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ARTICLE

Naasioi metrical structure: a challenge to syllable integrity

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Abstract
Syllable integrity, the idea that the content of syllables may not be metrified separately, is often taken to be an inviolable constraint of grammar. This has been challenged in recent work, though the data are often subject to competing analyses. This article claims that syllable integrity is readily violable in Naasioi. Evidence from stress, the minimal word and metrically sensitive allomorphy supports an analysis of the metrical system operating on bimoraic feet, and in which long vowels can be metrified separately. Despite this, there is also evidence, in the form of vowel shortening and truncation, to indicate that long vowels constitute a single syllable. The net result is a stress system which systematically ignores syllables, a state of affairs which allows for syllable integrity violations to arise.

Contents

1. Introduction

An oft-cited inviolable constraint of grammar is the pressure to keep the constituents of single syllables metrified together. This is the principle of syllable integrity, which can be defined as in (1):

(1) Syllable integrity: Components of syllables do not belong to distinct metrical feet (Prince 1976; Rice 1988; Hayes 1995).

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The motivation behind syllable integrity lies in the observation that natural languages do not appear to split smaller syllable constituents, such as moras, across different feet. That is, a hypothetical metrical system which is based on bimoraic feet, as in the representation in (2a), with a surface μμ sequence belonging to a single syllable, such as a long vowel or a diphthong, does not allow for the metrification of the two moras into different feet. The result is a syllable that simultaneously has content in two separate feet, by virtue of each mora being parsed by a distinct foot.

(2)


A corollary to this is the claim that the constituents of syllables must be metrified together. This is a slightly different state of affairs, in that it prohibits structures in which one mora of a syllable is parsed by a foot and another is left unparsed, as in (2b). Such a scenario could arise if final moras were extrametrical, a scenario which Hayes (1995) has claimed to be non-existent. The reason for this is tied to syllable integrity: If the right-hand mora of a word-final long vowel were extrametrical, this would violate syllable integrity, as the first mora would be metrified into a foot, while the second would not be metrified at all.

The assumption underlying syllable integrity is that syllables are universally stress-bearing units (Hayes 1995), and that feet may not directly organise moraic constituents while ignoring the syllables they are presumably constituents of, a function of the prosodic hierarchy. There are several predictions that fall out from this theoretical position. For instance, syllable integrity violations would predict stress contrasts such as tautosyllabic v́v *vs.* vv́ (Hayes 1995). Furthermore, as Hyde (2007) points out, allowing syllable integrity to be a violable constraint predicts that extreme cases of syllable splitting are possible, that is, syllables with multiple moras which can be footed separately, resulting in multiple stresses on a single syllable.

While syllable integrity has been posited as an inviolable constraint, there have been notable cases raised in recent years which have challenged this idea. For instance, in demonstrating that Japanese employs bimoraic feet independent of syllable structure, Poser (1990: 103) suggests that this state of affairs could lead to syllable integrity violations. In the most widely discussed case to date, Buller *et al.* (1993) and Everett (1998) have claimed that the metrical structure of Banawá includes syllable integrity violations. In Banawá, the unique behaviour of initial vowels and a predictable metrical system conspire to yield this pattern (see also Martínez-Paricio & Kager 2020 for further support for this view). This is similar to what obtains in Southern Paiute, which likewise has been claimed to violate syllable integrity (Cairns 2002; Cairns & Raimy 2009). In addition, Breteler & Kager (2022) have claimed that tonal spreading phenomena in Copperbelt Bemba require a metrical analysis which occasionally yields syllable integrity violations. Rehg (1993) has demonstrated that in Pohnpeian, stress is based on bimoraic feet regardless of syllable structure. The interaction of unique syllable-structure conditions and metrical patterns has also led Blevins & Harrison (1999) and Kager & Martínez-Paricio (2019) to claim that syllable integrity is readily violated in Kiribati, and Kennedy (2003) has made this wider claim for all Micronesian languages. On a theoretical level, Everett (1998) has claimed that syllable integrity is a violable constraint of grammar. The broad idea is that syllables can be ignored in the construction of feet, and that feet can immediately organise moraic structure. This raises the following question, which will be addressed in this article: If syllable integrity is conceptualised as a violable constraint, how does it interact with other constraints?

Many of the above-mentioned cases have been challenged, and the status of syllable structure in some of these languages is unclear. For instance, Hyde (2007) adopts an alternative view of the prosodic and metrical patterns in Banawá which would still respect syllable integrity. Allan (2021) has challenged the evidence for syllable structure in Kiribati, and Labrune (2012) claims Japanese makes no use of syllables. These claims intersect with the larger debate about whether syllables are universally available in all languages (Hyman 1985, 2011, 2015; Labrune 2012), calling into question whether syllable

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integrity can be violated if there are arguably no syllables in a given language, a point made explicit by Allan (2021). Thus, the status of syllable integrity as a violable constraint remains very much under debate.

