The Locus of Exceptionality: Morpheme-Specific Phonology as Constraint Indexation*

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1. Introduction

Morphemes often behave differently phonologically in ways that cannot be explained purely phonologically: one morpheme undergoes or triggers a process while another morpheme fails to undergo or trigger that process, even though the two are in all relevant respects indistinguishable. Piro syncope (Matteson 1965, Kisseberth 1970, Lin 1997) provides an example of such morpheme-specific phonology. Morphemes differ in whether they cause the preceding vowel to delete (/heta+nu/ [hetanu] 'going to see' vs. /heta+lu/ [hetlu] 'see it'), and in whether they undergo deletion themselves (/meyi+wa+lu/[meyiwlu] 'celebration' vs. /heta+wa+lu/ [hetawalu] 'going to see him yet'). As the behavior of the homophonous pair of /-wa/ morphemes illustrates, morphemes that fail to condition syncope can differ in whether they undergo the process.

The distinction between exceptional triggering and blocking exemplified by Piro is captured straightforwardly in Optimality Theory (OT) if markedness and faithfulness constraints can be lexically indexed (Pater 2000). Morphemes that trigger a process are indexed for the application of a lexically specific markedness constraint, and morphemes that block a process are indexed for the application of a lexically specific faithfulness constraint. However, this distinction is not expressed in either of two alternative approaches to exceptionality in OT: a theory in which morphemes select constraint rankings (the cophonology approach; e.g. Anttila 2002, Inkelas and Zoll 2003), or a theory in which only faithfulness constraints can be lexically indexed (e.g. Fukuzawa 1999, Itô and Mester 1999, 2001). The second section of this paper shows how constraint

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indexation deals with the Piro data, and also provides a learnability account that uses inconsistency detection (Tesar 1998, Prince 2002) to trigger the creation of indexed constraints. This account of the genesis of constraint indexation resolves the apparent inconsistency of having morpheme-specific constraints in a theory that assumes constraint universality, and also ensures that learners will seek a phonological generalization before resorting to an analysis in terms of exceptionality.

Anttila (2002) uses data from Finnish /a+i/ allomorphy to argue for a version of the cophonology approach. In his theory, morphemes can only be specified for rankings that are left unspecified in a partially ordered grammar. In the third section of the paper, I show that the types of generalizations Anttila captures with this approach can in fact be straightforwardly analyzed with indexed constraints. In addition, I show that constraint indexation captures generalizations that escape the partial ordering theory of cophonologies: the localization of the alternation to a string that includes a portion of the exceptional morpheme, and distinctions between variation and exceptionality. I also use the Finnish data to illustrate a pattern of morpheme-specific phonology that escapes the faithfulness-only indexation theory: exceptional blocking of an alternation by a markedness constraint.

In the analysis of Finnish, I introduce a locality convention for the interpretation of indexed constraints: that they apply if and only if the locus of violation includes a phonological exponent of the indexed morpheme. This convention rules out a range of implausible cases of non-local morpheme-specific processes, such as a prefix triggering root-final consonant deletion in satisfaction of NoCoda. When this locality convention is applied to markedness constraints indexed for general morphological categories, it provides a straightforward analysis of morphological derived environment effects. In the fourth section of the paper, I show that a set of facts from Chumash discussed by Poser (1993) favor such a markedness based approach to derived environments.

Morpheme-specific constraints and morpheme-specific rankings are diacritic approaches to exceptionality. A long-standing alternative to diacritics is to differentiate morphemes using phonological structure (Chomsky and Halle 1968 use both approaches; see Inkelas, Orgun and Zoll 1997 for references to the subsequent literature, and development of the structural one in OT). The fifth section of the paper argues that learnability considerations favor morpheme-specific constraints as the default approach to exceptionality in OT.

2. Piro Syncope and Constraint Indexation

2.1 Morpheme-Specific Constraints and Morpheme-Specific Rankings

Morphologically indexed constraints make their first appearance in the foundational work in Optimality Theory. Prince and Smolensky (1993/2004) propose Edgemost constraints that apply to specific morphemes in order to distinguish prefixes, suffixes, and edge-oriented infixes from one another. McCarthy and Prince (1993) reformulate Edgemost constraints in terms of Generalized Alignment, which they also use for cases of prosodic subcategorization, in which a morpheme is placed next to an instance of a prosodic category. The schema for Generalized Alignment constraints appears in (1a). The categories Cat1 and Cat2 can be either prosodic or morphological categories. For Tagalog infixation, they propose the constraint in (1b), which requires the affix [um] to be at the left edge of the stem, thus capturing the left edge orientation of the infix. For Ulwa subcategorization, they propose the constraint in (1c), which requires the affix [ka] be realized at the right edge of the head foot (FT'). Since these constraints refer to specific morphemes rather than to general categories, they are instances of indexed constraints; see also Hammond's (1995) use of Alignment constraints to deal with exceptional stress patterns in Spanish.

(1) a. ALIGN(CAT1, EDGE1, CAT2, EDGE2)
b. ALIGN([UM]AF, L, STEM, L)
c. ALIGN([KA]AF, L, FT', R)

Alignment constraints are reformalized as Anchoring constraints in McCarthy and Prince (1995, 1999). These constraints demand that an input segment at the edge of a morpheme correspond to an output segment at the edge of a prosodic category. They are thus formally faithfulness constraints rather than markedness constraints; this distinction is of some import in the present context given claims that only faithfulness constraints can be indexed. In this connection, it is worth noting that it is not obvious how prosodic subcategorization constraints would be reformulated as Anchoring constraints.

Morpheme-specific rankings also appear in very early work in Optimality Theory. The first developed proposal is in Itô and Mester's (1995a, b) account of stratum-specific phonology in Japanese (see also Kirchner 1993). As in many other languages, there are phonotactic generalizations and alternations that hold only of particular sets of words in Japanese. For example, Yamato words undergo productive post-nasal voicing, while other words do not. Itô and Mester account for this by having different rankings of the markedness constraint forcing post-nasal voicing (*NT) and the faithfulness constraint blocking it (IDENT[VOICE] from McCarthy and Prince 1995, 1999) for Yamato and non-Yamato words:

(2)	Yamato ranking:	*NT >> IDENT[VOICE]
	Non-Yamato ranking:	IDENT[VOICE] >> *NT

On morpheme-specific rankings, sometimes termed cophonologies, see also Nouveau (1994), Orgun (1996), Inkelas (1999), Anttila (2002), Inkelas and Zoll (2003), Caballero (2005) and Zamma (2005).

As an alternative to cophonologies, Fukuzawa (1999), Itô and Mester (1999, 2001), Kraska-Szelenk (1997, 1999) and Pater (2000) extend morphological indexation from Alignment to other constraints. Under this view, a single constraint can be multiply instantiated in a constraint hierarchy, and each instantiation may be indexed to apply to particular set of lexical items. These indexed constraints are different from the 'parochial' morpheme-specific constraints in Hammond (1995) and Green (2005), in which morphemes directly demand the presence of some phonological structure (see Russell 1995 and Golston 1996 for related proposals). These parochial constraints are not markedness constraints, since they can demand marked structures, and they are not faithfulness constraints, since they apply directly to surface representations. As such, they wreak havoc with the predictions of factorial typology. By contrast, the indexed constraints discussed here are universal markedness or faithfulness constraints, whose application is relativized to a set of lexical items.

To take a simple hypothetical example, a language might have coda deletion (e.g. 3a,b), which is blocked in some lexical items (e.g. 3c):

(3) a. /pak/ → [pa] /pak+a/ → [paka]
b. /lot/ → [lo] /lot+a/ → [lota]
c. /tak/ → [tak] /tak+a/ → [taka]

Coda deletion requires a ranking of NOCODA >> MAX. The exceptional items are targeted by a morphologically indexed MAX constraint. This version of MAX (MAX-L) ranks above NOCODA, and applies only to those lexical items indexed for its application (here with an 'L' for 'lexical').

(4) Grammar: MAX-L >> NOCODA >> MAX
Lexicon: /pak/ /lot/ /tak_L/

The tableaux in (5) show the results of applying this grammar to a form that lacks the index (/pak/), and one that bears it (/tak_L/).

(5)

Input	Output	MAX-L	NOCODA	MAX
pak	pak		* !	
	☞ pa			*
tak_L	☞ tak		*	
	ta	* !		*

An important attribute of this approach to morpheme-specific phonology is that it captures the distinction between an exceptional form and an impossible one. Let us further assume that in our hypothetical language onset clusters are entirely absent. *COMPLEX ("no consonant clusters") would dominate MAX-L, since there is no evidence to contradict the preferred Markedness >> Faithfulness ranking (Smolensky 1996, Hayes 2004, Prince and Tesar 2004).[1] If under Richness of the Base (Prince and Smolensky 1993/2004) an underlying form with a cluster is given a lexical diacritic, the cluster is reduced, as shown in (6). This is not to say a language could not have both exceptional

[1] Since any conflict between lexically indexed markedness constraints and general markedness constraints will be observed in alternation, they will be ranked in the correct way by the constraint demotion algorithm; see further section 2.4.

codas and clusters, but rather that in the absence of evidence of a structure, a learner creates a grammar that rules it out completely.

(6)

Input	Output	*COMPLEX	MAX-L	NOCODA	MAX
CCV	CCV	* !			
	☞ CV				*
CCV_{L}	CCV	* !			
	☞ CV		*		*

In contrast, the distinction between exceptional and impossible patterns does not automatically fall out from the cophonology approach. If lexical items are specified for constraint rankings, then by Richness of the Base any constraint ranking should be available for lexical specification. Our hypothetical example could be analyzed with a ranking *COMPLEX, NOCODA >> MAX, with exceptional lexical items selecting the reverse ranking of MAX and NOCODA:

(7) Grammar: *COMPLEX, NOCODA >> MAX
Lexicon: /pak/ /lot/ /$\text{tak}_{\text{Max>>NoCoda}}$/

Input	Output	*COMPLEX	NOCODA	MAX
pak	pak		* !	
	☞ pa			*
Input	Output	*COMPLEX	MAX	NOCODA
$\text{tak}_{\text{Max>>NoCoda}}$	☞ tak			*
	ta		* !	

