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A UNIFIED ANALYSIS OF CROSSLINGUISTIC MORPHOLOGICAL GEMINATION*

Vieri Samek-Lodovici

1. INTRODUCTION

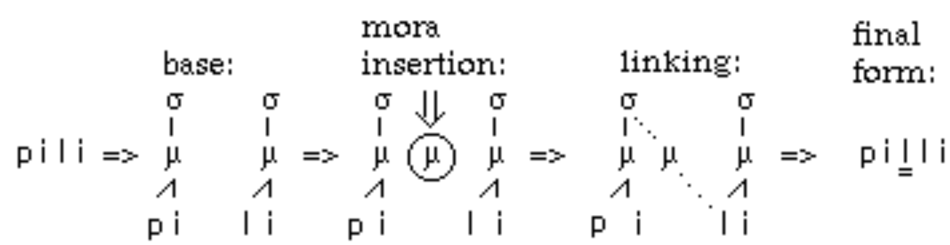
Morphological Gemination (MG) consists of the systematic gemination of a segment associated with a systematic change in meaning of the affected base. Any account of MG must deal with the following two issues:

(a) accurately model how the gemination occurs.
(b) predict where gemination occurs and which segment geminates.

In most analyses, a simple process tackles the two issues simultaneously. Inevitably, the strong cross-linguistic variation associated with issue (b) is tamed by means of parameters internal to the gemination process itself (see, among others, Lombardy and McCarthy (1990) for a crosslinguistic analysis; Archangeli (1987) and Hohulin and Kenstowicz (1979) for Keley-i; Hardy and Montler (1988a, 1988b) for Alabama; Shetler (1976) for Balangao). By distinguishing the two issues, the analysis presented here identifies a unique and non parametric gemination process, while the specific gemination pattern of a language follows from independently motivated universal wellformedness constraints.

As for issue (a), I follow Lombardi and McCarthy (1990) and recognize the existence of a purely prosodic affix constituted of an empty mora. Gemination emerges when this affix is inserted in a base and filled by one of the nearby segments, as illustrated by the derivation below from Keley-i:

(1)



As for issue (b). In accord with the insights of Optimality Theory (Prince and Smolensky 1991) and other important work on the role of constraints in grammar, this analysis claims that the insertion site and the filling segment follow from a need to comply with the prosodic and syllabic wellformedness constraints of the language (henceforth WF-constraints). For example, if the moraic affix is inserted within a heavy syllable, its realization would form a superheavy syllable, violating syllabic wellformedness, while insertion and realization of the affix within a light syllable would not, the latter thus being preferable.

It is the tension between affix realization and prosodic well-formedness that determines what segment will geminate and where: the actual derivation is the one that least violates the WF-constraints while best realizing the affix. These notions will be made fully explicit and formalized in the following sections.

MG is now decomposed into two modules:

(2) a. *Affixation module*: freely add the moraic morpheme to the original base and freely alter the original base's prosodic configuration.
b. *Selection module*: select the optimal derivation, i.e. that derivation whose phonological configuration fits best the constraints of the language.

Only module (2a) models MG proper. Since affixation is unconstrained, module (2a) characterizes a whole set of potential derivations, where for each derivation, the affix may affect a specific segment occurring in a specific position. Module (2b) evaluates all potential derivations against the WF-constraints of the language and selects the optimal one.

The evaluation and selection process closely follows the technical framework of Optmility Theory (Prince and Smolensky 1991), which inspired the whole proposal and for which this analysis, to the degree it is successful, provides further evidence.

Sections 2 and 3 introduce the necessary machinery in detail. Section 4 applies the analysis to gemination in Keley-i, a Malayo-Polynesian language. Section 5 deals with the more complex paradigm of Alabama, a language of the Eastern branch of Muskogean. Finally, section 6 discusses some possible universal restrictions on the relations among different WF-constraints.

2. PHONOLOGICAL REPRESENTATION AND WELLFORMEDNESS.

To understand how an optimal derivation can be singled out from a set of potential derivations, we need to know how derivations are represented, how they are generated and how their well-formedness is assessed.

First, all phonological representations are built in terms of prosodic units (among others, Hyman 1985; McCarthy and Prince 1986). They are also based on the notions of geminate (McCarthy 1979; Leben 1980; Hayes 1986; Schein and Steriade 1986), compensatory lengthening (McCarthy and Prince 1986; Hayes 1989), auto-segmental phonology (Goldsmith 1976, 1990), and underspecification (Steriade 1987; Stevens et al. 1986; Archangeli and Pulleyblank 1992; Pulleyblank 1986).

Second, a potential derivation for a base *b* is defined as a triple <*b,c,i*>, where *c* is the representation of the derived form and *i* is the interpretation of *c*. Potential derivations are generated by the Affixation module by randomly inserting the affix into the original representation of the base *b*, freely altering the representation's prosodic links and freely adding new prosodic units to it[1].

The interpretation *i* of a representation *c* obeys the principles in (3), which define which prosodic configuration is interpreted as segment deletion, which as prosodic weight-loss and which as epenthesis. The principles are based on the notions of stray-erasure, prosodic epenthesis and configuration-based licensing conditions along the lines of Steriade (1982), Ito (1989, 1986), Ito and Mester (1991).

(3) *Interpretation Principles*:

A: Any segment in *c* which is not directly or indirectly linked to a syllabic unit is interpreted as silent (segment deletion).

