# Gemination and the prosodic enhancement strategy

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## 0. Introduction

Geminates have been long observed to exhibit unique behavior including a resistance to rules which affect singletons, such as weakening rules, and to the positional neutralizations that are encoded in phonotactic constraints like coda conditions. In (1) and (2) are respective examples. In (1), in (a) Tirgrinya postvocalic stops spirantize unless they are geminate, in (b) in Hausa, the stem ending with a geminate consonant patterns with the form in (iii) which has singleton coda, and not the stem with the pattern in (i) or (ii): the geminate is not broken up. These are examples of classic cases of geminate integrity. In (2), an example of a postional neutralization, in Japanese the only consonants that appear in coda position are nasals and geminates. This distribution is characterized by a phonotactic constraint that prohibits all consonants but nasals from appearing in coda.

(1) a. Biblical Hebrew postvocalic spirantization (Kenstowicz 1982, from Barkai 1974):

hit-gaddel 'became great' → hiθ͡gadel
hit-tammen 'he acted uprightly' → hit͡tammen

b. Hausa (from Kenstowicz and Pyle 1973)

i. kask- kasaakee (-CC → CaaC)
ii. dam- damaamee (-VC → $C_1$aa$C_1$)
iii. zoom- zoomaayee (-VVC → Caay )
iv. gamm- gammaayee (-V$C_1C_1$ → $C_1C_1$aay)

(2) Japanese coda restrictions:

| | |
|---|---|
| kanden | 'electric shock' |
| minshu | 'democracy' |
| mikkei | 'secret plan' |
| misshitsu | 'a secret room' |
| mittsu | 'three' |

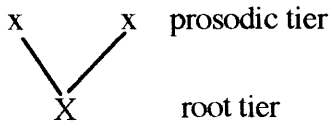
Any account of geminate behavior must offer an explanation for these two facts: one, they are resistant to rules which alter segments (1a) (the alterability effects) and prosodic processes like epenthesis as in (1b), and, two, geminates are often found hand in hand with positional neutralizations, like coda constraints as in (2). The purpose of the paper is to encompass this exceptional behavior within a broader context of the function of geminates in a grammar. This paper states that gemination is the name for a type of prosodic enhancement. This hypothesis states first, that gemination is a prosodic strategy in the same way that epenthesis or word minimality is. Epenthesis, for instance, is the name for processes which serve to fix-up illicit sound sequences by the insertion of material that brings them into line with language specific constraints on syllable structure. Epenthesis is prosodic because it is initiated by prosodic (specifically syllable structure) concerns (Itô 1986). And second, the hypothesis states that gemination is also initiated by prosodic concerns, as part of a prosodic enhancement strategy.

By enhancement strategy here, I mean two things, the prosody can enhance phonemic series, like the stop, obstruents or vowel series, by providing length contrasts, and the prosody can enhance weakened or neutralized contrasts. In these respects the prosody is mimicking featural enhancement strategies, as they have been presented in the literature. The exceptional behavior of geminates can be seen to fall out of this characterization.

## 1. The dual prosody of geminates hypothesis

In the common view, geminates are defined by the association of a single segment to two prosodic units as in (3) below. We'll call this for convenience, the dual prosody hypothesis:

(3) Gemination as twin association: the *dual prosody* hypothesis



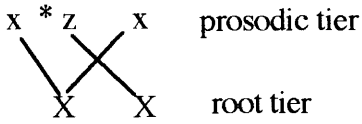

In this view of geminate structure, geminates differ from singletons in that a segment is associated to two, and crucially not to one, prosodic unit[1]. The exceptional way geminates interact with phonotactic constraints is related to this unique structure. For the coda constraint in (2), the formalism in (4a), from Itô (1986), interprets the association line between the segment and the coda as exhaustive (Hayes 1986), and geminate [-nas] segments are allowed in (b) by virtue of the double association or affiliation. The fact that they have two association lines in the usual view means that the constraint in (a) cannot apply because the rule refers only to a single association:

[1] The argument is an extension of a theory of geminate structure proposed by Kenstowicz and Pyle (1973), Leben (1980), Kenstowicz (1982), Schein and Steriade (1986), Hayes (1986).