Nothing would rule out the specification of a lexical item for the reverse ranking of *COMPLEX and MAX, as illustrated in the following Richness of the Base tableau:

(8)

Input	Output	*COMPLEX	NOCODA	MAX
CCV	CCV			*
	☞ CV	*!		
Input	Output	MAX	NOCODA	*COMPLEX
$\text{CCV}_{\text{Max >>*Complex}}$	☞ CCV			*
	CV	* !		

To overcome this problem, Anttila (2002) extends the partial ordering theory of variation to morpheme-specific phonology. Under the Subregularity Interpretation (Anttila 2002: 22), only pairs of constraints that are unranked in the grammar can have lexically specified rankings. Our hypothetical language would have a ranking of *COMPLEX over MAX, and NOCODA and MAX would be left unranked. Lexical items are then specified for a ranking of the unranked constraints.

(9) Grammar: *COMPLEX >> NOCODA, MAX
Lexicon: /pak$_{\text{NoCoda>>Max}}$/ /lot$_{\text{NoCoda>>Max}}$/ /tak$_{\text{Max>>NoCoda}}$/

At first glance, this analysis seems to be a notational variant of the morpheme-specific constraint analysis. However, there are two differences that we can see even in this simple example. First, indexed constraints account for impossible patterns in the standard OT way: by using the grammar, constructed on the basis of positive evidence, to filter out a rich base. On the other hand, the partial ordering/cophonology theory adds a stipulation that lexical rankings can only fix unordered constraints. The second is that in the partial ordering theory, all lexical items must be specified for a ranking of the grammatically unranked constraints. If a lexical item were left unspecified, then it would show variation, with a ranking chosen randomly each time it is submitted to the grammar. Anttila (2002) presents this connection between variation and exceptionality as a positive attribute of the model, but there are clearly many cases of exceptionality without accompanying variation, and variation without exceptionality. This is evident in that in lexical phonology, variation is seen as a characteristic of post-lexical rules, and exceptionality of lexical rules (e.g. Kaisse and Shaw 1985). In sections 2.4 and 3.2, I will show that this conflation of variation and exceptionality leads to missed generalizations in the Piro data, and in the Finnish data Anttila (2002) analyzes.

Another difference between having morpheme-specific rankings and having morpheme-specific constraints is that only the latter can distinguish between a lexically indexed markedness constraint, which produces exceptional triggering of a process, and a lexically indexed faithfulness constraint, which produces exceptional blocking. This distinction is also unavailable to a theory in which only faithfulness constraints can be indexed. While Pater (2000), Ota (2004), Gelbart (2005) and Flack (to appear) allow for indexation of both markedness and faithfulness constraints, the general view seems to be that only faithfulness constraints can be indexed (e.g. Fukuzawa 1999, Itô and Mester 1999, 2001, Kraska-Szelenk 1997, 1999; see Benua 2000, Alderete 2001, Inkelas and Zoll 2003 for related discussion). In the next section, I show that the distinction between exceptional blocking and triggering is necessary to capture the facts of Piro syncope.

2.2 Piro and Morpheme-Specific Constraints

Kisseberth (1970) draws attention to Piro syncope, as described in Matteson (1965), for its implications for a theory of exceptions in rule-based phonology. Unless indicated otherwise, the examples here are ones Kisseberth supplies. The forms in (10) show syncope applying before the nominalizing suffixes /-lu/ and /-nu/ ([ru] in (10c) is an allomorph of /-lu/; /nu/ is used for abstract nouns as in (10d)), before the indirective suffix /-ya/ (10e), and before the third person singular pronominal suffix /-lu/ (10f).

(10) a.	/yimaka+lu/	[yimaklu]	‘teaching’
b.	/kama+lu/	[kamlu]	‘handicraft’
c.	/kakonu+lu/	[kakonru]	‘a shelter in which a hunter hides’
d.	/hata+nu/	[hatnu]	‘light, shining’

e.	/heta+ya/	[hetya]	‘see there’
f.	/heta+lu/	[hetlu]	‘see it’

As the examples in (11) illustrate, syncope fails to apply before the verbal theme formative /-ta/, the anticipatory suffix /-nu/, and the intransitive verb theme suffix /-wa/.

(11)	/meyi+ta/	[meyita]	‘to celebrate’
	/hata+ta/	[hatata]	‘to illuminate’
	/heta+nu/	[hetanu]	‘going to see’
	/meyi+wa+ta/	[meyiwata]	‘to celebrate’ (Matteson: 303)

All of the suffixes that fail to trigger syncope in (11) do undergo it when placed before one of the syncope-triggering suffixes, as the examples in (12) show.

(12)	/meyi+wa+lu/	[meyiwlu]	‘celebration’
	/heta+nu+lu/	[hetanru]	‘going to see him’
	/yona+ta+na+wa/	[yonatnawa]	‘to paint oneself’

However, there is a further ‘exceptional’ suffix /-wa/ (yet, still) which neither conditions syncope nor undergoes it:

(13)	/heta+wa+lu/	[hetawalu]	‘going to see him yet’
	/n+hiʃinika+wa+lu/	[nuʃinikawalu]	‘I’m still thinking about it’ (Matteson: 74)

There is no phonological property that distinguishes the morphemes that trigger syncope from those that do not: the homophones with the shape /-nu/ fall into the two classes. Similarly, morphemes that block syncope and those that do not have no distinguishing property, as clearly illustrated by the two morphemes /-wa/. There is also no apparent morphosyntactic distinction between the different classes of morpheme, and no restriction that triggers must appear closer to the root than non-triggers (or vice versa), as might be expected under an interpretation of the data in terms of lexical or prosodic phonology. In her grammar, Matteson (1965) treats the distinction between triggers and non-triggers as idiosyncratic.

To deal with the Piro data, Kisseberth (1970: 57) proposes a theory of exceptionality in which lexical items are categorized as “either undergoing a rule or not, and as either serving as the context for a rule or not” (see Zonneveld 1973 for further discussion). This distinction is expressed naturally in a version of OT with indexed markedness and faithfulness constraints.

As the constraint driving syncope, I will make use of an Alignment constraint requiring the left edge of a suffix to coincide with the right edge of a consonant (cf. Lin

1997).[2] Piro syncope does not seem to be driven by a STRESS-TO-WEIGHT constraint (see Gouskova 2003 on prosodically driven syncope); it also occurs before bisyllabic suffixes, in which case the resulting CVC would occupy a stressless syllable, given Piro's pattern of penultimate main stress and clash-avoiding secondary stress. The Alignment constraint appears in (14).

(14) ALIGN-SUF-C Align(Suffix, L, C, R)
The left edge of a suffix coincides with the right edge of a consonant

The ranking ALIGN-SUF-C >> MAX produces vowel deletion, as shown in the tableau in (15):

(15)

Input	Output	ALIGN-SUF-C	MAX
heta+ya	hetaya	* !	
	☞ hetya		*

To distinguish the suffixes that trigger syncope from the non-triggers, the suffixal argument of the ALIGN constraint that dominates MAX is indexed to the set of morphemes that trigger syncope. The general ALIGN constraint rests beneath MAX. The result is shown in (16), which includes in the lexicon all of the suffixes found in examples (10) – (13) above.

(16) Grammar: ALIGN-SUF(L)-C >> MAX >> ALIGN-SUF-C
Lexicon: /-lu_L/ /-nu_L/ /-lu_L/ /-ya_L/ /-ta/ /-nu/ /-wa/ /-wa/

Input	Output	ALIGN-SUF(L)-C	MAX	ALIGN-SUF-C
heta+ya_L	hetaya	* !		*
	☞ hetya		*	
heta+wa	☞ hetawa			*
	hetwa		* !	

Similarly, to distinguish the suffixes that undergo syncope from those that don't, MAX appears in both a lexically indexed and a general version. The lexically indexed version ranks above the indexed markedness constraint; the general one ranks beneath it. The index for MAX is given as 'L2', and for ALIGN as 'L1'.

[2] Lin's (1997) syncope constraint requires the stem to end in a consonant. Lin does not analyze the absence of syncope in unsuffixed stems, or with non-triggering suffixes. Under the locality condition discussed in section 2, the scope of the indexed constraint must include the triggering morpheme. One might also invoke an Alignment constraint that requires a suffix to follow a heavy syllable; Matteson (1965: 24) describes post-vocalic consonants as variably closing the preceding syllable (cf. Lin 1997: 425). However, in deference to Matteson's claim that pre-consonantal consonants are invariably syllabic, I retain the formulation in (14).

(17) Grammar: MAX-L2 >> ALIGN-SUF(L1)-C >> MAX >> ALIGN-SUF-C
Lexicon: /-lu$_{L1}$/ /-nu$_{L1}$/ /-ya$_{L1}$/ /-ta/ /-nu/ /-wa/ /-wa$_{L2}$/

Input	Output	MAX-L2	ALIGN-SUF(L1)-C	MAX
heta+nu+lu$_{L1}$	hetanulu		* !	
	☞ hetanru			*
heta+wa$_{L2}$+lu$_{L1}$	☞ hetawalu		*	
	hetawlu	* !		*

Syncope is also blocked when it would create a triconsonantal cluster (Matteson 1965: 36, Lin 1997), which indicates that a constraint against such clusters dominates the indexed alignment constraint. I will use the simple constraint *CCC for this purpose; see Lin (1997: 420) for an alternative formulation. The result of this ranking is shown in (18), with an example Matteson (1965: 36) glosses as “she washes it”.

