Is grammar dependence real? A comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology*

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Abstract

This article compares and contrasts cophonology theory and indexed constraint theory, the dominant current proposals to morphologically conditioned phonology. In cophonology theory, morphologically conditioned phonology is captured by associating each morphological construction or lexical class with its own phonological grammar, or cophonology. All constraints within a given cophonology are purely phonological; no constraint directly refers to morphological context. By contrast, indexed constraint theory assumes a single fixed constraint ranking for the entire language, and captures morphologically conditioned phonology by indexing individual constraints to specific morphological contexts. The article raises three arguments in favor of cophonology theory: greater formal parsimony, the ability to handle free variation, and more accurate predictions about the scope of morphologically conditioned phonological effects. It also evaluates and rejects the primary argument for indexed constraint theory, i.e., Grammar Dependence, the claim that indexed constraint theory is more restrictive in the degree of language-internal diversity allowed. Cophonology theory and indexed constraint theory are equivalent in the range of language-internal diversity they allow; it is argued that the upper limit on language-internal diversity should not be a matter for formal grammar, but instead requires extra-grammatical explanation in terms of the factors influencing language change and variation.

1. Introduction

It has long been observed that the phonology of a language is not completely uniform. In addition to well-studied free variation in the pronunciation of certain words or word classes, phonological patterns in a language can vary systematically, in small or large ways, by social register,

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lexical stratum (e.g., native vs. foreign), part of speech, morphological category (e.g., stem vs. affix, reduplicant vs. base), and so forth.

Although attention to language-internal diversity of this sort is often subordinated to the quest for the broadest possible generalizations holding within a language, any complete phonological analysis of a language must take it squarely into account. This article evaluates the two dominant current proposals, both couched within Optimality Theory, about the nature of language-internal diversity.

(a) the COPHONOLOGY approach, in which diversity is captured by associating morphological constructions or lexical classes with different phonological grammars, i.e., constraint rankings. All constraints within a given cophonology are fully general (e.g., Max-C[onsonant], the ban on consonant deletion, or *[ʔ], the ban on glottal stop); morphological differentiation of phonological patterns results from different ranking of the constraints across cophonologies. Proponents include Orgun (1996, 1998, 1999); Anttila (1997, 2000); Inkelas (1998); Orgun and Inkelas (2002); Inkelas and Zoll (2005), among others. The cophonology approach builds on, but departs in certain key ways from, the theory of level ordering (e.g., Kiparsky 1982; Mohanan 1986), recast within Optimality Theory by Kiparsky (2000) under the name of "Stratal OT".

(b) the INDEXED CONSTRAINT approach, in which there is a single fixed constraint ranking for the entire language, and constraints within that fixed ranking are indexed to individual morphological contexts. In such approaches, constraints are potentially split into as many different indexed versions (e.g. Max-C_{root}, Max-C_{affix}, Max-C_{BR}, etc.) as are needed to describe morphologically conditioned phonology. Proponents include McCarthy and Prince (1995), Pater (2000), Itô and Mester (1999), Alderete (2001), and Smith (1997), among others.

While these two approaches might initially seem similar, prominent arguments have been advanced by advocates of each for its superiority over the other. This article evaluates existing arguments, adds new ones, and concludes that to the extent to which the two approaches differ, cophonologies are superior on both descriptive and explanatory grounds. The article begins in Sections 2 and 3, with overviews of cophonology theory and indexed constraint theory. Similarities and differences between the two approaches are covered in Section 4. Sections 5–11 are devoted to a critique of Grammar Dependence, the claim by Alderete (1999, 2001) and others that language-internal variation is limited to the degree to which particular morphological contexts permit the overall default phonology of the language to be imposed; this generalization is modeled in Optimality Theory by a restriction on constraint indexation that we call "Faith-Based Variation". We argue against Faith-Based Variation on the grounds that the generalization it seeks to capture is wrong (Section 9), that, in any case, Faith-Based Variation is nearly vacuous (Section 10), that the one prediction Faith-Based Variation does make is incorrect (Section 11), and that Faith-Based Variation is at odds with the important Optimality Theory concept of the emergence of the unmarked (Section 12). Section 13 steps back from the particulars of existing theoretical proposals to consider extra-theoretical explanations for the types of language-internal diversity that are found, and Section 14 brings the article to a conclusion.

2. Cophonologies: multiple rankings, general constraints

The cophonology approach, developed in Orgun (1996), Anttila (1997), and much subsequent work, holds that within a single language there can be co-existing distinct phonological systems, indexed to such components of the language as register, lexical class, morphological category, and, most conspicuously in the context of this article, individual morphological constructions.

A useful illustration is provided by the morphologically conditioned resolution of vowel hiatus in Turkish (see e.g., Lewis 1967; Underhill 1976; Kornfilt 1997). Turkish has a number of vowel-initial suffixes. When these combine with vowel-final bases, what would be the resulting vowel hiatus is always resolved. In the case of most suffixes, hiatus is resolved through glide insertion (1a)–(1b); in at least one case, namely the progressive suffix, hiatus is resolved by vowel deletion (1c):[1]

(1)

a.	V-V			
	/anla-adʒak/	[anla**j**a'dʒak]	*anlayacak*	'understand-FUT'
	C-V			
	/anla-t-adʒak/	[anlata'dʒak]	*anlatacak*	'understand-CAUS-FUT'
	/al-adʒak/	[ala'dʒak]	*alacak*	'take-FUT'
b.	V-V			
	/anla-ɯndʒa/	[anla'**j**ɯndʒa]	*anlayınca*	'understand-ADV = having understood'

	/anla-ma-ɯndʒa/	[an'lama**j**ɯndʒa]	*anlama**y**ınca*	'understood-NEG-ADV = having not understood'
	C-V			
	/anla-t-ɯndʒa/	[anla'tɯndʒa]	*anlatınca*	'understand-CAUS-ADV = having taught'
	/gel-indʒe/	[ge'lindʒe]	*gelince*	'come-ADV = having come'
c.	V-V			
	/anl-ɯjor/	[an'lɯjor]	*anlıyor*	'understand-PROG'
	/anl**a**-ma-ɯjor/	[an'lamɯjor]	*anlamıyor*	'understand-NEG-PROG'
	/tekm**e**-le-ijor/	[tekme'lijor]	*tekmeliyor*	'kick-VBL-PROG'

The initial vowels of the suffixes illustrated in (1) have much in common: all undergo vowel harmony, all involve the same consonant inventory, all respect the same overall syllable phonotactics, and all show allomorphy that results in avoidance of vowel hiatus. The significant difference between the suffixes in (1a)–(1b) and those in (1c) lies in whether insertion or deletion is used to repair VV sequences.

In cophonology theory, every morphological construction is affiliated with a cophonology which governs the input-output mapping between daughters and mother. The three affixal constructions represented in (1) are, between them, associated with two different cophonologies. Both cophonologies rank *VV, the ban on vowel hiatus, above faithfulness, forcing resolution. The cophonology of the progressive suffix (call it "A") ranks Dep-C above Max-V, favoring vowel deletion; the cophonology of the adverbial and future suffixes (call it "B") has the opposite ranking, favoring consonant epenthesis, as shown below:

(2)

Progressive suffix: Cophonology A	/anla-ɯjor/	*VV	DEP-C	MAX-V
a.	anlaɯjor	*!		
b.	anlajɯjor		*!	
☞ c.	anlɯjor			*

Adverbial suffix: Cophonology B	/anla-ɯndʒa/	*VV	Max-V	Dep-C
a.	anlaɯndʒa	*!		
☞ b.	anlajɯndʒa			*
c.	anlɯndʒa		*!	

Following Anttila and Cho (Anttila 1997; Anttila and Cho 1998; Anttila 2002; and Anttila forthcoming), we assume that the cophonologies of a language are related in a grammar lattice whose superordinate node contains what we term the "Master Ranking", a partial ranking of constraints to which all individual cophonologies in the language must conform. The fragment of the grammar lattice relevant for Turkish vowel hiatus resolution is shown below. The Master Ranking contains the imperative that hiatus is resolved, i.e., the ranking *VV ≫ {Dep-C, Max-V}, which both cophonologies conform to. It is left to the individual cophonologies to further specify the relative ranking of Dep-C (which bans glide insertion) and Max-V (which bans vowel deletion):

(3)

Master Ranking
*VV ≫ {Max-V, Dep-C}

Cophonology A
*VV ≫ Dep-C ≫ Max-V

Cophonology B
*VV ≫ Max-V ≫ Dep-C

In this very simple grammar lattice, only one node (the top) has a partial constraint ranking. It is, however, also possible for subordinate nodes to themselves be associated with partial constraint rankings, as Anttila has demonstrated, based on larger fragments of Finnish grammar (see in particular Anttila 1997, 2002, forthcoming).