The claim of this article is that Naasioi exhibits syllable integrity violations as in (2), and that a primary diagnosis for these violations is in final mora extrametricality. The argument is that feet are sensitive only to moraic structure. Despite this, there is a range of evidence, independent of the metrical facts, for syllables which can be bimoraic. It will be claimed that it is the interplay of constraints in the metrical system that results in syllable integrity violations, and constraints on the size of syllables and feet which prevent unattested structures from surfacing. It will be demonstrated that syllable integrity can be decomposed into a set of alignment constraints which enforce crisp alignment between edges of feet and edges of syllables. If a constraint that demands binary moraic feet dominates these alignment constraints, syllable integrity violations will arise.

This article is structured as follows: §2 outlines the arguments for a bimoraic foot in Naasioi, citing stress patterns, minimal words and prosody-sensitive allomorphy as evidence. §3 presents arguments for the syllable as a unit which is not necessarily coextensive with the mora, where evidence from vowel shortening in reduplication indicates that long vowels constitute a structural unit, and where evidence from truncation, allomorphy and segmental distributions indicates that there are syllables in the language. §4 discusses the implications of these findings for syllable integrity, and presents an analysis where constraints on foot form and extrametricality interact to yield patterns where syllable integrity violations arise. This is then related to the dynamics of the prosodic hierarchy. §5 concludes.

2. Data

This section will outline the arguments for a bimoraic foot in Naasioi, based on evidence from patterns of stress, allomorphy and minimal words.

Naasioi (ISO 639-3 code nas) is a South Bougainville language spoken in the Autonomous Region of Bougainville, Papua New Guinea. The primary published source of data relevant to the current work is Hurd & Hurd (1970), though additional discussion of the language can be found in Hurd & Hurd (1966) and Hurd (1977). Hurd (n.d.) is an unpublished dictionary of Naasioi. Data from Hurd & Hurd (1970) will be cited in the text as HH (followed by page numbers). Morpheme glosses have been updated to conform to the Leipzig Glossing Rules (Comrie *et al.* 2015). Except where relevant for describing the phenomenon at hand, phonologically null morphemes have been removed from examples in order to make the mora counts of each word more transparent. Orthographic forms have been rendered into IPA.

Additional Naasioi data were collected during fieldwork in the Autonomous Region of Bougainville, Papua New Guinea. Unless otherwise indicated, data are from the author's fieldwork. Data collection was conducted in the town of Arawa and in the village of Tubiana. Fieldwork on the language has been ongoing since 2017; data for this particular project were collected during trips in 2017, 2018 and 2020. Elicitation sessions involved collecting lexical items, as well as re-eliciting relevant forms from Hurd & Hurd (1970). Principal Naasioi consultants included AG, ND, PG, CS and SK. All speakers are from the North Naasioi dialect area (specifically, the Baava Pirung region near the village of Tubiana), except for SK, who is from the South Naasioi dialect area. All consultants are multilingual (fluent in English and Tok Pisin), but their L1 is Naasioi, and they speak it daily in the home, and often in activities outside the home.

Syllables in the language are relatively simple, consisting of a (C)V(C) template, with syllable codas restricted to nasals or the glottal stop.[1] Syllabic nasals are tolerated in word-initial position, when preceding other consonants. For reference, the vowel inventory is a canonical five-vowel system: [i, e, a, o, u]. There are phonetically long vowels, though Hurd & Hurd (1970) suggest that each vocalic portion constitutes a single syllable; that is, long vowels are sequences of underlying singletons, and

[1] Though not obviously syllable-based, there are also consonantal alternations involving /d/ and /b/ surfacing as [ɾ] and [β], respectively, in intervocalic position.

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constitute two syllables. This article challenges the assumption that a long vowel comprises two separate syllables. Instead, the position will ultimately be advanced that long vowels form a single unit, and thus a single bimoraic syllable. For the reason that the status of long vowels is under investigation, long vowels are indicated throughout with a doubling of the vowel symbol, and the generalisations which follow will avoid mention of syllables until §3, when evidence is presented to support the existence of the syllable as a unit distinct from the mora.

2.1. Stress patterns

Since metrification is at issue here, some discussion of Naasioi word stress is warranted. Stress normally falls on the second mora of words with three or more moras, as shown in (3) and (4), which suggests a peninitial pattern.