(4) Coda constraint (adapted from Itô 1986):


Geminate resistance to positional neutralizations like post-tonic spirantization, fall under the same analysis: the neutralizing rules does not apply to geminates because geminates have two instead of one association line. The dual structure of geminates is also used to account for their resistance to prosodic devices like epenthesis. The prosody does not break geminates up, even in the case that they represent apparent violations to syllable structure or morpheme structure constraints. In the dual prosody hypothesis, this effect is argued to be a result of their representation, a separate initiative in the grammar disallows the crossing of association lines that would arise if material were to be inserted between the two prosodic units.

(5)

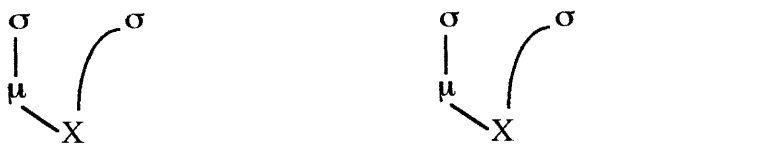



Thus crucially, 1) in this view the prosodic structure of geminates makes them unique, and different from singletons. And 2) the representation of their structure in (3) is used to account for their behavior. An interesting and important refutation and revision of this characterization of geminate structure and geminate behavior has been made in a recent proposal by Inkelas and Cho (1993).

## 1.1 Prespecification

Inkelas and Cho present a review of geminate behavior that is interesting because its failure reiterates the importance of the prosody in gemination effects. They claim that geminates, which account for the main class of examples of resistance to coda constraints, do not in turn violate onset constraints. That is, examples in (6a) are common while there are no examples of (6b):

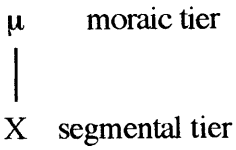
(6) a. coda constraint: *b. onset constraint:




This proposed asymmetry between the way geminates work with coda versus onset constraints is presented as a strong argument in a class of cases (syllable constraints) that provide evidence for the formal inadequacy of characterizing geminate inalterability by reference to the dual prosodic structure of geminates. This characterization, they claim,

causes a loss of an important generalization. Rather, in their argument, these effects are directly related to an underlying and independent asymmetry between codas and onsets: prespecification of moraic material is allowed in coda but not onset position.

(7) Prespecification: geminates and some singletons are 'prespecified' for moras:




The advantage of this proposal is that it shifts the burden of argument away from a dependence the evaluation of association lines. I refer the reader to the paper for their arguments. In this view, in particular, the inalterability effects that geminates exhibit are due to the prespecification of moraic material inherent to consonants in coda, and thus there are no onset constraint effects. Geminates, then, are argued to exhibit behavior not different from other 'prespecified' segments, including singletons.

However, if it can be shown that geminates resist onset constraints as they resist coda constraints, -that is to say, geminates fundamentally resist positional neutralizations-, an essential impetus both for the prespecification argument and for generalizing geminate behavior away from its jointed structure is removed. We will see that constraint violations of the type in (6b), onset constraints, although rare, do in fact exist. The comparatively fewer examples of type (6b) is related to the differences in the way phonotactics treat onsets versus codas, and not an inherent and principled property of geminates.

### 1.2 Korean laterals

The data in (8) exhibit a set of alternations that illustrate an important constraint in Korean. In these examples, the lateral surfaces as a geminate lateral in (a), a flap in (b), a nasal in (e) or, in word initial position, it is deleted, as in (c) and (d) (Yip 1990, Jun 1993). The two lateral variations that concern us are in (a) and (b). Pertinent to the present discussion, an intervocalic lateral alternates to a flap (Maddieson 1984), as in (b). As we can see in (a), the flapping process does not affect geminate laterals, (even those derived by assimilation (McDonough and Jun 1993)), a phenomenon that falls under the aegis of classic geminate 'inalterability' or 'integrity'.

(8) Lateral alternations in onset

| | | | |
|---|---|---|---|
| a. dʒin-lyo | → dʒillyo | 'check-up' | (nl → ll) |
| b. susulyo | → susuɾyo | 'service charge' | /VlV/ → [VɾV] |
| c. lyo-kim | → yokim | 'fee' | #l → glide |
| d. li-dʒa | → idza | 'interest' | #l → Ø |
| e. kip-lyo | → kimnyo | 'salary' | l → n (regressive) |

Waveforms and spectrograms of these words show that the intervocalic lateral is significantly different from the geminate and the coda laterals. The intervocalic lateral is a very short stop of about three or four glottal pulses in duration; a flap, not different from the English flap in 'butter'.