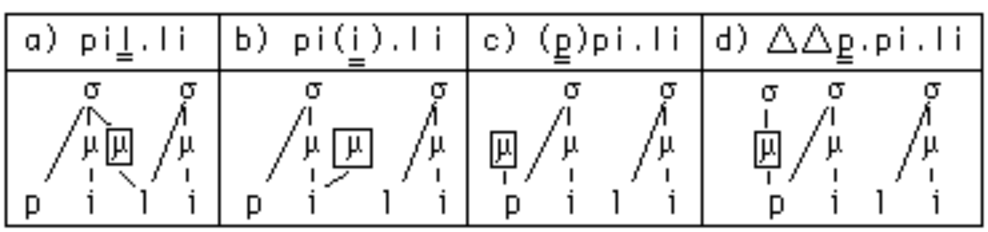
B1: Any mora in *c* which is not linked to a segment is interpreted as filled by a default segment (segment epenthesis).

B2: Any mora in *c* linked to a segment but not to a syllabic unit is interpreted as silent, i.e. it does not contribute its weight to the segment phonetic realization (mra deletion or weight loss).

C: Any syllabic unit in *c* which lacks a nucleus and/or an onset is interpreted as if its nucleus were filled by a default mora (mora epenthesis), and/or its onset were filled by a default segment (segment epenthesis).

The figure in (4) shows the representation *c* of some potential configurations derived from the base *pi.li*, headed by their orthographic representations. The affix is boxed. In (4a), the affix is licensed by the syllabic unit and filled by the segment */l/*. In (4b), the affix is not syllabically licensed, thus the gemination of */i/* is silent. In (4c), the affix is again unlicensed and interpreted as silent. In (4d), the affix has its own syllabic licenser, and its interpretation involves an epenthetic nucleus as well as an epenthetic onset (triangles mark epenthesis sites).

(4)



Notice that for any given base *b*, the Affixation modules characterizes a set of potential derivations of the form $<b,c_k,i>$, each identified by a distinct representation c_k.

The representation and interpretation principles permit us to define WF-constraints over the interpretation of potential derivations. The next section will present some examples and define how the model identifies for any given base, its optimal potential derivation with respect to the WF-constraints.

3. RANKED WELLFORMEDNESS CONSTRAINTS.

In Keley-i, MG is part of a complex of morphological alterations by which verbs relate to the focus-status of specific NP's (Reid 1975; Schachter 1976; Hohulin and Kenstowicz 1979). MG itself marks the non-perfect. Its derivation pattern follows in (5) below, with the gemination morpheme underlined Notice that gemination always occurs in the first light syllable from the left and always geminates the following onset (the bases mean respectively ‘to chose’, ‘to pour’, ‘to carry on the head’ and ‘to punch’).

(5) *Keley-i MG* (derived from Hohulin and Kenstowicz (1979))[2].

Bases:	pi.li	duy.ag	?ag.tu	dun.tuk
Subject focus:				
-input	um-pi.li	um-du.yag	man-?ag.tu	um-dun.tuk
-output	um-pil.li	um-duy.yag	man-?ag.tu	um-dun.tuk
Object focus:				
-input:	pi.li	du.yag	?ag.tu	dun.tuk
-output:	pil.li	duy.yag	?ag.tu	dun.tuk
Access. focus:				
-input:	?i-pi.li	?i-du.yag	?i-?ag.tu	?i-dun.tuk
-output:	?i-p.pi.li	?i-d.du.yag	?i-?.?ag.tu	?i-d.dun.tuk

This pattern follows from two simple constraints: left-edge proximity, a constraint which favours those derivations where the affix is realized as close to the left edge as possible, and syllabic wellformedness (henceforth 'σWF'), a constraint which favours those derivations which do not contain superheavy syllables. Left-edge proximity, which, incidentally, confirms the affixational nature of the gemination morpheme, favours the derivation *?ip.pi.li* against the suboptimal **?i.pil.li*, where the affix lies unnecessarily further right. However, in a contest, left-edge proximity must yield to σWF. In order to avoid the formation of super-heavy syllables, the affix must skip all intervening heavy syllables starting from the left edge. Compare *um.pil.li* with **uum.pi.li* and **umm.pi.li.*

Notice that σWF prevails over left-edge proximity across the board; there is no trade off between the two. In fact, bases like *dun.tuk* and *?ag.tu*, which lack a non final light syllable and therefore cannot realize the moraic affix without creating an ill-formed syllable, do not realize the gemination morpheme at all. In other words, derivations satisfying σWF are always preferred to alternative derivations satisfying left-edge proximity. Left-edge proximity is thus relevant only when two competing derivations strike a tie on σWF.

We will see that consistent prevalence of one constraint over another is the rule rather then the exception. In order to capture this state of affairs, optimality must be defined relative to a hierarchy of constraints ranked according to their prominence. The optimal derivation(s) is defined as that potential derivation *<b,c,i>* such that for any constraint *C* under which another derivation *<b,c',i'>* scores better than *<b,c,i>*, there is a higher ranked constraint *C'* under which *<b,c,i>* scores better than *<b,c',i'>*.

How is the optimal derivation technically determined? First, we exclude all those derivations which fail the top constraint, unless all derivations fail it, in which case no derivation is excluded. Next, we repeat the same procedure with the remaining derivations with respect to the next highest ranked constraint. The derivation(s) that remain after the lowest constraint has been considered is the optimal one. Notice that each constraint is relevant only to determining the optimality-status of those derivations which had a tie on the immediately higher constraint, either because they all passed it or because they all failed it.