(3) *Stress in trimoraic words*

a. panóko 'five'
b. kopíni 'back'
c. pióka 'navel'
d. oβóntuŋ 'chief'
e. mokóno 'turtle'
f. siképa 'crayfish'
g. nantéi 'coconut-leaf mat'

(4) *Stress in quadrimoraic words*

a. simpénoi 'naked'
b. ikámau 'shoulder'
c. kopósina 'ankle'
d. kaɾíkau 'laulau'
e. itónia 'banana sp.'
f. neɾáina 'young woman'

As can be observed in the data above, there is no evidence to suggest that coda consonants are moraic in the system, because stress does not shift as a function of the presence or absence of codas (e.g., [simpénoi] 'naked'). The fact that codas are non-moraic will be raised again in the next section.

It is in smaller words that a different pattern emerges, and lends crucial evidence for the role that metrical constraints play in many of the other patterns to be explored. Observe the bimoraic forms in (5), which have stress on the first vowel:

(5) *Stress in bimoraic words*

a. báɾeŋ 'bird'
b. déɾaʔ 'slippery'
c. émuʔ 'now'
d. bénto 'star'
e. kómaŋ 'raw'

This is apparently an avoidance of stress on the final mora in words.[2]

In terms of stress placement, long vowels are treated as if they were sequences; that is, each vowel portion counts as a stress bearing unit (Hurd & Hurd 1970). Stress therefore falls on the second half of a long vowel in initial position:

(6) *Long vowels as first element*

a. taáβi 'fish'
b. toóu 'dugong'
c. taámaŋ 'food'
d. siípuŋ 'dust'
e. koóβa 'hibiscus'

[2] This nonfinality condition is overridden in disyllabic words with an initial syllabic nasal such as [n̩tá̍ʔ] 'fire' or [n̩tóŋ] 'water'.

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Since the default position for stress is the peninitial mora, when long vowels occur in this position, stress falls on the initial mora of the long vowel sequence:

(7) *Long vowels as second element*

a. baŕáama 'eel'
b. bakáasi 'canoe'
c. kemáaki 'yesterday'

This gives the appearance of a 'final' stress in disyllabic forms ending in a long vowel:

(8) *Long vowels as second/final element*

a. kakúu 'crab'
b. toŕáa 'wild cane'
c. meŕáa 'yellow'

These generalisations around stress are largely due to Hurd & Hurd (1970), though independent data were collected and observed spectrographically. Stress acoustically involves a peak in F0 and amplitude. For forms which do not involve long vowels, this also involves an increase in duration. Some speakers (such as PG and AG) are clear in their judgements about the location of stress; thus, even if the acoustic cues turn out to be correlates of an accentual system, this does not nullify the results here, as the placement of the accent would still need to be determined by metrical properties.

Hurd & Hurd (1970: 38) note that stress is fairly robust, but make no mention of any evidence for secondary stress. Acoustic evidence suggests that in words with five or more moras, there is a stress on the second mora, and no other detectable pitch peaks or durational differences. This is true, for example, for [otómemoa] 'to not have'. The lack of secondary stress will also be important for determining the overall prosodic behaviour of the language.

As mentioned, the generalisations above indicate a peninitial pattern with a constraint prohibiting final stress. One possible analysis is that the stress system is based on unbounded feet with initial extrametricality, as there are no apparent secondary stresses. While this type of system is not difficult to model, the presence of only a single unbounded foot makes certain predictions about the metrical parsing of the word – that is, that it is exhaustive (see also arguments against similar unbounded foot analyses in Bennett 2012). However, a different interpretation of peninitial stress based on bounded binary feet makes slightly different predictions. One possibility is that there is a single bounded iambic foot that is placed word-initially (Prince 1985; Baković 2004):

(9) *Single-foot hypothesis*

(μ μ́) μ μ …

Such an analysis would predict that foot binarity is a relatively high-ranked constraint, though it also predicts that the word is not exhaustively parsed. It will be argued in the next section that evidence from prosody-sensitive allomorphy suggests that there is not simply a single foot, and that instead, the Naasioi word is exhaustively footed (aside from an extrametrical final mora), thus splitting the difference between these two approaches.

At this point, the consequences of stress avoidance on the final mora are not clear. A common analysis of the stress retraction found in bimoraic words is of a prohibition of a prosodic head in final position, yielding a shift in foot type from iambic to trochaic (μ́ μ) such that the word is exhaustively footed.[3] Alternatively, leaving the final mora extrametrical in bimoraic forms would yield a degenerate foot:

[3]For instance, this analysis has been proposed for Awajún (McCarthy 2008), Axininca Campa (McCarthy & Prince 1993b; Prince & Smolensky 1993; Hung 1994), Choctaw (Prince & Smolensky 1993), Hopi (Gouskova 2003), Latin (Mester 1994), Nanti (Crowhurst & Michael 2005), Panoan (Elias Ulloa 2006), Southern Paiute (Prince & Smolensky 1993) and Ulwa (Prince & Smolensky 1993), to name a few.