To summarize cophonology theory thus far, each morphological construction in a language — individual affixes, compounding, truncation, reduplication, etc. — is associated with a cophonology. Each cophonology is composed of the same phonological constraints (in the above example, *VV, Max-V and Dep-C); no individual constraint makes reference to morphological information. Morphological conditioning of phonology is entirely a matter of which cophonology is associated with which morphological construction. Cophonologies are organized in a grammar lattice, the locus of generalizations about what rankings cophonologies must share and in what rankings they may differ.

3. Indexed constraint theory: one ranking, indexed constraints

The indexed constraint approach, developed by Benua (1997a, 1997b), Alderete (1999, 2001) and Itô and Mester (1999), uses one constraint ranking for the entire language. Rather than using reranking (i.e., cophonologies), indexed constraint theory handles morphologically conditioned phonology by splitting phonological constraints into families whose members are indexed to particular morphological contexts.

To illustrate how indexed constraint theory can handle a situation in which some affixes trigger an alternation that others do not, we present Alderete's analysis of the difference between dominant vs. recessive suffixes in Tokyo Japanese, based on data and generalizations in McCawley (1968) and Poser (1984). Japanese is a pitch-accent language. Following Poser and much earlier work on Japanese, we assume accent is represented formally as H(igh) tone. Each phonological phrase is allowed one and only one H.[2] Some morphemes have lexical H tone; others do not. A phrase composed entirely of words without H tone receives default final H. A phrase containing more than one H-toned word is subject to a general principle of Rightmost Wins, whereby only the rightmost H survives; other H's are deleted. Rightmost Wins also applies word-internally, though it can be overridden by morphologically conditioned phonological patterns that add, delete or shift H tones. Alderete's (1999, 2001) primary concern is the distinction between dominant affixes, which delete a H tone from the base of affixation, and recessive affixes, which leave a base H tone in place. Example (4) illustrates two dominant suffixes and two recessive suffixes. The adjective-forming suffix -*ppó* (4a) and the "indigène" suffix -*kko* (4b) are dominant, causing deletion of H tone (if any) from the base of affixation. The conditional suffix -*tára* (4c) and the past tense suffix -*ta* 4(d) are recessive; both preserve base accent, if any. The data are taken from Poser (1984: 48, 49, 72):

(4) Dominant suffixes

a.	/adá + ppó$_{\text{Dom}}$ + i/	ada-ppó-i	'coquettish'
	/kaze + ppó$_{\text{Dom}}$ + i/	kaze-ppó-i	'sniffly'
	/egára + ppó$_{\text{Dom}}$ + i/	egara-ppó-i	'acrid'
b.	/kóobe + kko$_{\text{Dom}}$/	koobe-kko	'indigène of Kobe'
	/nyuuyóoku + kko$_{\text{Dom}}$/	nyuuyooku-kko	'indigène of New York'
	/edo + kko$_{\text{Dom}}$/	edo-kko	'indigène of Tokyo'

Recessive suffixes

c.	/yob-tára$_{\text{Rec}}$/	yoN-dára	'if he calls'
	/yóm-tára$_{\text{Rec}}$/	yóN-dara	'if he reads'

d.	/yob-ta_{Rec}/	yoN-da	'called'
	/yóm-ta_{Rec}/	yóN-da	'read'

Note that whether a suffix itself bears a lexical H tone is unrelated to whether it is dominant or recessive; the suffixes in (4a) and (4c) bear H tone, while those in (4b) and (4d) do not. (The H-toned recessive suffix in (4c) loses its H tone when attaching to a H-toned stem by the general principle of "Rightmost Wins", mentioned above.)

Alderete handles the distinction between dominant suffixes (4a)–(4b) and recessive suffixes (4c)–(4d) using constraint indexation, as follows:

(5) $\neg OO_{Dom}$-MAX-ACCENT:
'It is not the case that every accent in S1 has a correspondent in S2'

This indexed anti-faithfulness constraint compares words ending in dominant ("Dom") suffixes to their unsuffixed counterparts. "S1" refers to the unsuffixed counterpart, and "S2" to the stem portion of the suffixed word. The effect of the constraint is to penalize stems formed by dominant affixes in which tone is preserved on the base of affixation, rather than deleted. A tableau, modified slightly from Alderete (2001: 218), is shown below, reflecting the output-output correspondence model of the morphology-phonology interface which Alderete assumes.[3] In this tableau, *-ppó* is a dominant suffix, incurring the effects of $\neg OO_{Dom}$-MAX-Accent on the preceding root:

(6)

	unsuffixed stem	stem + *-ppó* + *-i*	$\neg OO_{Dom}$-MAX (Accent)	IO-MAX (Accent)	¬OO-MAX (Accent)
a.	adá	adá-ppo-i	*!		
b.	adá	ada-ppo-i		**!	
☞ c.	adá	ada-ppó-i		*	

The choice of output-output correspondence, and word-based morphology, is not critical to Alderete's indexed constraint analysis; the indexed constraint would have the same effect if it were treated as an input-output constraint, with *adá* serving as the morphological input to *ada-ppó-i*, as shown below:

(7)

	/adá-ppó$_{dom}$-i/	¬IO$_{Dom}$-MAX (Accent)	IO-MAX (Accent)	¬IO-MAX (Accent)
a.	adá-ppo-i	*!		
b.	ada-ppo-i		**!	
☞ c.	ada-ppó-i		*	

The difference between input-output and output-output implementations of morphology has largely to do with whether morphological rules operate strictly on words (= outputs) or whether stems are also formal levels of representation; this issue is beyond the scope of the present article, though for general discussion, see e.g., Anderson (1992); Bochner (1992); Aronoff (1994); Orgun (1996); Kiparsky (2000); Blevins (2001).

4. Cophonologies and constraint indexation, compared

Cophonology theory and indexed constraint theory have significant areas of overlap. However, there are also a number of differences between the theories, ranging from formal to substantive in nature.

4.1. *Determinism and the too-many-solutions problem*

We begin our comparison of the two theories with a formal observation: cophonology theory is more formally parsimonious than indexed constraint theory. Indexed constraint theory permits more analyses of the same data than does cophonology theory, forcing the user of indexed constraint theory to make many arbitrary choices that do not affect the predictions of the analysis. The easiest way to demonstrate this point is to translate between cophonological and indexed constraint analyses of the same phenomenon.

Indexed constraint accounts translate deterministically into cophonology accounts. For example, the indexed constraint analysis offered by Alderete for Japanese dominant and recessive suffixes in (8a) can be unpacked into the cophonological account in (8b) by collapsing the indexed and unindexed versions of ¬MAX(Accent) and ranking the resulting, purely general constraint differently with respect to MAX(Accent) in the two cophonologies associated with dominant and recessive affixes:

(8) a. ¬MAX(Accent)$_{Dom}$ ≫ MAX(Accent) ≫ ¬MAX(Accent)
b. Dominant affix cophonology: ¬Max-accent ≫ Max-accent
Recessive affix cophonology: Max-accent ≫ ¬Max-accent

Going in the opposite direction, i.e., from cophonologies to indexed constraints is, while generally equally possible, formally less straightforward. Consider the case of competing vowel hiatus resolution strategies in Turkish. The cophonology account provided in Section 2 ranks Max-V and Dep-C differently in the progressive and adverbial suffix cophonologies. An indexed constraint account could achieve the same effect by splitting Dep-C into two versions, one indexed to progressive stems and ranked above Max-V, and the other, fully general, ranked below Max-V. As a result, consonant epenthesis is disfavored in progressive stems, but preferred elsewhere as the strategy for resolving hiatus:

(9) One indexed constraint account of Turkish VV resolution strategies:
*VV ≫ Dep-C$_{ProgressiveStem}$ ≫ Max-V ≫ Dep-C

Progressive suffix: conditions V deletion (cf. Cophonology A: *VV ≫ Dep-C ≫ Max-V)

	/anla-ɯjor/	*VV	DEP-C$_{Prog}$	MAX-V	DEP-C
a.	anlaɯjor	*!			
b.	anlajɯjor		*!		*
☞ c.	anlɯjor			*	

Adverbial suffix: conditions glide insertion (cf. Cophonology B: *VV ≫ Max-V ≫ Dep-C)

	/anla-ɯndʒa/	*VV	DEP-C$_{prog}$	MAX-V	DEP-C
a.	anlaɯndʒa	*!			
☞ b.	anlajɯndʒa				*
c.	anlɯndʒa			*!	

