Phonology **14** (1997) 371–402. Printed in the United Kingdom
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*Non-moraic geminates in Leti**

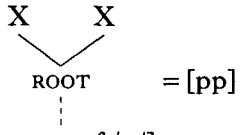
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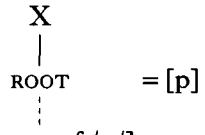
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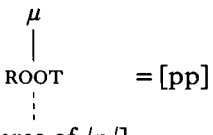
1 Introduction

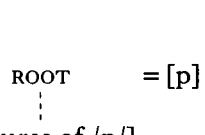
The representation of geminate consonants remains a controversial topic in phonological theory. In a skeletal theoretic approach, for example, a geminate is represented as bipositional: a single root node multiply linked to two skeletal positions, as in (1) (see e.g. Clements & Keyser 1983, Levin 1985).

(1) a. 

b. 

Conversely, in moraic theory, 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 (2):

(2) a. 

b. 

It is noteworthy that evidence bearing on the representation of geminates has thus far come predominantly from the patterning of intervocalic geminates, where the first part of a geminate occurs in coda position.[1] Discussion of syllable-initial geminates, on the other hand, has received little attention in the literature.

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One notable exception is Hayes (1989: 302), 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 (see also Hyman 1985, McCarthy & Prince 1986). 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 also Clements & Keyser 1983, Levin 1985, and for related discussion Kenstowicz 1994, Blevins 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 therefore suggests that phonological theory should not be required to account for them.

That initial geminates do indeed exist is suggested by the analyses of Malayalam and Breton in T. Mohanan (1989) and Carlyle (1988), respectively. With respect to Malayalam, Mohanan cites evidence from native intuitions regarding syllabification, language games and stress (postvocalic geminates do not contribute to syllable weight) in support of the claim that intervocalic geminates in Malayalam are tautosyllabic and syllable-initial. Similarly, Carlyle argues that geminate consonants in Breton occur syllable-initially, syllable-finally and intervocalically as coda/onset.

In this paper we provide new and striking evidence for the view that geminates are non-moraic and may occur in syllable-initial position. This, we show, provides strong support for an analysis of geminates as bipositional, as in (1). The evidence comes from the patterning of syllable-initial geminates in the Austronesian language Leti, spoken on the island of Leti off the northeastern coast of East Timor. The bipositional nature of geminates draws support from the observation that geminates pattern with consonant clusters as opposed to single consonants both in distribution and phonological processes. For example, geminates and clusters trigger metathesis and block processes such as vowel deletion and secondary articulation formation, while singleton consonants do not.

Unlike consonant clusters, however, geminates are comprised of a single multiply linked root node. Evidence for this representation comes from a new type of geminate 'integrity' phenomenon: reduplication cannot break up a geminate. Further support comes from the prosodic process of DOWNGRADING, in which the first lexeme of a syntactic phrase is optionally destressed. Of interest is the observation that downgrading is systematically blocked if the first word contains a long vowel or geminate consonant. This blocking effect is shown to derive from a constraint which

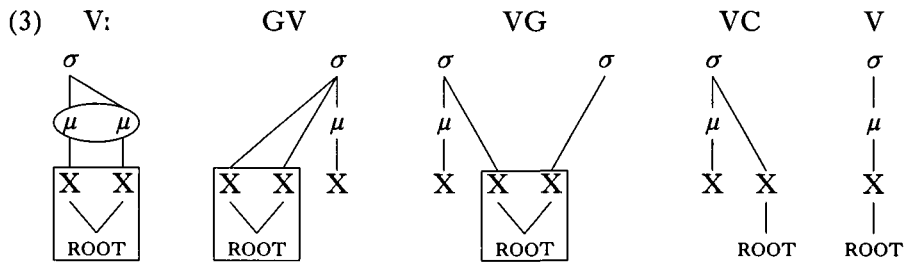
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makes crucial reference to multiply linked structures, generalising over consonants and vowels. The observed patterning of geminates with long vowels is reminiscent of that observed in Hindi, where syllables that contain long vowels or are closed by a geminate pattern to the exclusion of all other syllable types (Davis 1994). Unlike Hindi, however, Leti includes syllable-initial geminates which, interestingly, also conform to this pattern.

While this pattern would seem 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-accepted view that moras are excluded from onset position. Second, 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. For example, geminates do not contribute to mora count in Leti's bimoraic minimal word requirement. Further, in stress assignment, syllables containing geminates pattern with light syllables, to the exclusion of syllables with long vowels. Thus, not only is an analysis which treats geminates as inherently moraic problematic on theoretical grounds, it is also inconsistent with the observed facts.

We will propose that the Leti facts fall out in a straightforward manner from a representation that incorporates both syllable weight and segmental length, as shown in (3) (where G = geminate consonant) (see also Hock 1986, Lahiri & Koreman 1988, Odden 1997, Schmidt 1994). Along these lines, the patterning of geminates with long vowels is accounted for in terms of segmental length, characterised by reference to multi-attached association lines linking one root node to two skeletal positions, as shown in the boxes in (3). To account for the observation that only syllables containing long vowels attract stress, we argue that it is syllable weight that is at issue; only heavy syllables are stressed. Given that long vowels are bimoraic, as encircled in (3), while consonants are non-moraic, only syllables with long vowels attract stress.

(3)



Leti is spoken in four villages on the western half of Leti island. The dialect of Leti spoken in this region is the Cape variant of Tutukei, which had approximately 500 speakers in 1990. Leti is a separate language within the Luangic-Kisaric subgroup of the Austronesian languages of Timor (van Engelenhoven 1995b). Our research is based in large part on data

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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.

For reference, the consonantal inventory of Leti is provided in (4). As can be seen, underlying geminates occur at all places of articulation and may be sonorant or obstruent, with both continuant and non-continuant geminates attested.

(4) *Underlying consonantal inventory*[2]

labial	dental	alveolar	velar
p, pp	t, tt	d	k, kk
v	s, ss		
		l, ll r, rr	
m, mm	n, nn		

A few comments concerning the phonetics of geminates may also prove useful. We note that our observations are preliminary at the present time and await further instrumental analyses. As would be expected, the phonetic attributes of geminate consonants in Leti include a closure gesture of increased duration. This is particularly evident for voiced and continuant geminates. However, for voiceless geminates in absolute initial position (i.e. at the beginning of an utterance), duration of closure seems to be insufficient as a perceptual cue. That is, in this context the duration of voicelessness is difficult, if not impossible, to determine. Therefore, it would seem that other acoustic cues are necessary to signal the presence of an initial voiceless geminate. Abramson (1992) shows that in addition to closure duration, increased amplitude of the first syllable is a crucial phonetic cue for initial geminate consonants in Pattani Malay. Our preliminary investigation of initial geminates in Leti suggests similar results with respect to utterance-initial as well as utterance-internal positions.

2 The bipositional nature of Leti geminates

We begin our study by establishing that initial geminate consonants in Leti are indeed geminates. That is, they behave phonologically as more than one segment, both with respect to distribution and patterning in phonological processes.

