Prosodic Constraints on Roots, Stems and Words

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1. Introduction*

How are phonological levels to be dealt with in Optimality Theory (Prince & Smolensky 1993)? We could treat different phonological levels within a language the same way OT treats the phonologies of different languages: in terms of constraint re-ranking (cf. McCarthy & Prince 1993a). We might formulate this proposal as:

(i) Different levels = different constraint rankings

I will argue against such a move here and sketch an alternative in terms of Alignment (McCarthy & Prince 1993b). I'll argue that different phonological levels are best described in terms of the *edges* of newly created domains:

(ii) Different levels = different morphological edges

I will claim that (i) places no real contraints on the grammars of different levels and that (ii) is far more restrictive in this regard. The idea is that two phonological levels within a language are always far more alike than they are different: given two levels defined in terms of different grammars (different constraint rankings), similarities between the two levels are accidental; given two levels defined in terms of different constraints, similarities between the two levels arepredicted.

The paper proceeds as follows. Section 1 sketches the main argument against (i). Section 2 sketches the counterproposal (ii). Sections 3 and 4 exemplify the counter proposal with data from Sanskrit and Classical Greek. Section 5 looks at a possible problem case and section 6 offers a short conclusion.

1. Levels and reranking

The main problem with a reranking analysis of phonological levels is that it does not guarantee structure preservation (Kiparsky 1985), broadly construed. Kaisse & Hargus (1993, 11) characterize structure preservation as follows:

> The general idea is that the prototypical lexical rule preserves the basic underlying segment and tonal inventory of the language and the basic arrangement of strings of segments as well. There will be a lexical vocabulary of segments and tones, which does not alter during the derivation of words, and an enriched array of allophones, which is derived postlexically.

Thus if a language has only 5 vowels underlyingly no lexical rule may introduce a 6th or a 7th vowel.

Structure preservations is completly accidental on a model of grammar in which two lexical levels may differ in the same way as two languages may differ. And this is the case with structure preservation in general, not just with the preservation of segment types or tonal inventory. (i) above is compatible with the following highly unlikely scenarios, where L stands for some abritarily chosen language:

(1) Different levels = different constraint rankings

(a) L has the vowels of Hawaiian at level x and those of Swedish at level y
(b) L has the syllables of Polish at level x and those of Japanese at level y
(c) L has syllabic iambs R->L at level x and moraic trochees L->R at level y

Languages like these are either really rare or don't exist. Two levels within a language are much more alike than the phonologies of randomly chosen different languages.

As pointed out by Inkelas, Orgun and Zoll (1994), constraint reranking multiplies the number of grammars within a single language. In derivational theories like Lexical Phonology (Kiparsky 1982, Mohanan 1982), it is precisely (the stipulation of) structure preservation that lets us avoid grammar multiplication across lexical levels in a single language.

In what follows I'll try to show that merely incorporating (stipulating) the principle of structure preservation into OT is not the answer. Sanskrit and Greek both show that the well-formedness of prosodic structure can differ at different levels of the lexical phonology. But the differences are clear only at morphological edges, leading to the hypothesis in (ii).

2. Levels and edges

What we commonly find in languages are the following sorts of scenario:

(2) Different levels = different edges

(a) L has the vowels of Spanish at level x *plus nasalized vowels stem-finally*
(b) L has the syllables of Polish at level x *but allows an extra C word-initially*
(c) L has syllabic iambs R->L at level x *with final extrametricality at level y*

Such facts do not require that the phonologies of entire morphological domains differ; rather they require that only the phonologies of morphological domain edges differ. Insofar as (ii) is correct, we expect non-edge phonology to be uniform across domains and only edge phonology to differ.

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In what follows I will assume that all phonological constraints can be handled as pairings of information about Morphology (M), Prosody (P) and Features (F).[1] Typical doublets include those in (3), where the top row is quantified universally and the bottom row is quantified existentially, following McCarthy & Prince 1993b.