But indexed constraint theory offers another, equally viable means of distinguishing the behavior of the progressive and adverbial suffixes: instead of indexing Dep-C to the progressive, Max-V can be indexed to stems formed with the adverbial suffix /-IndʒE/:

(10) Another indexed constraint account of Turkish VV resolution strategies:
*VV ≫ Max-$V_{AdverbialStems}$ ≫ Dep-C ≫ Max-V

Progressive suffix: conditions V deletion (cf. Cophonology A: *VV ≫ Dep-C ≫ Max-V)

	/anla-ɯjor/	*VV	MAX-V_{Adv}	DEP-C	MAX-V
a.	anlaɯjor	*!			
b.	anlajɯjor			*!	
☞ c.	anlɯjor				*

Adverbial suffix: conditions glide insertion (cf. Cophonology B: *VV ≫ Max-V ≫ Dep-C)

	/anla-ɯndʒa/	*VV	MAX-V_{Adv}	DEP-C	MAX-V
a.	anlaɯndʒa	*!			
☞ b.	anlajɯndʒa			*	
c.	anlɯndʒa		*!		*

Yet further alternatives are available in which both Max-V and Dep-C are indexed, in any of the three following ways:

(11) a) Max-V_{Adv}, Dep-C_{Prog} ≫ Max-V_{Prog}, Dep-C
or b) Max-V_{Adv}, Dep-C_{Prog} ≫ Max-V, Dep-C_{Adv}
or c) Max-V_{Adv}, Dep-C_{Prog} ≫ Max-V_{prog}, Dep-C_{Adv}

The last of these represents the logical extreme where every constraint is indexed and no constraint is fully general (11). In this limit case, constraints indexed to complementary environments do not interact at all, and indexed constraint theory converges almost completely with cophonology theory, which provides separate, noninteracting constraint rankings for each morphological context. Insofar as indexed constraint theory (with one ranking) is a meaningful alternative to cophonology theory (multiple rankings), indexed constraint theory should ideally rule out the hyper-indexation situation in (11c) in some manner.

Even excluding some or all of the scenarios in (11), however, indexed constraint theory still offers more solutions than cophonology theory to the same problem, and is therefore less formally parsimonious.[4]

4.2. *Free variation: an argument for cophonologies*

A strong argument raised by Anttila (2002) in favor of cophonological morphologically conditioned phonology is that the existence of free variation independently requires cophonologies, i.e., constraint reranking (see e.g., Kiparsky 1993; Reynolds 1994; Nagy and Reynolds 1995; Guy 1997; Itô and Mester 1997; Pater and Werle 2001 for analyses of free variation along these lines). Free variation cannot be described using indexed constraints, since, by definition, patterns that are in free variation occur in identical contexts.

A theory that extends cophonologies to handle morphologically conditioned phonology is clearly more economical than one which uses cophonologies for free variation but indexed constraints for morphologically conditioned phonology. Moreover, free variation and morphologically conditioned phonology often involve the same variables.

Anttila (forthcoming) discusses several examples from Finnish in which the same constraints are involved both in free variation and morphologically conditioned phonology. Here we present only the case of /ea/-final roots, which undergo coalescence to /ee/ under a number of conditions. As Anttila observes, coalescence is optional in adjectives, but banned in nouns (modulo a small number of exceptional native nouns, like *hopea* ~ *hopee* 'silver').

(12)	Nouns:	no coalescence			
		/idea/	→	idea	'idea'
	Adjectives:	optional coalescence			
		/makea/	→	makea ~ makee	'sweet'

Anttila uses ranking differences both to model the distinction between nouns and adjectives and also to model the variation observed within adjectives. Necessarily simplifying an interesting discussion, the basics of Anttila's proposal are as follows. Nouns and adjectives are subjected to distinct constraint rankings (cophonologies); in nouns, *EA (the ban on /ea/ sequences) ranks below faithfulness, predicting no coalescence, while for adjectives as a class, the two constraints are unranked. This means that adjectives can be produced with either ranking: *EA ≫ Faith, producing coalescence, or Faith ≫ *EA, without coalescence.[5]

(13) Master Ranking
{Faith, *EA}

Nouns	Adjectives	
Faith ≫ *EA	{Faith, *EA}	
	Variant 1	Variant 2
	Faith ≫ *EA	*EA ≫ Faith
No coalescence	*No coalescence*	*Coalescence*

In contrast to the cophonology model, which captures free variation and morphological conditioned via reranking, an indexed constraint approach to this fragment of Finnish would require a hybrid approach, using indexation for the noun-adjective differences and reranking for the adjective-internal free variation, as follows:

(14) $\text{Faith}_{\text{noun}} \gg \{\text{Faith}, \text{*EA}\}$

In summary, using one mechanism for both free and morphologically conditioned variation is more economical than using constraint reranking for free variation and constraint indexation for morphological conditioning.

4.3. *Stem scope and bracket erasure*

Having shown, thus far, that cophonology theory handles phenomena which indexed constraint theory cannot and that cophonology theory is more economical at handling the phenomena which both theories are designed for, we move now to several issues of deeper linguistic substance that distinguish the two approaches.

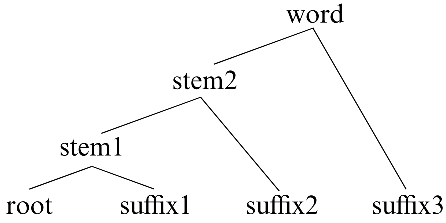
The basic architecture of cophonology theory makes two important predictions about morphologically conditioned phonology. Both correspond to well-known empirical generalizations that theories without cophonologies have either handled through stipulation or ignored at their peril:

(15) *Stem scope*: the scope of morphologically conditioned phonology is the stem formed by the word-formation construction in question.
Locality: the phonological pattern tied to a particular stem will never refer to morphological structure internal to the stem ("bracket erasure").

Cophonology theory makes both predictions, but indexed constraint theory makes neither, thus missing important empirical generalizations.

Cophonologies are tied to word-formation constructions. As a direct consequence, cophonology theory correctly predicts that the special phonological effects associated with a particular affix will be felt only within the stem created by attachment of that affix, and nowhere else in the word. Consider a morphologically complex word like that in (16):

(16)



Each branching node in this structure is associated with a cophonology that takes the phonological substance of the daughters of that node as its phonological input and produces as its phonological output the phonological substance of the stem in question. Thus "stem2" is the phonological output of the input-output mapping whose input is /stem1, suffix2/; "stem1" is itself the phonological output of the input-output mapping whose input is /root, suffix1/. The cophonologies associated with the word-formation constructions adding suffix1 and suffix2 — let us call them cophonology1 and cophonology2 — may be identical, or may be different.

What is important is that each cophonology affects only its daughters. The input-output mapping imposed by cophonology2 applies only to /stem1, suffix2/. It cannot affect suffix3, which is not in its scope. Nor can it interact with the word-level cophonological mapping producing the surface form of the word. The stem scope of special phonological effects associated with an affix (or with any word-formation construction) is clearly delimited in this model.

This same basic architecture also predicts locality, or so-called "bracket erasure" effects, i.e., the generalization that phonology applying within higher-order stems in a word does not make reference to deeply embedded morphological structure. Bracket erasure effects, of great interest in the 1980's, were captured in the theory of Lexical Morphology and Phonology with a stipulated principle erasing internal structure after the application of each cycle (or level) of phonological rules. Although bracket erasure effects have attracted little attention in Optimality Theory, capturing them remains an important desideratum for theories of the phonology-morphology interface. In cophonology theory they follow from the same two tenets of the theory that predict stem scope: cophonologies are definitionally local, relating mothers to daughters, and constraints are purely general. There is therefore no way for the internal morphological structure of an input stem, or the history of what cophonologies participated in its phonological makeup, to influence the cophonology applying to it.[6]

A theory without stem scope and locality principles predicts unattested types of phenomena. To illustrate this point, we introduce data from Hausa, whose morphologically conditioned tonal replacement effects are discussed by Newman (1986, 2000) and analyzed, in a cophonology framework, in Inkelas (1998). In Hausa, certain (typically affixal) constructions, which Newman calls tone-integrating, supply replacive tone melodies for the stems they attach to. Example (17) illustrates a tone-integrating suffix, in (17a), and a tone-integration zero-derivation construction, in (17b). Both delete stem tone, regardless of what it is, and impose a fixed tone melody:

(17) Tone-integrating morphological constructions

a. Ventive suffix (H) (Newman 2000: 663)

fìtá: (LH)	'go out'	→ fít-ó: (H)	'come out'
fáɗì (HL)	'fall'	→ fáɗ-ó: (H)	'fall down this way'
gángàrá: (HLH)	'roll down'	→ gángár-ó:	'roll down here'
tàimákà: (LHL)	'help'	→ táimák-ó:	'come and help'

b. Imperative construction (LH) (Newman 2000: 262–263)

kwá:ná (H)	'spend the night'	→ kwà:ná	'spend the night!'
tá:shì (HL)	'get up'	→ tà:shí	'get up!'
káràntá: (HLH)	'read'	→ kàràntá:	'read!'