In technical terms, given constraints *C1..Cn* and two derivations, we assign each a sequence of '√' and '*' representing the relative well-formedness of their interpretation *i* with respect to each constraint. The two derivations are ranked with respect to each other using the following lexicographic procedure n (6) (adapted from Prince and Smolensky 91). The *optimal derivation* is defined as that derivation that ranks higher than any other derivation.

(6) For any derivation *<b,c,i>*, let *Extract(<b,c,i>,j)* be equal to the j^{th} element of the sequence assigned to *<b,c,i>*.
For any two derivations *A* and *B*, *A ranks higher than B* iff there is a constraint C_k, for $1 \leq k \leq n$, such that:
- Extract(A,k)="√" and Extract(B,k)="*".
- For any j, $1 \leq j < k$, Extract(A,j)=Extract(B,j).

4. Deriving gemination patterns in Keley-i.

The previous sections suggested how the pattern of gemination is derivable from a set of ranked constraints. To the extent that these constraints are universal and independently motivated, the model enhances our understanding of gemination, because it reduces gemination itself to affixation, while coupling the morpheme distribution to WF-constraints responsible for independent phonological properties of a language.

In this section we will see that the optimal derivation is just the best solution for the problem of simultaneously satisfying the syllabic WF-constraints of the language, while avoiding epenthesis, trying to realize the moraic affix, trying to realize it as close to the left edge as possible, and departing as little as possible from the original base.

These requirements are encoded in the following list of constraints, listed by decreasing ranking[3].

I. Syllabic Wellformedness (henceforth 'σWF'): (a) syllables are maximally bimoraic; (b) onsets are not moraic; (c) syllables have onsets; (d) links do not cross ; (e) sonority ascending and descending phases are monotonic and steep; (the effect is to penalize any tautosyllabic geminate, thus excluding CVV syllables).

II. Prosodic Preservation I:

Avoid unfilled moraic slots ('FilM' for fill moras).

III. Prosodic Preservation II:

Avoid unparsed moras ('PrsM' for parse moras)

IV. Affixation: affix should be as close as possible to Left Edge ('Left'). One violation for each syllable intervening between the Left Edge and the first syllable *affected* by the affix. A syllable unit is *affected* by the moraic affix iff it directly dominates the affix mora or if it dominates directly or indirectly the segment directly dominated by the affix mora[4].

V. Original-Base Preservation: Preserve melodic weight. ('PresvW'). One violation for each segment that changed its syllabically licensed weight with respect to its original weight in the base.

The constraints grouped as σWF define the shape of Keley-i syllable structure, which is restricted to CV and CVC shaped syllables (bases like *um.pi.li* contain an unfilled onset slot, which surfaces as a default /?/, as in *?um.pil.li*. The proper representation is thus *Δum.pi.li*). Constraint (I.d) aside, all constraints check only the material licensed by the syllabic unit. Thus, the derived form *?ag(g).tu* does not violate σWF, because the parenthesized mora is not syllabically licensed, while the alternative derivation **?agg.tu* violates σWF, specifically constraints (I.a) and (I.e).

Constraint FilM encodes Keley-i disfavor for epenthesis, which could be a strategy to express the gemination morpheme. In the derived form **?ag.gΔ.tu*, the morpheme is realized as the epenthetic nucleus of a new syllable. If epenthesis were allowed, it would be the optimal derivation, but it is not, revealing the action of the FilM constraint. Notice that given a base like *Δum.pi.li*, FilM is violated by *all* derivations at least once, consequentely this failure is irrelevant with respect to the selection of the optimal derivation.

Constraint PrsM expresses Keley-i dislike for unparsed moras. Without this constraint, the derived form **Δ(u)um.pi.li* would be optimal, because the affix occurs closest to the left edge. It is the requirement that moras be parsed that forces the rightward migration of the moraic affix shown by the actual derived form *Δum.pil.li*.

Constraint Left requires that the affix occur as close as possible to the word's left-edge. Notice that the derived forms *pil.li* and **(p)pi.li* are equally optimal with respect to Left.

Constraint PresvW prizes faithfulness to the original prosodic representation of the base. PresvW states that differences in segment weight between the derived form and the original base should be minimal. PresvW is sensitive only to syllabically licensed material, therefore non-overt lengthening does not constitute a PresvW violation. For example, given the base *dun.tuk*, the derived form *(d)dun.tuk* does not violate PresvW, while the derived form **du(n)t.tuk* violates it twice, because it changes the syllabically licensed weight of two segments[5].

Notice that the constraints are all cross-linguistically motivated and independent of gemination itself. The constraint σWF sums up the robust results of the theory of syllabic structure as developed in the last 15 years.

As for the constraints for prosodic preservation, their absence would predict random occurrence of epenthesis and deletion operations, a behaviour found in no language.

The constraint Left extends to the moraic affix the preference for word-edge position, a cross-linguistically well attested property of affixes.

Finally, the constraint for the preservation of melodic weight formalizes the observation that the prosodic weight assigned to each segment is not altered randomly in the course of a phonological derivation. Those changes in weight that do occur are motivated by the pressure of higher ranked constraints which would otherwise be violated themselves.

What *is* language specific are polarities like the preferred affixation-edge, the specific settings of syllable-structure and the relative ranking of some constraints. Even these variations are well within the range which is empirically attested across languages.

As we saw in section 3, evidence for the ranking among the constraints comes from cases of direct conflict. The comparison in (7) shows that σWF prevails over PrsM. In fact, failure of σWF in the second derivation is sufficient to determine its suboptimal status relative to the first, regardless of the fact that the second derivation is superior with respect to PrsM (the exclamation point marks the decisive constraint violation, while the shadowing expresses the irrelevancy of the lower ranked constraints).