(18)

Input	Output	*CCC	ALIGN-SUF(L1)-C
terka+lu$_{L1}$	terklu	* !	
	☞ terkalu		*

A hierarchy for Piro syncope that incorporates indexed markedness and faithfulness constraints is thus as in (19).

(19) *CCC, MAX-L2 >> ALIGN-SUF(L1)-C >> MAX >> ALIGN-SUF-C

This analysis distinguishes morpheme-specific triggering from morpheme-specific blocking, and also accounts for phonological blocking.

2.3 Constraint Indexation as Inconsistency Resolution

In this section I propose an account of creation of lexically indexed constraints in terms of inconsistency resolution, and show that it can handle the Piro case, in which both faithfulness and markedness constraints must be appropriately indexed (see also Winslow 2003 and Pater 2004 on indexation as inconsistency resolution, as well as Ota 2004 for discussion of Japanese postnasal voicing in similar terms). As Tesar *et al.* (2003) point out in the context of lexical stress, exceptions give rise to an inconsistent set of mark-data pairs (see Tesar 1998, Prince 2002, McCarthy 2004a, and Tesar and Prince 2004 for other applications of inconsistency detection).[3] Consider the mark-data pairs for the hypothetical language discussed in section 2.1.

[3] This is only necessarily true of exceptions to alternations. On exceptions to static phonotactics and constraint indexation, see Coetzee and Pater (2006), though cf. Inkelas *et al.* (1997).

(20)

Input	W ~ L	NoCoda	Max
pak	pa ~ pak	W	L
lok	lo ~ lok	W	L
tak	tak ~ ta	L	W

Mark-data pairs indicate whether the constraint prefers the optimal 'winner' (W), or a suboptimal competitor termed the 'loser' (L). In constructing a ranking, the constraint demotion algorithm (Tesar and Smolensky 1998) seeks constraints that prefer only winners. Given the Mark-Data pairs in (20), the constraint demotion algorithm will stall, since neither NoCoda nor Max prefers only winners.

What happens next? For lexical stress, Tesar *et al.* (2003) propose that the lexical representation is altered, the mark-data pairs are updated, and constraint demotion restarts. It is unlikely, however, that all instances of morpheme-specific alternation can be dealt with in terms of differences in lexical representation. And even in those cases in which a structural account is available, the search space of possible lexical changes is extremely large. Tesar *et al.* (2003) abstract from this problem by only considering changes in underlying stress, but if lexical "surgery" is disconnected from constraint ranking, it is not at all clear how the pattern of constraint violations can guide the change in underlying representation (see further section 5).

Here I suggest instead that when the constraint demotion algorithm can no longer find constraints that favor only winners, it seeks a constraint that favors only winners *for all instances of some morpheme*. It then ranks that constraint, indexed to all of the morphemes for which it favors only winners. In the simple case in (20), there are two such constraints: Max and NoCoda. It is perhaps inconsequential which is chosen, since an indexed version of either one will allow inconsistency to be resolved. If, however, it is taken as a goal to lexically index the smaller set of forms (i.e. the 'exceptional' ones), then a bias to a smaller set of indexed morphemes could be built in (see Winslow 2003, Pater 2004), thus choosing Max to be the indexed constraint, as in (3) above.

The Piro case is more interesting in that the correct choice between constraints must be made for each morpheme in order to get the right results. For example, the following data must lead to morpheme-specific Align for /-lu/ and morpheme-specific Max for /-wa/, and no marking for the other morphemes

(21)	/heta+lu/	[hetlu]	'see it'
	/heta+nu/	[hetanu]	'going to see'
	/heta+nu+lu/	[hetanru]	'going to see him'
	/heta+wa+lu/	[hetawalu]	'going to see him yet'

When learning commences, there are only unindexed versions of the constraints:

(22) Align-Suf-C, Max

In (23) we see that the mark-data pairs are inconsistent with one another. Here I abstract from the order in which the data are presented to the learner, and process of generating winner-loser pairs.[4] Alongside the W and L marks, the relevant morpheme is also indicated.

(23)

Input	W ~ L	MAX	ALIGN-SUF-C
heta+lu	hetlu ~ hetalu	L (heta)	W (lu)
heta+nu	hetanu ~ hetnu	W (heta)	L (nu)
heta+wa+lu	hetawalu ~ hetawlu	W (wa)	L (lu)
heta+nu+lu	hetanlu ~ hetanulu	L (nu)	W (lu)

A more explicit statement of the inconsistency resolution routine appears in (24).

(24) Clone a constraint that prefers only Ws in all instances of some morpheme, and index it to every morpheme for which it prefers only Ws

In the first step, we can only index MAX for /wa/ - MAX prefers Ls and Ws for /heta/, and ALIGN-SUF-C prefers Ls and Ws for /lu/.

(25)

Input	W ~ L	MAX	ALIGN-SUF-C	MAX-L1
heta+lu	hetlu ~ hetalu	L	W	
heta+nu	hetanu ~ hetnu	W	L	
heta+wa_{L1}+lu	hetawalu ~ hetawlu	W	L	W
heta+nu+lu	hetanlu ~ hetanulu	L	W	

Since MAX-L1 prefers only winners, it can be ranked. Mark-data pairs are eliminated when a constraint preferring the winner is installed; here we end up eliminating one pair:

(26) MAX-L1 >>

Input	W ~ L	MAX	ALIGN-SUF-C	MAX-L1
heta+lu	hetlu ~ hetalu	L	W	
heta+nu	hetanu ~ hetnu	W	L	
~~heta+wa_{L1}+lu~~	~~hetawalu ~ hetawlu~~	~~W~~	~~L~~	~~W~~
heta+nu+lu	hetanlu ~ hetanulu	L	W	

In the above set of mark-data pairs ALIGN-SUF-C now prefers only Ws for /lu/, so we clone and rank it, which eliminates all but one mark-data pair:

[4] It is possible that with an incomplete set of data, the wrong constraint could be cloned. This would likely cause no harm, since if the constraint turned out to contribute to, rather than resolve inconsistency, it would simply get ranked low in the hierarchy.

(27) MAX-L1 >> ALIGN-SUF(L2)-C

Input	W ~ L	MAX	ALIGN-SUF-C	MAX-L1	ALIGN-SUF-C-L2
~~heta+lu$_{L2}$~~	~~hetlu ~ hetalu~~	~~L~~	~~W~~		~~W~~
heta+nu	hetanu ~ hetnu	W	L		
~~heta+wa$_{L1}$+lu$_{L2}$~~	~~hetawalu ~ hetawlu~~	~~W~~	~~L~~	~~W~~	
~~heta+nu+lu$_{L2}$~~	~~hetanlu ~ hetanulu~~	~~L~~	~~W~~		~~W~~

This allows us to rank all of the constraints:

(28) MAX-L1 >> ALIGN-SUF-C-L2 >> MAX >> ALIGN-SUF-C

The ranking of the constraint *CCC will be established straightforwardly, given forms like /terkalu/ [terkalu] *[terklu], which show that *CCC dominates ALIGN-SUF-C:

(29)

Input	W ~ L	*CCC	ALIGN-SUF-C-L2
terka+lu$_{L2}$	terkalu ~ terklu	W	L

In fact, except for the special circumstances discussed in Lin (1997), from which I abstract here, *CCC is unviolated in Piro.[5] Thus, *CCC would be installed in the first step of the constraint demotion algorithm, since it prefers only winners, and the mark data pair in (29) would be immediately eliminated from consideration. The grammar constructed for Piro by the constraint demotion algorithm with inconsistency resolution would thus be as in (30).

(30) *CCC >> MAX-L1 >> ALIGN-SUF-C-L2 >> MAX >> ALIGN-SUF-C

The ranking of *CCC raises an important point. Given morphologically indexed faithfulness constraints, one might worry that the learner wouldn't bother with the phonological generalization at all. In the present case, why doesn't the learner just index /terka/ to MAX, and treat this as another morphological exception?[6] The answer lies in the way that the modified constraint demotion algorithm works. The constraint demotion algorithm seeks to deal with the data in terms of a constraint ranking. Only when inconsistency prevents this from happening are indexed constraints created. In the case of forms like /terkalu/, the mark-data pair in (29) will already have been eliminated from consideration by the ranking of *CCC before inconsistency resolution applies; the phonological explanation takes precedence over the lexical one.

[5] These special circumstances include an opaque interaction in which vowel deletion feeds consonant deletion and compensatory lengthening, as well as clusters incorporating a monoconsonantal affix.

[6] There seem to be no stems that exceptionally block syncope; /wa/ is apparently the only morpheme that does so. If this gap is non-accidental, one might relativize lexically indexed MAX to suffixes.

This learnability account of indexation also deals with another worry. The existence of morpheme-specific constraints is sometimes seen as incompatible with a theory in which constraints are universal (see e.g. Green 2005): is Tagalog ALIGN([UM]AF, L, STEM, L) present in all grammars? Inconsistency resolution provides an explicit resolution of this apparent theoretical inconsistency: morpheme-specific constraints are constructed from universal constraints in the course of learning.