Non-tone-integrating affixes preserve stem tone, as illustrated below by the nominalizing suffix -*wa:*, in (18a), with a LH pattern, and the pluractional reduplicative prefix, in (18b), which reduplicates the tone of the first syllable of the base. (The L of the LH melody of -*wa:* is realized on the preceding syllable because of a general ban in Hausa on tautosyllabic LH sequences, i.e., rising tones.)

(18) Non-tone-integrating morphological constructions

a. Nominalizing ("verbal noun"-forming) suffix -*wa:* (LH) (Newman 2000: 705)

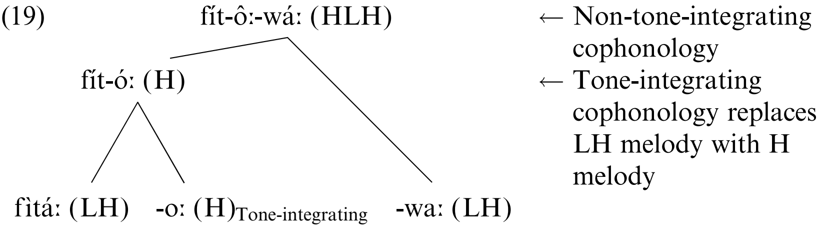
búgà: (HL)	'beat'	→ búgà:-wá: (H-LH)	'beating'
káràntá: (HLH)	'read'	→ káràntâ:-wá: (HLH-LH)	'reading'
sánár̃ (H)	'inform'	→ sánâr-wá: (H-LH)	'announcement'
cê: (HL)	'say'	→ cê-wá: (H-LH)	'saying'

b. Pluractional reduplicative prefix (Newman 2000: 424)

búgà: (HL)	'beat'	→ búb-búgà: (HL)
káràntá: (HLH)	'read'	→ kák-káràntá: (HLH)
kírá: (H)	'call'	→ kík-kírá: (H)
gyà:rú (LH)	'be well repaired'	→ gyàg-gyà:rú (LH)

The relevance of the stem scope and locality principles emerges in words with both tone-integrating and non-tone-integrating suffixes. In the following example, ventive *-o:* (H; tone-integrating) is followed by nominalizing *-wa:* (LH; none-tone-integrating). As seen, ventive *-o:* replaces the tone pattern of the base, but does not affect the tones of the outer suffix.

(19)

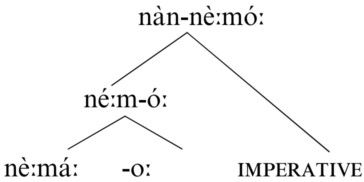


'go out-ventive-nml'

This outcome is consistent with Stem Scope. Outcomes that would be inconsistent with Stem Scope are hard to imagine. For example, we would never expect to find a language like Hausa in which the ventive suffix caused deletion of the LH tones of an outer suffix, e.g., as in this case, nominalizing *-wa:* (LH). Such a situation would violate Stem Scope; the ventive cophonology would be affecting morphemes outside its scope.

Next, consider (20), in which a ventive stem is converted to an imperative through tone-integrating zero-derivation:[7]

(20)



'search and bring!'

The interaction between ventive and imperative tone replacement illustrates both the Stem Scope principle and the Locality principle. This word has two cophonologies both calling for deletion of input tones and replacement by a fixed tone melody. The ventive calls for replacement by H, while the imperative calls for replacement by LH.[8]

(21) Ventive cophonology: Tone = H $\gg$ Ident-tone $\gg$ Tone = LH
Imperative cophonology: Tone = LH $\gg$ Ident-tone $\gg$ Tone = H

By comparison, a non-tone-integrating cophonology would rank both Tone = LH and Tone = H below Ident-tone.

The rankings in the two cophonologies in (21) contradict each other. But in cophonology theory there is no indeterminacy. Tone = H is top-ranked in the ventive stem cophonology, producing the output né:m-ó:; these H tones are present in the input to the imperative cophonology, in which top-ranked Tone = LH overwrites them. In any case where markedness outranks faithfulness in the cophonology of the outermost morphological layer of a word, that ranking will prevail, no matter how constraints are ranked in cophonologies associated with inner morphological layers.

Stem Scope and Locality follow intrinsically, as we have seen, from cophonologies. They do not follow as automatic consequences from indexed constraint theory. Consider, for example, how the cophonological differences in (21) would be translated into an indexed constraint account. Below is one of several equivalent possibilities:

(22) Tone = $H_{Ventive}$, Tone = $LH_{Imperative}$ $\gg$ Ident-tone $\gg$ Tone = H, Tone = LH

This ranking is not specific enough to predict the outcome in words containing both ventive and imperative morphology. In cophonology theory, the hierarchical structure of the word determines which cophonology applies to which subpart of the word, and in what logical order. But in indexed constraint theory, it is the highest ranked morphologically indexed constraint that determines the outcome — not the hierarchical structure of the word. Thus in order to know whether the tones of the root in a word like /nè:má: -o: -IMPER/ surface as H, as required by the ranking Tone = $H_{Ventive}$ $\gg$ Ident-tone, or LH, as required by the ranking Tone = $LH_{Imperative}$ $\gg$ Ident-tone, it is necessary to rank Tone = $H_{Ventive}$ and Tone = $LH_{Imperative}$ relative to one another. If ranked as in (23a), the prediction is that imperative tone prevails over ventive tone, the correct outcome for the word in (b). But if ranked as in (b), the prediction is that ventive tone will prevail, no matter what outer tone-integrating suffixes are attached.

(23) a. Tone = $LH_{Imperative}$ $\gg$ Tone = $H_{Ventive}$
/nè:má: -o: -IMPER/ → [nè:mó:]
b. Tone = $H_{Ventive}$ $\gg$ Tone = $LH_{Imperative}$
/nè:má: -o: -IMPER/ → *[né:mó:]

In short, there is nothing in indexed constraint theory to tie the ranking between indexed constraints to the morphological layering of their respective morphological domains. The fact that morphologically-specific constraints are ever-present in the ranking predicts that the effects of morphologically conditioned phonology are potentially global, rather than necessarily local. An indexed constraint can influence the phonology of morphological domains both smaller and larger than the one to which the constraint is indexed. A constraint referring to a deeply embedded morpheme could be ranked higher even than constraints referring to a word or phrase, producing rampant lexical and morphological exceptionality to word-level or phrasal phonological patterns. It is the non-occurrence of precisely this type of phenomenon that prompted the original inclusion of Bracket Erasure principles in the theory of Lexical Morphology and Phonology. That cophonology theory derives the absence of such effects gives it a huge explanatory advantage over indexed constraint theory, which predicts them to occur.

5. The Grammar Dependence argument and Faith-Based Variation

Given that cophonology theory is formally more parsimonious than indexed constraint theory, extends naturally to free variation, and better captures known generalizations about the scope of morphologically phonology in complex words, what could favor indexed constraint theory over cophonology theory?

The primary argument that has been put forward in favor of constraint indexation, primarily by Benua (1997a), Alderete (2001), and Itô and Mester (1999), is that indexed constraint theory is more restrictive than cophonology theory in the degree of language-internal variation it permits. The argument, referred to by Alderete as "Grammar Dependence", takes this form:

(24) The Grammar Dependence argument
 a. Cophonology theory predicts the existence of markedness reversals
 b. Languages do not exhibit markedness reversals
 c. Indexed constraint theory predicts the absence of markedness reversals, because of the principle of Faith-Based Variation (see Section 7), which permits only faithfulness constraints to be morphologically indexed
 d. Faith-Based Variation is better suited to indexed constraint theory than to cophonology theory; therefore, even if

cophonology theory incorporated Faith-Based Variation it still wouldn't be as good a theory

We argue that every one of these points, except the first, is incorrect:

(25) Rebuttal of the Grammar Dependence argument
  b. Languages do exhibit markedness reversals
  c. Indexed constraint theory predicts markedness reversals even when Faith-Based Variation is strictly adhered to.
  d. Faith-Based Variation is as much a stipulation in indexed constraint theory as it would be in cophonology theory

Rebuttal point (b) might be interpreted to mean that Faith-Based Variation is simply vacuous. However, it is not. Though, contrary to its billing, Faith-Based Variation allows in many types of markedness reversal, there is at least one type that it succeeds in ruling out; this type in fact exists, as demonstrated in Section 11.

Our conclusion is that Faith-Based Variation must be abandoned and that indexed constraint theory and cophonology theory do not differ in the range of language-internal diversity they predict.

6. The markedness reversal taboo

A common criticism of cophonology theory is that it permits markedness reversals, i.e., the existence of what Benua (1997b: 6) calls "wildly various surface patterns" in the same language.