In Korean then, lateral distribution comprises a positional asymmetry; laterals are licensed in codas but not onsets. This can be framed as a constraint against syllable initial laterals, an onset constraint:

(9) *Korean onset constraint*: * [$_{\sigma}$ l

And importantly, the Korean laterals that do occur in onset position, occur only by virtue of being associated to a coda, as in (a). *Geminate* laterals are absolved from the onset constraint. This is exactly parallel to the violation of a coda constraint by a geminate for which examples proliferate (Japanese, Itô 1986, Persian, Hayes 1986, etc.). Thus Korean laterals provide an example of geminate resistance to onset constraints of the type in (6b), and this precludes prespecification as an account of the effects.

At this point we can raise the question implicated by Inkelas and Cho's arguments: why are examples of geminate resistance to onset constraints considerably rarer than geminate resistance to coda constraints? Because onset constraints themselves are rare. Onsets characteristically support a full range of contrasts, codas characteristically neutralize contrasts. The reverse case, where the range of contrasts that appear in onset is smaller than those that appear in final position, is very rare. One example is the Dravidian language family, where word final consonants are less constrained than elsewhere. In (10) are the Toda inventories for onset and coda consonants (Emeneau 1984, Shalev, Ladefoged and Baskararao 1993):

(10) Onset constraints in Dravidian : Toda

a. Consonants appearing in onset (from Shalev et al. 1993):

| | labial | dental | alveolar | palatal | velar |
|---|---|---|---|---|---|
| stop/ affricate | p | t̪ | | | k |
| nasal | m | | n | | |
| fricative | f | s̪ | | | |
| trill | | r̪ | | | |
| approx | | | | j | w |
| lateral | | | l | | |

b. Consonants appearing in coda:

| | labial | dental | denti-alveolar | alveolar | retroflex | palato-alveolar | velar |
|---|---|---|---|---|---|---|---|
| stop/ affricate | p b | t̪ d̪ | ts dz | t d | ɖ | ʧ ʤ | k g |
| nasal | m | | | n | ɳ | | |
| fricative | f | θ | s̪ | s | ʂ | ʃ | x ɣ |
| trill | | r̪ | | r | ɽ | | |
| approx | | | | | | j | w |
| lateral | | | ɬ l | | ɭ ɭ | | |

There are 11 contrasts in onset and 34 in coda. In Toda very extensive and restrictive onset constraints must be posited to account for place, manner, and laryngeal neutralizations we see in the chart.

Toda exemplifies the fact that there is a considerable asymmetry between onsets and codas in the way they handle and encode phonotactic constraints. This asymmetry not only amounts to fewer constraints that involve onset neutralizations, but important to the present issue, far fewer opportunities to violate those onset constraints by the more restricted coda consonant set (the reverse is plausibly expected to be true in Dravidian, barring the interaction of other effects). Contra *prespecification*, geminates do not inherently favor one type of violation over the other. Important to the point, any dearth of examples of geminate resistance to onset constraints is a direct result of the tendency of codas and not onsets to restrict contrasts, and thus is not properly a property of geminate behavior.

The failure of the prespecification theory brings us back to the original view, in (3). The geminate consonant as it is generally understood is a heterosyllabic segment[2], represented as being associated to two timing slots via association lines.

More contemporary views expose the problems with this sort of representation. One is the dependence of this characterization on an ill-defined theory of association lines, their properties and the constraints that govern them. In the characterization of inalterability by Hayes, the gemination effects are a result of an artifact of the representation, not of features of the prosody or of segmental issues where one might reasonably expect to find them. Furthermore, proposals such as Hayes' (1986) 'Inalterability' account demand that to undergo a rule, forms strictly adhere to the structural description of the rule. As Scobbie (1992) and others have pointed out in recent work on geminates in constraint-based approaches, these types of rule-based analyses of geminate behavior are flawed by their dependence on the evaluation of the inputs to rules. This undermines insights that structural conditions ought to be very general, and when they exist are often constraints on output level. Contra rule based accounts, Scobbie in turn suggests that the crux of geminate behavior is related to its ill-formedness, rather than their well-formedness. The proposal below owes much to this observation.