2.4 Piro and Morpheme-Specific Rankings

An analysis of Piro in terms of morpheme-specific rankings would allow morphemes to select a ranking between the markedness constraint causing syncope and the faithfulness constraint blocking it. Under this approach, a morpheme causing syncope could be distinguished from one that does not as follows (compare 16):

(31)

Input	Output	ALIGN-SUF-C	MAX
heta+ya	hetaya	* !	
	☞ hetya		*
Input	Output	MAX	ALIGN-SUF-C
heta+wa	☞ hetawa	* !	
	Hetwa		*

One issue is the determination of the outcome with morphemes that demand opposite rankings of the constraints. In /heta+nu+lu/ [hetanru], for example, /-nu/ requires MAX >> ALIGN-SUF-C, while /-lu/ requires ALIGN-SUF-C >> MAX. However, given some kind of cyclic evaluation, which Lin (1997) argues is independently necessary for Piro, the outcome for /heta+nu/ could be calculated before, and independently of, the outcome for the entire string (see Orgun 1996 and Inkelas and Zoll 2005 on cyclicity and cophonologies). This is not a complete solution, since the syncope-producing constraint must also be limited to apply only to the environment of the outermost suffix of the complete /heta+nu+lu/ (perhaps using bracket erasure), but the problem does seem resolvable.

The more serious problem is how to distinguish the two forms of /wa/ noted by Kisseberth (1970) and discussed in section 2.2. Both suffixes fail to trigger syncope, which should indicate that MAX dominates the markedness constraint. The problem is that only one of the suffixes fails to undergo syncope: in constrast to the /-wa/ meaning 'yet, still' in [hetawalu], the intransitive verb theme suffix in /meyi+wa+lu/ does syncopate ([meyiwlu]). As it stands, the account predicts that both should block (or that both should undergo, if the following suffix determines the ranking, as in the cyclic account in the last paragraph). In other words, morpheme-specific ranking fails to distinguish morpheme-specific triggering from morpheme-specific blocking.[7] This is an

[7] It might be possible to distinguish the two /wa/ morphemes structurally, and to use morpheme-specific rankings to generate only morpheme-specific triggering. However, it can be counted as an

instance of a more general locality problem for morpheme-specific rankings: when morphemes impose a ranking on the grammar, they do not specify where in the string that ranking should apply. When /wa/ demands a ranking MAX >> ALIGN-SUF-C, it does not specify whether that ranking stops /wa/, the preceding syllable, or some other syllable from undergoing syncope.

It is in fact taken as a fundamental and distinguishing assumption of the cophonology program that phonological constraints should not be indexed for morphological context:

(32) "All constraints are fully general, but morphological class or lexical class are potentially associated with distinct rankings of those constraints" Inkelas and Zoll (2003: 1)

"The alternative [to indexed constraints - JP] is to keep phonological constraints purely phonological, but posit a range of distinct COPHONOLOGIES, that is, different constraint rankings for different morphological categories" Anttila (2002: 2)

As well as creating locality problems, this assumption also rules out one potential analysis of the Piro data in terms of cophonologies: that the Alignment constraint is specified to apply only to the triggering morphemes, and that only the blocking /wa/ demands the MAX >> ALIGN-SUF-C ranking. Anttila (2002: 2) explicitly lists alignment constraints as amongst the "interface constraints" that cophonologies replace.

Piro can also be used to illustrate the difficulties that morpheme-specific rankings have in distinguishing exceptional patterns from impossible ones. Under Richness of the Base, a lexical ranking ALIGN-SUF-C >> *CCC could be specified, thus creating syncope at the expense of forming a triconsonantal cluster. However, no morphemes display this more powerful form of syncope. The grammar in (33) would express this prohibition in Anttila's (2002) approach, so long as grammatically specified rankings cannot be overturned:

(33) *CCC >> ALIGN-SUF-C, MAX

However, this allows another unattested pattern: a morpheme that is unspecified for a ranking of ALIGN-SUF-C and MAX, and thus displays variation in whether it causes the preceding vowel to delete.

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advantage of morpheme-specific ranking that the abstract structural distinction is rendered unnecessary, especially since it is unclear how the learner would discover it (see section 5).

3. Finnish /a+i/ Allomorphy

3.1 Locality and *[ai]

Anttila (2002) presents a pair of morphologically conditioned alternations in Finnish as providing evidence for a choice of cophonology theory's morpheme-specific rankings over indexed constraints. In this section, I discuss the constraint that triggers these alternations, and show that constraint indexation allows for an analysis of the local nature of this and other cases of exceptional triggering. I also show that extant versions of cophonology theory and faithfulness-only indexation fail to capture such locality effects. Except where indicated, all of the data come from Anttila (2002), who based his study on an electronic version of a dictionary of Modern Finnish (Sadeniemi 1973).

The alternations affect a stem-final low vowel /-a/ that precedes one of two homophonous suffixes /-i-/, which indicate either past or plural. The /-a/ either deletes, or mutates to [o]. The examples in (34) show that the choice between the alternations is sometimes lexically determined; the stems are identical in all relevant phonological respects, yet one undergoes final vowel mutation (34a), one undergoes final vowel deletion (34b), and one varies between mutation and deletion (34c).

(34)	a. /tavara+i+ssa/	[tavaroissa]		'thing (plural-inessive)'
	b. /jumala+i+ssa/	[jumalissa]		'God (plural-inessive)'
	c. /itara+i+ssa/	[itaroissa] ~ [itarissa]		'stingy (plural-inessive)'

The alternations do not apply stem internally (35a), nor do they apply in all derived environments; (35b) is an example of non-application with the conditional suffix /-isi/ (Arto Anttila p.c.).

(35)	a. /taitta-i/	[taittoi] ~ [taitti] *[toittoi] *[titi]	'break (past)'
	b. /anta-isi/	[antaisi]	'give (conditional)'

Anttila's (2002) analysis focuses on the interplay between morphological and phonological conditioning in the choice between mutation and deletion, and does not include the constraint that drives the alternation. To penalize the [ai] sequence in the appropriate morphological context, we can index the relevant constraint to the plural and past tense morphemes. For expository ease, I will adopt the straightforward, but stipulative, *[ai] as the active constraint. The indexed version of the constraint ranks above MAX and IDENT, while the general version of it ranks beneath the faithfulness constraints:

(36) Grammar: $*[\text{ai}]_{\text{L}}$ >> MAX, IDENT >> *[ai]
Lexicon: $/\text{-i-}/_{\text{L}}$ $/\text{-i-}/_{\text{L}}$ /-isi-/ /taitta/

In the analysis of Piro, the indexed markedness constraint was an ALIGN constraint that provides an argument for the suffix. As such, the alignment constraint automatically specifies the context in which it applies. The following schema specifies how other indexed constraints assess violation marks:

(37) $*X_L$
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L

This formulation serves as a locality convention for indexed constraints: they apply if and only if the locus of violation contains some portion of the indexed morpheme. This also provides an explicit formulation of how a constraint indexed to a general morphological category applies: $*X_{SUFFIX}$, for example, would apply to all instances of X including an element of a suffix. Along these lines, the Finnish *[ai] constraint could also have been specified to apply to Plural and Past tense morphemes.

The following tableau shows how the ranking in (36) applies to /taitta-i/:

(38)

Input	Output	$*[ai]_L$	MAX	IDENT	*[ai]
/taitta-i_L/	taittai	* !			**
	☞ taitti		*		*
	☞ taittoi			*	*
	titti		** !		
	toitttoi			** !	

This ranking selects either deletion or mutation of the stem-final vowel as the optimal outcome (see Casali 1997 on constraints that block changes to the suffix-initial vowel). Because the indexed constraint does not apply to the root-internal [ai] sequence, the faithfulness constraints protect it. The next section shows how the choice between deletion and mutation is made for stems that allow only one outcome. But first, I will discuss the difficulties that morpheme-specific rankings and morpheme-specific faithfulness have with localizing the effect of the *[ai] constraint, and with the generally local nature of morpheme-specific phonology.

A morpheme-specific ranking analysis would allow /-i-/ and /-isi-/ to select different rankings of *[ai] and the faithfulness constraints:

(39) a. /-i-/ *[ai] >> MAX, IDENT
b. /-isi-/ MAX, IDENT >> *[ai]

A morpheme-specific faithfulness analysis would also leave the *[ai] constraint in its general form, but have faithfulness constraints indexed to morphemes that do not trigger the alternation:

(40) Grammar: MAX_L, IDENT_L >> *[ai] >> MAX, IDENT
Lexicon: /-i-/ /-i-/ /-isi-/$_L$

It is not clear, on either account, how to deal with a form like /taitta-i/, in which one /ai/ sequence undergoes the alternation, and the other one does not. In the morpheme-specific ranking analysis, we might put /taitta/ in the list of morphemes with the FAITH >> MARK ranking:

(41) a. /-i-/ *[ai] >> MAX, IDENT
b. /-isi-/ /taitta/ MAX, IDENT >> *[ai]

But which ranking should /taitta-i/ select? Either ranking will yield the wrong result: either both /ai/ sequences will surface, or neither will.

In the morpheme-specific faithfulness account, we could similarly index /taitta/ to the faithfulness constraints:

(42) Grammar: MAX_L, IDENT_L >> *[ai] >> MAX, IDENT
Lexicon: /-i-/ /-i-/ /-isi-/$_L$ /taitta/$_L$

The problem here is that this would protect both instances of /a/, rather than just the second one.

A possible solution for the Finnish case would be to relativize *[ai] to the derived context. With this constraint, which I will label *[a+i], analyses are available in either framework:

(43) a. /-i-/ /taitta/ *[a+i] >> MAX, IDENT
b. /-isi-/ MAX, IDENT >> *[a+i]

(44) Grammar: MAX_L, IDENT_L >> *[a+i] >> MAX, IDENT
Lexicon: /-i-/ /-i-/ /-isi-/$_L$ /taitta/

One issue with this approach is that it requires an additional theory of derived environment effects: with morpheme-specific constraints, these are captured by simply indexing a constraint to a general morphological category like 'AFFIX' (see further section 4). A bigger problem is that this solution does not address the general locality problem for morpheme-specific phonology (see Horwood 1999, Wolf this volume, for discussion of locality problems in the Antifaithfulness theory of Alderete 2001 and the Realize Morpheme theory of Kurisu 2001).