As we have seen, cophonologies in the same language are constrained by what is specified in the Master Ranking. There is no intrinsic lower bound on the number of fixed rankings that the Master Ranking must contain, and so, in principle, any set of constraints could be left unranked there. In cophonology theory, therefore, two cophonologies can potentially differ from one another in any of the ways that two languages can differ from one another. They can differ in that one is more faithful than the other to underlying structure; they can also differ in the unmarked patterns that they impose when faithfulness permits. It is this latter point that troubles advocates of the Grammar Dependence argument. Alderete (2001), for example, is explicit in assuming that languages do not vary, internally, in the patterns that they predict to be unmarked. Instead, articulating a view that he has termed "Grammar Dependence", Alderete claims that phonological markedness is invariant within each language, and that language internal variation consists entirely in the degree to which each morphological construction permits the uniform default pattern of the language to emerge. For example, in a discussion of dominant affixes in Japanese, Alderete (2001: 222) writes that "a dominant affix is always grammar dependent [...] What this means is that dominant affixes trigger a deletion, but it is the rest of the grammar which determines the structure resulting from this deletion."

7. Faith-Based Variation

Faith-Based Variation is a putative universal principle, due to Fukazawa (1998); Alderete (1999); Itô and Mester (1999); Alderete (2001); and Kawahara (2001), and was proposed to capture the Grammar Dependence generalization. It states that only faithfulness constraints may be indexed to morphological or lexical contexts.[9]

(26) Faith-Based Variation: only faithfulness constraints can be indexed

Indexing a faithfulness constraint to a particular morphological domain makes it possible for that domain to be more faithful to its input than are other domains. Most of the constraint indexation we have illustrated thus far has been of this type:

(27) Indexed-Faith $\gg$ Markedness $\gg$ General-Faith

Faith-Based Variation is designed to rule out markedness reversals. Specifically, it rules out one straightforward means of generating them, namely the schema in (28):

(28) Markedness reversal schema (prohibited under Faith-Based Variation):
Indexed markedness $\gg$ General markedness

8. Faith-Based Variation and cophonology theory

The first plank in the Grammar Dependence argument is that Faith-Based Variation is more naturally implemented in indexed constraint theory than in cophonology theory. In this section, we present and critique this argument.

In cophonology theory, no constraints are indexed. However, the equivalent of Faith-Based Variation can still be implemented, if desired, as a requirement that the relative ranking of all markedness constraints must be firmly fixed in the Master Ranking of every language. This would allow cophonologies to vary only in the position of faithfulness constraints in the hierarchy. Proposals along these lines have already been made in the literature by Itô and Mester (1995a), in a cophonological implementation of a lexicon stratification analysis of Japanese that they subsequently converted to constraint indexation, and by Kiparsky (2003), for Stratal Optimality Theory.

Despite its apparent compatibility with both approaches, Benua (1997a), Alderete (2001: 227) and Itô and Mester (1999) have argued that Faith-Based Variation is more of a stipulation in cophonology theory than it is in indexed constraint theory. The logic offered by Ito and Mester (1999), building on earlier reasoning by Benua (1997b), is that faithfulness constraints are by their very nature intrinsically indexed (e.g., to input and output, or base and reduplicant), while markedness constraints are not, in that they always apply to the same string, namely the output. Itô and Mester conclude that Faith-Based Variation — i.e., the indexation only of faithfulness, not of markedness constraints — could therefore follow as a natural consequence of the way faithfulness and markedness constraints are stated and function within Optimality Theory.

However, this asymmetry is more a function of common practice than a formal consequence of the design of Optimality Theory. While it is true that faithfulness constraints are inherently indexed, it does not follow from this that they are inherently indexed to morphological categories. Input and output are morphologically neutral labels.

It should also be noted that markedness constraints have been indexed to morphological contexts in Optimality Theory analyses, proof by demonstration that nothing in the fundamental design of Optimality Theory rules out this practice. Two widely used examples are the constraint Lex $\approx$ PrWd, introduced by Prince and Smolensky (1993), which requires each lexical word to correspond to a prosodic word, and Affix $\leq \sigma$, proposed by McCarthy and Prince (1994a, 1994b), which restricts the prosodic shape of affixes.[10]

These precedents show that indexation of markedness constraints has been deemed possible, even necessary, in the past. No principled reason exists for why only faithfulness should be indexed; therefore, Faith-Based Variation is as much a stipulation within indexed constraint theory as its equivalent would be in cophonology theory. The ability to incorporate Faith-Based Variation does not distinguish the two theories.

9. Markedness reversals in actual languages

Our most important response to Faith-Based Variation and the schematic ranking that it prohibits is that markedness reversals are a fact of life in natural language, and theories should not be designed so as to predict their absence.

9.1. *Conflicting inventories: Japanese*

As our first illustration we turn to the phonotactics of Japanese lexical strata, which have been analyzed by Itô and Mester (1993, 1995a, 1995b, 1999) in both cophonological and indexed constraint frameworks. As Itô and Mester show, the Japanese lexicon can be subdivided into a number of lexical strata on the basis of phonotactic differences in root structure and, in some cases, patterns of alternation.[11] For four of the strata, there is an implicational relationship in the inventories of structures allowed in the strata they define: unassimilated foreign words are the most permissive in their structural possibilities, while the other three strata — assimilated foreign roots, Sino-Japanese roots, and Yamato roots — each have an increasingly more restricted subset of permissible structures:

(29)

	voiced geminate obstruents allowed	singleton /p/ allowed	voiceless postnasal obstruents allowed
Yamato (Y)	no	no	no
Sino-Japanese (SJ)	no	no	yes
Assimilated Foreign (AF)	no	yes	yes
Unassimilated Foreign (UF)	yes	yes	yes

This kind of language-internal diversity is consistent with Alderete's description of Grammar Dependence. The strata differ only in the degree to which they are faithful to lexical structure; in terms of markedness, all conform to the same ranking of the markedness constraints in (30), from Itô and Mester (1993, 1995a, 1995b, 1999):

(30) No-DD bans voiced geminates
No-P bans singleton /p/
No-NT bans voiceless post-nasal obstruents
Ranking for all strata: No-DD ≫ No-P ≫ No-NT

Itô and Mester's cophonological (1993, 1995a) and indexed constraint (1999) analyses are shown in (31a) and (31b), respectively. The indexed constraint account is consistent with Faith-Based Variation:

(31) a. Unassimilated Foreign: Faith ≫ No-DD ≫ No-P ≫ No-NT
Assimilated Foreign: No-DD ≫ Faith ≫ No-P ≫ No-NT
Sino-Japanese: No-DD ≫ No-P ≫ Faith ≫ No-NT
Yamato: No-DD ≫ No-P ≫ No-NT ≫ Faith

b. Faith_{UF} ≫ No-DD ≫ Faith_{AF} ≫ No-P ≫ Faith_{SJ} ≫ No-NT ≫ Faith_{Y}

However, these are not the only four lexical strata in Japanese. Itô and Mester (1993, 1995a, 1995b, 1999) also discuss a fifth stratum whose phonological inventory is neither a subset nor a superset of any of the inventories in (29). The Mimetic stratum of roots allows /p/ but bans voiceless postnasal obstruents; this puts it directly at odds with the Sino-Japanese stratum, which bans /p/ but allows voiceless postnasal obstruents.

(32)

	singleton /p/ allowed	voiceless postnasal obstruents allowed
Sino-Japanese (SJ)	no	yes
Mimetic (M)	yes	no

The fact that /p/ is too marked to occur in Sino-Japanese but unmarked enough to occur in the Mimetic vocabulary (e.g., *pata-pata* 'palpitating', from Mester and Itô 1989: 267), while postnasal voiceless obstruents are too marked to occur in the Mimetic vocabulary but unmarked enough to occur in Sino-Japanese (e.g., *sampo* 'walk'), is a clear reversal of markedness across lexical strata. It can be modeled straightforwardly with the kind of markedness indexation which, according to Faith-Based Variation, should not occur:

(33) {No-P_{SJ}, No-N_{TM}} ≫ Faith ≫ {No-P, No-NT}

9.2. *Conflicting alternations: Fox*

For a case in which alternations, rather than inventories, diagnose a markedness reversal, we turn to Fox. In Fox (Dahlstrom 1997; Fukazawa et al. 1998; Itô et al. 2001; see also Burkhardt 2001), vowel hiatus is resolved via consonant epenthesis. As has also been described for Mohawk (Michelson 1989), Fula (Paradis and Prunet 1989), and numerous other languages discussed in Lombardi (2002) and especially Blevins (2004), the identity of the epenthetic element varies across morphological contexts. In Fox, hiatus between stem and affix is broken up by an epenthetic *t* (34a), while hiatus between base and reduplicant is broken by an epenthetic *h* (34b). A form with both kinds of epenthetic segment is shown in (34c). Data are taken from Dahlstrom (1997):

(34) a. Epenthetic *t* breaks vowel hiatus between prefix and stem:

ne-t-en-a:wa	'I say to him'	220
ke-t-en-a:wa	'you say to him'	220
ne-t-amw-a:wa	'I eat him'	220
ke-t-a:čimo	'you tell a story'	220
ne-t-ek^{w}a	'he says to me'	221

b. Epenthetic *h* breaks vowel hiatus in (iterative) reduplication:

amwe-h-amwe:wa	'he eats him (iterative)'	219
ayo-h-ayo:ya:ni	'I use it; conjunct (iterative)'	219
iwa-h-iwa	'he says (iterative)'	219

c. ne-t-ek^{w}a-h-ik^{w}a 'he says to me (iterative)' 221

Still another epenthetic segment, *n*, is used in constructions involving a temporal particle.

