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INITIAL GEMINATES IN LETI: CONSEQUENCES FOR MORAIC THEORY[1]

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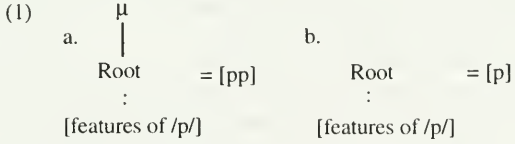
In this paper we provide new evidence for the view that geminates are nonmoraic and may occur in syllable onsets. Support for these claims comes from the patterning of syllable-initial geminates in the Austronesian language Leti. Evidence from distribution, phonological processes, such as metathesis and vowel deletion, geminate integrity effects, stress, and the patterning of geminates with long vowels is shown to support the position that while geminate consonants are bipositional, they do not bear weight.

1. Introduction

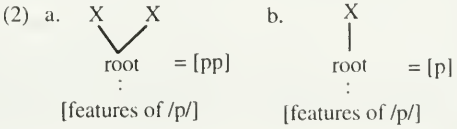
The representation of geminate consonants remains a controversial topic in phonological theory. Proponents of moraic theory, for example, claim that geminates are inherently moraic (see e.g., Hayes 1989, 1995; Davis 1994, 1996). Thus, an underlying geminate consonant differs from a single consonant of the same quality in terms of a mora, as shown in (1).

(1)



Conversely, evidence from the patterning of syllables containing geminates with light syllables in, for example, Selkup, suggests that geminates are nonmoraic (Rialland 1993, Tranel 1991). This type of evidence is consistent with an approach in which geminates are represented as a single root node multiply-linked to two skeletal positions (see e.g., Clements & Keyser 1983, Levin 1985).

(2)



It is noteworthy that evidence for each of these positions has thus far come predominantly from the patterning of intervocalic geminates, where the first part of the geminate occurs in coda position. Discussion of syllable-initial geminates, on the other hand, has received little attention in the literature.

One notable exception is Hayes 1989, where it is pointed out that "the theory of moraic phonology provides no straightforward way to represent a syllable-initial geminate." This follows from two fundamental claims of the theory. First, geminates are inherently moraic, as noted above. Second, moras are prohibited from onset position, given that moras are a measure of syllable weight and only syllable rhymes contribute to weight. Thus, an onset consonant cannot contribute to making its syllable heavy. It is important to point out that the claim that moras are prohibited from onset position is not exclusive to moraic theory per se, but is assumed by all theories of syllable structure which make use of the mora, either directly or indirectly (see e.g., Clements & Keyser 1983, Hyman 1985, Levin 1985, McCarthy & Prince 1986; for related discussion see Kenstowicz 1995). The representation of syllable-initial geminates is therefore problematic for a theory which assumes geminates to be moraic since moras cannot occur in the onset. Although Hayes 1989 proposes a number of alternative representations consistent with moraic theory, he brings into question the existence of true syllable-initial geminates and as such, suggests that phonological theory should not be required to account for them.

In this paper we provide new evidence for the view that geminates are nonmoraic and may occur entirely in syllable onsets. This, we show, provides strong support for an analysis of geminates as bipositional, as in (2). The evidence comes from the patterning of syllable-initial geminates in the Austronesian language Leti, spoken in Tutukei on the island of Leti, off the northeastern coast of East Timor. Of interest is the observation that Leti geminates display two different patterns of behavior. In the first, geminates pattern with long vowels in the prosodic process of downgrading. This includes both underlyingly syllable-initial geminates, as well as derived geminates, the first part of which occurs in coda position. As a result, Pattern 1 emerges, as given in (3), where a syllable containing a geminate patterns with a syllable containing a long vowel, to the exclusion of syllables closed by a nongeminate consonant, or no consonant at all. This pattern is reminiscent of Hindi, in which syllables that contain long vowels or are closed by a geminate, pattern to the exclusion of all other syllable types (Davis 1994). An important difference between Leti and Hindi, however, is that in Leti, syllables containing initial geminates also pattern with long vowels (syllable-initial geminates are not attested in Hindi).

(3) The patterning of geminates (G) in Leti:

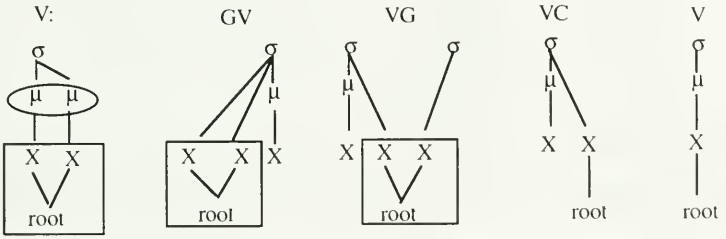
Pattern 1:	GV, VG, V:	vs.	VC, V
Pattern 2:	V:	vs.	GV, VG, VC, V

The second pattern in (3), supported by evidence from stress assignment, shows syllables containing geminates patterning with open syllables and syllables closed by a nongeminate consonant, to the exclusion of syllables with long

vowels. This pattern is similar to that observed in Selkup, as noted above, where syllables with geminate codas pattern as light (Rialland 1993, Tranel 1991). Once again, Leti differs from Selkup in that the former also includes syllable-initial geminates.

While Pattern 1 seems to concur with the claim that geminates are inherently moraic, since syllables containing geminates pattern with long vowels, we show this approach to be problematic. First, it contradicts the well-established view that moras are excluded from onset position. Second, given the patterning of syllables containing geminates with light syllables, as in Pattern 2, it is empirically incorrect. Instead, we will propose that the different patterns in (3) fall out in a straightforward manner from a representation that incorporates both weight and length (see also Hock 1986, Schmidt 1994, Tranel 1991). Along these lines, Pattern 1 is accounted for in terms of segmental length, characterized by reference to multi-attached association lines linking one root node to two skeletal positions, generalizing over both consonants and vowels, as shown in the boxes in (4). In Pattern 2, on the other hand, it is syllable weight that is at issue; only syllables with long vowels are bimoraic, as encircled in (4), and are thus distinguished from all other syllable types.