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(µ́)⟨µ⟩. Hung (1994: 88–89) entertains the degenerate-foot analysis for Axininca Campa, but rejects it on the assumption that foot binarity is an inviolable constraint. It will be argued, based on evidence presented in the next section, that the degenerate-foot analysis is correct for Naasioi, as the final mora does not appear to be computed in cases of allomorphy, and the prohibition appears to be one based on final feet, not on prosodic heads.

2.2. Present progressive allomorphy

Like many other Papuan languages of the region, Naasioi makes use of an elaborate system of verbal morphology. Each verb belongs to one of four conjugation classes. Verbs in each class have different properties, and for the most part take different forms of the suffixes to be outlined below, though several sets of suffixes overlap across different verbal classes. Some classes of verbs exhibit specific phonological properties (such as ending in nasals, or having similar bound *vs.* free forms), though these properties are largely irrelevant to the patterns to be discussed here. Aside from reduplication, the verbal morphology consists exclusively of suffixes. A detailed analysis and discussion of Naasioi verbal morphology can be found in Hurd & Hurd (1970). The verbal template includes a series of suffixes that mark (in order): object agreement, 'auxiliary number' (which marks non-singulars for either subject or object), subject agreement, number, negation and a series of tense/aspect suffixes. There are several verbal suffixes that exhibit allomorphic relationships, some of which are phonologically conditioned (Hurd & Hurd 1970 provide an exhaustive catalogue of these affixes). The morphemes under discussion in this section are tense/aspect markers, appearing at the end of the suffix string. The basic patterns were first identified by Hurd & Hurd (1970), and were verified during fieldwork by the author.

The present progressive suffix *-maaŋ*/*-maŋ* appears in the final position in the verbal template, and exhibits a length alternation that is contingent on mora count. The choice of allomorph is determined by a calculation of the mora count of the preceding string: odd-parity counts require *-maaŋ,* while even-parities require *-maŋ.*[4] This is demonstrated with the pair of examples in (10), where the verb stem in (10a) has only a single mora, but where the presence of the additional monomoraic dual suffix *-ɾe* in (10b) makes the mora count even.

(10) a. mo-máaŋ
I.come-PRS.PROG
'I am coming.' (HH: 54)

b. mo-ɾé-maŋ
I.come-DU-PRS.PROG
'We two are coming.' (HH: 54)

An analysis of this pattern is that the alternation in length in the present progressive suffix is such that it consistently yields words with an odd mora count, a fact noted by Hurd & Hurd (1970). Several more examples are presented in (11) in order to illustrate this behaviour with various verbs and suffixes. The stem mora counts are included with the relevant allomorph for reference.

(11) a. uɾ-ó-maŋ [µµ]-*maŋ*
lead-3-PRS.PROG
'He is taking the lead.' (HH: 54)

b. uɾ-ó-ɾe-maaŋ [µµµ]-*maaŋ*
lead-3-DU-PRS.PROG
'They two are taking the lead.' (HH: 54)

c. uɾ-éaa-maŋ [µµµµ]-*maŋ*
lead-3PL-PRS.PROG
'They are taking the lead.' (HH: 54)

[4] Hurd & Hurd (1970: 73) note that the suffix *-ma*/*-maa* behaves exactly the same; however, it is unclear from their account what meaning this suffix encodes, and it has not been confirmed in my fieldwork.

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d. bakíaaʔ-e-maaŋ [μμμμμ]-*maaŋ*
steal-2-PRS.PROG
'You're stealing it.' (HH: 71)

e. bakíaaʔ-e-ɾe-maŋ [μμμμμμ]-*maŋ*
steal-2-DU-PRS.PROG
'You two are stealing it.' (HH: 71)

This is clearly a pattern of prosodically conditioned allomorphy (McCarthy & Prince 1993b; Mester 1994; Kager 1996). The challenge that the above pattern raises is in accounting for the metrical structure of the output (i.e., to identify what formal property triggers the allomorphy), as well as the fact that the allomorph itself exhibits a metrical alternation (one *vs.* two moras). An analysis that ignores either of these facts will treat them as mere accidents. In addition, the preference for words of odd mora counts exhibited by this suffix is on the face of it somewhat mysterious for a metrical account, as it is not immediately clear what kinds of constituents will always result in an odd number of moras, though revisiting the patterns of word stress in the language uncovers a straightforward analysis.