## 2. The ecology of geminates

In the section below I will outline an argument that geminates show properties reminiscent of the devices of a component of the grammar, the prosody, that has been shown to utilize repair and enhancement strategies under parsing. If this be the case, then geminates can be considered a prosodic device. I will argue that they are a prosodic enhancement device and the geminate inalterability effects are a result of two things: their ill-formedness and constraints on the prosodic parser; the parser can not evaluate them. The argument has four parts.

The first part: given a definition of geminates as segments with double prosodic affiliation, we have two well defined types of segment-to-prosody relationships: singletons and geminates. Singletons represent the unmarked case, the association of a discrete segment to a discrete prosodic unit.

[2]The heterosyllabicity of geminate consonants versus vowels is an epiphenomenon of syllable structure in the post-Kahn view of syllables. This view precludes apparent examples of geminates in onset from this discussion.

(11) Singletons:

x prosodic tier
|
C segmental tier

Singletons can be both simple segments or contour segments like affricates (or even arguably complex segments such as doubly-articulated segments). Insofar as a set of features is combined into a discrete unit, –a segment–, and the segment is associated to a prosodic unit, the segments represent a set of contrasts in the language. That is to say, there is a set of operable contrasts that exist at the segmental level in a grammar. This is what we mean by the notion 'segmental inventory'.

Segmental inventories can be enhanced in two congruent ways: on the featural level and on the prosodic level. Discussion follows.

## 2.1 Enhancement strategies

The second part of the argument relates to enhancement strategies. The existence of featural enhancement strategies has been argued for (Maddieson 1984, Lindblom and Maddieson 1988, Stevens and Keyser 1989, Kingston and Deihl 1994). There are two kinds of featural enhancement assumed in these theories: featural contrast building where a feature can be used to produce a full series of contrasts, such as nasalization in vowel inventories: oral versus nasal vowels. In effect nasalization doubles the vowel contrasts. A second type of enhancement are strengthening strategies, where certain 'secondary' features act to perceptually enhance the existence of more 'primary' contrasts. An example, taken from Stevens and Keyser, is [+voice] enhancing or strengthening the feature [+sonorant]. Both types of featural enhancement strategies work from a set of more primary segmental contrasts.

The prosody also makes use of enhancement strategies. So for the prosody, there are also two congruent kinds of enhancement that work form a more primary set of contrasts: series building, and strengthening. And the difference between featural enhancement and prosodic enhancement is related to the differences between features and prosody. Featural primes and prosodic primes are different and have distinct properties. Features are subsegmental, the prosody organizes and parses segmental sized units. As a prosodic phenomena, gemination plays a role in both strengthening and series building types of prosodic enhancement:

(12) Enhancement strategies

| | ***Series building*** | ***Strengthening*** |
|---|---|---|
| Featural | [nasal] + V | [+voi] / [+son]<br>[-voi] / [-son] |
| Prosodic | gemination (lengthening) | gemination (indirect licensing) |

Consider the first type; series building. Gemination is the name for the enhancement of segmental inventories by a kind of contrast that allows singletons to oppose themselves by making use of prosodic timing. The following examples are from Italian[3].

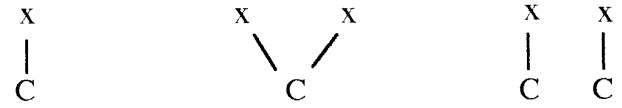
[3]My thanks to Maria-paola d'Imperio for these examples and discusssion of Italian.

(13)

| | |
|---|---|
| fato | 'fact' |
| fatto | 'fate' |
| pala | 'shovel' |
| palla | 'ball' |
| riso | 'rice' |
| rissa | 'brawl' |

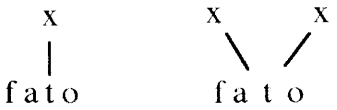
In Italian, geminates operate contrastively with singletons. Further examples can be found, of course, in any language with a 'length' contrast. The contrast is formalized below; (14a) is a singleton, (b) a geminate, (c) is a sequences of individual segments, 'C' represents a segment, 'x' a prosodically defined tier:

(14) a. b. c.