A foundational assumption in Optimality Theory has been that the identity of epenthetic segments reflects unmarkedness in the grammar (see e.g., Smolensky 1993, and more recently DeLacy 2002).[12] By this reasoning, the Fox data openly contradict Grammar Dependence. It is clearly not the case that all of the constructions in Fox are subject to the same default consonant epenthesis pattern. The Fox situation is exactly what one would expect if markedness constraints could be indexed to morphological contexts, following the schema that Faith-Based Variation rules out. In the following illustration, the subscripts Af, Rd, Tp represent the contexts "affixed stem", "reduplicated stem", and "temporal particle", respectively:

(35) Indexed markedness hierarchy for Fox:

$$\{{*}t_{Rd}, {*}t_{TP}, {*}h_{Af}, {*}h_{TP}, {*}n_{Af}, {*}n_{Rd}\} \gg \{{*}n_{TP}, {*}t_{Af}, {*}h_{Rd}\}$$

10. Emulating markedness reversals using indexed faithfulness

One might think that the demonstration that markedness reversals exist would doom the Faith-Based Variation principle. However, the principle is not technically falsified by the data in Section 9, for the following reason: Faith-Based Variation rules out only one means of generating markedness reversals, namely the markedness indexation schema in (28). As it happens, most kinds of markedness reversals, including those in Japanese (Section 9.1) and Fox (Section 9.2), can be generated in a back-door manner using faithfulness indexation. We illustrate, below, and then comment on the implications of this result for Grammar Dependence, Faith-Based Variation, and the comparison between cophonology theory and indexed constraint theory.

10.1. *A faithfulness approach to markedness reversals in Japanese*

The demonstration that faithfulness indexation alone can generate the markedness reversals of Japanese is due to Fukazawa, Kitahara and Ota 1998. They show that when a faithfulness constraint (or set of constraints), indexed to morphological context X, counteracts the effect of the higher-ranked of two markedness constraints (Markedness1 and Markedness2), the lower-ranked constraint emerges as a force for unmarkedness only in context X.

(36) $\text{Faith}_X \gg \text{Markedness1} \gg \text{Markedness2}$

This ranking will generate a language which in most contexts enforces Markedness1 rather than Markedness2, but in context X, enforces Markedness2 rather than Markedness1. This is a markedness reversal, pure and simple — but it is accomplished without any reranking or indexation of markedness constraints at all.

The analysis of Japanese lexical strata proposed, along these lines, by Fukazawa, Kitahara and Ota 1998 is encapsulated in the example below (slightly modified from their examples on pp. 4, 9, 12), in which Markedness1 corresponds to No-P and Markedness2 to No-NT. The faithfulness constraints IDENT(LABIAL) and IDENT(VOICE) are indexed to the Mimetic and Sino-Japanese strata. The partial ranking $\text{IDENT(LABIAL)}_{\text{Mimetic}} \gg$ $\text{*P} \gg \text{IDENT(LABIAL)}$ permits labials in the Mimetic stratum but bans them elsewhere (i.e., in the Sino-Japanese stratum); the partial ranking $\text{IDENT(VOICE)}_{\text{Sino-Japanese}} \gg \text{*NT} \gg \text{IDENT(VOICE)}$ permits NT sequences in the Sino-Japanese stratum but bans them elsewhere, i.e., from the Mimetic stratum:

(37) Analysis of Fukazawa, Kitahara & Ota 1998 (slightly modified):

$$\text{IDENT(LABIAL)}_{M} \gg \text{No-P} \gg \left\{ \begin{array}{c} \text{IDENT(VOICE)}_{SJ} \\ \text{IDENT(LABIAL)}_{SJ} \end{array} \right\} \gg \text{No-NT} \gg \text{IDENT(VOICE)}_{M}$$

10.2. *A faithfulness account of markedness reversals in Fox*

The markedness reversals seen in Fox are equally amenable to a pure indexed faithfulness account. Instead of making /t/, /h/ and /n/ relatively marked or unmarked, it penalizes the *insertion* of these segments (or, in a more deconstructed version, the crucial features that distinguish them):

(38) Indexed Faithfulness hierarchy for Fox:

$$\left\{\begin{array}{l}\text{Dep-t}_{\text{Rd}}\\ \text{Dep-t}_{\text{TP}}\\ \text{Dep-h}_{\text{Af}}\\ \text{Dep-h}_{\text{TP}}\\ \text{Dep-n}_{\text{Af}}\\ \text{Dep-n}_{\text{Rd}}\end{array}\right\} \gg \left\{\begin{array}{l}\text{Dep-n}_{\text{TP}}\\ \text{Dep-t}_{\text{Af}}\\ \text{Dep-h}_{\text{Rd}}\end{array}\right\} \gg \text{*n, *t, *h}$$

The parallelism between what markedness indexation and faithfulness indexation can achieve means that ruling out markedness indexation has little effect on the descriptive power of the theory. This situation is a direct consequence of the too-many-solutions problem for indexed constraint theory, discussed in Section 4.1.

11. Faith-Based Variation falsified

Does Faith-Based Variation make *any* predictions? The answer is a qualified yes. It is not simply the case that Faith-Based Variation set out to restrict the set of possible languages, failed to do so, and proved to be a harmless, if vacuous, addition to the theory. Faith-Based Variation does, under certain assumptions, restrict the power of the theory by making it impossible to describe markedness reversals for which faithfulness indexation cannot account. The problem with this prediction is that such cases actually occur in languages.

11.1. *Case study 1: conflicting minimality effects in Japanese*

The type of case that Faith-Based Variation predicts to be impossible is a markedness reversal in which the relevant markedness constraints interact with the very same faithfulness constraint. Recall that the Fukazawa et al. (1998) result discussed in Section 10.1 emerges from the fact that the markedness constraints involved in the markedness reversal (*P, *NT) interact with different faithfulness constraints (Ident-labial, Ident-voice); it is for this reason that switching the relative ranking of the relevant faithfulness constraints is equivalent to switching the relative ranking of the relevant markedness constraints. But when a markedness reversal involves the same dimension of faithfulness, reranking the relevant faithfulness constraint can only neutralize a markedness contrast; it cannot effect a markedness reversal.

Minimality restrictions provide an illustration of this prediction. Consider a hypothetical language in which all roots must be monomoraic. Such a language can be characterized by ranking the following constraints as shown in (39c), after Prince and Smolensky (1993):

(39) Relevant size constraints for language with monomoraic root template

a. LEX = σ — 'A root contains (minimally) a syllable, i.e., minimally one mora'

b. LEX = PWD — 'A root contains (minimally) a foot, i.e., minimally two moras'

c. Ranking: LEX = σ ≫ *STRUC(μ) ≫ LEX = PWD, MAX

The ranking of Max at the bottom of the system guarantees that words will be very small. Ranking *STRUC(μ) over LEX-PWd guarantees that words will be smaller than two moras; ranking LEX = σ over *STRUC(μ) guarantees that words will have at least one mora. Thus overall this ranking guarantees that every root will consist of a single monomoraic syllable, regardless of the size of the input, as shown by the following tableau:

(40)

	/pikola/	LEX = σ	*STRUC(μ)	LEX = PWD	MAX
a.	pikola		**!*		
b.	piko		**!		**
c.	pik		**!		***
☞ d.	pi		*	*	****
e.	p	*!		*	*****

Faith-Based Variation requires that if the language characterized by this set of constraints has any subpatterns, they must all obey the relative ranking of the markedness constraints shown above, namely LEX = σ ≫ *STRUC(μ) ≫ LEX = PWD. Any subpatterns will differ only as a result of indexation and ranking of Max, the only faithfulness constraint in the system. Treating A, B and C as specific morphological contexts to which Max might be indexed, the two possibilities for this language are shown below:

(41) $\textbf{Max}_A \gg$ Lex = σ $\gg \textbf{Max}_B \gg$ *Struc(μ) $\gg \textbf{Max}_C \gg$ Lex = PWd
Contexts A, B: roots can be one or more syllables; no upper limit
Context C, all other contexts: roots must be exactly monomoraic

Faith-Based Variation thus rules out for this language the possibility that in some morphological context, roots would be required to be bimoraic (i.e., to obey Lex-PWd). This pattern is describable with the constraints in (39), but would require reranking the markedness constraint Lex = PWd above *Struc(μ), contrary to what Faith-Based Variation would allow.