(3) Constraints as doublets

M	[Stem	
|	|	
P	[Foot	'Every stem begins with a foot'

P	[Foot	
|	|	
M	[Stem	'Every foot begins a stem'

F	Tone	
|	|	
P	Mora	'Every tone is linked to a mora'

F	mora	
|	|	
P	TONE	'Every mora is linked to a tone'

(cf. Itô 1986, 1989; Zec 1995.) Perhaps the most pervasive such doublets are Align constraints, which can pair types with themselves: morphology with morphology, prosody with prosody (McCarthy & Prince 1993b):

(4) Constraints as doublets

M	[Stem	
|	|	
M	[Root	'Every stem begins with a root'

P	[Word	
|	|	
P	[Foot	'Every prosodic word begins with a foot'

We can extend the analysis to account for feature co-occurrence restrictions if we assume that information about features can be paired with itself:

(5) Feature co-occurrence restrictions

F	SON	
|	|	
F	VOI	'Every sonorant is voiced'

[1] My thoughts on this topic have benefitted a great deal from discussion with Tomas Riad.

Faithfulness constraints can also be reduced to pairings of M, P and F. PARSESEG is a P-F requirement, PARSESYLL is a P-P requirement, and so on:

(5)

P	σ	
|	|	
F	•	'Every root node is linked to a syllable'

P	σ	
|	|	
F	LAB	'Every labial features is linked to a syllable'

There seems to be no need for triplets in formulating constraints, so I tentatively suggest the followig constraint on constraints:

(6) Constraints mention at most two levels (M, P, F) of information.[2]

This rules out constraints like: 'roots must end in coda consonants' while allowing constraints like 'roots must end in consonants' or 'roots must end in codas'. More generally,

(7) Constraints are not triplets

*MORPHOLOGY	*MORPHOLOGY	*MORPHOLOGY	
|	|	|	
PROSODY	MORPHOLOGY	PROSODY	etc.
|	|	|	
FEATURES	PROSODY	PROSODY	

The unlikelihood of constraints like 'roots must end in labials' or 'stems begin with nasals' suggests a further constraint on consraints: that M-F pairs are not possible. But the negative form of precisely this type of constraint does seem to be needed, as I'll show below for Greek and Sanskrit: 'roots must not end in labials', 'stems must not begin with nasal'. I see no way of deriving this at present and simply offer the stipulation in (8):

(8) M-F pairings are negative.

With this framework of constraints we return to the role of morphology in phonology and suggest that it merely defines new *edges* at which different constraints are active:

(9) All morphologically senstive phonology is expressible in terms of alignment constraints

Now to some data.

3. Sanskrit

[2] Most Alignment constraints can take the form Align-L (x, y) or Align-R (x, y). Mixed alignment of the type Align the L edge of x with the R edge of y, used sporadically in OT (eg, in McCarthy & Prince 1993b) can usually be handled in other ways. But this goes beyond the scope of this paper and I'll not try and defend the claim here.

In this section I'll show that there are constraints on roots and words in Sanskrit and that they are different. I'll consider an analysis in terms of different constraint rankings and reject it in favor of an analysis in terms of different edges.

Constraints on roots[3]

As Steriade(1988) has shown, Sanskrit verbal roots are all both heavy and monosyllabic.

> The verbal root in Sanskrit is **monosyllabic** and **bimoraic**. With few exceptions, a Sanskrit root consists of a string of segments that can be exhaustively analysed as a single syllable. There are no verb roots of the form CVCV or CV.V. (p.102)

Neither restriction (monosyllabicity or heaviness) is statable without assuming that syllable structure is part of underlying representation, since roots are by their very nature underived. (See Inkelas 1994 for additional arguments for underlying prosody in OT.) I propose that Sanskrit adheres to the M-P constraints in (10):[4]

(10) [Root]
|
[σ] 'Every root is a syllable'

(11) [Root]
|
[Foot] 'Every root is a bimoraic foot'[5]

Exactly what counts as a syllable is not part of (10), but part of the general phonology of Sanskrit (see below); similarly for what counts as a foot (two moras). (Note that neither (10) nor (11) is not a constraint on stems or words, both of which may be polysyllabic.)