(7)

dun.tuk	σWF	FilM	PrsM	LEFT	PresvW
(d)dun.tuk			*		
*duun.tuk	*!				*

In the next table, the conflict is between FilM and PrsM, with FilM prevailing over PrsM.

(8)

dun.tuk	σWF	FilM	PrsM	LEFT	PresvW
(d)dun.tuk			*		
*ΔΔ d.dun.tuk		*!*			***

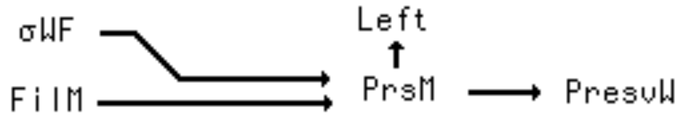
In the next table, PrsM is in conflict with Left and PresvW, while the derivations tie on the two highest ranked constraints.

(9)

Δum.pi.li	σWF	FilM	PrsM	LEFT	PresvW
Δum.pil.li		*		*	*
*Δum(m).pi.li		*	*!		

Summarizing the ranking relations, we get the following graph:

(10)



Given these constraints and ranking-relations, let's us examine how they determine Keley-i's gemination pattern. First of all, for any given base, all potential derivations violating σWF or FilM are out, because the alternative derivation that geminates the first onset non-overtly, as in *(p)pi.li*, does not violate them, and thus it constitutes a better candidate.

For any base which lacks a non-final light syllable, the alternative derivation just described is also optimal, since any attempt to realize the affix overtly would either violate σWF or FilM.

All remaining bases may realize the affix overtly by geminating the onset that follows the first light syllable. This always builds the optimal derivation, satisfying σWF, FilM, PrsM and placing the affix as far to the left as possible modulo satisfaction of all higher ranked constraints. It also changes the weight of only one segment, the minimal possible weight-change, given that PrsM must be satisfied.

This concludes the discussion of Keley-i. Gemination is caused by random affixation of a moraic morpheme. A very simple set of independently motivated constraints determines its eventual location and what segment is involved. The actual derivation is that potential derivation that best achieves syllabic wellformedness, absence of epenthetic material, overt realization of the affix, edgemost occurrence of the affix and minimal divergence from the original base.

5. ALABAMA IMPERFECTIVE GEMINATION

In Alabama, MG marks a type of imperfective aspect (Hardy and Montler 1988a). Alabama syllable structure includes long vowels and allows for onsetless as well as superheavy syllables word-initially (Lupardus 1982; Hardy and Montler 1988a, 1988b). In addition, the moraic affix prefers consonantal fillers and is associated to an accentual high tone. The richer syllable-structure increases the opportunities for fulfilling the lower ranked constraints while still satisfying σWF, yet the tighter morpheme-specification makes its overt expression more complex. The effect is a more articulated paradigm than Keley-i's. Notice the following empirical generalizations:

(i) Words with open AntePenultimates ('AP') always geminate the following onset.
(ii) Bisyllables and words with closed AP but light penultimate geminate their vocalic nucleus of the penultimate syllable.

(iii) Words with closed AP and closed antepenultimate express the affix tone in the penultimate syllable and do not express the affix mora.

Notice also that the last syllable shows an extrametrical character across the board and that whenever the moraic affix shows up overtly in the form of a weight increase, the associated tone shows up in the corresponding syllable, as expected.

(11) (From Hardy and Montler 1988, and Hardy (pc))[6].

Open AP, geminate following onset:

a.	a.ta.kaa-li	=>	a.ták.kaa.li	'hang one object'
	a.caa.-pa	=>	ác.caa.pa	'object to vocally'
b.	a.fi.nap-li	=>	a.fín.nap.li	'lock up'
	a.tak.-li	=>	át.tak.li	'hang more than one object'
c.	ho-co.ba	=>	hóc.co.ba	'big (pl)'
d.	a.taa.nap.-li	=>	a.tán.nap.li	'rancid'
e.	#..cvv.cv.σ	=>	#..cv'c.cv.σ	described, but not given

Bisyllables and Light Penultimate geminate vocalic nucleus:

f.	co.ba	=>	cóo.ba	'big (sing)'
	i.s-i	=>	íi.si	'take, catch'
g.	cam.po.-li	=>	cam.póo.li	'taste good'
	i.bak.pi.la	=>	i.bak.píi.la	'turn upside down'
h.	ho-f.na	=>	hóof.na	'smell'
	is.-ko	=>	íis.ko	'drink'

Word-internal Heavy Penultimate show only accentual high tone:

i.	#..cvc.cvv.σ	=>	#..cvc.cv'v.σ	described, but not given
	#..cvc.cvc.σ	=>	#..cvc.cv'c.σ	described, but not given

Following in part Lombardi and McCarthy (1990), I assume that the Imperfective affix is associated with accentual high tone and specified as *[+consonantal]*. A syllabic unit *licenses* the high tone iff it directly dominates the affix, as in *hóc.co.ba* and *cóo.ba*, or its vocalic nucleus fills the moraic affix, as in *cóo.ba* and *có(o).ba*. When the tone is licensed it shows up on the syllable nucleus.

Alabama's MG is decomposed into the same two modules discussed for Keley-i. The Affixation module generates the potential derivations, inserting the affix into a base and freely altering its prosodic representation. The Selection module selects the optimal derivation with respect to the WF-constraints of the language.