(42) Prohibited subgrammar of the hypothetical language in (39):

	/pikola/	Lex = σ	Lex = PWd	*Struc(μ)	Max
a.	pikola			***!	
☞ b.	piko			**	**
c.	pik			**	***!
d.	pi		*!	*	****
e.	p	*!	*		*****

This hypothetical case exemplifies the kind of system that Faith-Based Variation predicts not to exist. However, this prediction is one we do not want to make, as this hypothetical case is actually a real one in Japanese. As documented by Itô and Mester (1995b), citing Hamano (1986) and Tateishi (1989), Sino-Japanese roots are mono-moraic, while mimetic roots are foot-sized. If, with Itô and Mester, we assume that the grammar is responsible for capturing generalizations of this sort, then Faith-Based Variation is overly restrictive.

11.2. *The alignment loophole*

One possibility for rescuing Faith-Based Variation from falsification by the above data would be to appeal to yet another back-door method of generating markedness reversals, namely the use of indexed alignment constraints. Requiring mimetic roots in Japanese to align with a well-formed foot would make them bimoraic; not requiring such alignment of other (e.g., Sino-Japanese) roots would, assuming the minimizing effects of *Struc, render non-Mimetic roots monomoraic:

(43) Mimetic root = σσ

	/σσσ/	Align L/R(mimetic, foot)	Lex = σ	*Struc
a.	σσσ	*!		***
☞ b.	σσ			**
c.	σ	*!		*

(44) Sino-Japanese root = σ

	/σσσ/	Align L/R(mimetic, foot)	Lex = σ	*Struc
a.	σσσ			**!*
b.	σσ			**!
☞ c.	σ			*

However convenient in the short term, this analysis bodes ill generally for Faith-Based Variation and the notion of Grammar Dependence. Either it is stipulated that neither markedness nor alignment constraints can be indexed, in which case the predictions of the theory are too narrow, or one includes alignment constraints in the set of potentially indexable constraints, in which case the predictions of Faith-Based Variation become very weak. Insofar as many things that can be accomplished with markedness constraints can also be accomplished with alignment constraints, prohibiting the indexation of markedness constraints while allowing indexation of alignment constraints renders Faith-Based Variation essentially vacuous.

In recognition of this fact, Alderete (2001: 214) takes care to avoid using indexed alignment constraints in his analyses of Japanese and Limburg Dutch accentuation, pointing out that his anti-faithfulness analyses retain their grammar-dependent character *only* if the accentuation patterns are handled using markedness constraints rather than indexed accentual alignment constraints. No principled reason for not indexing alignment constraints is offered, however. Indeed, a principled reason would be virtually impossible to find within contemporary versions of Optimality Theory, which routinely rely on indexed alignment constraints for such very basic purposes as ordering affixes within words and distinguishing between infixes and affixes.

11.3. *Case study 2: conflicting markedness patterns in English stress*

Another type of markedness reversal which faithfulness cannot resolve, and which Faith-Based Variation therefore predicts to be impossible, can be constructed in domains where faithfulness constraints play little or no role and thus cannot be relied on to neutralize the higher-ranking of two markedness constraints. This situation often arises in Optimality Theory analyses of stress assignment in which stress is assigned by grammar rather than being lexically present. The typology of stress assignment relies on alignment constraints and markedness constraints (e.g., Parse-σ, which requires the presence of stress feet; *Struc, which bans stress feet; WSP, which requires heavy syllables to be stressed; Ft-bin, which requires stress feet to be binary; and Clash, which prohibits adjacent stressed syllables). Here we focus on a typological parameter that is governed only by markedness constraints.

According to Pater (2000), the usual situation in English, due to a general requirement of iterative quantity-sensitive footing, is for a (word-initial) pretonic heavy syllable to be stressed, even if a stress clash would result (45). Exceptionally, however, there are some words that resist stress when clash would result (46):

(45) Class S1 words: Pretonic heavy syllables get secondary stress: *bàndána*, *Nàntúcket*, *pòntóon*, *càntéen*, *cèntúrion*, *càntánkerous*, *bàctéria*, *Òctóber*, *èxtrínsic*, *cògnítion*, *prìvátion*, *vòcátion*, *cìtátion*, *èjéction*, *Hàlicàrnássus*, *pìthecànthrópus*, *àpothègmátic*, *ànimàdvérsion*
(Pater 2000: 244)

(46) Class S2 words: Pretonic heavy syllables not stressed: *advántage*, *combúst*, *congréssional*, *extínguish*, *obtáin*
(Pater 2000: 263)

Pater demonstrates (2000: 265) that the Class S1 pattern can be generated by giving Parse-σ priority over Clash-Head, while for Class S2 words the priority is reversed. Pater implements the prioritization as indexation: Clash-Head is split into two constraints, one indexed to S2. As shown in (47), by having the Clash-head-S2 constraint outrank PARSE-σ, clashing configurations are avoided.

(47) *Clash-Head-S2 ≫ PARSE-σ ≫ *Clash-Head

For words that do not belong to Class S2, the high-ranking Clash-S2 constraint is irrelevant. PARSE-syllable therefore forces the footing of the pretonic heavy syllable, causing only a violation of the lower-ranked general CLASH constraint.

This case seemingly cannot be made consistent with Faith-Based Variation. Unlike the Japanese and Fox cases discussed in Section 10, it cannot be rescued by indexing faithfulness; unlike the Japanese case discussed in Japanese case discussed in Sections 11.1 and 11.2, it cannot be rescued using alignment. The presence of stress in S1 is not attributable solely to faithfulness to underlying pretonic stress; because S1 is the regular pattern, pretonic stress in S1 words can be assumed to be imposed by the grammar. Nor is the absence of pretonic stress in S2 words a matter of faithfulness to the *absence* of pretonic stress. S2 words do not generally resist stress assignment; if DEP-foot (or its equivalent) were even a component of the analysis at all, it would have to rank below PARSE-σ in both word classes. The only difference between S1 and S2 is whether or not the footing of heavy syllables can violate CLASH-HEAD.

Thus, by virtue of instantiating a markedness reversal in a system where faithfulness plays no role, Pater's observation about English illustrates that Faith-Based Variation does make limited predictions, but that those predictions are incorrect.

12. Optimality Theory embodies markedness reversals

The rejection of Grammar Dependence on empirical grounds, and the demonstration that theoretical attempts to derive Grammar Dependence do not work, should come as a welcome result to researchers working within the Optimality Theory framework: the Grammar Dependence concept is fundamentally at odds with two essential theorems of Optimality Theory, namely the concept of the emergence of the unmarked (i.e., that markedness can rank below faithfulness), and the fundamental assumption that markedness is relative (i.e., that markedness constraints are themselves ranked). These two key planks of Optimality Theory naturally interact to produce markedness reversals of all kinds. It is not desirable or possible to rule out markedness reversals in Optimality Theory. Optimality Theory is in fact a theory of multiple default patterns, ranked differently in every language.

(48) The multiple-default schema:
Faithfulness ≫ Markedness1 ≫ Markedness2 ≫ ... Markedness n

Even in a language where Markedness1 appears to establish some default setting, it is possible to override its effects through a higher-ranking indexed faithfulness constraint that neutralizes it in some contexts, thus permitting a lower-ranked markedness constraint, e.g., Markedness2, to establish the unmarked setting in that context. This is exactly the logic of the Fukazawa, Kitahara and Ota 1998 analysis of Japanese, in which indexed faithfulness was used to drive different markedness patterns in different lexical strata, and of the indexed faithfulness analysis of Fox.

13. A taxonomy and typology of diversity

We have shown up to this point that cophonology theory is more formally parsimonious than indexed constraint theory, that it is needed anyway to handle to free variation, that it better captures stem scope and locality generalizations about morphologically conditioned phonology, that it is no different from indexed constraint theory in the degree of language-internal diversity that it allows, and that the kind of markedness reversal which both theories predict to be possible do in fact exist. But we have not yet addressed, head-on, the concern voiced by many researchers about how much internal diversity a language can exhibit. This is the question that proponents of Grammar Dependence are interested in. While Grammar Dependence did not answer the question, abandoning it also leaves us no closer to an answer, if there is one. The clear presupposition of those who seek to constrain the theory is that the possible degree of language-internal diversity is far more restricted than the degree of possible diversity across languages. But what should the upper limit on language-internal diversity actually be?

This question was very important in pre-1993 lexical morphology and phonology (e.g., Kiparsky 1984, 1985; Halle and Mohanan 1985; Mohanan 1986; Zec 1993), from which the Strong Domain and Stratum Domain hypotheses emerged as possible answers. Both hypotheses depend on the organization of grammar into strictly ordered strata (e.g., Level 1 > Level 2 > Word > Phrase). The Stratum Domain Hypothesis (Mohanan 1982, 1986) requires a phonological pattern enforced in two different levels to also be enforced at all levels in between; the Strong Domain Hypothesis (Kiparsky 1984) makes the even stronger claim that a phonological pattern enforced in any given level also must be enforced at all earlier levels.