With regard to distribution, underlying geminates, like consonant clusters, occur only in word-initial position, as the examples in (5) illustrate.[3]

(5)	ppikan	'plate'	ptuna	'star'
	ppuna	'nest'	pninu	'fool'
	ttui	'genre of literature'	kd^{y}eli	'ring'
	kkusal	'to be small'	vroan	'axe'

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kkɔi	'child'	sraki	'gong'
ssoran	'cough'	vlira	'weaving rod'
mmɛi	'table'	snuran	'thread'
mmanan	'food'	mniniru	'soft'
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 (INCL) 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).[4]

(7) a. pɛn-ne 'his pen' pɛŋku /pɛn-ku/[5] '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) a. /d+n/ →[nn]	/lɔdan/	[lɔnna]	'rattan'
b. /d+l/ →[ll]	/dudal/	[dulla]	'horn'
c. /l+n/ →[ll]	/vulan/	[vulla]	'moon'
	/ɛla+ne/	[ɛlle]	'sister (POSS)'
d. /n+l/ →[ll]	/na+losir/	[llosir]	'follow (3SG)'
e. /v+p/ →[pp]	/vavi+pure/	[vappure]	'wild pig'
f. /v+m/ →[mm]	/vavi+mu/	[vammu]	'young pig'
g. /t,d+s/→[ss]	/puata+seran/	[p^{w}asseran]	'Seranese woman'
	/kuda+seran/	[kusseran]	'Seranese horse'

Distribution aside, ample evidence supports the patterning of geminates in phonological processes with consonant clusters, as opposed to single consonants. This is most readily observed when words or morphemes are concatenated within a phrase (see §3 for related discussion). As shown in (9), clusters (a) and geminates (b) trigger metathesis of the final vowel and consonant of a preceding morpheme. Word-initial single consonants, as in (c), do not trigger metathesis.[6] As argued in Hume (1997a, b), phrase-medial metathesis applies before a word-initial geminate or consonant cluster as a means of avoiding a complex syllable margin. Note that surface vowel length in, for example, [ma:nuppuna] /maun+ppuna/ 'bird's nest' is a compensatory lengthening effect triggered by the deletion or

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transposition (by metathesis or secondary articulation formation) of the immediately following vowel, e.g. /maun/ → [ma:nu] (see above references for further discussion).

(9) a.	/kunis + vnutan/	[kunsivnutan]	'iron key' (key + iron)
	/vuar + spou/	[vu:raspou]	'schooner mountain' (mountain + boat)
	/danat + kviali/	[dantakv^{y}ali]	'millipede' (*meaning unknown* + flipped over)
	/morut + kdieli/	[mortukd^{y}eli]	'very curly hair' (hair + ring)
	/maun + tpunan/	[ma:nutpunan]	'bird's throat' (bird + throat)
b.	/ukar + ppalu/	[ukrappalu]	'index finger' (finger + bachelor)
	/maun + ppuna/	[ma:nuppuna]	'bird's nest' (bird + nest)
	/kapal + ttɛnan/	[kaplattɛnan]	'keel' (ship + spine)
c.	/urun + mɔa/	[urunmɔa]	'Moanese breadfruit' (breadfruit + Moa)
	/mɛsar + lavan/	[mɛsarlavan]	'professor' (teacher + big)
	/vuar + lavan/	[vuarlavan]	'highest mountain' (mountain + big)
	/pɔkar + ne/	[pɔkarne]	'their leanness' (to be lean + 3PL)

Moreover, 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]	'tricoloured squirrel' (mouse + coconut tree)
b.	/samɛla + ttɛnan/	[samɛlattɛnan]	'mouse's spine' (mouse + spine)
	/samɛla + tpunan/	[samɛlatpunan]	'mouse's throat' (mouse + throat)

Similarly, before a CV-initial morpheme, the final high vowel of a preceding morpheme is realised as a secondary articulation on an adjacent prevocalic consonant, as shown in (11).[7] No secondary articulation formation occurs before a morpheme beginning with a consonant cluster or geminate.

(11) a.	/rai + lavan/	[ral^{y}avan]	'Timor' (land + big)
	/lopu + do/	[lopd^{w}o]	'dolphin then' (dolphin + then)
	/kkani + tani/	[kkant^{y}ani]	'earthenware plate' (plate + soil)
	/tultulu + enu/	[tultul^{w}enu]	'kind of hat' (hat + turtle)
b.	/sivi + ttɛi/	[sivittɛi]	'hen' (chicken + female)
	/lɔi + llatutun/	[lɔillatutun]	'Laitutunese proa' (proa + Laitutun)
	/ai + vlakar/	[aivlakar]	'cross' (wood + crossed)
	/koni + mderi/	[konimderi]	'Mderian grasshopper' (grasshopper + Mdery)

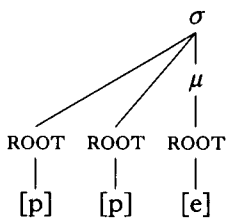
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Thus, based on the patterning of geminates with consonant clusters as opposed to single consonants, it is clear that geminates in Leti are bipositional.

3 Geminates as multiply linked segments

Under the assumption that a cluster is comprised of two segmental positions, the patterning of geminates with consonant clusters 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). However, this characterisation of Leti geminates is problematic, as we show below.

(12)



3.1 Reduplication

The first source of evidence against the characterisation of initial geminates as in (12) comes from geminate integrity effects observed in Leti reduplication. The general pattern of reduplication in Leti is illustrated in (13). As can be seen, the reduplicant (underlined) is aligned as closely as possible to the left edge of a (trochaic) foot, which itself is aligned to the right edge of a lexical word (see van der Hulst & Klamer 1996, Muller 1997). In many cases, the left edge of the foot corresponds exactly to the beginning of the input word, as in the first two examples, i.e. *sɔp*[sɔpan], *lu*[luli]. Muller (1997) accounts for the position of the reduplicant by the Optimality Theoretic constraint, ALIGN(Red-R, Ft-L): align the right edge of a reduplicant to the left edge of a foot. Like all OT constraints, ALIGN may be violated, as in the third example, *na-o*[lʷolu], where the rightmost segment of the reduplicant is actually included in the foot. As Muller shows, such misalignments are required as a means of satisfying more highly ranked constraints, typically relating to syllable structure. In this case, for example, onset satisfaction forces misalignment.

(13) a.	sɔpan	'to order'	sɔpsɔpan	'messenger'
b.	luli	'taboo'	lululi	'taboo (ADJ)'
c.	na-olu	'he sells'	na-olʷolu	'(which) he sells'

When the word to be reduplicated begins with a consonant cluster, the reduplicant occurs between the two consonants, as in (14):

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(14)

mnina	'to be calm'	m-ni-nina	'calm'
kriat	'to be slow'	k-ri-riat	'slow'
kpuri	'to be short'	k-pur-puri	'becoming short'
mtaut	'to be afraid'	m-ta-t^{w}aut	'afraid'

The splitting up of an initial consonant cluster is also shown by Muller (1997) to be a consequence of ALIGN(Red-R, Ft-L), as we briefly outline. Unlike the forms in (13a, b), prefixation of the reduplicant in the forms in (14), as in ill-formed **nim*[nina], would result in an alignment violation, given that the left edge of the foot falls between the two members of the consonant cluster; that is, the reduplicant is one segment away from the foot boundary. Conversely, by placing the reduplicant between the two consonants, i.e. *mni*[nina], the reduplicant is perfectly aligned to a foot and thus ALIGN is satisfied.

While the reduplicant systematically intrudes between the segments of a consonant cluster, the same does not hold when an initial geminate is at issue. Instead, the reduplicant always precedes the geminate, as shown in (15). In other words, a geminate is never split up.

(15)

ppɛrat	'to be heavy'	pɛ-ppɛrat	'heavy'
kkɔi	'kid'	kɔ-kkɔi	'child'
mmɛran	'to be swift'	mɛ-mmɛran	'swiftly'
na-mmali	'he laughs at'	na-ma-mmali	'someone he laughs at'
kkusal	'to be small'	ku-kkusal	'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 (see e.g. Hayes 1986, Schein & Steriade 1986) and provides strong evidence against (12) as a viable representation of Leti geminates.

(16)

Consonant cluster (*singly linked*)		*Geminate consonant* (*multiply linked*)
x x	*vs.*	x x
| |		\ /
p t		p

3.2 Downgrading

Further evidence for the multiply linked nature of geminates comes from the process of DOWNGRADING, as it is referred to in van Engelenhoven (1995a). Downgrading is an optional prosodic process which affects a sequence of two syntactically related lexical words: verb–object, pos-

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sessor–possessed, location–locational. In downgrading, the first word is realised completely without stress and at a faster rate, thus rendering the first word prosodically inferior to the second. Of interest is the observation, illustrated below, that geminates pattern with long vowels in blocking downgrading. To anticipate our analysis of downgrading (see §5), we argue that a constraint referring to multiply linked structures serves to group geminate consonants and long vowels together as a natural class.