For the analyses of Finnish in (43) and (44) to be successful, a certain amount of non-locality must be countenanced. The morpheme /-isi-/ must demand higher faithfulness not for itself, but for the immediately adjacent segment, so that the stem-final /a/ neither mutates nor deletes. A similar scenario will obtain for any situation in which triggering morphemes must be distinguished from non-triggers, and the alternation takes place outside of the morpheme. Piro provides another such case, as would many instances of morpheme-specific assimilation and dissimilation (see Finley 2005 on assimilation). The problem is in defining how much non-locality is allowed.

If the ranking introduced by a morpheme holds over the entire string, clearly undesirable results follow (see also Horwood 1999). For example, a language could have a general ranking ONSET >> DEP, which produces epenthesis in vowel-initial stems. If a suffix could introduce a DEP >> ONSET ranking that holds over the entire string, then epenthesis would be blocked word-initially only in the presence of that suffix, as in (45), where /ba/ is the exceptional morpheme.

(45)	/amana/	[ʔamana]	/amana+da/	[ʔamanada]
	/amana+ba/	[amanaba]		

A legion of similarly implausible cases could be constructed; I leave this to the reader's imagination.[8]

A position between the extremes of the ranking holding only of the morpheme itself, and of the whole string, is that it holds of a string that contains some portion of that morpheme, as (37). But such a restriction is unstateable in a theory with only indexed faithfulness constraints, or with morpheme-specific rankings, especially given the positions on the absence of morphological information in phonological constraints cited in (32). In terms of an indexed faithfulness constraint, one might consider restricting its scope to the immediately adjacent segment, since this would capture the Finnish and Piro facts. However, not only would this be stipulative, but it would fail to deal with cases in which the alternation occurs further away from the morpheme, which would arise when a markedness constraint has a larger scope.

3.2 Morphological and Phonological Conditions on Repair Choice

Anttila (2002) shows that both morphological idiosyncrasy, and the phonological environment, can affect the choice of mutation or deletion as the repair for *[ai]. He uses the partial ordering/cophonology theory to analyze the interplay between morphological and phonological conditioning. Here I replicate a portion of Anttila's analysis with indexed constraints to show that they are capable of expressing these sorts of generalizations. I also provide an analysis of generalizations that can be captured with indexed constraints, but not under partial ordering/cophonology theory.

[8] Kiparsky (1993), Inkelas (2000) and Mascaró (2003) discuss several cases in which affixation has effects that are somewhat similar to (45); it leads to a change that is not phonologically conditioned by the affix, and occurs at a distance. In Catalan, which they all discuss, exceptions to unstressed vowel deletion are regularized in derivation (e.g. the exceptional unreduced [e] of [tótem] 'totem' is lost in [tutəmízmə]). As Kiparsky (1993) notes, this type of case can be characterized as the loss of exception features under derivation. Note that this is different in at least two ways from the hypothetical example in (45), in which derivation induces exceptionality, and only one morpheme introduces the exceptional alternation. Possible analyses for the Catalan type include an exceptionality analogue of bracket erasure, or indexation of faithfulness to a category that identifies the bare stem, but not the derived one. It does not seem that the full power of cophonology theory is needed (cf. Inkelas 2000), since this would also generate unattested cases like those in (45).

As mentioned in the last section, stems of the same phonological shape can show three patterns. They can either select mutation, deletion, or vary between the two. The examples are repeated in (46).

(46)	a. /tavara+i+ssa/	[tavaroissa]		'thing (plural-inessive)'
	b. /jumala+i+ssa/	[jumalissa]		'God (plural-inessive)'
	c. /itara+i+ssa/	[itaroissa] ~ [itarissa]		'stingy (plural-inessive)'

I will follow Anttila (1997, 2002) in analyzing variation as the result of conflicting constraints being unranked with one another, with a ranking being randomly selected each time the grammar derives an output. However, it is worth noting that the present account of morpheme-specific phonology is compatible with other approaches to variation, such as that of Boersma and Hayes (2001).[9]

The grammar in (47) deals with the three stem types. The general MAX and IDENT are left unranked, so that unindexed stems show variation. Morpheme-specific versions of the constraints are ranked above the general ones; stems indexed to one of them will show consistent deletion or mutation.

(47) Grammar: *[ai]-L1 >> MAX-L2, IDENT-L3 >> MAX, IDENT >> *[ai]
Lexicon: /-i-/$_{L1}$ /-i-/$_{L1}$ /-isi-/ /tavara/$_{L2}$ /jumala/$_{L3}$ /itara/

The result of applying this grammar to each of the three stem types is shown in (48).

(48)

Input	Output	*[ai]-L1	MAX-L2	IDENT-L3	MAX	IDENT
/itara-i$_{L1}$-ssa/	itaraissa	* !				
	☞ itarissa				*	
	☞ itaroissa					*
/tavara$_{L2}$-i$_{L1}$-ssa/	tavaraissa	* !				
	tavarissa		* !		*	
	☞ tavaroissa					*
/jumala$_{L3}$-i$_{L1}$-ssa/	jumalaissa	* !				
	☞ jumalissa				*	
	jumaloissa			* !		*

Antilla (2002) presents data showing that in some phonological contexts, not all these options are observed. With stems that consist of an even number of syllables (the stems in (48) are trisyllables), the generalization he uncovers is relatively straightforward: mutation occurs unless the preceding vowel is round, in which case deletion occurs

[9] One might see it as an advantage of Anttila's (2002) theory that it derives variation and exceptionality from a single mechanism, while the current approach requires separate accounts of the two phenomena. However, not only does it seem empirically correct to separate the two, there is no real parsimony in the partial ordering/cophonology theory: variation is achieved with unranked constraints, exceptionality is due to lexical specification of a ranking.

instead. Anttila (2002) analyzes deletion after round vowels as an effect of an OCP constraint against adjacent round vowels. Since Finnish constructs trochees from left-to-right, Anttila (2002: 17) derives the syllable count generalization by restricting the constraint to the foot-internal context, which as he points out, also gets the right results where the binary syllable count and foot parsing diverge, due to the avoidance of LH feet. To rule out mutation for this type of stem, Anttila (2002) ranks OCP/V[rd]$_\phi$ above MAX (which he labels *DEL). In his account, the presence of this ranking in the grammar bans lexical items from choosing the reverse order of the constraints. We can achieve the same effect with morpheme-specific constraints by ranking OCP/V[rd]$_\phi$ above the indexed version of MAX:

(49) OCP/V[rd]$_\phi$, IDENT-L3 >> MAX-L2 >> MAX, IDENT

With this ranking, even if a lexical item is indexed to lexically specific MAX, it will undergo deletion, rather than mutation, if mutation conflicts with OCP/V[rd]$_\phi$. The difference between disyllabic and trisyllabic stems is demonstrated in the following Richness of the Base tableaux, in which foot boundaries are indicated by parentheses. These tableaux show the result of indexation to MAX-L2 for both stem shapes. In disyllabic forms, where OCP/V[rd]$_\phi$ applies, mutation is ruled out, even with this indexation. In trisyllabic forms, mutation does occur with indexation. Hypothetical forms are used in both cases; Anttila (2002: 10) states that 1/3 of the forms like /itota/ undergo categorical mutation, though he does not provide any examples.

(50)

Input	Output	OCP/V[rd]$_\phi$	IDENT-L3	MAX-L2	MAX	IDENT
/tota$_{L2}$-i$_{L1}$/	☞ (toti)			*	*	
	(totoi)	* !				*
/itota$_{L2}$-i$_{L1}$/	(ito)ti			* !	*	
	☞ (ito)(toi)					*

The other side of this even-numbered stem generalization, that mutation applies in the absence of a preceding round vowel, is not dealt with in Anttila's (2002) analysis. As it stands, the analysis predicts that these stems should behave just like trisyllables of the same phonological shape. To some extent, this is borne out: as the example /taitta-i/ [taitt-oi] ~ [taitt-i] discussed in the last section shows, this side of the generalization is not iron-clad. Anttila (2002: 5) cites Karlsson (1982) as noting approximately 35 verb stems with variation in this context. However, unlike the trisyllabic stems, none of this type undergo categorical deletion.

To generate the default pattern of mutation, we need a constraint that applies to even-numbered stems, but not odd-numbered ones; ranking MAX over IDENT will not suffice. Drawing on Anttila's proposal that foot structure is responsible for syllable count generalizations, we can note that in the bare form of an odd-numbered stem, the final syllable will be unparsed. Given a faithfulness relation between the stem and the suffixed form (see esp. Bakovic's 2000 elaboration of Benua's 2000 proposal), a MAX constraint that protects only footed segments will target the final vowels of only even-numbered stems. This constraint, which I will label OO-MAX$_\phi$, ranks above the general form of IDENT, but beneath OCP/V[rd]$_\phi$, so that deletion still occurs with a preceding round vowel, as in /tota-i/ [toti] (see (50)). To allow for variation between mutation and deletion in exceptional cases like /taitta-i/, the lexically specific version of IDENT ranks evenly with OO-MAX$_\phi$. The tableaux in (51) demonstrate the results of these rankings for an unindexed disyllabic stem (/pala/ 'burn'; Anttila 2002: 3) and an indexed one (/taita/ from (35)), along with an indexed trisyllabic stem (/jumala+i+ssa/ 'God' (plural-inessive)).

