization assuming a redundancy-free lexicon and lexical faithfulness

Input	Output	*SPEC	FAITH-LEX	PAL	IDENT(ant)
/pani/ 'a name'	[pan^{j}i]				*
/pan^{j}i/	[pan^{j}i]	*!			
/pan+i/ 'class'	[paɲi]				*
/paɲ +i/	[paɲi]	*!			
/mati/ 'knot'	[mǎji]		*!		*
	[madi]			*	
/mat+i/ 'eldest'	[mǎji]				*
	[madi]			*!	

The ranking in (16) is also appropriate for Korean learners of English at stage I, as this represents the same system that governs Korean itself. Stage II learners, it will be recalled, have acquired the English contrast between /s/ and /š/, as in *sea* and *she*, but morpheme-finally they neutralize the contrast in favor of postalveolar /š/ whenever /i/ begins the next morpheme, as in *messing* = *meshing*. This too conforms to the constraint ranking in (16), as displayed in interlanguage tableau (17), because at the stage II level of learning the difference between [s] and [š] has been phonemicized, hence it is no longer a violation of *SPEC to include lexical representations with postalveolar /š/ contrasting with alveolar /s/. Per FAITH-LEX, optimal candidates must not be distinct from their input representations when these are also lexical items (hence [si] is optimal for *sea* /si/), but at the juncture between morphemes FAITH-LEX is not relevant (hence both *messing* and *meshing* have [š]). Stage III

learners, finally, have progressed to the English-like state in which the markedness constraint PAL has been subordinated to the feature faithfulness constraint IDENT(ant), the result of which is that the contrast between /s/ and /š/ before /i/ is now maintained between as well as within morphemes. Thus, the acquisition follows a natural progression triggered by phonemicization of native allophones toward the target norm, followed by target-like subordination of the interfering markedness constraint. Moreover, there is no possible ranking that results in the excluded stage (*sea = she* but *messing ≠ meshing*).

(17) (a) Stage I: As in Korean, [s] and [š] are allophones of /s/, and there is no phoneme /š/

Input	Output	*SPEC	FAITH-LEX	PAL	IDENT(ant)
/si/ (both) 'she' &	[ši]				*
/ši/ 'sea'	[ši]	*!			
/mɛs+ɪŋ/ 'meshing'&	[mɛšɪŋ]				*
/meš+ɪŋ/ 'messing'	[mɛšɪŋ]	*!			

(b) Stage II: [s] and [š] split into the separate phonemes /s/ and /š/

Input	Output	*SPEC	FAITH-LEX	PAL	IDENT(ant)
/si/ 'sea'	[si]			*	
	[ši]		*!		*
/ši/ 'she'	[si]		*!	*	*
	[ši]				
/mɛs+ɪŋ/	[mɛšɪŋ]				*
'messing'	[mɛšɪŋ]			*!	
/ mɛšɪŋ/	[mɛšɪŋ]				
'meshing'	[mɛšɪŋ]			*!	*

(c) Stage III: Markedness constraint PAL subordinates to feature faithfulness IDENT(ant)

Input	Output	*SPEC	FAITH-LEX	IDENT(ant)	PAL
/si/ 'sea'	[si]				*
	[ši]		*!	*	
/ši/ 'she'	[si]		*!	*	*
	[ši]				
/mɛs+ɪŋ/	[mɛšɪŋ]			*!	
'messing'	[mɛšɪŋ]				
/mɛšɪŋ/	[mɛšɪŋ]				
'meshing'	[mɛšɪŋ]			*!	*

This is a very conventional way of looking at the phonology, of course, making that most fundamental of distinctions between phonemes and allophones and calling for lexical representations to be devoid of phonemically redundant phonetic properties. But a shift down this well traveled path pays off nicely in capturing the phonological unity of Korean palatalization within the context of an optimality theory whose top co-ranked constraints are *SPEC and FAITH-LEX, two meta-constraints which together reprise the essence of the Derived Environment Constraint. Whether this approach advances the theory beyond a derivation-oriented model governed by universal limitations and principled generalizations, however, is still open to investigation.

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