(4) Length and Weight



Leti is spoken in four villages on the western half of Leti island. The dialect of Leti spoken in that region is the Cape variant of Tutukei, which had approximately 500 speakers in 1990. Leti is a separate language within the Luangic-Kisaric subgroup, which belongs to the Austronesian languages of Timor (van Engelenhoven 1995b). Our research is based in large part on data from the grammar of van Engelenhoven 1995a and inspired by the analyses in that work, Hume 1997a, b and Muller 1997. Additional data has been provided by one of the authors, a native speaker of Leti.

The outline of this paper is as follows. We begin by establishing, on the basis of evidence from distribution and phonological processes, that initial geminates in Leti are indeed geminates. As will be shown, geminates consistently pattern with consonant clusters, as opposed to single consonants. However, unlike consonant clusters, geminates must be represented as a single melody multiply-linked to two skeletal positions. We introduce a new type of geminate "integrity" phenonemon in support of this position: reduplication cannot break up a geminate. With this as a basis, we move on to discuss evidence from the prosodic process of downgrading, which supports Pattern 1, noted in (3) above. This is followed by

discussion of stress assignment, which supports Pattern 2. In section 5 we outline the consequences of these observations for moraic theory, in particular. Section 6 presents our proposed analysis of the Leti facts.

2. Distribution and Patterning of Geminates

We begin by establishing that initial geminate consonants in Leti are indeed geminates. That is, they behave phonologically as more than one segment, but unlike consonant clusters, they are best viewed as a single melody multiply-linked to two prosodic positions.

With regard to the first point, ample evidence supports the patterning of geminate consonants with consonant clusters, as opposed to single consonants. With respect to distribution, underlying geminates, like consonant clusters, only occur in word-initial position, as the examples in (5) illustrate.[2]

(5)	ppikan	'plate'	ptuna	'star'
	ppuna	'nest'	pninu	'fool'
	ttui	'genre of literature'	kdʸeli	'ring'
	kkusal	'to be small'	vroan	'axe'
	kkɔ̣i	'child'	sraki	'gong'
	ssoran	'cough'	spou	'[sailing]boat'
	mmɛi	'table'		
	mmanan	'food'		
	nnɛi	'sign'		
	llai	'shore/beach'		
	llilin	'candle/wax'		
	rraa	'again'		

Initial geminates and consonant clusters are also derived by morpheme concatenation, as in (6).

(6)	r-rusa	'they nail'	t-kari	'we [inc] work'
	n-neu	'he creeps'	n-mori	'he lives'

Non-initial geminates and sequences of consonants also result from morpheme concatenation and metathesis, as in (7).[3]

(7)	a.	pɛn-ne	'his pen'	pɛŋku /pɛn-ku/[4]	'my pen'
	b.	*Phrase-finally*	*Phrase-medially* (before a CV-initial word)		
		anni	anin	'wind'	/anin/
		kunsi	kunis	'key'	/kunis/

In addition, both initial and non-initial geminates can be derived by assimilation, as the representative examples in (8) illustrate.

(8)	i.	/d+n/	→ [nn]	/lɔdan/	[lɔnna]	'rattan'
	ii.	/d+l/	→ [ll]	/dudal/	[dullu]	'horn'
	iii.	/l+n/	→ [ll]	/vulan/	[vulla]	'moon'
				/ɛla+ne/	[ɛlle]	'sister, poss.'
	iv.	/n+l/	→ [ll]	/na losir/	[llosir]	'3sg, to follow'

v.	/v+p/	→ [pp]	/vavi+pure/	[vappure]	'wild pig'
vi.	/v+m/	→ [mm]	/vavi+mu/	[vammu]	'your pig'
vii.	/t,d + s/	→ [ss]	/puata+seran/	[p^{w}asseran]	'Seranese woman'
			/kuda+seran/	[kusseran]	'Seranese horse'

The patterning of initial geminates with consonant clusters is also observed when words or morphemes are concatenated within a phrase (see section 3 for related discussion). As shown in (9), clusters as in (a), and geminates in (b) trigger metathesis of the final vowel and consonant of a preceding morpheme (/VVC/-final forms also show compensatory lengthening of the penultimate vowel). As the forms in (c) illustrate, word-initial single consonants do not trigger metathesis.[5]

(9) a.	/kunis+vnutan/	kunsivnutan	'key + iron'
	/vuar+spou/	vu:raspou	'mountain+boat = schooner mountain'
	/danat+kviali/	dantakv^{y}ali	'millipede'
	/morut+kdieli/	mortukd^{y}eli	'hair + ring = very curly hair'
	/maun+tpunan/	ma:nutpunan	'bird + throat'
b.	/ukar+ppalu/	ukrappalu	'finger + bachelor = index finger'
	/maun+ppuna/	ma:nuppuna	'bird + nest'
	/kapal+ttɛnan/	kaplattɛnan	'ship + spine = keel'
c.	/urun+mɔa/	urunmɔa	'Moanese breadfruit'
	/mɛsar+lavan/	mɛsarlavan	'teacher, big'
	/vuar+lavan/	vuarlavan	'highest mountain'
	/pɔkar+ne/	pɔkarne	'their leanness'

Similarly, before a CV-initial morpheme, as shown in (10a), a final low vowel of a preceding morpheme is deleted. No deletion occurs before a morpheme-initial consonant cluster or geminate, as in (b).