These proposals have not, however, survived the intervening years. They have been falsified by the finding, in various languages, that lexical strata are not strictly ordered, making it meaningless in many cases to talk about "earlier" or "later" strata (see e.g., Mohanan 1986, 1995; Inkelas and Orgun 1998). Even in languages whose levels do seem strictly ordered there is evidence of phonological patterns that skip one or more intermediate levels (see e.g., Hualde 1989; Inkelas and Orgun 1995). It would in any case be difficult to translate the Strong and Stratum Domain Hypotheses into Optimality Theory, there being no one-to-one correspondence between phonological alternations and constraint rankings.

The view we advance here is that it is futile to look for a synchronic principle that will correctly limit subgrammatical variation within a language to something less than the variation that is possible across languages.

First, we know that even language-internally there is more variation between, say, ideophones and non-ideophones than there is between, say, verbs and nouns. For example, in Yir-Yoront (Cape York Peninsula, Australia) ideophones allow certain onsets not otherwise permitted in the language, yet ban certain codas which are otherwise possible (Alpher 1994: 162). Any grammar that can describe the kinds of asymmetries holding between ideophones and non-ideophones in Yir-Yoront is clearly capable of describing comparable, or even more extreme, asymmetries between categories like noun and adjective, or passive vs. active verb, etc. Thus any formal principle that tolerates the kind of language-internal variation that exists between ideophones and non-ideophones will overgenerate variation potential in other sectors of grammar. In this way, then, any broad-based constraints on grammatical variation are already doomed to miss a large part of the picture.

A second reason for not wanting to restrict language-internal variation to being a subset of cross-linguistic variation is that language-internal variation and cross-linguistic variation are logically and materially related: language splits evolve from dialect splits, and dialect splits result from language-internal variation. Crucially, Anttila (1997, 2002) has explicitly related subgrammatical variation, for which he posits cophonologies, to the kind of free variation giving rise to dialect splits, based on solid diachronic and synchronic data from Finnish (see also Anttila and Cho 1998 on Korean). If one takes seriously the Optimality Theory view that languages differ only in their constraint ranking, then it has to be the case that dialects can differ in the ways languages can differ, and therefore that language-internal variation can encompass the same types of differences that characterize dialect splits. It therefore follows that there should not be any extrinsic, a priori limits on the dimensions along which two subgrammatical patterns can differ. The fact that the degree of difference between two languages is typically greater than the degree of difference found among patterns within a language is surely intimately related to the fact that distantly related languages differ from one another more than closely related languages do.

A third reason for not wanting an extrinsic limitation on language-internal diversity is that diachrony already provides us with a reason for why languages exhibit the internal diversity that they do. Many morphological restrictions on phonological patterns have as their source a one-time sound change that died out but was preserved in the morphophonology of morphological constructions extant at the time of the change. Morphological constructions acquired in subsequent stages of the language do not trigger these ossified alternations, and thus what was originally a general, unconditioned pattern can end up being a morphologically conditioned one. As observed in Zec (1993), waves of sound changes made opaque by subsequent morphologizations can give rise to the kind of distribution of phonological patterns that the Strong Domain Hypothesis predicts. Of course, there are other diachronic factors that can result in morphological conditioning of phonology, as well. Analogy can result in the extension of morphologically conditioned phonological patterns to additional morphological environments, obscuring the historical record; new sound changes can also obscure older, morphologically conditioned phonological patterns. Thus historical layers are constantly being added and removed.

This scenario helps to explain why languages generally do not show wild internal diversity of the hypothetical sort that concerned Benua (1997b), quoted in Section 6. Wild morphologically conditioned diversity — e.g., Mandarin-style tone on verbs, English-style stress in nouns — is not a situation that phonetically driven sound change alone is capable of producing. But there is at least one other diachronic scenario under which it could develop, namely extreme language contact. Indeed, this is precisely the presumed historical source for the extreme split system in present-day Michif, a so-called "mixed language" in which the nominal systems is largely based on French and the verbal system largely based in Cree (see e.g., Bakker 1997). Michif has distinct co-existing phonological systems, one French-influenced and one Cree-influenced. It was the unique history of the language that gave rise to these unusually different cophonologies.

A similar, if less dramatic, instance of contact-driven subgrammatical diversity occurs even in English. As has most recently been pointed out by Bermudez-Otero and McMahon (2006), the phonological differences between "level 1" and "level 2" in English are largely due to differences between English and French, most "level 1" morphophonemic alternations are due entirely to allomorphy in words borrowed from French.

In sum, the coexistence of disparate phonological systems in the same language may be unlikely, for solid historical reasons, but such systems do exist and must not be ruled out in universal grammar. The scales of difference observed within languages and language families are phenomena for historical linguists and variationists, rather than Optimality Theory typologists, to explain.

14. Conclusion

Cophonologies are superior to a single ranking of potentially indexed constraints as a method of capturing morphologically conditioned phonology. Cophonologies are formally economical, make accurate predictions regarding the scope of morphologically conditioned phonology within the word, and use the same formal mechanism that is needed to account for free variation — a phenomenon to which constraint indexation does not extend. Scrutiny of Grammar Dependence, previously put forward as an argument in favor of constraint indexation, shows it to be a nonfactor in the comparison between the two theories.

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Notes

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1. Turkish data are presented both in IPA and orthography (italicized). To eliminate unnecessary distractions, the effects of vowel harmony are shown as already present in underlying representation.
2. For full discussion of lexical vs. phrasal rules for accent assignment, and the issue of whether or the single H tone spreads phonologically, see e.g., Poser 1984; Pierrehumbert and Beckman 1988 and references therein.
3. One modification is our depiction of the low-ranked, general version of ¬OO-MAX (Accent) in the tableau.
4. In this particular Turkish case, Max-C ≫ Dep-V represents the minority pattern, which could motivate choosing the option of indexing Dep-V to the progressive over indexing Max-C to the adverbial (and other suffixes). But the larger issue of indeterminacy and

too-many-solutions still remains. In general, the number of distinct grammars that n constraints can define is n!; this is the number of distinct cophonologies that any one language can deploy and therefore, in cophonology theory, the number of distinct morphologically conditioned patterns a language can potentially exhibit. (The more constraints that are ranked in the Master Ranking, of course, the fewer cophonologies there can be, and nothing requires a language to utilize every cophonology that its Master Ranking makes possible.)

Constraint indexation can emulate the effects of co-existing cophonologies, as we have seen; therefore, given n constraints, indexed constraint theory is also possible of generating n!; this is the number of distinct morphologically conditioned outcomes. But the number of ways in which it can do so is multiplied by at least a factor of n, because there are always at least n equivalent ways to index a set of n constraints to any given context. As the mini-example from Turkish shows, any of the n constraints can be left purely general, so long as the others are indexed.

5. Anttila's grammar lattice is far more articulated than this, as it is accounting for more effects that we describe here, namely non-derived environment blocking (motivating an additional Faithroot constraint) and a process of /ia/ → [ii] coalescence which patterns differently from /ea/ → [ee] coalescence.
6. However, see Orgun and Inkelas 2002 on cophonological sensitivity to stem type.
7. The imperative is represented as an abstract suffix purely for graphical convenience. On the options for handling realizational morphology of this sort using cophonologies, see e.g., Orgun 1996; Inkelas 1998; Inkelas and Zoll 2005.
8. There are in Optimality Theory a number of possible ways to impose an all-H or LH tone pattern, the differences among which are irrelevant here; the shortcuts "Tone = H" and "Tone = LH" circumvent this issue.
9. On the relevance of indexed alignment constraints, see Section 11.2.
10. According to Prince and Smolensky, prosodic words by definition contain feet, and therefore Lex ≈ PrWd compels each lexical word to contain at least one metrical foot.

    See also Smith (1998) for the proposal that Tuyuca requires stem-specific markedness constraint requiring stems to possess stress. In this and many other examples in which indexed markedness constraint have been used, it is likely that indexed alignment constraints are equally viable; see Section 11.2 for discussion of relationship between Faith-Based Variation and alignment constraints.
11. Rice (1997) critiques this division of the lexicon into strata; Itô et al. (2001) respond with further arguments in its favor. An alternative analysis of the lexical strata of Japaneses, which treats the Sino-Japanese stratum as the least marked, can be found in Kawahara et al. 2003, who otherwise take the same general approach as Itō and Mester to stratal differentiation.
12. According to DeLacy (2002: 7), "consonant epenthesis is a 'pure' expression of markedness reduction". See, however, Blevins 2004 for the view that many epenthetic consonants have a morphological origin and therefore have no reason to manifest universal phonetic or phonological unmarkedness, even once their presence vs. absence becomes controlled by phonology rather than morphology.

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