2.3. The metrical structure of Naasioi words

Entertaining a system with binary feet as in (9) makes positive predictions in this case, as it suggests that length-based alternations may arise in order to satisfy metrical needs, though the 'reach' is limited to the first foot in the word. As is evident from the data above, Naasioi words are often longer than three moras. The assumption that the entire word is exhaustively footed, though with only an initially prominent iamb, makes predictions about whether output structures can satisfy metrical requirements. This effectively posits covert feet for the purposes of counting or other rhythmic properties (Halle & Vergnaud 1987; Halle 1990; Poser 1990; Crowhurst 1991; Hung 1994; Bennett 2012; Golston 2017). This will be the approach endorsed here, as it is the only way to account for the behaviours of the present progressive suffix.

(12) *Single-stressed-foot hypothesis*

(μ μ́) (μ μ) …

The fact that there is a consistent mora parity in each case in (11) points to an analysis based on metrical principles. The resulting odd number of moras, as noted above, constitutes an outstanding problem, as feet are canonically binary, implying that the pattern should yield an even, rather than odd, number of moras. One possibility is that the system works like hypocoristic formation in many languages, where there is a template based on exhaustively metrified feet, to which a special affix is attached, and where the affix itself is not computed in the metrical structure (McCarthy & Prince 1995). The case of Japanese hypocoristics helps illustrate this idea, in that the truncated name is based on a bimoraic foot, but the suffix used for hypocoristics does not count in this computation (Poser 1990). Excluding the suffix from the computation of mora counts in Naasioi, however, ignores the fact that the suffix itself exhibits an alternating number of moras.

The allomorphy resulting in words with odd numbers of moras is on the face of it an unusual or unexpected pattern, but makes sense in the context of the stress system of the language. As mentioned above, stress consistently falls on the peninitial mora. The only condition where this does not obtain is in bimoraic forms, where stress falls on the initial mora, as in (5). This behaviour is consistent with a constraint prohibiting stress on a final mora, which in the case of bimoraic words overrides regular stress assignment, yielding initial stress. The final mora, then, appears to be set off as extrametrical. If a nonfinality constraint is respected in the cases of allomorphy in question, then setting off the final mora as extrametrical will result in an otherwise consistently even-numbered mora count, one whose natural interpretation is of *n* binary feet, as in (13). In other words, considering the final mora extrametrical renders the rest of the word exhaustively parsed into binary feet when this suffix is present. This is illustrated with the metrical analyses of (11d) and (11e) given in (13):

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(13) a. (ba.kí)(aa)(ʔe.ma)⟨aŋ⟩ = (11d)
b. (ba.kí)(aa)(ʔe.ɾe)⟨maŋ⟩ = (11e)

This implies that a constraint like Nonfinality must be ranked relatively high. Nonfinality can be defined as in (14), which makes the most sense in a context where it is truly extrametricality, and not simply avoidance of a prosodic head, that is being enforced (see Hyde 2003, 2011 for discussion). The reason for this is because in longer words there are only covert feet beyond the initial foot, and therefore there is no sense in which a prosodic head would threaten to be in the final position; instead, any footed material would trigger a violation.

(14) Nonfinality: A foot may not be final

In order to correctly model the Naasioi case of extrametricality, Nonfinality must dominate Parse-μ, which in turn interacts with Ft-Bin. The definition of Ft-Bin must crucially rely on part of the 'under syllabic or moraic analysis' clause, which is typically how the constraint is formulated (Prince & Smolensky 1993).

(15) Parse-μ: Moras must be parsed by feet

(16) Ft-Bin: Feet must be binary under a moraic analysis

While relatively important for phenomena such as the present progressive allomorphy, Ft-Bin is violated in some contexts. There is a bimoraic minimality requirement on words in Naasioi. For example, the lexical corpus of 456 items elicited from a basic Melanesian word list (Brown & Irvine 2021) does not include any monomoraic lexical words.[5] Examples of the smallest words are as below (including forms with long vowels, as in (17b)). Thus, if Nonfinality is respected in bimoraic forms, there must be degenerate feet. This yields a scenario in which a bimoraic minimal word does not equate a bimoraic foot; that is, the minimal word is not reducible to the minimal foot in the language (Crowhurst 1991; Garrett 1999).