(51)

Input	Output	OO-MAX$_\phi$	IDENT-L3	MAX-L2	MAX	IDENT
/taita$_{L3}$-i$_{L1}$/	☞ taiti	*			*	
	☞ taitoi		*			*
/pala-i$_{L1}$/	pali	* !			*	
	☞ paloi					*
/jumala$_{L3}$-i$_{L1}$-ssa/	☞ jumalissa				*	
	jumaloissa		* !			*

Because the final vowel of the trisyllabic stem /jumala/ is not subject to OO-MAX$_\phi$, indexing it to IDENT-L3 will categorically choose deletion. And as the tableaux in (48) show, indexation to MAX-L2 chooses consistent mutation, while lack of indexation produces variation. For disyllables like /taita/ and /pala/, however, the options in (51) are the only available ones; consistent deletion requires a preceding round vowel.

This analysis cannot be translated into Anttila's (2002) theory. As noted above, because the partial ordering/cophonology theory allows lexical rankings to fix only grammatically unordered constraints, exceptionality and variation are conflated. Piro provided a case of exceptionality without corresponding variation, and here we have an instance of variation without corresponding exceptionality. To get variation for /taita-i/, in partial ordering/cophonology theory the constraints picking mutation and deletion would have to be unranked. But if they are unranked, then stems should be able to select a ranking of the constraint picking deletion over the one preferring mutation, resulting in the unattested pattern of consistent mutation in this environment.

There are other generalizations in the Finnish data that the partial ordering theory of variation and morpheme-specific rankings similarly renders inexpressible. Amongst the trisyllabic patterns Anttila (2002: 10) extracts from a corpus of 1,302 stems, we also sometimes see stem-types that display only mutation and variation, but never deletion, as well as those that undergo deletion and variation, but never mutation. Stems of the former type include those with high vowels in penultimate position. So long as their last consonant is coronal (velars and labials skew the pattern towards mutation (e.g. *ki) and deletion (e.g. *po) respectively), they allow both mutation and variation. Anttila (2002: 19) analyzes the absence of deletion as due to an OCP/V[hi] constraint, which applies between the stem's penultimate vowel and the suffix-initial vowel whenever the stem-final vowel is deleted (e.g. /apina-i-ssa/ [apinoissa] *[apinissa]). However, to generate the observed variation, this constraint must be unranked with one or more constraints preferring deletion, which predicts the unattested consistent deletion pattern.

3.3 Exceptional Blocking by Markedness

The above analysis of a portion of the Finnish data on /a+i/ allomorphy challenges Anttila's (2002: 30) assertion that morpheme-specific constraints cannot capture the phonological generalizations displayed in those data. In this section, I show that other generalizations, in Finnish and elsewhere, do in fact escape a theory of morpheme-specific constraints if only faithfulness constraints can be indexed.

Amongst the trisyllables, the generalization that comes closest to being categorical is that if the final consonant in the stem is velar, deletion never applies (e.g. /silakka-i-ssa/ [silakkoissa] *[silakissa]). Of the 426 stems in which the last consonant is a velar, only 4 do not consistently mutate. These 4 fall into a particular phonological category: they all have penultimate [o]. Within this category, these exceptions are proportionally common, since it is made up of only 10 stems with this shape. The generalization, then, is that deletion never applies following a velar consonant, unless the preceding consonant is [o], in which case mutation applies sometimes, but not always.

To capture the blocking of deletion in trisyllabic stems, Antilla (2002) imposes a ranking corresponding to the one in (52), in which I replace his OCP/s[hi] with *[ki] ('no velar consonant/high vowel sequences'), and his *MUT with IDENT. The ranking of OCP/V[rd]$_{\phi}$ above *[ki] allows even-numbered stems with penultimate round vowels to continue to select deletion, even at the expense of *[ki].

(52) OCP/V[rd]$_{\phi}$ >> *[ki] >> IDENT

In terms of morpheme-specific constraints, *[ki] must dominate the indexed version of IDENT. This ranking is incorporated into the analysis from the previous section in (53).

(53) OCP/V[rd]$_{\phi}$ >> *[ki] >> IDENT-L3 >> MAX-L2 >> MAX, IDENT

Given this ranking, it is impossible for a stem to select deletion if a violation of *[ki] would result, since the indexed IDENT-L3 is ranked beneath *[ki]. To allow deletion in just those stems that contain a penultimate [o], we can invoke an indexed version of an OCP/V[rd] constraint that applies only between vowels of the same height, OCP/[o]-L4. This constraint ranks evenly with *[ki] and is indexed to the 3 stems that display variation. For the one stem that has consistent deletion, we would need another instance of the constraint, which would be ranked above *[ki].

(54) OCP/V[rd]$_{\phi}$ >> OCP/[o]-L4, *[ki] >> IDENT-L3 >> MAX-L2 >> MAX, IDENT

With only indexed faithfulness constraints, we would be forced to rank IDENT-L3 evenly with *[ki], in place of OCP/[o]-L4:

(55) *[ki], IDENT-L3 >> MAX-L2 >> MAX, IDENT

This would fail to capture the generalization that violations of *[ki] are limited to the post-[o] context; if by Richness of the Base a stem with a different final vowel were specified as L3, it would create a violation of *[ki].

This type of exceptionality can be referred to as exceptional blocking by markedness: an alternation applies, except when the output violates another markedness constraint, in which case it is sometimes blocked (and in a case like Finnish, an alternative repair applies). The schema for this type of exceptionality in terms of indexed constraints is as in (56). A ranking of a markedness constraint above a faithfulness constraint produces an alternation (M1 >> F). A lexically specific version of a conflicting markedness constraint (M2-L) blocks this alternation for words indexed to it, but not for other words, in which case the conflict is resolved in favor of the first markedness constraint (M1 >> M2)

(56) M2-L >> M1 >> M2, F

To illustrate with a simple hypothetical case, consider a language in which coda deletion is exceptionally blocked only in monosyllabic words. As opposed to the hypothetical language in section 1.1, bisyllabic words consistently undergo deletion.

(57) /pak/ → [pa] /pidot/ → [pido]
/lot/ → [lo] /talak/ → [tala]
/tak/ → [tak] /likot/ → [liko]

With indexed markedness constraints, we can attribute blocking in monosyllables to the activity of a constraint on minimal word size that is violated by CV forms. A lexically specific version of this constraint, MINWD-L, dominates NOCODA.

(58) Grammar: MINWD-L >> NOCODA >> MINWD, MAX
Lexicon: /pak/ /lot/ /tak$_L$/ /pidot/ /talak/ /likot/

(59)

Input	Output	MINWD-L	NOCODA	MAX	MINWD
pak	pak		* !		
	☞ pa			*	*
tak $_L$	☞ tak		*		
	ta	* !		*	*
pidot	pidot		* !		
	☞ pido			*	

The following Richness of the Base tableau shows that if a CVCVC form is supplied with a lexical diacritic, it still undergoes deletion, since word minimality is satisfied:

(60)

Input	Output	MINWD-L	NOCODA	MAX	MINWD
CVCVC$_L$	CVCVC		* !		
	☞ CVCV			*	

With only lexically specific faithfulness constraints, MAX must be indexed:

(61) Grammar: MAX-L >> NOCODA >> MINWD, MAX
Lexicon: /pak/ /lot/ /tak$_L$/ /pidot/ /talak/ /likot/

This grammar fails the Richness of the Base test, showing it is insufficiently restrictive:

(62)

Input	Output	MAX-L	NOCODA	MAX	MINWD
CVCVC$_L$	☞ CVCVC		*		
	CVCV	* !		*	

Cases like these can easily escape identification, since one might not notice that the exceptions all have a particular phonological shape, especially since there will be words of the same shape that are regular. However, Chomsky and Halle (1968: 379) do identify a Russian pattern that fits this description, and is a close parallel with the Finnish one: deletion of [i] from the suffix /-isk/ is sometimes blocked, but only when the preceding stem ends with a velar or palatal consonant.

In terms of the learnability proposal in 2.3, exceptional blocking by markedness requires a bias towards cloning a markedness constraint, when either a faithfulness or a markedness constraint could resolve inconsistency. For example, in the hypothetical case above, /tak/ could be distinguished from the other monosyllabic stems by cloning either MAX or MINWD:

(63)

Input	W ~ L	NOCODA	MAX	MINWD
pak	pa ~ pak	W	L	L
lok	lo ~ lok	W	L	L
tok	tok ~ to	L	W	W
kopak	kopa ~ kopak	W	L	
lotak	lota ~ lotak	W	L	
ratok	rato ~ ratok	W	L	

Either one meets the criterion of preferring only winners for some morpheme, but to ensure restrictiveness, NOCODA must be chosen. However, this choice requires no new stipulation, since it is just another instance of the general Markedness bias that Smolensky (1996), Hayes (2004) and Prince and Tesar (2004) show is necessary to maintain restrictiveness elsewhere.

4. Derived Environments as Local Indexation

In section 3.1, a convention for the interpretation of morphologically indexed constraints was introduced. This convention, repeated in (64), has the effect of limiting the scope of a morphologically indexed constraint to a string that contains some element of that morpheme, which is necessary for the analysis of Finnish, and also to rule out unattested non-local cases morpheme-specific phonology.

(64) $*X_L$
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L

One positive consequence of this interpretation of indexed constraints is that a simple analysis of morphological derived environment effects (MDEEs) is achieved. MDEEs refer to processes that are blocked root-internally, but apply when the conditioning environment includes a portion of an affix (see Inkelas 2000, Lubowicz 2002 for recent reviews of the literature). If a markedness constraint is indexed to the general morphological category 'AFFIX', then these effects are generated straightforwardly.[10] Here I will discuss data from Chumash that shows the necessity of a markedness based analysis (see Lubowicz 2002 and McCarthy 2002, 2003a, 2005 for alternative analyses of MDEEs that incorporate markedness without indexation, see Itô and Mester 1996, Cho 1998, Inkelas 2000, Pater 1999, Burzio 2000, and Bradley 2002 for faithfulness-based proposals).