It is an important claim of this analysis that the Affixation module is identical in all languages, while the Selection module may differ only to the degree that each specific WF-constraint and its relative ranking differs cross-linguistically.

I avoid a redundant description of the Affixation module, and address right away the well-formedness constraints of Alabama, which follow below, ranked by decreasing prominence:

I. Last Syllable Extrametricality (XTR): The last syllable is always extrametrical.
II. Syllabic Wellformedness (σWF): as in Keley-i but looser. Specifically, onsetlessness is relaxed word-initially, allowing for #CVVC, #V, #VV, #VC, #VVC syllables. Moreover tautosyllabic vocalic geminates are permitted[7].
III. Prosodic Preservation I (FilM): as in Keley-i.
IV. Right-Edge Affixation (Right): as in Keley-i, but to the right.
V. Affix Realization (Afx): realize the two specifications of the affix in a syllabically overt and detectable manner. One violation for each specification which is left unrealized.
VI. Prosodic Preservation II (PrsM): as in Keley-i
VII. Original Base Preservation (PresvW): as in Keley-i.

Besides the slightly modified σWF and Right constraints, there occurred three major changes.

First, the new XTR constraint requires that the last syllable of the base be unaffected by the changes contributed by the gemination affix.

Second, besides the expression of the mora itself, warranted by PrsM, full realization of the affix includes realization of the associated consonantal specification and realization of the associated tone. In principle, this amounts to four possible combinations. However, while the tone can be licensed even without realizing the consonantal specification, realization of consonantal specification always involves the realization of the tone. In practice, there are only three possibilities: non-realization of any specification, realization of the tone alone, and realization of the consonantal specification and of the tone. Thus, it is possible to represent the degree of dis-harmony of a derivation with respect to the Afx constraint with a violation for each non realized specification.

The Afx constraint states that a potential derivation *realizes* the affix's specifications iff these are syllabically licensed and clearly detectable with respect to the original base. For example, if the affix is left syllabically unlicensed, as in **(c)co.ba* or **hof(f).na*, the consonantal specification is not realized. Also notice that the consonantal specification calls for a detectable change in consonantal weight, while it is insensitive to consonantal quality. Thus, given the base *cam.po.li*, the derived form **ca(m)p.po.li* fails to detectably realize the specification, because in terms of the amount of licensed consonantal material, the syllables *cam* and *ca(m)p* are indistinguishable[8]. A derived form of the same family that does detectably realize the specification is **camp.po.li*, however the superheavy CVCC syllable fails σWF. It follows that there is no way to realize the affix's consonantal specification within a closed syllable without failing either Afx once or σWF.

In passing, notice that the newly added constraints are also cross-linguistically motivated. Extrametricality of peripheral constituents is encountered in many languages and a constraint like XTR is needed to warrant the extrametrical nature of such material. As for Afx, it merely demands that the idiosyncratic properties of a morpheme be overtly realized. The Afx constraint can be generalized to Keley-i, where its effects are null, given the absence of specifications on the Keley-i's affix.

The third and most important change is the ranking between Right and PrsM, the opposite of that in Keley-i. In Keley-i, the prevalence of PrsM over Left leads to the affix's rightward shift in order to be expressed while satisfying σWF. Alabama shows the reverse picture: prevalence of Right over PrsM requires that the affix always affect the penultimate syllable[9], even when σWF inhibits overt expression of the morpheme, forcing a violation of PrsM. The two pairs of derivations in (12) and (13) show the conflict between PrsM and edge proximity in Keley-i and in Alabama. In (12), the optimal derivation satisfies PrsM but fails Left, while the ungrammatical one satisfies Left but fails PrsM. In the mirror case (13), from Alabama, the optimal derivation maximally satisfies Right (modulo XTR) but fails PrsM, while the ungrammatical one satisfies PrsM but significantly fails Right.

(12)	Δum.pi.li	=>	Δum.pil.li	PrsM=√	Left=*
	Δum.pi.li	=>	*Δum(m).pi.li	PrsM=*	Left=√
(13)	a.taa.nap.li	=>	a.tá(a)n.nap.li	PrsM=*	Right=*
	a.taa.nap.li	=>	*át.taa.nap.li	PrsM=√	Right=**

The evidence for the other ranking relations follows in form of synoptic tables. The first shows that XTR prevails over Right and Afx.

(14) co.ba	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
cóo.ba				*	*		*
*cób.ba	*!						*

The next shows prevalence of σWF over PrsM. The two derivations score a tie on FilM, Right and Afx, which are thus irrelevant.

(15) ...cvc.cvc.σ	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
...cvc.cv́(v)c.σ				*	*	*	
* ...cvc.cv́vc.σ		*!		*	*		*

In a similar fashion, the following tables show the prevalence of FilM over Afx in (16), of FilM over PrsM in (17), of Right over PrsM and PresvW in (18), of Afx over PrsM and PresvW in (19), of Afx over PresvW in (20) and of PrsM over PresvW in (21).