Prosodic constraints on roots are not limited to Sanskrit. As is by now well established, Proto-Indo-European roots had one of the three shapes below:

(12) Proto-Indo-European Roots

a. (C)VO	ag	'drive'	(O = Obstruent)
b. (C)VR	gen	'beget'	(R = Sonorant)
c. (C)VRO b^{h}end^h		'bend'	

PIE had no roots of the form V, VOR, VOO or VRR. We may separate this into two constraints: every root is a syllable (10) and every root ends in a consonant (13):

(13) Root]
|
C 'Every root ends in a consonant'

The fact that PIE roots never violate sonority sequencing restrictions (eg, CVOR) follows from the constraints on syllable structure in the language as a whole and need not be stated separately for roots. The following tableau illustrates how (10) and (13) rule out illicit roots:

(14) PIE constraints on roots

	[Rt] | [σ]	Rt] | C
ag		
gen		
b^{h}end^h		
*ga		*!
*geni	*!	*
*genin	*!	

Only the first three candidates are well-formed; the fourth and fifth fail because they are vowel-final, the fifth and sixth fail because they are polysyllabic.

The difference between Sanskrit and PIE in this regard is that Sanskrit lost a set of laryngeal consonants that PIE had. These laryngeals deleted with compensatory lengthening in coda position, with the result that the second and third classes of roots split in Sanskrit. Roots that had final laryngeals in PIE have long vowels in Sanskrit.

(15) Sanskrit Roots

a. (C)VC	aj	'drive'
b. (C)VR	gam	'go'
(C)V:	sta:	'stand'
c. (C)VRC band^h	'bind'	
(C)V:C	sa:d^h	'succeed'

These root shapes are ruled in as follows, using (10) and (11):

[3] I'm grateful to Stanley Insler for discussion of the Sanskrit and Indo-European facts.
[4] Note that (10) requires both edges of the root to align with the edge of one syllable; this rules out the possibility of extrametrical consonants in the root. Extrametrical root consonants in Greek are treated below (see #37).
[5] I follow Kager (1993) in having only two sizes of foot: bimoraic and bisyllabic. Sanskrit and Greek have the former type.

(16) Sanskrit constraints on roots

	[Rt] | [σ]	[Rt] | [Foot]
aj		
gam		
sta:		
*ga		*!
*gami	*!	
*gami:	*!	

There are no additional root-specific constraints in Sanskrit.

It remains to be seen, of course, what constraints there are on Sanskrit syllables at this level. Abstracting away from root-initial and -final [s] Sanskrit roots have at most two onset consonants and at most wo coda consonants (Steriade 1982, 1988). Sanskrit root-syllables may end in any consonant, regardless of laryngeal specifications or place of articulation.

(17) Roots may end in any consonant

VCLS	pat	'fly'
VOICE	ad	'eat'
VOICE ASP	ksudh	'be hungry'
VCLS ASP	likh	'scratch'

LABIAL	tap	'heat'
DENTAL	ad	'eat'
PALATAL	aj	'drive'
VELAR	çak	'be able'

Roots may end in any two consonants that do not violate sonority sequencing:

(18) Roots may end in any cluster with falling sonority (Steriade 1982 for details)

jambh	'chew up, cush'
iinkh	'swing'
valg	'spring'
krand	'cry out'
bharv	'devour'
sphuurj	'rumble'

We turn now to prosodic constraints on words in Sanskrit. As we will see, the edges of words are more highly constrained than the edges of roots, even though the insides of roots and words share identical phonology.

Constraints on words

Word-final consonants in Sanskrit are voiceless, unaspirated, non-palatal singletons. Of the 25 stops in Sanskrit, restrictions against word-final PALATAL and LARYNGEAL features leave only 8 that may occur word-finally:

(19) Permitted word-final stops

	LAB	DENT	RETR	*PAL	VEL
PLAIN	p	t	T	c	k
*ASP	p^h	t^h	T^h	c^h	k^h
*VOI	b	d	∂	j	g
*VOI ASP	b^h	d^h	$∂^h$	j^h	g^h
NAS	m	m	=	ˆ	N

We may postulate the following constraints for the phonological word in Sanskrit and note that they are unviolated in the language. The first, a P-F constraint, forbids word-final palatals; the second, also a P-F constraint, forbids laryngeal features (ASP, VOI). To these must be added a third which forbids word-final clusters of any type.