Before examining downgraded forms, however, a few comments regarding phrasing are warranted. In Leti, words can either occur in separate phonological phrases, or be concatenated to form a single phrase, as the representative examples in (17) illustrate (phonological phrases are indicated by curly brackets). While stress will be discussed in greater detail in §4, we note that stress typically falls on the penultimate syllable of a lexical word (suffixes are generally extraprosodic); all words in isolation bear stress.

(17)	*separate phrases*	*single phrase*	*UR*
a.	{sívi} {térannu}	{sivtʸérannu}	/sivi + teran-nu/
	'the egg of the chicken'	'his chicken-egg'	
b.	{spóu} {ttɛ́nanne}	{spóuttɛ́nanne}	/spou + ttɛnan-ne/
	'the keel of the boat'	'his keel'	
c.	{ntútnu} {wái}	{ntútunwái}	/na-tutun + uai/
	'he lights the fire'	'he kind of lights the fire'	

Evidence for phrasing comes both from phonological considerations and, in many cases, from morphological and syntactic considerations. In terms of phonology, all phrase-final morphemes end in a vowel. For underlyingly vowel-final forms, as in the first morphemes in (17a, b), there is no change in the underlying shape of a morpheme when occurring in phrase-final position. 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/ of (17c). Note that in each of these pairs of words, the rightmost word appears in phrase-final position and hence is vowel-final.

When words are concatenated within a phrase, as in the second column, a variety of phonological processes affect the elements at the adjacent edges of morphemes (secondary articulation formation, vowel deletion, resyllabification), depending on the syllable structure and segmental quality of the morphemes involved. In (17a), for example, the morpheme-final vowel of /sivi/ is realised as a secondary articulation on the following consonant; in (b), the initial part of the geminate in /ttɛnan/ syllabifies as coda of the preceding syllable; while in (c), there is essentially no change. We refer the reader to Hume (1997a, b) for discussion of these and other changes affecting phrase-medial morphemes; see also (9)–(11) for additional examples.

Phrasing often serves a morphological function, as in (18), where phrasing distinctions are evidenced by both phonological and semantic differences.

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(18) /na vali vatu la eni/
3SG + turn + stone + go + sand
{nvali} {vatu} {la} {eni} 'He turns the stone to the beach.'
{nvalv^{y}atl^{w}a} {eni} 'He somehow turns a stone to the beach.'

These distinctions may be used to convey, among other things, the notions of definiteness/indefiniteness, transitivity/intransitivity, or to form causatives or verbal nouns (see van Engelenhoven 1995a). In other cases, particular morphemes must always be concatenated, thus occurring within a single phrase, such as the members of a compound, stems and suffixes, a reduplicant and its base (for some types of reduplication), and under certain conditions, nouns and adjectives. The goal of this paper is not to provide an in-depth treatment of the syntactic and morphological restrictions which determine phrasing in Leti; this is beyond the scope of the present paper and requires further study (see Muller ms). Our goal is simply to lay the groundwork for the discussion of downgrading, to which we now turn.

A third possible realisation of the pairs of words in (17) is shown in the third column of (19), where the first word of the sequence is downgraded. That is, the first word is entirely unstressed, and thus prosodically inferior to the second. Note that in pairs displaying downgrading, each word occurs in a separate phrase, as evidenced by the fact that the first word is consistently vowel-final, in accordance with the requirement that phrase-finally, morphemes end in a vowel. Further, phonological processes such as vowel deletion and secondary articulation formation which typically affect phrase-medial morphemes are not observed. In downgraded sequences, the morphological distinction between the sequences in separate and single phrases is lost, with the relevant semantics of the downgraded sequence determined by the context in which it occurs. Thus, while the prosody of a phrase is affected by downgrading, the meaning is not. Note also that in pairs involving downgrading, the vowels /e/ and /ɛ/ are realised as [ɪ], and /o/ and /ɔ/ are neutralised to [o], as indicated to the right of downgraded forms when relevant. In non-downgraded sequences, there is no change in vowel quality.

(19)	*separate phrases*	*single phrase*	*downgraded* (*underlined*)	*UR*
a.	{sívi} {térannu}	{sivt^{y}érannu}	{<u>sivi</u>} {térannu} = [sɪvɪ tírannu]	/sivi + teran-nu/
b.	{spóu} {ttɛ́nanne}	{spóuttɛ́nanne}	{<u>spou</u>} {ttɛ́nanne} = [spou ttínannɪ]	/spou + ttɛnan-ne/
c.	{ntútnu} {wái}	{ntútunwái}	{<u>ntutnu</u>} {wái}	/na-tutun + uai/

Of interest to the present study is the observation that downgrading is systematically blocked just in case the first word contains a long vowel. This can be seen by comparing the forms in (20a), where downgrading is impossible, with those in (20b), which do not contain a long vowel in the first word and where downgrading is possible. The fact that the quality of

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mid vowels in the words in (20a) is not affected, as is the case in downgraded sequences, supports our claim that these words are not subject to downgrading.

(20) a. *no downgrading*

lá:re wá:rne	'the root of the lara tree'
ntú:tu p^{w}órse	'he strikes [at] the door'
nvá:lu vátu	'he flings the stone'
lo vú:re ná:ni	'under the mountain'

b. *downgrading*

lare lávarne	[larɪ lávarnɪ]	'the cloth of the sail'
ntutu p^{w}órse	[ntutu p^{w}órsɪ]	'he hits the door'
nvali vátu	[nvali vátu]	'he turns the stone'
lo vure ná:ni	[lo vurɪ ná:nɪ]	'under the oil'

Words containing a geminate consonant pattern in an identical manner. That is, downgrading never affects 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 (21a). Those created by morpheme concatenation are in (b), while geminates formed by assimilation appear in (c). In none of these cases is downgrading observed. 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).

(21) a. *underlying geminates*

no downgrading

ppátne únne	'trunk of the orange (tree)'
lo mmɛ́i vávna	'on the table'
ssísme úlatni	'the skin of the sepia'
kkáni sn^{y}aktúvnu	'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/

downgrading

nura únne	[nura únnɪ]	'trunk of coconut tree'

b. *geminates formed through morpheme concatenation*

no downgrading

pénne r^{y}árma	'inside his pen'
lókku ná:ni	'under my foot'

downgrading

pɛne r^{y}árma	[pɪnɪ...]	'inside the pen'
pɛnku r^{y}árma	[pɪŋku...]	'inside my pen'
pɛnmu r^{y}árma	[pɪnmu...]	'inside your pen'
pɛnmi r^{y}árma	[pɪnmi...]	'inside your (PL) pen'
lokni ná:ni		'under his foot'

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c. *geminates formed through assimilation*

no downgrading

úmmu[8] á:nne 'the child of your (SG) grandparent'
úmmi á:nne 'the child of your (PL) grandparent'
vúlle dáinni 'a/the beam of the moon'
vulan 'moon'+e 'INDEXER'+dain 'beam'+nV 'POSS'
énne ná:ni 'under the pineapple (plant)'
ɛdan 'pineapple'+e 'INDEXER'+nain 'under'

downgrading

upku á:nne [upku á:nnɪ] 'the child of my grandparent'
upnu á:nne [upnu á:nnɪ] 'the child of his grandparent'
lɛre dáinni [lɪrɪ dáɪnnɪ] 'a/the beam of the sun'

Note also that while a syllable closed by a geminate consonant blocks downgrading, one closed by a non-geminate consonant does not, as in (22):

(22) *no downgrading*

pénne r^{y}árma 'inside his pen'

downgrading

pɔtle r^{y}árma [potlɪ...] 'inside the bottle'
pɛnku r^{y}árma [pɪŋku...] 'inside my pen'

Comparing non-downgraded [pénne] with downgraded [pɪŋku] /pɛn+ku/ is also instructive since these forms show that while a word containing a geminate resists downgrading, a word containing a place-assimilated consonant does not. While we assume 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 condition for blocking downgrading.