(17) a.	i.	kóe	'tree'	b.	i.	míi	'hill'
	ii.	káu	'leg'		ii.	íi	'smoke'
	iii.	béi	'bamboo'		iii.	óoʔ	'to sew'
	iv.	tái	'to burn'		iv.	dúu	'to wash'
	v.	méu	'marrow'				

As mentioned in §2.1, in bimoraic words, an initial stress would result in either a trochaic foot (μ́ μ) or a degenerate foot (μ́)⟨μ⟩. Under the former scenario, Ft-Bin ≫ Nonfinality (and Ft-Bin would also dominate a constraint on foot well-formedness, for example, one that demands right-headed feet, such as Iamb); under the latter, Nonfinality ≫ Ft-Bin. Since the allomorphy exhibited by the present progressive suffix is sensitive to covert feet, and thus Nonfinality must be defined as a prohibition on final feet (and not on prosodic heads), the shift in foot type from iambic to trochaic would not satisfy Nonfinality, as the final mora would still be footed. However, the structure with a degenerate foot plus extrametrical mora, (μ́)⟨μ⟩, would satisfy the constraint. This obtains if Ft-Bin is ranked sufficiently

[5]There are lexical roots that may fall below this, though these are bound forms (such as the bound forms in verbal roots belonging to classes 1, 2 and 4; Hurd & Hurd 1970). Function words, clitics and particles may also be subminimal, though it is typical for these elements to be immune to minimality requirements (McCarthy & Prince 1986, 1995; Selkirk 1996). Hurd & Hurd (1970: 44) list the four class-4 verb stems in their free (non-bound) forms. These include /beʔ/ 'to go' and /poʔ/ 'to come', which appear to be exceptions to the above generalisation. The examples given in that text involve the verb stem followed by the causative marker *anta* (the same is true for the class-1 stem /puʔ/ 'to stumble'). However, Hurd & Hurd note that when there are no verbal suffixes attached to *anta,* it is bound to the verbal stem. This suggests that *anta* is part of the verbal morphology, bound to the stems, and this is in fact how these words are represented in the Naasioi dictionary (Hurd, n.d.).

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low, and monomoraic minimal words are ruled out because a degenerate foot on its own would violate NONFINALITY. Importantly for Naasioi, NONFINALITY must be respected, even if this is at the expense of a foot well-formedness constraint that demands that feet have a right-prominent mora, such as IAMB. In addition, PARSE-μ must be violated because of the demands of NONFINALITY, but this violation must be minimal in the sense that if extra moras are left unparsed in an uneconomical fashion, this would defeat the effect of the allomorphy. This dynamic is illustrated with the tableaux in (18) and (19), where competing allomorphs are listed in the input (following Mascaró 2007). The ranking of NONFINALITY ≫ PARSE-μ ensures that (18a) (ba.kí)(aa)(ʔe.ɾe)⟨maŋ⟩ is selected over (18c) *(ba.kí)(aa)(ʔe.ɾe)(maaŋ).

(18) *Allomorphs with even stems*

bakiaaʔeɾe {maŋ, maaŋ}	NONFINALITY	PARSE-μ	FT-BIN
☞ a. (ba.kí)(aa)(ʔe.ɾe)⟨maŋ⟩		*	
b. (ba.kí)(aa)(ʔe.ɾe)(ma)⟨aŋ⟩		*	*!
c. (ba.kí)(aa)(ʔe.ɾe)(maaŋ)	*!		**
d. (ba.kí)(aa)(ʔe.ɾe) ma ⟨aŋ⟩		**!	

(19) *Allomorphs with odd stems*

bakiaaʔe {maŋ, maaŋ}	NONFINALITY	PARSE-μ	FT-BIN
a. (ba.kí)(aa)(ʔe)⟨maŋ⟩		*	*!
☞ b. (ba.kí)(aa)(ʔe.ma)⟨aŋ⟩		*	
c. (ba.kí)(aa)(ʔe)(maaŋ)	*!		*
d. (ba.kí)(aa) ʔe ⟨maŋ⟩		**!	

While the allomorphy provides evidence for the metrical structures in question, the analysis is not limited to forms with the present progressive suffix. What can be inferred is that, based on evidence from stress and the minimal word, non-final 'stray' moras form degenerate feet, and thus violate FT-BIN. Thus, in cases without the suffix present, potential parses are (μ μ)(μ)⟨μ⟩ for even forms, and (μ μ)⟨μ⟩ for odd forms. The present progressive suffix is simply a case of optimisation, where an exhaustive footing, that is, one where there are no unparsed moras, will emerge. This is illustrated in (20) with the lexical word [kopósina] 'ankle'. The ranking of PARSE-μ ≫ FT-BIN ensures that (20c) (kopó)(si)⟨na⟩ is selected over (20a) (kopó)si⟨na⟩, as both respect NONFINALITY, but the former minimises the number of unparsed moras.