(20) WORD]
|
*HI] 'Words may not end in palatal segments'

(21) WORD]
|
*LAR] 'Words may not end in voiceless or aspirated segments'

(22) WORD]
|
*CC] 'Words may not end in clusters'

The effects of (20) can be seen in a suffixless form of a root like vac 'voice':

(23) vac]$_{Rt}$vak]$_{\omega}$ 'voice'

	[RT] | [σ]	[Rt] | [Foot]	Word] | *HI	FILL	PARSE
☞ vak<Hi>					*
va.cE				*!	
vac			*!		
va<c>		*!			*
v<ac>	*!	*			**

The first candidate violates PARSE because of the unparsed feature HI. But the rest of the candidates all violate higher ranked constraints: the epenthetic vowel of the second violates FILL;

the third violates (20), the fourth (10) and the fifth (11). Exactly parallel considerations obtain for (24) and (25):

(24) likh$]_{Rt}$ lik$]_{\omega}$ 'scratch'

(25) dant$]_{Rt}$ dan$]_{\omega}$ 'tooth'

Underparsing of the SpreadGlottis feature in (24) avoids violation of (21). Underparsing of the final consonant in (25) is done to respect (22).

Constraints on roots and words

How are we to understand the differences between root- and word-final restrictions on consonants? The preceding analysis works easily because it separates constraint on roots from those on words: (10) and (11) align both sides of a root with a heavy syllable, (20)- (22) forbid prosodic words to align with certain features. This is in keeping with (ii), the claim that differet levels of phonology reduce to different edges.

A more traditional analysis might treat roots as unsyllabified strings of segments subject to to no prosodic well-formedness constraints; if they only become sylabified when they reach the word level, we have an explanation of the different syllable structures possible for roots and words. But we have already seen that roots must be syllabified if we are to understand the prosodic restriction on root shapes. What these data force us to recognize is that well-formed roots in a language need not be well-formed words, even when both roots and words are syllabified.

A second option is to treat roots and words as governed by different phonologies, ie, by constraint reranking. We might do this as follows. At the root level (26), lexemes (LEX) are underspecified for ROOT; this information is factored out to the level (upper left-hand corner of tableau.) The conflicting constraints play out as follows at the root level:

(26) vac$]_{Rt}$ 'voice'

Root Level	PARSE	Lex] | *HI
vak<Hi>	*!	
☞ vac		*

Similarly at the word level (27), where lexemes are underspecified for WORD.

(27) vak$]_{\omega}$ 'voice'

Word Level	Lex] | *HI	PARSE
☞ vak<Hi>		*
vac	*!	

The difference between root and word level is given simply as a difference of constraint ranking. In (26) Parse dominates the constraint against final HI, in (27) the reverse. The major advantage of a two phonology approach like this is that edge-brackets need not be labeled, since the labeling is a function of the level of analysis.

But exactly this advantage leads to problems. While it is true that all Sanskrit roots are maximally monosyllabic, this is not at all the case for words. Suffixes often create polysyllabic words:

(28) vac-as 'voice (gen sg)'

Underspecifying brackets by filling in morphological information by level makes (10) and (11) into constraints on words as well as on roots. But this is patently false, as (28) shows.

We could, of course, rerank (10) and (11) below PARSE, making them ineffective in shortening words like (28). But this reranking follows from nothing and explains nothing: we have merely missed the fact that only roots must be heavy and monosyllabic in Sanskrit. The big problem with such an analysis, moreover, is that nothing guarantees structure preservation, broadly defined. We know that Sanskrit roots and words make use of the same set of segment and syllable types but nothing in the analysis leads us to expect this.