(16) co.ba	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
cóo.ba				*	*		*
*Ác.co.ba			*!	*			**

(17) a.taa.nap.li	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
a.tá(a)n.nap.li				*		*	**
*a.taa.ΔÁn.nap.li			*! *	*			***

(18) a.taa.nap.li	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
a.tá(a)n.nap.li				*		*	**
* át.taa.nap.li				**!			*

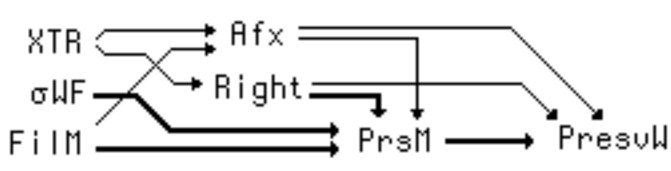
(19) ...cvv.cv.σ	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
...cv́(v)c.cv.σ				*		*	**
*...cvv.cv́v.σ				*	*!		*

(20) a.taa.nap.li	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
a.tá(a)n.nap.li				*		*	**
*a.taa.ná(a)p.li				*	*!	*	*

(21) co.ba	XTR	σWF	FilM	RIGHT	Afx	PrsM	PresvW
cóo.ba				*	*		*
*có(o).ba				*	*	*!	

Summarizing, we have the graph in (22), where the bolder lines reflect the ranking relations shared with Keley-i, but the relation between Right and PrsM is reversed.

(22)



Let us then derive the gemination paradigm of Alabama from the ranked constraints just described. Remember the descriptive generalizations of the paradigm: (i) Bases with open AP always geminate the following onset; (ii) Bisyllables and words with a closed AP but a light penultimate geminate the nucleus of the penultimate; (iii) words with closed AP and closed penultimate express the affix only through its high tone.

Let's begin with the bases with an open AP. If the AP is short, gemination of the following onset builds the optimal derivation, since it fully satisfies all constraints, as for example *hóc.co.ba*, from the base *ho.co.ba*.

If the AP is long, shortening of the antepenultimate vocalic nucleus and gemination of the following onset, as for example in *a.tá(a)n.nap.li*, satisfies XTR, σWF, FilM, Right (modulo XTR) and Afx, putting all alternative derivations that violate XTR, σWF, FilM, Right and Afx out of the competition.The shortening induces a violation of PrsM, but no alternative derivation could satisfy PrsM without violating one of the higher ranked constraints. The shortening also involves two violations of PresvW, but no alternative derivation could satisfy the same array of higher ranked constraints without also accumulating two violations of PresvW, because they are necessary for expressing the affix overtly, thus satisfying Afx, without violating σWF.

Lets now turn to bisyllables and bases with a closed AP. Bisyllables lengthen the vocalic nucleus of the penultimate, as in *cóo.ba*. These derivations satisfy XTR, σWF, FilM, Right (modulo XTR) and partially Afx. Better fullfillment of Right and Afx is possible only at the expense of XTR or other higher ranked constraints. As for the remaining constraints, PrsM is fullfilled and, as it is always the case, PresvW must be violated once if the higher ranked Afx and PrsM are to be fullfilled at all. The same reasoning holds for bases like *hof.na*, whose derivation exploits the word-initial relaxation of syllabic bimoraicity to get the optimal derivation *hóof.na*.

Words with a closed AP but a light penultimate behave as bisyllables and for the same reasons. Thus a base like *cam.po.li* geminates as *cam.póo.li*. The only alternative derivations available, place the affix on the closed penultimate, as in **cámp.po.li*, **cam(p).po.li* and **cá(m)p.po.li*. However, notice that **cámp.po.li* fails σWF, while **cam(p).po.li* and **cá(m)p.po.li* fail PrsM, all constraints that the optimal derivation *cam.póo.li* satisfies. Nor does **cá(m)p.po.li* satisfies Afx fully, as discussed at length when introducing the constraint.

Finally, let's turn to words with closed AP and heavy penultimates. Their optimal derivation is as in (23) below:

(23) #...cvc.cvx.σ# => #...cvc.cv'(v)x.σ#

The derived form satisfies XTR, σWF, FilM, Right (modulo XTR) and partially Afx. Since the penultimate and the antepenultimate syllables are both heavy, no alternative derivation may satisfy Afx more fully or satisfy PrsM without violating any higher ranked constraint. Nor is it possible to avoid the single PresvW violation without failing to express the tone and thus causing a worse violation of Afx.

6. CONCLUSIONS

In spite of their complexity and differences, the gemination paradigms of Keley-i and Alabama are derived by the same fundamental process of free affixation followed by the general process of selection of the optimal derivation.

Making explicit the role of the WF-constraints reveals that despite superficial differences, the two languages are remarkably similar. Alabama differs from Keley-i only in its less constrained syllable structure, in licensing final extrametrical material, in its moraic affix, which is suffixational in nature and has a richer specification than its Keley-i counterpart, and finally in reversing the ranking of Right and PrsM. Such similarity may extend to other languages, reflecting the common role that UG plays crosslinguistically. In particular, by grouping together the constraints, we may identify major ranking relations among groups of constraints. The schema in (24) is consistent with the precedence graphs of both Keley-i and Alabama.

(24)

What emerges is the beginning of a theory of ranking relations. Constraints XTR and σWF are ranked highest, and therefore they are never violated. In the intermediate block the constraints responsible for the full realization of the affix's properties merge with the constraints responsible for the proper organization of prosodic structure. Crosslinguistic variation is related, but also limited, to the affix's idyosyncratic specifications as well as to the possible ranking combinations determined by the merging of the two groups. Finally, PresvW yields to all other constraints, but prevents any unmotivated alteration in melodic weight.

In conclusion, Keley-i and Alabama suggest that variation among ranking relations might be limited to a few constraints. This strongly reduces the possible alternative settings and provides a framework for deriving the crosslinguistic distribution of Gemination, as well as its surface paradigms.