(10) a.	/samɛla + nura/	samɛlnura	'mouse + coconut tree'
b.	/samɛla + ttɛnan/	samɛlattɛnan	'mouse + spine'
	/samɛla + tpunan/	samɛlatpunan	'mouse + throat'

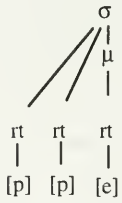
As a final illustration, before a CV-initial morpheme, a final high vowel of a preceding morpheme is realized as a secondary articulation on an adjacent prevocalic consonant, as shown in (11). No secondary articulation formation occurs before a morpheme beginning with a consonant cluster or geminate.

(11) a.	/rai + lavan/	ral^{y}avan	'land + to be big'
	/lopu + do/	lopd^{w}o	'dolphin + then'
	/kkani + tani/	kkant^{y}ani	'plate + soil'
	/tultulu + enu/	tultul^{w}enu	'hat + turtle'
b.	/sivi + ttɛi/	sivittɛi	'chicken that has not yet laid eggs'
	/lɔi + llatutun/	lɔillatutun	'proa + Laitutunese'
	/ai + vlakar/	aivlakar	'wood + crossed'
	/koni + mderi/	konimderi	'grasshopper + Mderi'

Based on the above observations, it is clear that geminates pattern with consonant clusters, as opposed to single consonants. Under the assumption that a

cluster is comprised of two segmental positions, this might suggest the representation of geminates in (12), where a geminate is made up of two root nodes, linked to individual feature complexes (Hayes 1989).

(12) Geminates as two segmental positions.



Evidence against this characterization of initial geminates comes from geminate integrity effects observed in Leti reduplication. The reduplicant (underlined) is aligned as close as possible to the left edge of a trochaic foot, which itself is aligned to the right edge of a lexical word, as illustrated in (13) (see Muller 1997, van der Hulst & Klamer 1996).[6]

(13)	sɔpan	sɔ<u>p</u>sɔpan	'to order, messenger'
	luli	<u>lu</u>luli	'taboo, taboo (adj.)'
	na-olu	na-ol<u>w</u>olu	'he sells, (which) he sells'

When the word to be reduplicated begins with a consonant cluster, the reduplicant occurs between the two consonants, as shown in (14).[7]

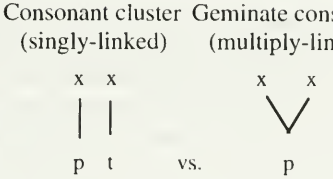
(14)	mnina	m-<u>ni</u>-nina	'to be calm/calm'
	kriat	k-<u>ri</u>-riat	'to be slow/slow'
	kpuri	k-<u>pur</u>-puri	'to be short/becoming short'
	mtaut	m-<u>ta</u>-t<u>w</u>aut	'to be afraid/afraid'

However, when the word to be reduplicated begins with a geminate consonant, the reduplicant always precedes the geminate. In other words, a geminate is never split up.

(15)	ppɛrat	<u>pɛ</u>-ppɛrat	'to be heavy/heavy'
	kkɔi	<u>kɔ</u>-kkɔi	'kid/child'
	mmɛran	<u>mɛ</u>-mmɛran	'to be swift/swiftly'
	na-mmali	na-<u>ma</u>-mmali	'he laughs at/someone he laughs at'
	kkusal	<u>ku</u>-kkusal	'to be small/to get small'

The differences in patterning of clusters and geminates can be accounted for in a straightforward manner by drawing on the well-established view that clusters are two segments, while a geminate is a single multiply-linked segment, as shown in (16). The observation that geminates may not be split up in reduplication is consistent with cross-linguistic observations concerning geminate integrity and provides strong evidence against (12) as a viable representation of Leti geminates.

(16)



3. Pattern 1: The patterning of geminates with long vowels

We turn now to evidence bearing on Pattern 1 in (3): syllables containing geminates pattern with long vowels to the exclusion of all other syllable types. Evidence for this pattern comes from the process of *downgrading*, as it is labelled in van Engelenhoven 1995a. Downgrading is an optional prosodic process which affects a sequence of two syntactically related lexical words: verb-object, possessor-possessed, location-locational. In downgrading, the first word is realized completely without stress and at a faster rate, thus rendering the first word prosodically inferior to the second.

Before examining downgraded forms, however, details concerning phrasing in Leti may prove useful. In Leti, words can either occur in separate phonological phrases, as in the leftmost column in (17), or be concatenated to form a single phrase (column 2). Evidence for phrasing comes both from phonological considerations as well as, in many cases, morphological and syntactic considerations. Due to space considerations we are not able to provide a detailed discussion of phrasing, but note that differences in phrasing often serve a morphological function, denoting semantic differences such as definite/indefinite, transitive/intransitive, etc.

(17)

1. *Separate phrases*	2. *Single phrase*	3. *Downgraded (underlined)*	*UR*[8]
a. sívi térannu	sivtʸérannu	sivi térannu	/sivi+teran-nu/
b. spóu ttɛ́nanne	spóuttɛ́nanne	spou ttɛ́nanne	/spou+ttɛnan-ne/
c. ntútnu wái	ntútunwái	ntutnu wái	/na-tutun+uai/

In terms of phonology, all phrase-final words end in a vowel. For underlying vowel-final forms, as in the first morpheme in (a, b), there is no change in the morpheme's shape. For underlyingly consonant-final forms, on the other hand, the final vowel and consonant of a word undergo metathesis as a means of satisfying this phrasal requirement, as shown by the morpheme /tutun/ in (17c, column 1).[9]

When words are concatenated within a phrase, as in column 2, a variety of processes affect the elements at the inner edges of morphemes (secondary articulation formation, glide formation, vowel deletion, metathesis, resyllabification) depending on the syllable structure and segmental quality of the morphemes involved (for detailed discussion see Hume 1997a, b; see also (9) through (11) above for examples of some of these processes). (For details concerning stress assignment in Leti, see section 4).