What is most important about the analysis in terms of edges is that it predicts rather than stipulates the unmarked case: that the segmental inventory, syllable templates, etc. of roots and words is the same. Put another way, morphological levels like root, stem and word label edges not domains. This makes the strong prediction that we will not find constraints like those below corresponding to those in (20) - (22):

(29) *'Words may not contain palatal segments (but roots may)'

(30) *'Words may not contain voiceless or aspirated segments (but roots may)'

(31) *'Words may not contain clusters (but roots may)'

4. Greek

I turn now to data from Classical Greek. It is parallel to the Sanskrit case in that it shows there are different constraints on roots and on words. The data concerns a prohibition against stem-final stops that has been largely misunderstood in Greek scholarship. It applies to stems, but not to words, giving us another case where differet phonological levels seem to be best described in terms of different morphological edges.

Constraints on roots

As shown in Golston (1991), Greek roots are minimally bimoraic. They may consist of one or more syllables, open or closed as long as the whole thing consistitutes an acceptable string of Greek syllables (with one exception discussed below). Roots of the Sanskrit type include:

(32) Heavy monosyllabic roots

guup	‘vulture’
pod	‘foot’
aig	‘goat’
pemp	‘send’
leont	‘lion’
alg	‘pain’

Roots may also be polysyllabic, showing that the constraint on monosyllabic roots does not make itself apparent in Greek.

(33) Polysyllabic roots

Aithiop	‘Ethiopian’
aspiid	‘spear’
piinak	‘table’

Finally, Greek roots may end in exactly one unsyllabifiable or ‘floating’ consonant. These unsyllabified consonants would otherwise result in violation of the sonority sequencing principle. They include root-final clusters of equal (*galakt* ‘milk’, *hipp* ‘horse’) or rising sonority (*hypn* ‘sleep’, *anr* ‘man’)

(34) Root with final extrametrical consonants

galak(t)	‘milk’	(no fall in sonority)
hip(p)	‘horse’	
thalas(s)	‘sea’	
hyp(n)	‘sleep’	(rise in sonority)
an(r)	‘man’	

There are no roots with two such consonants:

(35) Non-occurring root types

*galak(tr)
*hip(pr)

We may characterize Greek roots as follows:

(36) Root
|
Foot ‘Every root contains a foot’

(37) (C)
|
Root] ‘Every extrametrical consonant is root-final’

The constraint in (36) is not stated in terms of align because Greek roots need not align on the left (*galakt-* ‘milk’) or the right (*iilu-* ‘mud’) with a foot; they must merely contain one.

Greek roots are like their Sanskrit counterparts in that they may end in any type of segment. There are no restrictions on root-final place, manner or laryngeal features.

Constraints on Stems

In stark contrast to this, stem-final stops are quite marginal in Greek. This is especially clear word-finally, where stops never occur: Greek words may end only in [n, r, s] or a vowel. To account for the non-appearance of word-final stops, previous work on Greek phonology (eg, Steriade 1982 and references therein) has assumed that stops delete word-finally, citing 3rd declension nominal examples such as the following:

(38)

sooma<t>	‘body’
elpi<d>	‘hope’
gunai<k>	‘woman’
ana<kt>	‘king (vocative)’
gala<kt>	‘milk’

This has been taken to motivate a rule like (39):

(39) STOP -> ø / __]Word

I’ll show in this section that (39) misses an important set of generalizations about Greek morphology. Instead, I’ll argue for the constraint below.

(40) Stem]
|
*Stop ‘No stem ends in a stop’

Aside from the labeling (Word vs. Stem), the difference between (39) and (40) is that the latter doesn't say what happens to the offending stops. As we'll see below, only dental stops generally undergo anythingl like the deletion process in (39); labial and velar stops don't delete, making (39) too strong. Let us turn then to the data and see what the actual patterns are.

The Greek 3rd declension is the declension for consonant-final stems and thus provides the only direct evidence for what happens to consonants word-finally. But the data in (38), however commonly cited, is misleading and overlooks important phonological and morphological generalizations. First, the vast majority of cases like (38) involve dental-final stems. There are exactly three cases of deleted velars in the language (those in 38) and absolutely no cases of deleted labials. This is very surprising given the commonness of velar- and labial-final roots in Greek. So what happens to all these labial- and velar-final roots when the morphology does not provide them with a suffix? The answer is that the phonology epenthesizes an [s] to save them.