7. NOTES

. See references for Archangeli and Pulleyblank, Broselow, Cairns and Feinstein, Chomsky and Halle, Goldsmith, Hayes, Ito, Kaye and Lowenstamm and Vergnaud, Kean, Kisserbeth, Libermann, McCarthy, Mester, Noske, Paradis, Prince, Selkirk, Smolensky, Steriade, Yip, and others.

[1]. Free alteration cannot delete syllabic, moraic or segmental units from the representation nor alterate the segment linear sequence in the representation. This does not prevent deletion or permutation of segments in the interpretation of the representation; see Samek-Lodovici (1992).

[2]3 This pattern is derived from a more general paradigm in Hohulin and Kenstowicz (1979), which arguably is composed of the original base and its focus and tense affixes according to the

formula: Tense-Focus-BASE-Focus&Tense. Gemination proper is associated with the present and future tense and occurs after that the Focus affixes have been provided. See Samek-Lodovici (1992) for a detailed argumentation in favour of this decomposition.

The pattern of the Referential and Beneficial focus are excluded from table (5) because they are the same as those for the Object and Access focus.

In the examples, gemination occurs in the first or in the second syllable, of the base because the available data include only bisyllabic bases.

[3]. Similar versions of the syllabic and prosodic constraints were first introduced by Prince and Smolensky in their work on Optimality Theory.

[4]. In Alabama, where the mirror constraint Right holds, extrametricality is sensitive precisely to this notion of *affectedness*: gemination of the onset of the rightmost syllable clearly violates its extrametricality character, although the affixational mora itself is linked to the penultimate syllable unit. The same notion plays a role in other processes of Alabama; see Samek-Lodovici (1992).

[5] Representing Left and PresvW by a sequence of violations does not introduce any counting capability in the system. When ranking two potential derivations <*b,c,i*> and <*b,c',i'*>, the lexicographic procedure needs only to know which one satisfies the constraint best. This is easily defined as the potential derivation that first runs out of violations when the violations of the two derivations are matched one to one with each other.

[6]. Only known morphemic boundaries are reported.

The form (12d) was kindly provided by Hardy (pc).

The derivation in (12e) and (12i) are derived from Hardy and Montler's empirical generalization (1988:404):

(i) If the stem is disyllabic or if the antepenul-timate is closed, the nucleus of the penultimate is geminated and gets high tone;

(ii) If the stem has an open antepenultimate, the onset of the penultimate is geminated and the antepenultimate gets high tone. No actual case of heavy antepenultimate is reported in the original paper.

Finally, no derivation is presented for bases of the *cvv.σ* type, because the derived form c*vvv.σ*, consistent with the Hardy and Montler generalization, is inconsistent with their inventory of Alabama syllabic shapes, which does not include *CVVV* syllables. Whatever the derivation is, it does not have a strong impact on the analysis. For discussion of such a case, see Samek-Lodovici (1992).

[7]. For a technical interpretation, one could say that Alabama requires sonority ascending and descending phases to be strictly monotonic. A central vocalic plateau is thus possible, because it is outside of the above mentioned phases.

[8]. Other Alabama affixes have tighter specifications. In the Alabama H-grade, a process that can be modeled as an instance of MG, the moraic affix is associated with the melodeme */h/*. The melodic quality of the contribution becomes detectable, because the specification itself makes a finer distinction. Indeed, the derivation of a base like *sa.lat.li* is *sa.láh(t).li*.

[9]. The last syllable is off-limits even for Right, given the higher ranking of XTR.

8. BIBLIOGRAPHY

Archangeli, D. (1987) Keley-i consonant assimilation, *Coyote papers* 6, University of Arizona, Tucson.

Archangeli, D. and D. Pulleyblanck (1991) *African Tongue Root harmony: Optimal Sstems*. Paper given at NSF/LSA Conference on Phonological Feature Organization, UCSC, Santa Cruz.

Archangely, D. and D. Pulleyblank (1992) *Grounded phonology*. Unpubl. ms University of Arizona and University of British Columbia.

Broselow, E. and J. McCarthy (1983) A theory of internal reduplication, *The Linguistic Review 3*.

Cairns, C. and M. Feinstein (1982) Markedness and the theory of syllable structure, *Linguistic Inquiry 13*.

Chomsky, N. and M. Halle (1968) *The sound pattern of English*, New York: Harper and Row.

Goldsmith, A. (1976) *Autosegmental phonology*. MIT PhD Dissertation.

Goldsmith, A. (1990) *Autosegmental and metrical phonology*. Oxford: Basil Blackwell.

Hardy, H. and T. Montler (1988a) Imperfective gemination in Alabama. *International Journal of American Linguistic* 31.

Hardy, H. and T. Montler (1988b) Alabama radical morphology: H-infix and disfixation, in M. Langdon and W. Miller et al. (eds), *Papers in Honor of Mary R. Haas*. Berlin: Mouton de Gruyter.

Hayes, B. (1980) *A metrical theory of stress rules.* MIT: PhD Dissertation.

Hayes, B. (1986) Inalterability in CV phonology, *Language 62 #2.*

Hayes, B. (1989) Compensatory lengthening in moraic phonology, *Linguistic Inquiry* 20.

Hayes, B. (1990) *Metrical stress theory: principles and case studies.* Unpubl. ms UCLA.

Hohulin, L. and M. Kenstowicz (1979) Keley-i phonology and morphophonemics, *South-East Asian Linguistic Stuides* 4:241-254. Pacific Ling. Series, School of Pacific Studies, ANU.

Hung, H. (1992) *Relativized suffixation in Choctaw: a constraint-base analysis of the verb grade system*, Unpubl. ms. Brandeis University.