In this common view, under the dual prosody hypothesis, the singleton is a segment associated to one prosodic unit and the geminate is a single segment associated to two prosodic units:

(15) a. b.

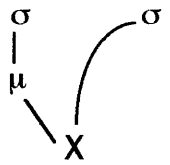



The double affiliation of the segment creates a new object, a geminate. The new object produces a contrast with a singleton, and the contrast is true of the series. So a language like Italian can have a contrast between a 't' that is single and a 't' that is doubly affiliated.

Thus gemination enhances the inventory of segmental contrasts by providing a new contrast, length, within a series. In effect, gemination can double the available contrasts within the set of consonants it applies to. We'll refer to this as *series building*.[4]

[4]For a discussion of this kind of featural enhancement in consonant inventories see Lindblom, MacNeigle and Studdard-Kennedy (1984), Maddieson (1984), Lindbolm and Maddieson (1988) and Stevens and Keyser (1990).

(16) Prosodic Enhancement (syllable level)
Series building:



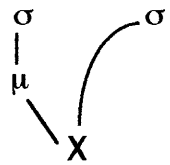

where '**X**' is a segmental contrast and the double prosodic affiliation constitutes a contrast with a singleton

The contrast between a singleton and a geminate, considered a 'length' contrast, is clearly a prosodic contrast. It is also the case that we do not expect to find gemination applying to a single consonant within a series, say the /p/, and not to the other stop consonants, gemination applies to a class of segments. In it is in this sense that it is comparable to nasalization in a vowel series, the autosegmental feature [nasal] enhances the vowel contrasts by applying to all the vowels, the prosodic features gemination enhances contrasts by applying to all stops. Thus both segmental and prosodic processes can enhance contrasts, what we are calling 'series building'.

The second type of prosodic enhancement, strengthening, is related to positional neutralizations.

Positional neutralizations neutralize contrasts in structural positions like onset and coda. Toda, for instance, as we saw, neutralizes many place and manner features in onset. Japanese neutralizes all consonantal contrasts in coda except nasals. Stop contrasts may violate this constraint if they are geminates. So by double linking, or gemination, a segment in a legal position, the onset, can be affiliated to a position where it is otherwise illegal, the coda (Steriade 1992, Itô and Mester 1992). Thus a contrast occurs between a segment that does and does not appear in a structural position, overriding a structural constraint that weakens or neutralizes the contrast. In this way the prosody strengthens the weak or neutralized segmental contrast.

(17) Prosodic enhancement (syllable level):
Strengthening:




where singleton affiliation constitutes a weak or neutralized contrast

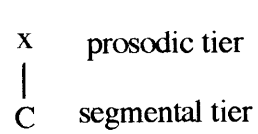
And geminates neutralize positional neutralizations.

There are then two kinds of prosodic enhancements that match the two kinds of featural enhancements: series building and strengthening. We are left with this question: How do we explain the fact that geminates and geminates alone are resistant to these kinds of structural constraints? This is the third part of the argument.

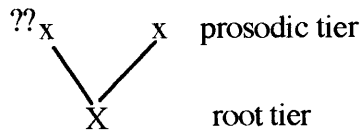
The simple answer to the preceding question is that the basis of geminate behavior lies in its structure, that is, in the one area where geminates are different from singletons.

Singletons are defined by their association to a single prosodic unit. If there is a one-to-one relationship between segments and prosodic units, then geminates are defined by their violation of this relationship.

(18) a.

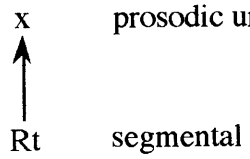



b.




We'll encode this ill-formedness in a principle called *segmental monogamy*. This principle makes explicit an uncontroversial and generally assumed notion: segmental association to a prosodic unit is interpreted as monogamous[5]. The arrow in the diagram below indicates that the direction of association is one way; i.e. the monogamy is not transitive.

(19) *The Principle of Segmental Monogamy*
segmental association to a prosodic unit is interpreted as monogamous




The only segments that violate this principle are by definition geminates. Thus, geminates are ill-formed. This ill-formedness is at the core of their ability to violate neutralizations. This constitutes the fourth part of the argument.