To see this we need to closely consider the morphology of nominative and vocative 3rd singular stems, where the stop-deletion data comes from:

(41) 3rd Declension nouns

	Masculine	Feminine	Neuter
Nom	-s	-s	-ø
Vocative	-s/-ø	-s/-ø	-ø

Neuters are unmarked elsewhere in Greek, making the final column unexceptional. The masculine and feminine forms of the vocative are -s for labial and velar-final stems (42), -ø for dental stems (43):

(42) Suffixed non-neuter vocatives

Ait^{h}iop-s	'Ethiope'	
p^{h}leb-s	'vein'	(surface [p^{h}lep-s])
p^{h}ulaak-s	'guard'	
aig-s	'goat'	(surface [aik-s])

(43) Bare non-neuter vocatives

pai<d>	'boy'	(masc)
thee<t>	'serf'	(masc)
gigant<t>	'giant'	(masc)
geron<t>	'old man'	(masc)
damar<t>	'wife'	(fem)
elpi<d>	'hope'	(fem)
khari<t>	'grace'	(fem)
ornii<th>	'bird	(fem, masc)

As is clear from (43), stem-final dental stops delete word-finally. The point of (42), however, is that stem-final labial and velar stops are saved from deletion by an epenthetic [s].

Vocative -s is the only instance of a distinctive vocative singular suffix within Greek. As the following shows, 1st and 2nd declension nouns, as well as dental-final 3rd declension nouns take no suffix in the vocative:

(44) Bare vocatives

	Feminine	Masculine	
1st Declension	xhoraa	neaaniaa	'land' 'sailor'
	nikee	Atreidee	'victory' 'son-of-Atreus'
2nd Declension	hode	hippe	'road' 'horse'
	neese	anthroope	'island' 'person'
3rd Declension			
Labial	phalank-**s**	kloop-**s**	'phalanx' 'thief'
Dental	elpi<d>	pai<d>	'hope' 'child'
Velar	kliimak-**s**	phulak-**s**	'ladder' 'guard'

Comparative evidence from other Indo-European languages confirms that the inherited vocative suffix is -ø (Buck, 1933§229). This means that at some point in its history, Greek decided to add -s suffixes to labial and velar-final vocatives.

I would argue that the final [s] in labial and velar-final stems is here only to allow parsing of distinctive place features.[6] Given the constraint in (45), we are now in a position to analyze labial-, velar- and dental-final vocatives.

(45) PARSE PLACE 'Place features must be parsed'

[6] The three exceptions (gunai<k> 'woman', ana<kt> 'king (vocative) and gala<kt> 'milk') are not exceptional with respect to their unparsed final stops, but with respecto to the lack of the final [s] which normally allows final vocatives with place features to surface. Two of the words are exceptional in other ways: *ana* is found only in Homer, other dialects of Greek having regular *anaks*; *gunai* has a different final vowel than we'd expect from the stem, which has *-ee*.

Assuming that dentals are unmarked (Kiparsky 1982; Paradis & Prunet 1993) in Greek, the constraint tableau necessary for dental-final stems is as follows:

(46) Vocative singulars (dental-final stems)

	Parse Place	Stem] ǀ *Stop	Fill
☞ soo.ma<t>			
soo.mats			*!
soo.mat		*!	

The first candidate respects the constraint against stem-final stops (40) by deleting the final stop. The second does so by epenthesizing an -s; this is fatal since a better candidate exists. The third leaves the stem unchanged, in fatal violation of (40).

Labial and velar-final stems work slightly differently:

(47) Vocative singulars (velar-final stems)

	Parse Place	Stem] ǀ *Stop	Fill
☞ pii.naks			*
pii.nak		*!	
pii.na<k>	*!		

Here the candidate that violates Fill is the best one going. Candidates that respect Fill by violating higher ranked (40) or ParsePlace lose out.

The same constraint on stem-final coda stops can be seen at work elsewhere in the phonology of Greek. Especially important are cases of stem-final stops that are not word-final. Here labial and velar stops are retained in the coda due to the overriding constraint ParsePlace. Note that epenthesizing an [s] would be frivolous here and is not considered:

(48) Retention of stem-final labial and velar stops

	Parse Place	Stem] ǀ *Stop	Fill
☞ pii.nak] -si		*	
pii.naS] -si	*!		
pii.na<k>]-si	*!		