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

4 The non-moraicity of Leti geminates

At first blush, the facts from downgrading would seem to concur with the claim that geminates are inherently moraic since syllables containing geminates pattern with those containing long vowels (see e.g. Hayes 1989). However, this approach is problematic for a number of reasons. First, since syllable-initial geminates pattern with long vowels, a moraic representation of geminates would require a mora to occur in the onset, thus running counter to the widely accepted view that moras are excluded from onset position. This claim, we emphasise, is maintained in 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, Hayes 1989, 1995, Blevins 1995).

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A second problem with an account which assumes geminates to be inherently moraic relates to the observation that geminates do not contribute to mora count in Leti's bimoraic minimal (lexical) word requirement. That is, there are no words comprised of a geminate + vowel, e.g. *[ppe], even though such forms would satisfy word minimality were geminates moraic.

Third, in stress assignment, syllables containing geminates pattern with light syllables, to the exclusion of syllables with long vowels. As shown in (23), when a word occurs in isolation, stress always falls on the penultimate syllable.[9] (Note that words are illustrated in phrase-final position and, thus, are vowel-final.)

(23)	spóu	'kind of boat'	pdudúklu	'bubbling'
	ppúna	'nest'	tuvúri	'kind of shell'
	kúnsi	'key'	marsína	'machine'
	lópu	'dolphin'	kars^{y}ɔ́na	'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 (24). Of interest is the observation that the first syllable is also stressed only if that syllable contains a long vowel, as in (e).[10] In all other cases, the initial syllable remains unstressed. This holds regardless of whether the first syllable is open, as in (a), closed by a non-geminate consonant, as in (b), or by a geminate, as in (c). Note that a syllable containing an initial geminate does not attract stress either, as shown in (d). In other words, all syllables containing a geminate pattern with light syllables, whether open or closed.

(24)	a.	rimɔ́ta	'kind of turtle'	ría + mɔ́ta	'man + green'
		pup^{w}éni	'dragonfly's chrysalis'	púpu + wéni	'dragonfly + place'
	b.	nvalt^{y}áni	'he digs'	nváli + táni	'he turns + dirt'
		matrúma	'master of the house'	máta + rúma	'master + house'
	c.	pɛppérta	'heavy'	RED + ppérta	'heavy'
		kɔkkɔ́i	'child'	RED + kkɔ́i	'child'
		vappúre	'wild pig'	vávi + púre	'pig + wild'
		p^{w}assérna	'Seranese woman'	p^{w}áta + sérna	'woman + Serna'
		kussérna	'Seranese horse'	kúda + sérna	'horse + Serna'
	d.	ppunárta	'nest's edge'	ppúna + árat	'nest + edge'
		nnɛm^{y}ása	'golden sign'	nnéi + másа	'sign + gold'
		kkant^{y}áni	'earthenware'	kkáni + táni	'plate + dirt'
	e.	má:n^{w}or^{y}óri	'crow'	má:nu + or^{y}óri	'bird + buffalo'
		rɔ́:nénu	'they eat turtle'	rɔ́:na + énu	'eat + turtle'
		má:n^{w}á:na	'chick'	má:nu + á:na	'bird + child'

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Thus, not only is an account which assumes geminates to be inherently moraic problematic on theoretic grounds, it is also empirically incorrect.

5 Analysis

We turn now to our proposed account of the Leti facts. We suggest that geminates as well as long vowels are represented as long segments: a single root node multiply linked to two skeletal positions, along the lines proposed in, for example, Clements & Keyser (1983), Levin (1985) and more recently Tranel (1991).[11] Further, while vowels are inherently moraic, consonants are not,[12] 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 non-moraic at all levels of analysis, a claim supported by the observation that consonants pattern as light with respect to stress.

Reference to segmental length alone is not sufficient to account for all of the Leti facts, however. The observation that long vowels attract stress, while light syllables do not, suggests that syllable weight is also of relevance. To account for these combined facts, our account of Leti incorporates the view that both length and weight are integrated into the representation (see also Hock 1986, Lahiri & Koreman 1988, Odden 1997, Schmidt 1994). Hence, long vowels and geminates are represented as a single root node multiply linked to two skeletal positions, as in (3). They are thus distinguished from single consonants and short vowels in terms of segmental length. Further, long vowels are analysed as bimoraic; only syllables containing long vowels are evaluated as heavy, while all other syllable types are light. Given this approach, the patterning of Leti geminates in stress and downgrading receives a straightforward account, as we show below.

5.1 Stress

Our account focuses first on the general stress pattern of Leti words, concentrating on sequences of two lexemes, given the relevance of this context for downgrading. It may be assumed, however, that the proposed analysis extends to longer sequences of words in the language as well. With this as a basis, we will then turn to downgrading.

We begin our analysis with sequences of words in which each lexeme occurs within a separate phonological phrase, as exemplified by the forms in (25) (as before, phonological phrases are indicated by curly brackets). It will be recalled that in such sequences, stress falls on the penultimate syllable of the lexeme (not the morphological word).

(25) a.	{sívi} {térannu}	'the egg of the chicken'	/sivi+teran-nu/
b.	{spóu} {ttɛ́nanne}	'the keel of the boat'	/spou+ttɛnan-ne/
c.	{ntútnu} {wái}	'he lights the fire'	/na-tutan+uai/
d.	{ppúne} {samékne}	'stuff from the nest'	/ppune+sameken/

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Within an Optimality Theoretic approach (see e.g. Prince & Smolensky 1993, McCarthy & Prince 1993), penultimate stress may be accounted for by means of two constraints (see (26)). The first, ALIGN-FT, aligns an edge of a foot to an edge of a word. The specific instantiation of the constraint relevant for Leti requires right alignment of a foot to the right edge of a lexical word. The second, FTTYPE = TROCHAIC, sets the parameter for foot type as trochaic.

(26) ALIGN-FT(lexeme-R, foot-R)
Align the right edge of a lexeme to the right edge of a foot.
FTTYPE = T
Feet are trochaic.

Also relevant to our analysis are constraints governing the shape of morphemes, depending upon whether they are in phrase-medial position, or at the edge of a phrase. With respect to phrase-medial position, these include a constraint prohibiting the occurrence of the (underlying) final vowel of a morpheme in an open syllable. To satisfy this requirement, a final vowel may, for example, delete, or be realised as a secondary articulation on an adjacent prevocalic consonant. For concreteness, we refer to this constraint as *V, as stated in (27), though refer the reader to Hume (1997b) for more detailed discussion and motivation. To anticipate the discussion further below, a second constraint which requires the alignment of the right edge of a phrase with a vowel will also figure in the analyses.

(27) *V
The final vowel of morpheme in the input may not occur in an open syllable phrase-medially in the output.

With this as a basis, consider the derivation of [sívi térannu] 'the egg of the chicken' in (28), representing cases in which each word occurs in a separate phonological phrase (foot structure is indicated by square brackets while phonological phrase boundaries continue to be marked with curly brackets).[13] As can be seen, candidate (28a) satisfies all relevant constraints; specifically, *V is satisfied, all feet are trochaic, and a foot is aligned to the right edge of each lexeme. In the second candidate, both lexemes are combined within a single phonological phrase, yet due to the occurrence of the final vowel of the first morpheme in a phrase-medial open syllable, *V is violated, thus marking candidate (b) as ill-formed. This candidate may be compared with the single-phrase sequence {siv-tʸérannu} 'his chicken-egg' (see (30) below), which, on the other hand, does occur as a well-formed output in the language. However, recall that since the occurrence of words in separate phrases or within a single phrase affects meaning, this particular single-phrase output has a different meaning than candidate (28a); see (17) and §3.2. In candidates (c, d, e), one or more of the words is devoid of stress, thus violating the constraint

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ALIGN-FT, which requires a foot to be aligned to the right edge of a lexeme.[14] Finally, the presence of an iambic foot rules out candidate (f).