A third possible realization of these pairs of words, as shown in column 3, is when the first word of the sequence is downgraded. That is, the first word is entirely unstressed, and thus is prosodically inferior to the second. Note that in pairs displaying downgrading, each word occurs in a separate phrase (cf. column 1). However, in downgraded sequences, the morphological distinction between the sequences in columns 1 and 2 is essentially lost, with the relevant semantics of the downgraded sequence determined by the context in which it occurs. Note also that, while not shown in these examples, in pairs involving downgrading, the vowels /e/ and /ɛ/ are realized as [ɪ], and /o/ and /ɔ/ are neutralized to [o]. In non-downgraded sequences, there is no change in vowel quality.

Of interest is the observation that downgrading is systematically blocked if the first word contains a long vowel. This can be seen by comparing the forms on the left in (18) where downgrading is impossible, with the forms on the right, which do not contain a long vowel but where downgrading is possible.

(18) *No Downgrading*		*cf. Downgrading*	
lá:re wá:rne	'the root of the la:ra tree'	lare lavárne	'the cloth of the sail'
ntú:tu pʷórse	'he strikes [at] the door'	ntutu pʷórse	'he hits the door'
nvá:lu vátu	'he flings the stone'	nvali vátu	'he turns the stone'
lo vú:re ná:ni	'under the mountain'	lo vure ná:ni	'under the oil'

Words containing a geminate consonant pattern in an identical manner. That is, downgrading never occurs in a word that contains a geminate. It is important to point out that this is the case with both underlying and derived geminates. Words with syllable-initial (underlying) geminates are shown in (19a). Those created by morpheme concatenation are in (b), and geminates formed by assimilation appear in (c). In none of these cases is downgrading possible. Given that derived geminates pattern with underlying geminates, we assume that the former also consist of a single multiply-linked root node resulting from OCP-driven root node fusion (i.e., adjacent identical segments are prohibited).

(19) a. Underlying geminate:

No Downgrading		*cf. Downgrading*
ppátne únne	'trunk of the orange (tree)'	nura únne 'trunk of coconut tree'
lo mmɛ́i vávna	'on the table'	
ssísme úlatni	'the skin of the sepia'	
kkáni snʸaktúvnu	'the story of the [golden] plate'	
ppúne samékne	'stuff from the nest'	
kɔkkɔ́i sékni	'the toy of the child' /Red + kkɔi/	
lo pɛppérta ná:ni	'beneath the heavy one' /Red + ppɛrat/	

b. Geminate formed through morpheme concatenation:

No Downgrading		*cf. Downgrading*	
pénne rʸárma	'inside his pen'	pɛne rʸárma	'inside the pen'
		pɛŋku rʸárma	'inside my pen'
		pɛnmu rʸárma	'inside your pen'
		pɛnmi rʸárma	'inside your [pl.] pen'
lókku ná:ni	'under my foot'	lokni ná:ni	'under his foot'

c. Geminate formed through assimilation:

No Downgrading		*cf. Downgrading*	
úmmu[10] á:nne	'the child of your [sg] grandparent'	upku á:nne	'the child of my grandparent'
úmmi á:nne	'the child of your [pl] grandparent'	upnu á:nne	'the child of his grandparent'
vúlle dáinni	'a/the beam of the moon'	lɛre dáinni	'a/the beam of the sun'

/vulan 'moon' + e 'indexer' + dain 'beam' + nV 'poss.'/

énne ná:ni 'under the pineapple [plant]'

/ɛdan 'pineapple' + e 'indexer' + nain 'under'/

Note also that while a syllable closed by a geminate consonant blocks downgrading, one closed by a nongeminate consonant does not, as in (20).

(20) *No Downgrading* *Downgrading*

pénne rʸárma 'inside his pen' pɔtle rʸárma 'inside the bottle'

pɛŋku rʸárma 'inside my pen'

Comparing nondowngraded [pénne] with downgraded [pɛŋku] /pɛn+ku/ is also instructive since these forms show that while a word containing a geminate blocks downgrading, a word containing a place-assimilated consonant does not. Given that a geminate is comprised of a single multiply-linked root node, and a place-assimilated consonant is represented with a multiply-linked place node, it is clear that multiple-linking alone is not a sufficient criterion for blocking downgrading.

Thus, in downgrading, geminates and long vowels pattern together as a natural class; downgrading is only blocked when a word contains one of these two types of segments.

4. Pattern 2: Syllables with geminates pattern as light

We turn now to the second pattern noted in (3): syllables with geminates pattern with light syllables to the exclusion of those with long vowels. The evidence comes from stress assignment. As shown in (21), when a word occurs in isolation stress always falls on the penultimate syllable.[11] (Note that words are illustrated in phrase-final position and, thus, are vowel-final.)

(21) spóu	'kind of boat'	pdudúklu	'bubbling'
ppúna	'nest'	tuvúri	'Charonia tritonis'
kúnsi	'key'	marsína	'machine'
lópu	'dolphin'	karsʸɔ́na	'pumpkin'
má:nu	'bird'	polí:sa	'police'

In the case of trisyllabic forms, generally resulting from reduplication or morpheme concatenation, stress also falls on the penultimate syllable, as shown in (22). Of interest is the observation that the first syllable is also stressed only if that syllable contains a long vowel, as in (m-o).[12] In all other cases, the initial syllable remains unstressed. This holds regardless of whether the first syllable is open, as in (a-c), closed by a nongeminate consonant, as in (d), or by a geminate as in (e-i).

Note that a syllable-initial geminate does not attract stress either, as shown in (j-l). In other words, all syllables containing a geminate pattern with light syllables, whether open or closed.