With stem-final dentals PARSE PLACE is not an issue and the stop feature goes unparsed. The segment lenites to underspecified [s], however, rather than deleting as it does word finally. We may understand this as follows: word-internally dentals lenite rather than delete because deletion necessarily involves more violations of Parse:

(49) Lenition of stem-final dental stops

Perfect Med-Pass	Parse Place	Stem] ǀ *Stop	Fill	Parse
☞ ge-gum.naS]-mai				*
ge-gum.na<d>]-mai				**!
ge-gum.nad]-mai		*!		

Word-finally an additional constraint comes into play which demands that phonological words end in some phonological feature:

(50) Word] ǀ Feat ‘Every word ends in a distinctive feature’

This makes lenition of [t] to completely underspecified [S] a worse option than full deletion:

(51) Vocative singulars (dental-final stems)

	Stem] ǀ *Stop	Fill	Word] ǀ Feat	Parse
soo.maS<Stop>			*!	*
☞ soo.ma<t>				**
soo.mats		*!		
soo.mat	*!			

The constraint in (50) has no effect on velar- and labial-final stops because of its ranking below Fill; as inspection of (52) reveals, the winning candidate is selected without regard to Fill or any constraint ranked lower than it:

(52) Vocative singulars (labial- and velar-final stems)

	Parse Place	Stem] ǀ *Stop	Fill	Word] ǀ Feat
☞ kloops			*	*
kloop		*!		
kloo<p>	*!			

It must be pointed out that there is no general constraint against coda stops in Greek; rather, it is stem-final coda stops that are ruled out so vigorously. This is evident from two types of data: first, there are tautomorphemic dental codas:

(53) a.rit^h.m-os 'number'

Second, dental codas occur before unproductive suffixes:

(54) e.ret.-mon 'oar' (row-thing)

Labeling (40) to apply to the edges of Stems allows coda-stops that stem-internally:

(55) Stem-internal coda stops

	PARSE PLACE	Stem] | *Stop	PARSE	Word] | Feat
☞ a.rit^h.m-os				*
a.riS.m-os			*!	*
a.ri<t^h>.m-os			*!*	*
☞ aret-mon				
areS-mon			*!	
are<t>-mon			*!*	

One final consideration before we return to the larger picture: the violability of STEM]-STOP with vowel-initial suffixes. As is not surprising, stem-final stops are retained when they provide an onset to the following syllable: the dative singular of *soomat-* 'body' is *soo.ma.t-i*. The relevant constraint would seem to be the familiar ONS (Prince & Smolensky 1993), reformulated here as:

(56) [Syll
|
C 'Every syllable begins with a consonant'

Ons is ranked above Stem]-Stop, as the following tableau makes clear:

(57) Vocative singulars (dental-final stems)

	[Syll | C	Stem] | *Stop
☞ soo.ma.t-i		*
soo.ma<t>.-i	*!	

But this formulation of ONS is too coarse and fails to reflect the fact that less sonorous onsets are better than more sonorous onsets (the reverse for codas). This is clear from Greek data like the following:

(58) damart-i [da.mar.t-i]

The result we'd expect given the general formulation of ONS is *da.mar<t>-i. I propose the following refinement of Ons: stop-initial onsets are completely unmarked and the following constraints tie the well-formedness of an onset consonant to its sonority:

(59) [Syll
|
*Fric 'No syllable begins with a fricative'

(60) [Syll
|
*Nas 'No syllable begins with a nassal'

(61) [Syll
|
*Liq 'No syllable begins with a liquid'

(62) [Syll
|
*Glide 'No syllable begins with a glide'

(63) [Syll
|
*V 'No syllable begins with a vowel'

The ranking of these constraints is given universally, such that vowels never make better onsets than glides, etc.

The correct surface form of damart-i follows once we replace(56) with (59) - (63). In the following, only (61) is relevant:

(64) Vocative singulars (dental-final stems)

	[Syll | Liq	Stem] | *Stop
☞ da.mar.t-i		*
da.ma.r<t>-i	*!	