(28)

sivi+teran-nu	*V	FTTYPE=T	ALIGN-FT
☞ a. {[sívi]}{[téran]nu}			
b. {[sívi][téran]nu}	*!		
c. {sivi}{[téran]nu}			*!
d. {[sívi]}{terannu}			*!
e. {sivi}{terannu}			*!*
f. {[sívi]}{[térannu]}		*!	

Consider next cases in which more than one lexeme occurs within a single phonological phrase. It will be recalled that when, as a result of final vowel deletion or secondary articulation formation, the first morpheme loses the nucleus of its final syllable, stress does not generally occur on the first lexeme, as the examples in (29) (cf. (24) above) illustrate. We set aside forms in which the first lexeme contains a long vowel but return to them further below.

(29)

matrúma	'master of the house'	máta+rúma	'master+house'
rimɔ́ta	'kind of turtle'	ría+mɔ́ta	'man+green'
pup^{w}éni	'dragonfly's chrysalis'	púpu+wéni	'dragonfly+place'
nvalt^{y}áni	'he digs'	nváli+táni	'he turns+dirt'
sivt^{y}érannu	'his chicken-egg'	sívi+térannu	'chicken+his egg'
vappúre	'wild pig'	vávi+púre	'pig+wild'
p^{w}assérna	'Seranese woman'	p^{w}áta+sérna	'woman+Serna'
kussérna	'Seranese horse'	kúda+sérna	'horse+Serna'
ppunárta	'nest's edge'	ppúna+árat	'nest+edge'
nnɛm^{y}ása	'golden sign'	nnéi+mása	'sign+gold'
kkant^{y}áni	'earthenware'	kkáni+táni	'plate+dirt'

Central to our account is the claim that all consonants in Leti, whether geminate or singleton, are non-moraic at all levels of analysis. This, in conjunction with the claim that feet are binary in terms of syllables or moras (FOOTBINARITY (FT-BIN); see e.g. McCarthy & Prince 1993), provides a straightforward account of the observed patterns.

To illustrate, consider the stress pattern of concatenated lexemes in which the first morpheme surfaces with a closed syllable. Note that since all consonants are non-moraic, the CVC pattern illustrated by (30a) below can be considered representative of any light syllable whether open, or closed by a geminate or singleton consonant; the stress pattern is identical in all cases. In our example, {sivt^{y}érannu} 'his chicken-egg', the final vowel of the first morpheme is realised as a secondary articulation on the following consonant (cf. (28)). As shown in (30a), the optimal candidate

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surfaces without stress on the first morpheme, thus incurring a single violation of the constraint ALIGN-FT. Candidates (b, c) are evaluated as non-harmonic since each incurs two alignment violations, given that neither lexeme has a foot aligned to its right edge. FT-BIN comes into play in ruling out candidate (d), where the first lexeme, comprised of a monomoraic foot, bears stress. Note that the crucial ranking of FT-BIN above ALIGN-FT assures the correct selection of candidate (a) over (d). Candidate (e) fails due to a violation of *V, given that the final vowel of the first morpheme occurs in a phrase-medial open syllable.

(30)

sivi+teran-nu	ALIGN-PHR	*V	FT-BIN	ALIGN-FT
☞ a. {siv[tʸéran]nu}				*
b. {sivtʸerannu}				**!
c. {[sívtʸe]rannu}				**!
d. {[sív][tʸéran]nu}			*!	
e. {sivi[téran]nu}		*!		*
f. {siv}{[tʸéran]nu}	*!			*

Finally, candidate (f) is ill-formed due to the fact that the first morpheme ends in a consonant. Recall that all morphemes must end in a vowel phrase-finally. To account for this observation, we incorporate the constraint ALIGN-PHRASE, which requires the right edge of a phrase to be aligned with the right edge of a vowel (Hume 1997a, b).

(31) ALIGN-PHRASE(PhPhrase-R, Vowel-R)
Align the right edge of a phonological phrase with the right edge of a vowel.

We turn now to forms in which a long vowel occurs in the first lexeme, which, it will be recalled, attracts stress, as the examples in (32) (cf. (24e)) illustrate:

(32)

má:nʷorʸóri	'crow'	má:nu+orʸóri	'bird+buffalo'
rɔ́:nénu	'they eat turtle'	rɔ́:na+énu	'eat+turtle'
má:nʷá:na	'chick'	má:nu+á:na	'bird+child'

Given that syllables containing long vowels are bimoraic, the independently motivated constraint WEIGHT-TO-STRESS (WS; McCarthy & Prince 1993) will correctly predict stress to occur on a syllable containing a long vowel. The observation that long vowels are always stressed in Leti motivates the undominated status of WS in the language.

(33) WEIGHT-TO-STRESS (WS): if heavy then stressed.

Through the interaction of WS and ALIGN-FT, as in (34), candidate (a), with a stressed heavy syllable, is correctly selected; [rɔ́:nénu] 'they eat

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turtle' serves to illustrate. It should be noted that given the syllabification of [n], the final consonant of the first morpheme, as onset of the initial syllable of the second lexeme in (a), the initial foot of the sequence is not properly aligned to the right edge of the first lexeme. Despite the ALIGN-FT violation, candidate (a) nonetheless surfaces as optimal, given the more costly violations incurred by each of the other candidates. Specifically, candidates (b, c) emerge as non-harmonic, since in neither case is the syllable containing the long vowel stressed. Moreover, the final candidate fails due to two violations of ALIGN-FT.

(34)

rɔ:na+enu	WS	ALIGN-FT
☞ a. {[rɔ́:][nénu]}		*
b. {rɔ:[nénu]}	*!	*
c. {rɔ:nenu}	*!	**
d. {[rɔ́:ne]nu}		**!

To summarise, by basing our analysis on the claim that consonants in Leti are non-moraic, words with geminates, whether in onset or coda position, are correctly predicted to pattern with other light syllables for stress assignment. Further, only syllables with long vowels are evaluated as heavy and, as predicted, emerge as stressed.

5.2 Downgrading

We turn now to the analysis of downgrading. Recall from §3.2 that a downgraded word systematically occurs in a separate phonological phrase, evidenced by the fact that phonological processes such as phrase-medial vowel deletion and secondary articulation formation do not occur, while phrase-final metathesis is applicable. Also of relevance is the observation that downgrading only affects pairs of syntactically related lexical words: verb–object, possessor–possessed, location–locational. In such cases, the first word of the sequence is optionally downgraded, indicated by the complete absence of stress.

Our account of this pattern is inspired by the notion of relative prominence, originally proposed in Liberman & Prince (1977), which we formulate in (35). As stated, RELATIVEPROMINENCE requires that in a (syntactic) phrasal category, the prominence of the first lexeme must be less than that of the second.[15]

(35) RELATIVEPROMINENCE (RP)
Given $[X\ Y]_P$, where X, Y are lexemes and P is a phrasal category, $|X| < |Y|$.

Further, to account for the observation that downgrading is an optional process, we adopt the notion of variably ranked rules, developed in works such as Kang (1997) and Reynolds (1994). Within this approach, the

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optionality of downgrading falls out from the variable ranking of the constraints, ALIGN-FT and RP. In non-downgraded forms, as illustrated by the form *nváli vátu* 'he turns the stone' in (36), ALIGN-FT outranks RP. Consequently, the stressed variant (a) is selected.

(36) *No downgrading:* ALIGN-FT≫RP

nvali+vatu	ALIGN-FT	RP
☞ a. {[nváli]}{[vátu]}		*
b. {nvali}{[vátu]}	*!	