(22)	a.	matrúma	'master of the house'	máta, rúma
	b.	rimɔ́ta	'kind of turtle'	ría, mɔ́ta
	c.	pupʷéni	'dragon fly's chrysalis'	púpu, wéni
	d.	nvaltʸáni	'he digs'	nvá́li, táni
	e.	pɛppérta	'heavy'	RED + ppérta
	f.	kɔkkɔ́i	'child'	RED + kkɔ́i
	g.	vappúre	'wild pig'	vávi, púre
	h.	pʷassérna	'Seranese woman'	pʷáta, sérna
	i.	kussérna	'Seranese horse'	kúda, sérna
	j.	ppunárta	'nest's edge'	ppúna, árat
	k.	nnemʸásа	'golden sign'	nnɛ́i, másа
	l.	kkantʸáni	'earthenware'	kká́ni, táni
	m.	má:nʷorʸóri	'bird + buffalo = crow'	má:nu, orʸóri
	n.	rɔ́:nénu	'they eat turtle'	rɔ́:na, énu
	o.	má:nʷá:na	'chick'	má:nu, á:na

To summarize, two patterns involving geminates in prosodic processes are observed in Leti. In downgrading, all syllables containing geminates pattern with long vowels. In stress, on the other hand, syllables with geminates pattern with light syllables.

5. Consequences for Moraic Theory

In moraic theory, syllables containing geminates are predicted to pattern with long vowels on the basis of syllable weight; given the view that geminates are inherently moraic, a syllable containing a geminate will be heavy, as will a syllable containing a long vowel (see e.g., Hayes 1989, 1995). Along these lines, one might attempt to account for the blocking of syllables containing geminates or long vowels in Leti downgrading by reference to syllable weight: a word containing a heavy syllable cannot be downgraded. While at first glance this account appears straightforward, there are a number of intractable problems associated with it, which we now outline.

For a syllable with an initial geminate to be heavy, and thus block downgrading, it must be assumed that the mora of the geminate occurs in the onset. Problematic with this account is the fact that it contradicts one of the fundamental claims of moraic theory: moras are excluded from the onset. This claim, it should be emphasized, is not exclusive to moraic theory per se, but is held by all theories of syllable structure which make use of the mora, either directly or indirectly (see e.g., Clements & Keyser 1983, Hyman 1985, Levin 1985, McCarthy & Prince 1986). It is precisely this claim that allowed for the insightful treatment of compensatory lengthening effects in Hayes 1989. As he showed, compensatory lengthening of a vowel consistently occurs when a coda consonant, but not an onset consonant, is deleted. This observed asymmetry receives an elegant account if it is assumed that only rhymes contribute to syllable weight.

Thus, a coda may be moraic, while an onset consonant never is. Following this line of reasoning, deletion of a coda consonant will leave a mora available for compensatory lengthening, while deletion of an onset consonant will not. Thus, abandoning the claim that moras are prohibited from the onset would not only run counter to well-established views of syllable structure, but leave unexplained the observed asymmetry between onset and coda consonants in compensatory lengthening, stress and other weight-related phenomena.

It is important to point out that alternative representations of initial geminates, as suggested in Hayes 1989, would not resolve this problem. Hayes proposes two representations which are consistent with the view that geminates are moraic, and that moras are excluded from the onset. The first is illustrated in (23), where the first half of the geminate comprises a separate syllable. We note two problems with this representation. First, in Leti, lexical words must be minimally bimoraic. If (23) were the representation of initial geminates, we might expect to find words made up of an initial geminate and a vowel, e.g., [ppe], since the minimal word condition would be satisfied. None are attested.[13] On the other hand, if we assume that initial geminates are part of the onset of a single syllable, words containing geminates conform to the overwhelming tendency in Leti for lexical words to be exactly two syllables long. Second, if one were to assume that it is syllable weight that is at issue in blocking downgrading, then representing an initial geminate as bisyllabic would make the wrong prediction since the syllable containing the initial part of the geminate is not heavy, and so it would not be expected to pattern with a syllable containing a long vowel.

(23) The first half of the geminate as a separate syllable.

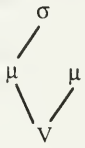
A second representation consistent with moraic theory would be for the mora of an initial geminate to be unattached to the syllable, as in (24). In other words, a geminate's mora would be extrasyllabic. This representation is problematic since first, a mora unattached to a syllable node would not contribute to syllable weight. As a result, a geminate-initial syllable would again not be predicted to pattern with long vowels in blocking downgrading. Note that this same problem would arise if the extrasyllabic mora were linked to a node higher than the syllable, e.g., foot, prosodic word.

An additional problem with representation (24) stems from the observation that a mora which is not prosodically licensed would be uninterpretable phonetically. Precisely this point was made in Prince & Smolensky 1993, where they claim that the representation in (25) corresponds to a shortened vowel. Since the mora unattached to syllable structure is uninterpreted, they claim that it gives rise to a phonetically short vowel. Consequently, were (24) the representation of an initial

geminate in Leti, it would be phonetically indistinguishable from a short consonant, which is not the case. Geminate consonants are consistently produced with a longer constriction than that of a corresponding non-geminate segment.

(24) Allow a stray mora to occur initially.

(25) Shortened vowel (Prince & Smolensky 1993)



As a result, none of the alternative representations of syllable-initial geminates proposed by Hayes are consistent with the Leti facts.

A further problem associated with a weight-based account of the Leti facts relates to the observation that in downgrading, syllables with geminate codas pattern with long vowels while those closed by a singleton consonant do not. In other words, coda geminates would contribute to syllable weight while other coda consonants would not. Recall that coda geminates are derived by assimilation or morpheme concatenation, and so cannot be assumed to have a mora underlyingly. Thus, a mora would need to be assigned to a coda consonant, just in case it is geminate. In moraic theory, the assignment of a mora to a coda consonant is achieved by Weight-by-Position (WP) (Hayes 1989, 1995). Since WP assigns a mora to all coda consonants, lacking further restrictions, we would incorrectly predict syllables closed by a nongeminate to pattern in an identical manner to those closed by a geminate.