(20) *Lexical words*

/koposina/	NONFINALITY	PARSE-μ	FT-BIN
a. (kopó)si⟨na⟩		**!	
b. (kopó)(sina)	*!		
☞ c. (kopó)(si)⟨na⟩		*	*

Forms with odd numbers of moras will exhaustively parse the moras into feet. This simultaneously satisfies PARSE-μ and FT-BIN. Forms with even numbers (larger than two) cannot satisfy both constraints and still respect NONFINALITY. This is where their ranking becomes crucial. It is in the case of allomorphy that FT-BIN emerges as relevant, guiding the choice of allomorph, and in contexts where NONFINALITY is respected, all moras are otherwise exhaustively parsed into feet. Having a choice between two allomorphs which vary in length allows for this optimisation. Under normal circumstances,

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where this choice is not presented to the grammar, it will yield to Parse-μ by readily violating Ft-Bin, admitting a degenerate foot if there are any moras that would otherwise be left unparsed.

At this point, it is worth asking whether the above analysis of Naasioi stress is correct, and whether a reanalysis would alter the consequences for syllable integrity. It is evident from the behaviour of stress that if the system is constructed out of iambs, they are moraic iambs. These are accepted foot types under some theories of stress (Kager 1993; see also Leer 1985; Crowhurst 1991; Rice 1992; Driscoll 2019), but not all, particularly those based on Hayes (1995). Even though initial extrametricality is thought to be highly marked (Elenbaas & Kager 1999), an argument could be made that the system is constructed out of trochees which are offset from the left edge by initial extrametricality; that is, ⟨μ⟩(μ́ μ). Thus, (bakí)(aa)(ʔema)⟨aŋ⟩ in the iambic analysis would under the trochaic alternative be represented as ⟨ba⟩(kía)(aʔe)(maaŋ). In fact, Lathroum's (1991: 84–85) analysis of the reduplication and minimal word patterns in Naasioi posits a default trochaic foot. Under this scenario, in disyllabic forms Noninitiality would be violated in order to satisfy Trochee.[6] It will be demonstrated in §4, however, that re-analysing stress in this way yields exactly the same results in terms of syllable integrity violations. The obvious advantage that the iambic approach holds over the trochaic approach is in the relative infrequency of initial extrametricality, and the marked structure that Noninitiality demands. For these reasons, the iambic analysis will be employed in the remainder of this article.

2.4. Summary

This type of allomorphy, and the basic analysis sketched so far, are consistent with Kager's (1996) treatment of Estonian, which exhibits a similar prosodically sensitive allomorphy. Both of these cases can be argued to be optimising. A point of contrast, however, is that the allomorphy outlined above is consistent with a stress system composed of quantity-insensitive syllables; in no case does what could be construed as a syllable coda disrupt the pattern by adding a mora. An alternative approach would view the matching between allomorph and stem as a property of subcategorisation (Paster 2005), where the information that a short allomorph attaches to an even-numbered stem (and a long suffix attaches to an odd-numbered stem) is encoded into the lexical entry of the allomorphs. This approach views the fact that the allomorphs themselves differ in length as an accident, and must stipulate the subcategorisation information for any given allomorph. Severing the connection between the shape of the allomorph and the shape of the stem eliminates the optimisation that would otherwise be apparent in the metrical approach. Thus, the Naasioi case illustrates optimisation, where the length allomorphy in this morpheme creates exhaustively metrified feet.

Up to this point, all patterns can be accounted for under the assumption that syllable and mora are coextensive – that is, that all surface long vowels are simply sequences of short vowels. The force of Nonfinality has yielded final-mora extrametricality, but under the above assumption, this can be considered final-syllable extrametricality, and thus it does not pose a threat to syllable integrity, as each syllable by hypothesis only dominates a single mora (and thus its content cannot be split across feet). However, if this assumption is incorrect, there is the possibility that syllable integrity is violated. These violations would arise with the long vowels, if they can be shown to be monosyllabic, in cases where they would potentially be split across metrical structures, such as in the long forms of the present progressive suffix; for example, (ba.kí)(aa)(ʔe.ma)⟨aŋ⟩. The next section will present evidence for syllables being non-isomorphic with moras, and will demonstrate that there are phonological operations which treat long vowels as a structural unit, that is, a vocalic root note associated with two moras, and by assumption, a single syllable.

[6]A reviewer raises the question of whether a weight-sensitive version of this analysis might capture the facts. Under this scenario, a non-initial trochee is generated by Noninitiality ≫ Align-Ft-Left; initial stress in bimoraic forms is derived by Trochee ≫ Noninitiality; and a high-ranked constraint prohibiting unstressed long vowels would capture the CVC$\acute{V}_x V_x$ pattern in (8). This analysis, however, would fail to capture the fact that CVC$\acute{V}_x V_x$ and CVC$\acute{V}_x V_y$ are equivalent for stress purposes (compare [kakúu] 'crab' and [nantéi] 'coconut-leaf mat'), and that rightward-oriented long vowels are not stressed in longer words; for example, [bakíaaʔ] 'to steal'.