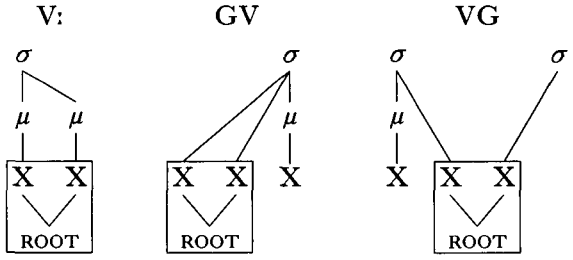
Conversely, in downgraded forms, the subordination of ALIGN-FT to RP correctly selects the unstressed variant (37b).

(37) *Downgrading:* RP≫ALIGN-FT

nvali+vatu	RP	ALIGN-FT
a. {[nváli]}{[vátu]}	*!	
☞ b. {nvali}{[vátu]}		*

To account for the blocking effect of words with geminates or long vowels, we propose that it is segmental length that groups these sounds together as a natural class. In other words, a word containing a root node multiply linked to two skeletal positions inhibits downgrading, as shown in (38) (cf. (3)). Note that a derived geminate, whose first part occurs as coda, is also comprised of a single root node multiply linked to two positions, under the assumption that adjacent identical segments are fused by the OCP.

(38)



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 not only without stress but at a faster rate. If a word containing a phonologically short segment were produced in this way, there would be no loss of contrastiveness: a durationally short segment would merely be shorter. However, if a word containing a long vowel or geminate consonant were produced in this manner, a phonologically long segment would be realised as short, resulting in an endangerment of

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contrast. 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.

It is also worth noting that, downgrading aside, geminates and long vowels always occur in a phrase with stress in Leti. While geminates, unlike long vowels, need not occur in a stressed *syllable*, there is no case in which a syllable containing a geminate occurs in a *phrase* without stress. The same does not hold for singleton consonants, of course. Hence, the presence of stress in a phonological phrase is a necessary condition for the presence of a long segment; stress can never be lost (i.e. through downgrading) in domains with phonologically long segments. We speculate therefore that prosodic prominence in the phrase enhances the perceptual salience of segmental duration. Put another way, the contrast between short and long segments is facilitated by stress in the phonological phrase (see Steriade 1994 for related discussion).

We incorporate this observation into the constraint LENGTH-TO-PROMINENCE in (39), which requires a long segment to occur in a domain with prominence. In Leti, the relevant domain for LP is the phonological phrase. Since LP is never violated in Leti, we assume the constraint to be undominated.

(39) LENGTH-TO-PROMINENCE (LP): if long, then in a domain with prominence.

For concatenated lexemes, as we have seen, a geminate may occur in an unstressed syllable provided that it occurs in a phrase with stress, e.g. {ppunárta} /ppuna+arat/ 'nest's edge'. Tableau (40) illustrates the derivation of such forms assuming the downgrading ranking RP ≫ ALIGN-FT.[16] In this particular example, concatenation of the two lexemes results in the deletion of the final vowel of /ppuna/. Note that the resultant stress pattern in (40) is predicted regardless of whether the ordering of constraints is RP ≫ ALIGN-FT as shown, or *vice versa*. Further, this same analysis extends to words in which the first part of the geminate occurs in coda position.

(40)

ppuna+arat	LP	*V	FT-BIN	RP	ALIGN-FT
☞ a. {ppu[nárta]}					*
b. {[ppú][nárta]}			*!	*	*
c. {ppunarta}				*!	**
d. {ppuna}{[árta]}	*!	*			*
e. {[ppú]}{[nárta]}			*!	*	*

Consider now the role of LP in blocking downgrading. While we assume the downgrading ranking RP ≫ ALIGN-FT, either ranking of these two constraints will select the non-downgraded form when a geminate consonant occurs in the first word, given the undominated status of LP.

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We illustrate with [ppúne samékne] 'stuff from the nest' in (41). LP comes into play in ruling out candidate (b), in which the first lexeme containing an initial geminate occurs in a separate phonological phrase lacking stress. While including both lexemes within a single phrase, as in (c), satisfies LP since stress does occur in the phrase, a *V violation marks this candidate as non-harmonic. Candidate (d), in which the initial geminate surfaces as a single segment, fails for the same reason.[17] Despite the violation or RP, candidate (a) emerges as the winner, assured by the subordination of RP to both LP and *V.

(41)

ppune+sameken	LP	*V	RP	ALIGN-FT
☞ a. {[ppúne]}{[samékne]}			*	
b. {ppune}{[samékne]}	*!			*
c. {ppune[samékne]}		*!		*
d. {pune[samékne]}		*!		

Identical results obtain for words in which the first part of a geminate occurs in coda position, as shown in (42) for [lókku ná:ni] 'under my foot'.

(42)

lokku+nain	LP	*V	RP	ALIGN-FT
☞ a. {[lókku]}{[ná:ni]}			*	
b. {lokku}{[ná:ni]}	*!			*
c. {lokku[ná:ni]}		*!		*

Words containing long vowels are also correctly predicted to resist downgrading, as exemplified by [nvá:lu vátu] 'he flings the stone' in (43). Note that both LENGTH-TO-PROMINENCE and WEIGHT-TO-STRESS rule out candidate (b), while candidate (c) fails due to violations of WS and *V.

(43)

nvaul+vata	LP	WS	*V	RP	ALIGN-FT
☞ a. {[nvá:lu]}{[vátu]}				*	
b. {nvá:lu}{[vátu]}	*!	*			*
c. {nvá:lu[vátu]}		*!	*		*

5.3 Summary

By drawing on syllable weight as well as segmental length, the two observed patterns involving geminate consonants are described in simple terms. To account for the patterning of geminates and long vowels in downgrading, we have proposed that it is phonological length that is at issue. Conversely, in stress assignment, where syllables with geminates pattern with other light syllables, we have argued that it is phonological

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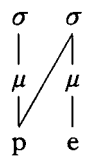
weight that is the key, with a distinction drawn between heavy syllables, i.e. syllables containing a long vowel, and all other syllable types. Segmental length is not a sufficient condition for stress assignment. As a result, a syllable containing a coda consonant in Leti, whether the consonant is geminate or singleton, will never attract stress since consonants are non-moraic.

6 Against a weight-based account

Given the patterning of geminates with long vowels in downgrading, an obvious alternative account would be one in which geminates are analysed as moraic. As assumed in moraic theory, a syllable containing a geminate would be heavy, as would a syllable containing a long vowel. However, as pointed out in §4, such an account is highly problematic since it contradicts a fundamental claim of syllable theory: moras are excluded from the onset. This claim, we reiterate, is not exclusive to moraic theory *per se* (Hyman 1985, McCarthy & Prince 1986, Hayes 1989, 1995), 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, where moras are characterised indirectly in terms of slots in the nucleus, and Levin 1985 and Blevins 1995, where moras are characterised indirectly in terms of the rhyme; see related discussion in Rialland 1993). Note that treating the prohibition against onset moras as a violable constraint in an Optimality Theoretic approach would have equally detrimental effects on the theory. Not only would it result in a weaker, less predictive theory, the observed asymmetries concerning coda *vs.* onset consonants with respect to weight-related phenomena would remain unexplained.

It is also important to point out that alternative representations of initial geminates, as suggested in Hayes (1989), are equally problematic. We consider 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 (44), where the first half of the geminate comprises a separate syllable.

(44)



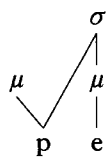
We note two problems with this representation. First, recall that in Leti, lexical words must be minimally bimoraic. If (44) were the representation of an initial geminate, we might then expect to find words made up of an initial geminate and a vowel, e.g. [p.pe], since the minimal word condition would be satisfied. None are attested.[18] On the other hand, if we assume that initial geminates are part of the onset of a single syllable, words

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containing geminates conform to the overwhelming tendency in Leti for lexical words to be exactly two syllables long, e.g. [ppu.na] 'nest' (see (5) for additional examples). Second, the representation in (44) would leave unexplained the patterning of long vowels and geminates in blocking downgrading even if we were to assume, for the sake of argument, that it is syllable weight that is at issue. Specifically, 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 would not be expected to pattern in terms of weight with a syllable containing a long vowel.