How does the ill-formedness produce the inalterability effects of (1) and (2)? As we know, Hayes and others have argued that inalterability arises as a result of the notations used to represent geminates. However a much simpler answer is available which refers directly to the prosodic uniqueness of geminates: these effects will occur if the constraints that govern prosodic well-formedness require segmental monogamy. In effect, prosodic parsers cannot read dually affiliated units.

## 2.3 Prosodic parsing

In this view, we need only say that the parsing mechanism in the prosody cannot evaluate dual prosodic structures. Thus prosodic parsing devices in a language which has a strict CV syllable structure will repair consonant clusters, in a number of ways. In a constraint based theory like OT (Prince and Smolensky 1993 and McCarthy and Prince 1993) candidates with consonant clusters (/ V k t V/) will be evaluated and discarded over

[5]Note that in theories that use syllable and mora nodes in lieu of CV or x slots, this calls up questions concerning the status of onset consonants in these structures, questions that are by no means settled. While different representations predict different things, there are no absolute arguments which prefer one representation, say affiliation of onsets directly to syllable nodes, over the another which affiliates onset consonants to moras to syllables. One thing is clear, the status of segments as sequences of unique and separable units within onsets is open. There are a series of cross linguistic and extra-linguistic facts that support the validity of this quandary: the status of 's' in languages like English and Spanish, the status of post-vocalic glides, sonority hierarchies in general, the large clusters in languages like Bella Coola and the Salish languages which are ignored in reduplication, the reported (huge) segment inventory of languages like !xhosa where there is no pre-existing orthography to segmentalize the onset contrasts. For the purpose of this argument we will assume that onset clusters are interpreted as monogamous unless they violate their tautosyllabicity.

candidates with inserted vowels ( / V k <V> t V / ) through that language's specific ranking of constraints FILL over PARSE. But geminates will always be passed over, no matter what the individual constraint rankings are. The claim here is that this is because of their dual prosody. The parsers require single affiliation, geminates violate this. Their prosodic ill-formedness means *not* that they represent a violation of constraint rankings, but that they cannot be evaluated. Thus geminates will not yield to epenthesis, or to any prosodically driven device that requires evaluation of forms by the prosody.

Where epenthesis is prosodically driven, the failure of epenthesis to split geminates is puzzling. If constraints that produce epenthesis read the output prosodic structure, we ought to expect it to evaluate the prosodic structure without recourse to the segment. Yet we know epenthesis does not break up geminates. In the present view, epenthesis will not split up a geminate because it cannot read the structural violation the geminate represents, its dual structure confounds the parser.

(20) Palestinian Arabic :: epenthesis / metathesis (Abu-Salim 1980)

$C_1VC_2VC_3$ --> $C_1VC_2C_3V$
$C_1VC_2C_2$ --> $C_1VC_2C_2V$

| | |
|---|---|
| a. ʔíbin | 'son' |
| b. ʔíbni | 'my son' |
| c. ʔákil | 'food' |
| d. ʔákli | 'my food' |
| e. ʔimm / *ʔimim | 'mother' |
| f. ʔimmi | 'my mother' |

*Inalterability* refers to the fact that geminate consonants do not undergo processes that singletons undergo. Thus in a language which requires spirantized alternates of stops postonically, like Biblical Hebrew in (1), forms with postonic stops will not occur. This is a positional neutralization: the contrast between stops and fricatives has been neutralized in this position. But we know that grammars will allow forms with tacit violations of these neutralizations, if the violations are geminates. How can this be? Geminates have an output shape that the structural conditions and constraints on structure cannot evaluate. Thus (b) will constitute a violation of a Biblical Hebrew constraint barring postonic stops, but not (a) or (c).

(21) a. hiθgadel
b. * hit-gaddel
c. hittammen

Again the form in (c) does not receive a violation because the geminate cannot be evaluated, they are neglected. Thus geminates will consistently override phonotactic constraints.

And finally, this hypothesis predicts that feature spreading will be unaffected by the fact of gemination unless the rule is prosodically motivated, in which case the rule will fail.

This account is akin to the intuitions encoded in Hayes' Linking Constraint and Schein and Steriade's Uniform Applicability Condition and others in its attention to the unique prosodic structure of geminates. It differs in several respects: it does not evaluate inputs to rules and thus does not requires special case evaluation metrics. In the Hayes account, for instance, inalterability effects must be provided with a separate mechanism from the epenthesis effects. Second, its relates geminate behavior to the broader context of its function in the grammar as a prosodic enhancement device.