Hyman, L. M. (1985) *A theory of phonological weight*. Foris.

Ito, J. (1986) *Syllable theory in prosodic phonology*. UMass Amherst: PhD Dissertation

Ito, J. (1989) A prosodic theory of epenthesis, *NLLT* #7.

Ito, J. A. Mester (1991) *Melodic and prosodic licensing.* Paper given at LSA Summer Institute Feature Workshop, UCSC, SantaCruz.

Kaye, J., J. Lowenstamm and R. Vergnaud (1985) The internal structure of phonological elements: a theory of charm and government, *Phonology Yearbook 2*.

Kean, M.L. (1974) *The theory of markedness in generative grammar*. MIT: PhD Dissertation.

Kisserbeth, C. (1970) On the functional unity of phonological rules, *Linguistic Inquiry* 1.

Leben, W. (1980) A metrical theory of length, *Linguistic Inquiry* 11.

Libermann, M. (1975) *The intonational system of English.* MIT:PhD Dissertation.

Lombardi, L. and J. McCarthy (1991) Prosodic circumscription in Choctaw morphology, *Phonology* 8.

Lupardus, K. (1982) *The language of the Alabama indians*. University of Kansas:PhD Dissertation.

McCarthy, J. J. (1979) *Formal problems in semitic phonology and morphology*. MIT:PhD Dissertation.

McCarthy, J.J. and A. Prince (1986a) *Prosodic morphology*. Unpubl ms UMass Amherst and Brandeis University.

McCarthy, J.J. and A. Prince (1990) Foot and word in prosodic morphology: the Arabic broken plural, *NLLT* #8.

McCarthy, J.J. and A. Prince (1992) *Constraint interaction in prosodic morphology and phonology*. Talk at University of Pennsylvanya, NY.

Mester, A. (1986) *Studies in Tier Structure*. UMass Amherst: PhD Dissertation.

Niklas, T. (1974) *The elements of Choctaw*. University of Michigan, Ann Arbor: PhD Dissertation.

Niklas, T. (1975) Choctaw morphophonemics, in J. Crawford (eds), *Studies in Southeastern Indian languages*. Athens:University of Georgia Press.

Noske, R. (1982) Syllabification and syllable-changing rules in French, in H. van der Hulst and N. Smith (eds), *The structure of phonological representations.* (part 2), Dordrecht: Foris.

Paradis, C. (1988a) On constraints and repair strategies, *The Linguistic Review* 6.

Paradis, C. (1988b) Toward a theory of constraint violation, *McGill Working Papers in Linguistics* 5.

Prince, A. (1992) Quantitative consequences of rhythmic organization, in D. Karen, M. Noske and M. Ziolkowski (eds), *Papers from the parasession on the syllable in phonetics and phonology*. Chicago: Chicago Linguistic Society 26-II.

Prince, A. and P. Smolensky (1991a) Lectures on phonology, at Linguistic Institute 91. University of California, Santa Cruz CA.

Prince, A. and P. Smolensky (1991b) *Optimality*, Paper given at Arizona Phonology Conference.

Prince, A. and P. Smolensky (1992) *Optimality: constraint interaction in generative grammar*. Paper given at 12th *WCCFL*, Santa Cruz CA.

Pulleyblank, D. (1986) *Tone in lexical phonology*. Dordrecht:Reidel.

Reid, L. A. (1975) The pronominal system of Proto-Cordilleran, Philippines, *Working Papers in Linguistics*, University of Hawaii 6/6.

Samek-Lodovici V. (1992) *A constraint-based unified analysis of crosslinguistic morphologcial gemination*. Unpubl. ms Rutgers University.

Schachter, P. (1976) The subject in Philippine languages: topic, actor, actor-topic, or none of the above?, in C. N. Li (eds), *Subject and Topic* 491-518. NY Acdemic Press.

Schein, B. and D. Steriade (1986) On geminates, *Linguistic INquiry* 17

Selkirk, E. (1982) The Syllable, in H. van der Hulst and N. Smith (eds), *The structure of phonological representations*. Dordrecht:Foris.

Selkirk, E (1984) *Phonology and syntax: the relation between sound and structure*. Cambridge:MIT Press.

Shetler, J. (1976) Notes on Balangao grammar, *Summer Institute of Linguistics*. Hungtington Beach CA.

Smolensky, P. (1986) Information processing in dynamical systems: foundations of armony theory, in S. Rumelhart, J. McLelland and the PDPR goup (eds), *Parallel distributed processing: explorations in the microstructure of cognition 1: foundations*. Cambridge: MIT press/Bradford Books.

Steriade, D. (1982) *Greek prosodies and the nature of syllabification*. MIT:PhD Dissertation.

Steriade, D. (1987) Redundant values. In A. Bosch, B. Need and E. Schiller (eds), *Papers from the parasession on metrical and autosegmental phonology*. Chicago: Chicago Linguistic Society.

Stevens, K., S. J. Keyser and H. Kawasaki (1986) Toward a phonetic and phonological theory of redundant features. In J. Perkell and D. Klatt (eds), Sy*mposium on invariance and variability of speech processes*. Hillsdale: Lawrence Erlbaum.

Yip, M. (1988a) Template morphology and the direction of association, *NLLT* 6.

Yip, M. (1988b) The obligatory contour principle and phonological rules: a loss of identity, *Linguistic Inquiry* 19.

samek@cancer.rutgers.edu
Department of Linguistics - Rutgers University
18 Seminary Place
08901 New Brunswick NJ