To restrict mora assignment to a coda geminate, one might posit a violable Optimality-theoretic constraint such as Geminate = Moraic (G=M), which penalizes a nonmoraic geminate consonant. Ranked above input-output constraints on mora faithfulness, such a constraint could be used to assign a mora to a derived (underlyingly nonmoraic) geminate. We illustrate this in tableau (27) with an example of a geminate derived by morpheme concatenation. As shown, inclusion of G=M into the constraint inventory allows for the selection of the moraic geminate in (c) as optimal. This is assured by subordinating Dep-mora, which penalizes insertion of a mora, as stated in (26), to the constraints OCP and G=M. (Note that a derived geminate, whose first part occurs as coda, will, like an underlying geminate, also be comprised of a single root node multiply-linked to two prosodic positions under the assumption that adjacent identical segments are fused by the OCP.)

(26) Geminate = Moraic (G=M): a geminate is moraic.
Dep-mora: a mora in the output has a correspondent in the input.
OCP: adjacent identical segments are prohibited.

(27)

		I= cvc + cv | | rt_a rt_a	OCP	G=M	Dep-mora
	a.	σ σ | | rt_a rt_a	*!		
	b.	σ σ \ / rt_a		*!	
☞	c.	σ σ \ / μ / \/ rt_a			*

While incorporating a constraint such as G=M into the constraint inventory would predict derived geminates to pattern with underlying geminates and long vowels in terms of syllable weight, there are problems with this approach. First, we are still faced with the problem of moras in the onset, as indicated above, in order to allow both syllable-initial geminates and coda geminates to pattern with long vowels.

Second, the constraint G=M is a stipulation. That is, the observation that derived coda geminates, to the exclusion of all other consonants, pattern with long vowels and underlying geminates does not follow in a principled way from the theory; only underlying geminates are claimed to be inherently moraic. Moreover, given the ability to posit a constraint requiring the surface presence of a mora on a derived geminate, it would be equally plausible to construct a constraint which instead requires only *nongeminates* to be moraic. By doing so, however, we would predict a language in which syllables with long vowels and underlying geminates pattern with syllables closed by nongeminate consonants, but not by derived geminate consonants. To our knowledge, no such language exists.

Third, given that G=M, like all constraints, is violable, we predict a language to exist in which underlying geminates contribute to syllable weight, since they are inherently moraic, while derived geminates in the same language do not. We illustrate this in (28) where input (a) contains a derived geminate while input (b) contains an underlying geminate (an uppercase character represents a moraic geminate). With the ranking of Dep-mora over G=M, we predict a moraless (derived) geminate to surface in (a.1) while the mora of an underlying geminate is preserved in (b.2). This pattern, as far as we are aware, is also unattested.[14,15]

Fourth, there is no independent evidence in Leti supporting the view that geminates contribute to syllable weight. What we have, on the contrary, is evidence indicating that they do not. First, as noted above, geminates do not contribute to mora count in Leti's bimoraic minimal word requirement; that is, there are no words comprised of a geminate plus vowel, even though such a form

would satisfy word minimality. Second, syllables containing geminates pattern with light syllables in stress assignment. Thus, not only is an analysis which treats geminates as inherently moraic problematic on theoretical grounds, such an approach is also empirically incorrect.

(28)

	a.	I= lok-ku	Dep-mora	G=M
☞	1.	lokku		*
	2.	loKku	*!	
	b.	I= loKku		
	1.	lokku		*!
☞	2.	loKku		

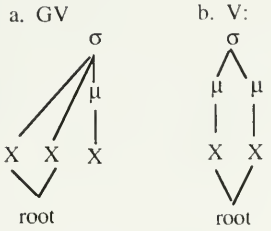
Note that since the patterning of a syllable with a long vowel to the exclusion of one containing a geminate is not predicted by moraic theory, an added proviso would be required to derive the observed stress facts. For example, one might invoke a requirement that only moras which link to a vowel (Hyman 1992) or branch to a single vocalic root node count as heavy (de Lacy 1996). Problematic for such an account, however, is that the exact opposite stipulation would be required to handle stress in Dutch. As Lahiri & Koreman 1988 show, stress generally falls on the penultimate syllable, e.g., *va:lú:ta:* 'currency'. However, if the final syllable is closed, stress falls on the penult only if that syllable is closed, e.g., *de:téktor* 'detector.' Otherwise, it falls on the antepenult, e.g., *mó:ni:tor* 'monitor'. Of interest is the observation that a syllable containing a long vowel does not pattern with a closed syllable in attracting stress. The constraint for Dutch would then require that only moras *not* multiply-linked to a single root node count as heavy.[16]

To summarize, in order to account for the observed facts from Leti, it cannot be simultaneously assumed that geminates are inherently moraic and that moras are excluded from the onset. To do so is not only problematic for theory-internal reasons, as noted above, it is also empirically incorrect.[17]

6. Proposal

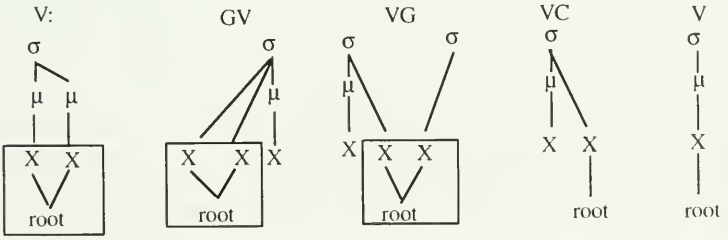
To account of the patterning of geminates in Leti, we propose that geminates are not underlyingly moraic. Instead, along the lines proposed in, for example, Clements& Keyser 1983 and Levin 1985, and more recently Tranel 1991, we suggest that geminates, as well as long vowels, are represented as long segments: a single root node multiply-linked to two skeletal positions.[18] Further, while vowels are inherently moraic, consonants are not,[19] but may be assigned a mora on a language-by-language basis (consistent with Weight-by-Position as proposed in Hayes 1989, 1995). In Leti, consonants are nonmoraic at all levels of analysis. As a result, both weight and length are incorporated into the representation as shown in (29), where (29a) shows a syllable-initial geminate, and (b) gives the representation of a long vowel (see also Hock 1986, Lahiri & Koreman 1988, and Schmidt 1994, where weight and length are also integrated into the representation).