Constraints on Roots and Stems

Returning now to the bigger issue, we see that there is more than one way to account for all of this data. We could, as I've done here, label constraints so that they apply to one type of morphological consituent or another. Alternatively, we could leave constraints unlabeled and have separate tableaux for each level (as proposed in the abstract for this paper). I won't try and show that this second aproach is not possible. Given that reranking constraints could give us any phonological system from Hawaiian to Polish it's easy to see what is really at issue here. Different levels within the phonology of a language are more similar than they are different. This is completely unexpected given a model in which levels differ by constraint ordering. We may account for this general fact much more directly by labeling constraints as applying at the edges of morphological domains.

5. A problem case?

Greek and Sanskrit inhereited from PIE a constraint against tautomorphemic aspirates. The deaspiration of an aspirate preceding another aspirate is known as Grassman's Law. A paradigm case is the Greek diapirate root for 'hair', which never surfaces with both aspirates:

(65) t^{h}rik^h 'hair'

nom: t^{h}rik<^{h}>-s
gen: t<^{h}>rik^h-os

In the nominative form the second aspirate deaspirates because of the tautosyllabic [s], allowing the first aspirate to surface. In the genitive form the second aspirate remains, forcing the first aspirate to de-aspirate in accordance with Grassman's Law. If we formulate Grassman's Law as in (66), it leads to a big problem for the present account of how morphology and phonology interact.

(66) $*[\text{ASP...ASP}]_{\text{STEM}}$

The problem for the proposal I have made is this: Grassman's Law reaches inside a stem and deletes the first of two aspirates in the genitive singular case in (54). It is thus not a constraint on the edge of a stem but on it's insides. And it obviously cannot be a constraint on the inside of a root because there would then be no roots like *t^{h}rik^h*.

The way out of this mess is to follow Steriade (1982) in treating Grassman's Law as a constraint against tautomorphemic aspirated onsets. The loss of aspiration in the genitive case results not because thrikh-os is a stem but because the two aspirates are both onsets. Crucially, they are not both onsets in the root, where the second aspirate is a coda. Grassman's Law may then read as a general prohibition on any morphological unit with adjacent aspirated onsets:

(67) * ONS ONS
| |
ASP ASP 'Successive onsets may not be aspirated'

A tableau makes clear how this works for the root:

(68) Roots and Grassman's Law

	* ONS ONS | | ASP ASP	PARSE
☞ thrikh		
thrik<h>		*!

The monosyllabic root contains a single onset, making Grassman's Law inapplicable; gratuitous violation of Parse is fatal, making *thrikh* the winning candidate. With a vowel initial suffix, the stem-final stop resyllabifies into the following onset and Grassman's Law takes effect:

(69) Stems and Grassman's Law

	* ONS ONS | | ASP ASP	PARSE
t^{h}ri.k^h-os	*!	
☞ t<^{h}>rik^h-os		*

Grassman's Law does apply differently to the roots and stems, but only because of re-syllabification. Once this is factored out, we see that Grassman's Law is a general fact about Greek lexical phonology, not a peculiar property of the stem-level. Its problematic status thus disappears.

6. Conclusion

I've argued against analyses which treat multiple levels in terms of multiple grammars: such analyses are too weak because they allow two levels of the phonology of a single language to differ as much as the phonologies of any two languages differ. Since we have yet to find a language with 5 vowels at level 1 and 28 vowels at level 2 or the reverse, there's reason to be very suspicious of anything approximating (i) above.

I've argued instead that the phonology of a language is always uniform, statable in OT with a single tableau. Constraints merely need to labeled as to what morphological costituent edges they apply to. Given a suitably restrained theory of what a constraint can be, this seems to be possible for the cases discussed here, prosodic constraints on roots and words in Sanskrit and Greek.

A full account will have to tackle all of the cases in the literature which have been used to substantiate the theory in (i). I haven't even begun to address these cases here. Whether a more developed version of edge-based phonology, such as I've sketched here, will be able to handle such cases remains to be seen. The theoretical superiority of (ii) over (i) seems indisputable, but its empirical adequacy for all languages remains to be shown.

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