A second representation consistent with an approach in which geminates are inherently moraic would be for the mora of an initial geminate to be unattached to the syllable, as in (45).

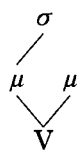
(45)



In other words, a geminate's mora would be extrasyllabic. Again the patterning of long vowels and geminates in blocking downgrading would remain unexplained even if, once again, we were to assume that it is syllable weight that is of relevance. Since a mora unattached to a syllable node would not contribute to syllable weight, a geminate-initial syllable would again not be predicted to pattern with long vowels in terms of weight. Note that this same problem would arise if the extrasyllabic mora were linked to a node higher than the syllable, e.g. foot or phonological phrase.

An additional problem with representation (45) stems from the observation that a mora which is not prosodically licensed would be uninterpretable phonetically. Precisely this point is made in Prince & Smolensky (1993), where it is claimed that the representation in (46) corresponds to a shortened vowel.

(46)



Since the mora unattached to syllable structure is uninterpreted, they claim that it gives rise to a phonetically short vowel. Consequently, were (45) 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.

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A further problem associated with a weight-based account of the Leti facts relates to the observation that in downgrading, syllables with geminate codas also pattern with long vowels, while those closed by a singleton consonant do not. In other words, coda geminates would be required to 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, however, the assignment of a mora to a coda consonant is achieved by Weight-by-Position (Hayes 1989, 1995). Since Weight-by-Position assigns a mora to all coda consonants, lacking further restrictions we would incorrectly predict syllables closed by a non-geminate 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 penalises a non-moraic geminate consonant. Ranked above input–output constraints on mora faithfulness, such a constraint could be used to assign a mora to a derived (underlyingly non-moraic) geminate. We illustrate this in tableau (47), with an example of a derived geminate resulting from morpheme concatenation. As shown, inclusion of G = M in the constraint inventory allows for the selection of the moraic geminate in (c) as optimal. This is assured by subordinating DEP-MORA, which penalises insertion of a mora (48) to the constraints OCP and G = M. (Note that a derived geminate, whose first part occurs as coda, will, like an underlying geminate, 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.)

(47)

CVC + CV	OCP	G = M	DEP-MORA
RT$_a$ RT$_a$			
a. σ σ / RT$_a$ RT$_a$	*!		
b. σ σ \ RT$_a$		*!	
☞ c. σ σ / μ \ RT$_a$			*

(48) 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.

While incorporating a constraint such as G = M into the constraint

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inventory would predict derived geminates to pattern with underlying geminates and long vowels in terms of syllable weight, there are intractable problems with this approach. First, we are still faced with the problem of moras in the onset, as indicated above, in order to also allow syllable-initial 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 possibility of constructing a constraint which requires the surface presence of a mora on a derived geminate, it would be equally plausible to write a constraint which instead requires only *non-geminates* to be moraic. By doing so, however, we would predict a language in which syllables with long vowels and underlying geminates patterned with syllables closed by non-geminate consonants, but not be 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 (49), 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.i) while the mora of an underlying geminate is preserved in (b.ii). This pattern, as far as we are aware, is also unattested.[19,20]

(49)

a. lok-ku	DEP-MORA	G=M
☞ i. lokku		*
ii. loKku	*!	
b. loKku		
i. lokku		*!
☞ ii. loKku		

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. For example, as noted above, geminates do not contribute to mora count in Leti's bimoraic minimal word requirement. Further, syllables containing geminates pattern with light syllables in stress assignment.

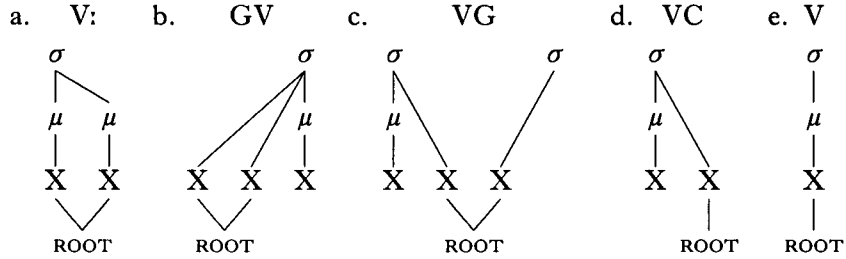
Thus, in order to account for the observed facts from Leti, it cannot be simultaneously assumed that geminates are inherently moraic and that moras are excluded from the onset. To do so is not only problematic for theory-internal reasons, as noted above, it is also empirically incorrect.

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7 Predictions

We turn now to some of the predictions of the claim that both weight and length are included in the representation. In (50) (cf. (3) above), we provide the proposed representations of syllable types, assuming all consonants to be underlyingly non-moraic. From left to right, these refer to: a syllable containing a long vowel, a syllable made up of a geminate + vowel, a syllable closed by a geminate consonant, a syllable closed by a non-geminate, and an open syllable. Based on the claim that both length and weight are relevant in phonology, three patterns are predicted.

(50) *All consonants as non-moraic*



i. *Length only:* V:, GV, VG *vs.* VC, V
ii. *Weight only:* V: *vs.* GV, VG, VC, V
iii. *Weight and length:* V: *vs.* GV, VG, VC, V

First, when only length is relevant for a phonological process, we predict the patterning of long vowels with syllables containing a geminate consonant, either syllable-initial or syllable-final (a–c). Clearly, this corresponds to the pattern observed in Leti downgrading. A further candidate for this pattern is Hindi, as discussed in Davis (1994), where syllables containing long vowels and geminates pattern together, although unlike Leti, Hindi's inventory does not include initial geminates.

Second, when only weight is at issue, syllables containing long vowels pattern to the exclusion of all other syllable types. Recall that this is the pattern proposed to account for stress assignment in Leti. Another contender for this pattern is Selkup, where syllables containing long vowels pattern to the exclusion of other syllable types, as discussed in Tranel (1991) and Rialland (1993).

The third pattern involves both weight and length. In this case, syllables containing long vowels again pattern to the exclusion of all other syllable types. The crucial difference between the second and third patterns concerns the behaviour of syllables containing bimoraic diphthongs. In the second, they would be predicted to pattern with long vowels, while in the third, they would pattern with all remaining syllable types. Ossetic is reported to display this latter pattern (Hayes 1995, de Lacy 1996).

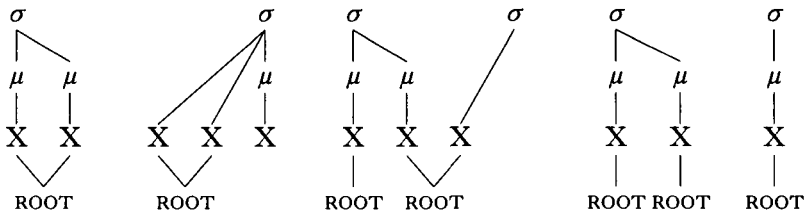
Three additional patterns emerge when we take into account Weight-

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by-Position, which assigns a mora to all coda consonants (Hayes 1989, 1995). The relevant representations of syllable types appear in (51).