(29)



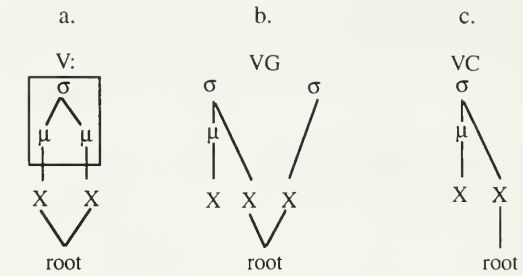
Given this approach, the two observed patterns involving geminates noted in (3) can be accounted for in simple terms. First consider pattern 1, where syllables with geminates pattern with long vowels, to the exclusion of all other syllable types. To account for the blocking affect of geminates and long vowels, we suggest that it is phonological length that is at issue. In other words, as shown in (30), a segment characterized by a root node branching to two skeletal positions blocks downgrading. We would suggest that the reason why phonological length is crucial in a process such as downgrading relates to the observation that downgraded forms are produced without stress and at a faster rate. If a word which contains a phonologically short segment were produced in this manner, there would be no loss of contrastiveness: a durationally short segment would merely be shorter. However, if a word containing a long vowel or consonant were produced in this manner, the result would be an endangerment of contrast. In other words, a durationally long segment would be produced as short. Thus, we speculate that maintaining the perceptual distinctiveness of long vs. short segments may play a key role in determining which forms can and cannot be downgraded.

(30)



With respect to pattern 2, where syllables containing long vowels pattern to the exclusion of all others, we propose that it is phonological weight that is key. To account for the observation that only long vowels attract secondary stress, we would suggest that only heavy, that is, bimoraic syllables attract secondary stress, as in (31). Segmental length is not a sufficient condition for stress assignment. As a result, a syllable containing a coda consonant, whether it is part of a geminate (b) or not (c), will never attract stress since consonants are nonmoraic.

(31)



7. Conclusion

In this paper we have presented new evidence bearing on the representation of geminate consonants. Given the paucity of discussion in the phonological literature concerning syllable-initial geminates, the evidence from Leti is particularly important not only for further enriching our understanding of these segments but, in addition, for serving as a testing-ground for theories of prosodic structure. We have shown that in order to account for the observed facts in Leti, syllable-initial geminates are best characterized as a single root node multiply-linked to two skeletal positions. Support for this approach comes in part from a new type of "integrity" phenomenon: reduplication cannot break up a geminate. It is also supported by the observation that a constraint on downgrading makes specific reference to multi-attached association lines linking one root node to two skeletal slots, generalizing over consonants and vowels. Consistent with Tranel 1991, the patterning of syllables containing geminates with light syllables also supports the view that geminates are underlyingly nonmoraic. In addition to successfully accounting for the observed facts in a straightforward manner, our proposed representation of geminates also avoids the problems noted in the previous section. First, the widely accepted claim that moras are excluded from the onset is maintained. Second, accounting for the patterning of geminates with long vowels in terms of segmental length obviates the need to posit a special Weight-by-Position proviso that only geminate codas, as opposed to other coda consonants, are assigned a mora. Finally, we correctly allow for the *non*patterning of geminates with long-voweled syllables, as required in Leti, without stipulation. Since geminates are not inherently moraic, syllables containing long vowels may pattern differently from those with geminates in terms of syllable weight.

NOTES

[1] We are especially grateful to Nick Clements, David Odden, Sam Rosenthall, and members of the MCWOP2 audience for valuable comments on aspects of this research. We also thank two anonymous reviewers for their useful suggestions.

[2] It should be noted that in absolute phrase-final position, all words end in a vowel. Thus, the final vowel and consonant of consonant-final forms in (5) undergo metathesis (with compensatory lengthening of the penultimate vowel if /VVC/-final) as a means of satisfying this phrasal requirement, e.g. ppikan → [ppikna] 'plate',

vroan → [vro:na] 'axe' (see section 3 and footnote 3 for related discussion).

[3] Metathesis occurs under two general conditions in Leti. First, it occurs in words within a phrase in order to avoid an initial complex onset or onsetless syllable. Second, it affects all underlying consonant-final words when they occur in phrase-final position in order to satisfy the requirement that all phrases end in a vowel (see Hume 1997a,b for related discussion and analyses).

[4] /n/ assimilates to the place of articulation of a following obstruent stop.

[5] To complete the paradigm, we note that before a following vowel-initial morpheme, a preceding consonant syllabifies as onset of the following syllable. Since (word-final) phrase-internal open syllables are avoided in Leti, the vowel preceding the resyllabified consonant deletes or is realized as a secondary articulation on an adjacent prevocalic consonant, e.g. /isuɔna + aan/ [is^{w}ɔna:n] 'witch + diminutive', /tikil + erun/ [tikl^{y}erun] 'to kick + downwards'. See Hume 1997a,b for discussion and analyses of these and subsequent alternations involving metathesis, resyllabification, vowel deletion, and secondary articulation formation.