The Chumash data I present here are taken directly from Poser (1993), who relies on Applegate (1972). Poser (1993) draws attention to this set of facts for the difficulties it poses for Kiparsky's (1993) structural analysis of MDEEs. A sibilant is laminalized when it precedes one of the non-strident coronals /t/, /l/, or /n/. This process is illustrated by the 3rd person subject prefix:

(65)	/s+nanʔ/	[ʃnanʔ]	'he goes'
	/s+tepuʔ/	[ʃtepuʔ]	'he gambles'
	/s+loxitʔ/	[ʃloxitʔ]	'he surpasses me'

Pre-coronal laminalization applies only in morphologically derived environments; the tautomorphemic clusters in (66) do not undergo the process:

(66)	[stumukun]	'mistletoe'
	[slowʔ]	'eagle'
	[wastuʔ]	'pleat'

[10] To wind up with constraints that refer to general categories, the inconsistency resolution approach to indexation must be elaborated. One possibility is that when it indexes a constraint, it seeks a morphological category that already distinguishes the morphemes in which it prefers only winners from those in which it prefers losers. Alternatively, specific indexed constraints could be collapsed to more general ones as part of the learning process (see further Pater 2005).

In terms of constraint indexation, we can limit the effects of the laminalization constraint (*sT; see McCarthy this volume for an OCP formulation) by indexing it to the affixal context (*sT_{AFF}). Given the interpretation of morphological indexation in (64), this constraint will apply if and only if its locus of violation contains part of an affix. This will be true in cases like those in (65), but not those in (66).[11] As (67) shows, this allows the derived environment effect to be captured. IDENT-DISTRIBUTED is the general faithfulness constraint violated by laminalization.

(67)

Input	Output	*sT_{AFF}	IDENT-DIST	*sT
/s+tepuʔ/	☞ ʃtepuʔ		*	
	stepuʔ	* !		*
/stumukun/	ʃtumukun		* !	
	☞ stumukun			*

Support for this analysis over a faithfulness based one comes from the interaction of this process with sibilant harmony. Chumash sibilant harmony causes all sibilants to agree in laminality with the last sibilant in the word, as the alternation in the 3rd person subject prefix /s/ shows:

(68) /ha+s+xintila/ [hasxintila] 'his gentile'
/ha+s+xintila+waʃ/ [haʃxintilawaʃ] 'his former gentile'

A [ʃ] followed by heteromorphemic /t, n, l/ fails to harmonize with a following [s] (69a and 69b), but starts a new harmonic domain, so that sibilants to the left are laminalized (69b). This applies whether the /ʃt/ sequence is derived (69a) or not (69b).

(69) a. /s+ti+yep+us/ [ʃtiyepus] 'he tells him'
b. /s+iʃ+lu+sisin/ [ʃiʃlusisin] 'they two are gone away'

This indicates that *sT_{AFF} dominates the constraint demanding harmony. The constraint I will label HARM assesses a violation for every sibilant that disagrees in laminality with the immediately following one (see McCarthy 2004 for discussion of the formalization of assimilation constraints; cf. McCarthy this volume on Chumash). HARM must itself dominate IDENT-DIST. Both rankings are illustrated in the following tableau.

[11] The constraint will apply to affix-internal sequences. In many cases, apparently including Chumash, affixes will simply lack the sequences. For the remaining ones, it is not clear if there is a generalization about whether derived environment effects do apply affix-internally or not. For the cases in which they are strictly limited to the junctural environment (see Inkelas 2000), we could invoke a doubly indexed constraint, if *$M_{AFF, ROOT}$ is interpreted as holding only if the locus of violation contains an exponent of an affix and one of a root.

(70)

Input	Output	*sT_{AFF}	HARM	IDENT-DIST
/s+iʃ+lu+sisin/	☞ [ʃiʃlusisin]		*	*
	[siʃlusisin]		**!	
	[sislusisin]	*!		*

A faithfulness based account would protect root-internal /sT/ sequences by indexing a faithfulness constraint to that context. One complication is that pre-coronal assimilation is a dissimilation process, rather than assimilation, so an analysis parallel to those of Cho (1998) and Bradley (2002) cannot be pursued. Following Burzio (2000), we might posit a constraint FAITH-sT, which applies only to such sequences contained in a single morpheme (though cf. Inkelas 2000, Lubowicz 2002 for critiques of this approach). This analysis could also be formalized in terms of Itô and Mester's (1996) NEIGHBORHOOD schema, or as we will see below, in the structural terms of Inkelas (2000); I use FAITH-sT as the simplest representative of a variety of possible faithfulness based approaches.

The analysis is illustrated in (71), with IDENT-DISTRIBUTED as the general faithfulness constraint violated by laminalization.

(71)

Input	Output	FAITH-sT	*sT	IDENT-[DIST]
/s+tepuʔ/	☞ ʃtepuʔ			*
	stepuʔ		*!	
/stumukun/	ʃtumukun	*!		*
	☞ stumukun		*	

The problem for the faithfulness based analysis is that sibilant harmony does target a root-internal /sT/ sequence, as in the following example:

(72) /uqsti/ [uqsti] 'of throwing'
/s+uqsti+meʃ/ [ʃ-uqʃti-meʃ] 'throw over it'

For the data in (72), HARM must dominate FAITH-sT. However, as shown in (70),*sT must dominate HARM, and as shown in (71), FAITH-sT must dominate *sT. These last two rankings entail a transitive ranking of FAITH-sT over HARM, which is incompatible with the ranking needed for (72). In the faithfulness account of MDEEs, a markedness constraint that displays a MDEE (*sT) must be ranked below the special faithfulness constraint, while a markedness constraint that fails to show this effect (HARM) must be ranked above it. But the fact that *sT creates violations of HARM requires an incompatible ranking of these constraints. This problem will obtain regardless of how one formalizes FAITH-ST, the faithfulness constraint that protects morpheme-internal /s/, even in the quite different approach in Inkelas (2000).

Inkelas (2000) advocates an OT based formalization of Kiparsky's (1993) theory of MDEEs. Alternating segments are distinguished from non-alternating ones in terms of their phonological specification. Though she does not provide a detailed analysis of Chumash, Inkelas suggests that non-alternating [s] could be specified as [-distributed], while the alternating [s] would be unspecified for [distributed]. In other analyses, she uses MAX-FEATURE constraints to protect the underlying specification: here MAX-[DISTRIBUTED] would be ranked above *sT. In the following tableaux illustrating this analysis, an input segment unspecified for [distributed] is capitalized. DEP-[DIST] is violated by insertion of either [-distributed] or [+distributed]; its ranking with respect to the other constraints is indeterminate.

(73)

Input	Output	MAX-[DIST]	*sT	DEP-[DIST]
/S+tepuʔ/	☞ ʃtepuʔ			*
	stepuʔ		* !	*
/stumukun/	ʃtumukun	*!		
	☞ stumukun		*	

One issue with this analysis is that it does not capture the generalization that the alternation is limited to derived environments (Burzio 2000). Inkelas (2000) proposes that speakers' knowledge of this generalization is based on analogy, but this undermines the program of accounting for phonological knowledge in terms of phonological grammar. Another issue for this analysis is that it fails to deal with the full set of Chumash facts. Since sibilant harmony targets the same root-internal instances of /s/ that resist *sT (see 72), MAX-LAM must rank beneath the harmony constraint. We thus once again have the transitive ranking HARM >> MAX-LAM >> *sT that is inconsistent with the fact that *sT overrides the demands of HARM.

A markedness based analysis of MDEEs faces no similar dilemma with the Chumash facts. All that is required to deal with the data in (72) is to have HARM outrank IDENT, the ranking already established in (70).[12] As McCarthy (this volume) points out, the Chumash data are problematic for the alternative markedness based analysis of Lubowicz (2002). Lubowicz (2002) analyzes MDEEs as being due to a conjunction of a markedness constraint with a constraint demanding stem/syllable alignment, which results in the markedness constraint only being active when alignment is violated. However, McCarthy shows that in some cases of Chumash pre-coronal laminalization, the stem does align with the edge of a syllable when the prefix is attached. A comparative markedness analysis does seem workable (McCarthy 2002, 2003), but as McCarthy points out, the implementation of this amendment to Optimality Theory is not without its

[12] McCarthy (2005) analyzes the morphological conditioning of pre-coronal laminalization by deriving it from the activity of a Crisp Edge constraint. In this sense, it is also a markedness-based explanation of the derived environment effect. However, it is not proposed as a general analysis of MDEEs. It is worth noting that McCarthy's argument for a correspondence based analysis of Chumash harmony is dependent on the use of this Crisp Edge constraint for precoronal laminalization; it does not hold under the present account, nor would it hold if the theory of MDEEs in McCarthy (2002, 2003) were applied.

difficulties. It thus seems that the local indexation analysis of MDEEs fills a gap in the coverage of morphological influences on phonology in Optimality Theory.

Admitting indexed markedness constraints into phonological theory has a number of further consequences, some positive, some negative (see Inkelas and Zoll 2003 for a demonstration that the restriction of indexation to faithfulness does not impose substantial limits on the range of language-internal variation). For example, Flack (to appear) points out that indexed markedness constraints allow for a simpler analysis of many cases of templatic phonology than a theory with only indexed faithfulness constraints, and argues that some templatic effects cannot be analyzed at all without extending indexation to markedness constraints. She also draws attention to a related liability: that indexed markedness constraints can produce the unattested templatic backcopying pattern that McCarthy and Prince (1995, 1999) avoid by eliminating templates from prosodic morphology. The other major worry with indexed markedness constraints is that if they can be relativized to a category like ROOT, then they can subvert a fixed ROOT-FAITH >> AFFIX-FAITH meta-ranking (McCarthy and Prince 1995), and produce a language that that neutralizes contrasts root-internally, but not in affixes (see Albright 2004, Tessier 2004, Beechey 2005, Urbanczyk to appear for related discussion). These two issues might be addressed by imposing limitations on either the set of markedness constraints that can be indexed, or on the domains to which they can be indexed.[13] However, completely ruling out markedness indexation does not seem to be a viable approach, given the need to distinguish exceptional triggering from blocking, to generate exceptional blocking by markedness, and most importantly, to impose locality restrictions on morpheme-specific phonology.