## 3. Conclusion

In conclusion, this hypothesis of gemination, the integrity and inalterability effects of geminates fall out entirely from independently motivated devices: the dual prosodic structure of geminates, the principle of segmental monogamy and the existence of phonotactic parsing constraints that neglect geminates. There are no special provisos. Gemination is a prosodic device which enhances segmental contrasts by affiliating a segment to two discrete prosodic units. This strategy will produce a complimentary series of existing segmental contrasts; i.e. 'length' contrasts. In this, it mimics featural enhancement strategies. This dual affiliation furthermore violates a basic parsing strategy: the parser expects unique segmental affiliation to a prosodic unit. From this fact falls out geminate integrity and inalterability effects. The grammar fails to parse double affiliated segments, and thus cannot evaluate geminate strings.

## References


Abu-Salim, I. 1980. Epenthesis and geminate consonants in Palestinian Arabic, *Studies in the Linguistic Sciences* , University of Illinois, Urbana, 10:2 1-11

Bell, T., D. Dirks and E. Carterette (1989). Interactive factors in consonant confusion patterns. *Journal of the Acoustic Society of America* , 85:339-346

Hayes, B. (1986). Inalterability in CV phonology. *Language, 62.2*, 321-352.

Hyman, L. (1982). The representation of length in Gokana. In M. a. W. Flickinger (Ed.), *The Proceedings of the First West Coast Conference on Formal Linguistics*, . Stanford University.

Emeneau, M. B. (1961). *Kolami: A Dravidian Language*. Annamalainagar: Annamalai University.

Inkelas, S., & Cho, Y.-M. Y. (1993). Inalterability as prespecification. *Language, 69.3,* 529-574.

Kenstowicz, M. (1970). On the notation of vowel length in Lithuanian. *Papers in Linguistics, 3.1*, 73-113.

Kenstowicz, M. (1982). Gemination and spirantization in Tigrinya. *Studies in the Linguistic Sciences, 12.1*, 103-123.

Kenstowicz, M., & Pyle, C. (1973). On the phonological integrity of geminate clusters. In K. a. Kisseberth (Eds.), *Issues in Phonological Theory* The Hague: Mouton.

Kingston and Deihl 1994.

Leben, W. (1980). A metrical analysis of length. *Linguistic Inquiry, 11.3*, 497-509.

Lindblom, B., & Maddieson, I. (1988). Phonetic universals in consonant systems. In L. M. Hyman & C. N. Li (Eds.), *Language, Speech and Mind: Studies in Honor of Victoria A. Fromkin* (pp. 62-80). London and New York: Routledge.

Maddieson, I. (1984). *Patterns of Sounds.* Cambridge: Cambridge University Press.

McDonough, J. (1994). The asymmetry of nasals and laterals. Talk given at the LSA, Boston, and *OSULL #94-03.*

McDonough, J. (1993). On the phonological representation of laterals. Talk given at the LSA, LA and *UCLA Working Papers in Phonetics* v 82.

McDonough, J. and S-A Jun. (1994). A preliminary study of nasal airflow in nasal-lateral alternations in Korean, *OSULL #94-01*, Ohio State University.

Scobbie, J. (1992). Licensing and inalterability in Tiberian Hebrew. In G. P. C. a. J. M. D. C.P. Canakis (Ed.), *Papers from the 28th Regional Meeting of the Chicago Linguistics Society.*

Schein, B., & Steriade, D. (1986). On geminates. *Linguistic Inquiry, 17*, 691-744.

Selkirk, E. O. (1990). On the inalterability of geminates. In P. M. Bertinnetto & M. Lopocardo (Eds.), *Cartamen Phonologicum: Papers from the Second Cortona Phonology Meeting* Torino: Rosenberg and Sellier.

Shalev, Ladefoged and Baskararao. (1993) Toda. *Fieldwork Studies of Targeted Languages*, UCLA WPP, v82
Stevens, K., & Keyser, J. (1989). Primary features and their enhancement in consonants. *Language, 65.1*, 81-106.

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