[6] In many, but not all cases the left edge of the foot corresponds to the beginning of the word, as in the first two examples, e.g. sɔp[sɔpan], lu[luli]. Muller 1997 accounts for the position of the reduplicant by the Optimality-theoretic constraint, Align (Red, R; Foot, L): align the right edge of the reduplicant to the left edge of a foot. Like all OT constraints, Align may be violated, as in the third example, nao-[l^{w}olu], where the rightmost segment of the reduplicant is actually part of the foot. As Muller shows, these misalignments are forced in order to satisfy more highly ranked (typically, syllable structure) constraints. (See footnote 7 for related comments.)

We also note that the shape of the reduplicant, which shows a number of different types of realization, is generally determined on the basis of syllable structure conditions. See Muller 1997 for detailed discussion.

[7] As Muller 1997 shows, the splitting up of an initial consonant cluster is forced by Align, which, as noted in footnote 6, requires the reduplicant to be aligned to the left edge of a foot. Thus, prefixation of the reduplicant before both members of an initial consonant cluster, as in *nim[nina], would result in an alignment violation, since the foot boundary falls between the two members of the consonant cluster (i.e., the reduplicant is one segment away from the foot boundary). Conversely, by placing the reduplicant between the two consonants, e.g. mni[nina], the reduplicant is perfectly aligned to a foot, and thus, alignment is satisfied.

[8] Glosses: a. 1. 'the egg of the chicken', 2. 'his chicken-egg'; b. 1. 'the keel of the boat', 2. 'his keel' (i.e., 'here I see a keel [in the sand] and it is his [referring to a human, not to a ship]'); c. 1. 'he lights the fire', 2. 'he kind of lights the fire'.

[9] We assume that the rightmost word in each sequence is in phrase-final position and therefore must be vowel-final. Consequently, metathesis will also change a morpheme ending in /VC/ to [CV].

[10] The realization of /pm/ as [mm] is characteristic of the dialects west of Tutukei.

In Tutukei proper, /pm/ is simplified to a nasal plosive and, consequently, downgrading is possible.

[11] Given Leti's bimoraic (lexical) word minimality condition, words of fewer than two syllables do not occur. Furthermore, monomorphemic forms of more than three syllables are not attested.

[12] Our phonetic analyses of Leti stress reveals that vowel duration is the most consistent and significant indicator of stress. Vowels in stressed syllables are significantly longer than those in unstressed syllables ($p<.0001$). While stressed syllables frequently also have higher pitch than unstressed syllables, this is not consistently the case; our data reveals examples in which completely unstressed syllables have higher pitch than surrounding stressed syllables.

[13] As San Duanmu (p.c.) has suggested to us, the observation that such words are not attested might also be accounted for under the assumption that degenerate syllables may not bear stress; only vowels may be prosodic heads. Given Leti's trochaic stress system, we might otherwise expect the initial part of a geminate in a non-existing form such as [p.pe] to bear stress.

[14] Tak & Davis 1994 claim that derived tense consonants in Korean are moraic geminates, while underlying tense consonants are nonmoraic single segments. Under the assumption that tense consonants in Korean are geminate, as has previously been claimed in the literature (e.g., Jun 1991, 1993, Han 1992, Silva 1992), this conclusion might be taken as support for a distinction between two types of geminates within a single language, one being moraic and the other nonmoraic (though notice that in this case it would be the underlying, tense, geminate that would be nonmoraic, and the derived geminate that would be moraic). However, drawing on a range of phonological evidence, Tak & Davis convincingly argue against the view that underlying tense consonants are geminate. The issue as to whether derived tense consonants are geminates as opposed to sequences of consonants is also questionable; no evidence is provided concerning geminate integrity effects, for example. Thus, it is reasonable to assume that geminates formed by morpheme concatenation are sequences of identical consonants. Furthermore, since all coda consonants in Korean must be assumed to be moraic in order to account for the stress facts reported in Tak & Davis, Korean can be viewed as a Weight-by-Position language in which all coda consonants, whether followed by an identical or non-identical consonant, receive a mora. The stress facts in question show that the first syllable is stressed if heavy ((C)VC, (C)V:), e.g. *ó:hu* 'afternoon', *sá:muso* 'office', *núnmul* 'tear', *kámgi* 'cold', *ákk'i* 'instrument' /ak+ki/. Otherwise, the second syllable is stressed, e.g., *bagúni* 'basket', *urí* 'we'.

[15] Assuming that G=M is undominated universally would be equally problematic. Not only would this force syllable initial geminates to bear a mora, it would also leave unexplained why in languages like Selkup, syllables with geminates pattern as light.

[16] To account for this pattern, Lahiri & Koreman represent long vowels in terms of segmental length rather than syllable weight. Thus, a long vowel is characterized

as a single root node multiply-linked to two skeletal positions, dominated by a single mora. Conversely, a closed syllable is bimoraic.

[17] We note that these same problems arise within an Optimality Theoretic analysis of the facts. Since, due to space limitations, we are not able to show this, we refer the reader to a detailed discussion of these points in Hume, Muller & van Engelenhoven 1997.

[18] Whether the elements on the skeletal tier are represented as Cs and Vs (Clements & Keyser 1983) or Xs (Levin 1985) is not crucial to our account.

[19] Selkirk 1990 also argues that geminates are nonmoraic. Our account differs from Selkirk's in that we assume two skeletal positions dominating a single root node, while in her account a long segment bears two root nodes dominating, for example, a single multiply-linked place node, laryngeal node, etc. Since voicing is noncontrastive in Leti, a geminate consonant in Selkirk's account would consist of a single place node linked to two root nodes. This representation, however, would be indistinguishable from a place-assimilated sequence of consonants. If both place assimilation and total assimilation (as in the case of geminate formation) involve spreading the place node, we are at a loss to explain why one process results in partial assimilation, while the other results in complete assimilation. Further, this approach incorrectly predicts place-assimilated consonants to pattern with geminates in blocking downgrading (see (20)).

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