5. The Structural Alternative

The lexical idiosyncrasies of Piro syncope could be reanalyzed in structural terms, without recourse to the lexical diacritics that morpheme-specific constraints or rankings require. Matteson's (1965: 36) convention for notating non-triggering morphemes in fact suggests such an analysis: that they possess an unspecified vocalic position (e.g. /-Vta/), whose presence blocks the application of syncope (see Wolf this volume on how to derive this sort of blocking in OT). For the /wa/ that fails to undergo deletion, one might lexically specify some aspect of syllable structure (e.g. a mora), which is protected by a faithfulness constraint (e.g. MAX-μ; see Inkelas and Zoll 1995, Inkelas, Orgun and Zoll 1997, Inkelas 2000 for related proposals).[14] A structural analysis of Finnish /a+i/ allomorphy might also be possible, with the triggering morpheme being endowed with floating features that are realized under the right conditions, though this would be

[13] It is also not entirely clear that leaving these generalizations unaccounted for would be a fatal flaw of a theory. Greater contrast amongst roots than affixes has a plausible grammar-external functional explanation: since there are more roots than affixes, there is greater pressure to maintain distinctions amongst them. The lack of templatic backcopying is more problematic, though see Inkelas and Zoll 2005 for discussion.

[14] The cited analyses invoke constraints that preserve underlying syllabification; as McCarthy 2003b: 60-62) points out, such constraints predict unattested minimal constrasts in syllabification.

somewhat more complex (see again Wolf this volume for a theory of floating features in OT that seems to have the capacity to deal with this complexity).

These analyses have no obvious advantages over the diacritic ones proposed here. They are only attractive insofar as structural analyses are in general more attractive than diacritic ones. In pre-OT autosegmental phonology, distinctions in degree of specification play a role not only in accounting for exceptionality, but also more generally in distinguishing segments that undergo processes from those that do not. Furthermore, learning in this framework is often held to consist of gradually elaborating lexical representations (e.g. Avery and Rice 1989). In this context, it is natural that a structural account of exceptionality should be preferred (see Inkelas *et al.* 1997 for a review of the literature). In OT, however, the only motivation for underspecified representations may be their role in structural accounts of exceptionality (as in Inkelas *et al.* 1997), since co-occurrence constraints and place-specific faithfulness constraints have replaced underspecification in analyses of assimilation (cf. Inkelas 2000 on MDEEs, but see section 4 above). And in OT, learning initially involves fixing constraint rankings based on a fully specified lexical representation (Tesar and Smolensky 1998 *et seq*., cf. Inkelas 1994). Thus, from the perspective of OT, it is not clear that a structural analysis of exceptionality should be preferred *a priori*.

Finding the underlying representations on which a structural analysis of exceptionality is dependent can pose a considerable learnability challenge, especially for analyses that require an underspecified representation. Inkelas (1994) proposes that Prince and Smolensky's (1993/2004) Lexicon Optimization derives underspecification: in cases of alternation, an underspecified representation results in a more harmonic set of Input-Output mappings than does a representation specified for either of the surface alternants. In the example of Yoruba [ATR] harmony she analyzes, she assumes that the underspecified representation maps to both the [+ATR] and [-ATR] variants without incurring faithfulness violations. In terms of current faithfulness theory (McCarthy and Prince 1995, 1999), it might be possible to maintain this assumption if IDENT constraints are held to be unviolated in mappings involving underspecified segments. However, this will not generalize to instances of segmental deletion and insertion, which violate MAX and DEP constraints, or to instances of moraic or tonal change, which presumably must violate MAX and DEP feature, since these features are often preserved independently of the segments involved. If the underspecified representation can participate in faithfulness violations, deriving it by Lexicon Optimization will require additional assumptions about constraint ranking (see Inkelas 1994 for one proposal). Therefore, it remains to be seen whether all the cases of exceptionality that have been analyzed in terms of underspecification in Inkelas *et al.* (1997) and Inkelas (2000) can in fact be dealt with in terms of Lexicon Optimization (see further Kager to appear on difficulties that cases of exceptionality involving moraic specification pose for underspecification).[15]

[15] Kager proposes a variation on the structural approach: that all cases of exceptionality are to be dealt with in terms of allomorphy. One worrisome consequence of this is that a single instance of exceptionality leads to an otherwise fully productive pattern to be fully lexicalized. For example, the existence of non-syncopating /wa/ in Piro would force all the other morphemes in the language that appear in the syncope environment to be listed in vowel- and consonant-final forms.

Tesar and Smolensky (1998) assume that Lexicon Optimization is insufficient to fix underlying representations, and instead propose that they are learned through an iterative process of hypothesis testing: an input representation is adopted, constraint ranking proceeds, and if it fails, the representation is changed, and the constraint ranking is resumed. This approach is pursued for lexical stress in Tesar *et al.* (2003). As they recognize, the space of possible representational changes is extremely large. This problem is exacerbated if underspecified representations are permitted. The most difficult cases are ones where the feature that must be specified in the non-alternating forms is not the only feature that alternates. Taking the Piro example of exceptional blocking of syncope, it is not just the vocalic mora that is variably present in surface allomorphs of alternating vowels, but the entire vowel. The learner must somehow be guided to choose the mora as the element to fix in non-alternating /wa/. Presumably, the guide would be the presence of a faithfulness constraint that specifically targets the mora, and can protect it from deletion. While it is plausible that a learner might restructure an underlying representation so that it allows a constraint to choose the correct output, no extant learnability proposal allows for this, since the process of surgery, as Tesar *et al.* term it, is grammar-blind. Finding the correct underlying representation through hypothesis testing has not yet been shown to be viable with a realistic hypothesis space. Such difficulties are presumably the inspiration for Tesar's (2004) approach to the acquisition of underlying representations, which narrows the hypothesis space considerably.

When inconsistency is resolved through indexation, on the other hand, the pattern of constraint violations directly guides the required fix to the system. Given the straightforwardness of this learnability proposal, it is arguable that the default solution for exceptionality should be a diacritic one, rather than a structural one, for both the learner and the analyst. From this perspective, the question is no longer whether diacritics can be abolished, but whether they can handle all cases of exceptionality. Inkelas *et al.* (1997) argue that exceptions to coda devoicing in Turkish provide a case that escapes a diacritic analysis. In some words, only the final consonant undergoes devoicing, and a medial coda remains exceptionally voiced. This is problematic for an analysis in which a lexically specific faithfulness constraint outranks NoCodaVoice, since this would force both the medial and final consonants to retain underlying voice. However, as Blevins (2005) points out, several languages have purely word-final devoicing. Thus, these words could be analyzed as having a lexically specific faithfulness constraint ranked below NoWordFinalVoice and above NoCodaVoice.

While the Turkish example does not seem particularly troublesome, it is of course yet to be determined whether all cases of exceptionality can, or should, be given a diacritic treatment (see also Itô and Mester 2001, Albright 2002, and Becker 2004 for recent arguments for diacritic analyses). Instances where the markedness motivation for the alternation has disappeared, as in many cases of mutation (see Wolf this volume), seem particularly amenable to a structural analysis. However, it is equally unclear whether a structural account of morpheme-specific phonology can be made fully general. It should be noted that even proponents of structural approaches in OT see a role for morpheme-specific constraints or rankings, but claim that they should be limited to cases in which a variety of evidence converges on the need for a grammatical distinction between morphemes (see e.g. Inkelas 1999, Kager to appear). If this limitation is motivated by learnability considerations, then in light of the proposal in section 2.3, it remains to be shown why this converging evidence is necessary (see Pater 2005 for discussion of how converging evidence might make indexation resistant to regularizing loss). If this limitation is motivated by a concern that indexation allows contrast to be misinterpreted as exceptionality, then indexation could be limited to cases of alternation, as it is if inconsistency resolution is the only source of indexation (i.e. phonotactic exceptionality will not be encoded; cf. Coetzee and Pater 2006).

Further research on morpheme-specific phonology should clarify the relative scope of purely diacritic and structural approaches, along with various intermediate positions (e.g. indexation limited to a subset of markedness constraints, or structural hypotheses limited to surface observable forms), and alternatives like the Antifaithfulness theory of Alderete (2001), the Realize Morpheme theory of Kurisu (2001) and others, and Zuraw's (2000) extension of Boersma (1998) (see also Hayes and Londe 2005). Given the results obtained here with a theory that indexes both markedness and faithfulness constraints, some previous conclusions may be in need of reassessment.

6. Conclusions

In this paper, I have shown that several considerations favor a theory of morpheme-specific phonology with indexed markedness and faithfulness constraints over either a theory with only indexed faithfulness constraints, or one with lexically specified rankings. It allows for a distinction between exceptional triggering and blocking, which was shown to be necessary to analyze the Piro data. Given the locality convention introduced here, indexed markedness constraints allow for a straightforward analysis of the locus of Finnish /ai/ allomorphy, and resolve general locality problems for morpheme-specific phonology, including that posed by morphological derived environment effects, as shown for Chumash. The Finnish data were also used to illustrate two other distinguishing characteristics of this approach: unlike partial ordering/cophonology theory, it does not conflate variation and exceptionality, and unlike faithfulness-only indexation, it can capture cases of exceptional blocking by markedness.

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