(51) *Coda consonants as moraic* (*with* Weight-by-Position)

a. V: b. GV c. VG d. VC e. V



i. *Length only:* V:, GV, VG *vs.* VC, V
ii. *Weight only:* V:, VG, VC *vs.* GV, V
iii. *Weight and length:* V:, VG *vs.* GV, VC, V

When only length is at issue, pattern (51.i) converges with that observed in (50.i) above. When syllable weight alone is relevant, syllables containing long vowels, diphthongs and coda consonants are predicted to pattern to the exclusion of open syllables and syllables with a geminate, singleton or no onset. This, of course, corresponds to the basic Weight-by-Position language, e.g. Latin, assumed in Moraic theory (Hayes 1989, 1995) (excepting, of course, that initial geminates do not occur in Latin). Finally, when length and weight are relevant, we predict syllables containing long vowels and coda geminates to pattern to the exclusion of all other types. We point once again to Hindi as a potential candidate displaying this pattern since syllables containing long vowels pattern with those containing coda geminates. However, due to the fact that the language does not also include syllable-initial geminates, we are unable to fully test this claim. The language that will confirm pattern (51.iii) is one which includes syllable-initial geminates in its inventory, and displays the observed patterning of long vowels and coda geminates as in Hindi, to the exclusion of all other syllable types.

Clearly, a model which incorporates both weight and length as above differs most strikingly from a weight-based theory in that the former allows for reference to segmental length in addition to syllable weight. This added power has been shown to be crucial in accounting for Leti downgrading, where the constraint LENGTH-TO-PROMINENCE makes specific reference to multiply linked structure, generalising over both consonants and vowels.

8 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

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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 and the representation of geminate consonants. In this latter regard, we have proposed that to account for the Leti facts, initial geminates are best characterised in terms of length: 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.

Further, the patterning of syllables containing geminates with light syllables supports the view of geminates as underlyingly non-moraic. In addition to successfully accounting for the observed facts in a straightforward manner, our proposed representation of geminates avoids the problems signalled above with respect to a strictly weight-based analysis. 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 vowels, as required in Leti stress, without stipulation. Since geminates are not inherently moraic, syllables containing long vowels may pattern differently from those with geminates in terms of syllable weight.

In conclusion, it is important to draw attention to the fact that the inclusion of skeletal positions, as necessitated by the Leti facts, forces a reconsideration of compensatory lengthening phenomena, as aptly pointed out to us by a reviewer. With skeletal slots present in the representation, it is then arguably possible to relink a segmental melody to an available slot, regardless of prosodic position, thereby resulting in compensatory lengthening. Consequently, earlier typological observations concerning the patterning of geminate consonants in compensatory lengthening, as examined most extensively in Hayes (1989), are no longer explained. While it is beyond the scope of this paper to undertake a reanalysis of this topic, the Leti facts clearly require a rethinking of the compensatory lengthening problem in the hope of finding a satisfactory solution.

NOTES

* We are particularly grateful to Nick Clements, David Odden and Sam Rosenthall for their valuable comments on a draft version of this paper. We would also like to thank members of the audiences at the Mid-Continental Workshop on Phonology 2 (University of Illinois, Urbana-Champaign), the Montreal-Ottawa-Toronto Workshop on Phonology (University of Toronto) and the Austronesian Formal Linguistics Association (UCLA) for their input. Finally, we acknowledge three anonymous reviewers for their helpful comments and suggestions. Naturally, we assume responsibility for any errors of fact or interpretation.

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[1] Though see Vago (1989) and Odden (1997) for discussion of geminates which are contained entirely within the coda.

[2] As aptly pointed out by a reviewer, voiced obstruent geminates as well as geminate fricatives are cross-linguistically disfavoured. Thus, the lack of /vv/ and /dd/ may be considered expected systematic gaps. Note also that [v] is in free variation with [β].

[3] It should be noted that in absolute phrase-final position, all words end in a vowel. As a means of satisfying this phrasal requirement, the final vowel and consonant of consonant-final forms in (5), for example, undergo metathesis (with compensatory lengthening of the penultimate vowel if /VVC/-final), e.g. /ppikan/ → [ppikna] 'plate', /vroan/ → [vro:na] 'axe' (see note 4 for related discussion).

No more than two consonants occur in onset position, and these only occur in absolute phrase-initial position. Phrase-medially, the first consonant of a geminate or word-initial cluster syllabifies as coda of a preceding vowel-final morpheme (see Hume 1997a, b). Attested initial clusters are: stop + stop [pt pd pk tp tk kp kt kd], stop + fricative [ps tv ts], obstruent + sonorant [pn pl pr vn vl tm tl tr dr sm sn sl sr km kn kl], sonorant + obstruent [mb ms mv ns rm rn rl rv rs] and sonorant + sonorant [mr nr rm rn rl]. Phrase-initial sonorants and fricatives are arguably syllabic preceding an obstruent stop, e.g. [m̩p m̩t m̩d m̩k n̩t n̩d n̩k l̩p l̩t l̩k r̩p r̩t r̩d r̩k s̩p].

[4] Metathesis occurs under two general conditions in Leti. First, it affects an underlyingly consonant-final word when followed by a CCV or CVV-initial word within the same phonological phrase. This type of metathesis is shown in Hume (1997a, b) to occur as a means of avoiding an initial complex onset or onsetless syllable. Second, all consonant-final words metathesise in phrase-final position in order to satisfy the requirement that all phrases end in a vowel (see references above for related discussion and analyses).

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

[6] 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-medial open syllables are avoided in Leti, the vowel preceding the resyllabified consonant deletes or is realised as a secondary articulation on an adjacent prevocalic consonant, e.g. /isuɔna + aan/ [is^{w}ɔna:n] 'witch + DIM', /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.

[7] This occurs provided that the following vowel is non-high. If it is [+high], the morpheme-final high vowel deletes in accordance with a general prohibition in the language against tautosyllabic sequences of [+high].

[8] The realisation 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.

[9] Monomorphemic forms of more than three syllables are not attested.

[10] Our phonetic analyses of Leti stress reveal that vowel duration is the most consistent and significant indicator of stress. Vowels in stressed syllables are significantly longer than those in unstressed syllables ($p < \cdot 0001$). 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.

[11] Whether the elements of the skeletal tier are represented as Cs and Vs (Clements & Keyser 1983) or Xs (Levin 1985) is not crucial to our account. See Piggott (1991) for additional arguments in support of the skeleton in syllable theory.

[12] Selkirk (1990) also argues that geminates are non-moraic. 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

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is non-contrastive 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 would incorrectly predict place-assimilated consonants to pattern with geminates in blocking downgrading (see (21)).

[13] We do not discuss possible differences in degrees of stress though note that the final stress of an intonational phrase is typically more prominent, in terms of pitch and vowel duration, than preceding stresses.

[14] Under the assumption that a phonological phrase contains a prosodic head and thus a foot, candidates (c–e) would presumably also violate the Strict Layering Hypothesis. As will be seen in the case of downgraded forms, however, this is precisely the structure which is assumed to surface.

[15] As correctly pointed out by a reviewer, RP alone does not guarantee that the first lexeme will surface completely devoid of stress. An additional constraint would arguably also be required to rule out cases in which the first lexeme bears secondary stress while the second has primary stress. At the present time we leave open the precise nature of this constraint for further consideration.

[16] Phonological changes such as metathesis and compensatory lengthening affect some of the words in this and subsequent tableaux. Due to space limitations, we are unable to offer a detailed account of all patterns here. An in-depth analysis can be found in Hume (1997a, b), however.

[17] Consonant deletion in Leti is non-occurring, thus motivating the undominated status of the constraint MAX-C, which penalises deletion of a consonant (see McCarthy & Prince 1995). Under the assumption that degemination is a type of consonant deletion, a violation of MAX-C would also suffice to rule out candidate (d).

[18] As San Duanmu (personal communication) 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.

[19] Tak & Davis (1994) claim that derived tense consonants in Korean are moraic geminates, while underlying tense consonants are non-moraic 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 non-moraic (though notice that in this case it would be the underlying (tense) geminate that would be non-moraic, 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 claim that derived tense consonants are geminate 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. Further, 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'.

[20] 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 leave

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unexplained why in languages like Selkup (Tranel 1991, Rialland 1993), syllables with geminates pattern as light.

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