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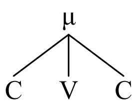
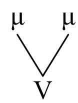
3. Evidence for syllable structure

The analysis thus far relies on the assumption that syllable and mora are coextensive in Naasioi. As suggested by Hurd & Hurd (1970), under this approach, each vowel constitutes its own syllable, and long vowels are simply sequences of underlying short vowels. If this is indeed the case, then the patterns involving final vowel inertness are not problematic for the theory, as this would simply be final-syllable extrametricality, and there would be no meaningful context in which syllables could be split. If it can be shown, on the other hand, that there are long vowels which constitute a single syllable, this would be problematic for syllable integrity, as it would imply that a final long vowel can be metrically split, with one mora parsed by a foot and the other extrametrical. It will be argued in this section that there is evidence that long vowels behave as a single unit for some operations, and thus constitute a single syllable.

A common structural assumption about long vowels is that they are bimoraic and contained within a single syllable (McCarthy & Prince 1986; Hayes 1989). This presupposes that a syllable level exists. There are, however, claims that syllables are not universal, or are not necessary in the analysis of some languages.[7] The most notable of these approaches include Hyman (1985, 2011, 2015), where it is proposed that moraic structure alone can account for all of the relevant processes in languages like Gokana (see also Labrune 2012 for similar claims about Japanese). Under this model, the mora dominates all segmental slots, as 'coda' consonants in Naasioi are not moraic:

(21) *Syllable-less representations for Naasioi*

a.


b.


According to Hyman's (1985, 2011) analysis, long vowels are vocalic slots associated with two moras, without a syllable node needed to further organise the structure. Thus, weight is autosegmentally achieved through branching (as in (21b)).

In light of this, any claims regarding syllable structure, above and beyond moraic structure, would need to demonstrate independent evidence for that structure. Without establishing that there are indeed syllables, it is impossible to demonstrate that there are violations of syllable integrity. However, a flat structure such as in (21a) predicts that there is no onset–coda asymmetry. So if an asymmetry can be established, this would argue for syllable structure. Likewise, if there were prosodic morphological phenomena which relied on syllables (and not simply moras), this would also constitute evidence.

In the next sections, the case will be made that long vowels constitute single units, consistent with (21b), but also that there is evidence, in the form of independent distributional generalisations and the behaviour of truncated forms, that this structure is dominated by a syllable.

3.1. Vowel shortening

The primary evidence for long vowels forming a structural unit comes from a process of vowel shortening. This is found morphophonologically with some roots, but much more robustly in reduplication. For instance, Hurd & Hurd (1970) note that the addition of certain affixes with class-4 roots triggers a shortening of a long root vowel: for example, *boo-aiŋ* 'He will die' *vs. bo-ieŋ* 'He died recently' (see also Lathroum 1991: 87, fn. 6). Class-4 roots are extremely infrequent, and not many of these roots have long vowels. However, the implication of this shortening is that a syllable (with a long vowel) has to be targeted if V_1V_2 sequences are not affected by shortening. Related to this is the fact that there are other morphophonological alternations in length. Pronominal number markers appearing in the DP complex

[7] On the latter point, many have asserted that it could be the case that syllables are universal, in that every language has syllables, but this does not entail that every language has processes that refer to them (Blevins 2003; Hyman 2011; Kiparsky 2018).

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exhibit fluctuations in length: the dual suffix is a short [-e] which occurs before vowels, and a long [-ee] which occurs before consonants; the plural suffix surfaces as [-i] / [-ii] in the same environments (Hurd 1977: 154–155). This in part supports an analysis of long vowels as structural units.

In addition to this more marginal pattern, there is a shortening pattern found in some cases of reduplication. According to Hurd & Hurd (1970), verbs reduplicate derivationally, with sometimes unclear shades of meaning. In addition, other patterns have been identified, such as reduplication with nouns to form plurals, or with verbs to derive adjectives. Reduplication is partial, and prefixing. Reduplicants always consist of two moras, illustrated in (22).

(22) *Bimoraic reduplicants*

	Base form		*Reduplicated form*		
a.	simáɾiŋ	'I left the house'	sima-simáɾiŋ	'I more or less left the house'	(HH: 46)
b.	doɾéʔmaɾiŋ	'I was happy'	doɾeʔ-doɾéʔmaɾiŋ	'I was *very* happy'	(HH: 46)
c.	amákoaɾiŋ	'he was tongue-tied'	ama-amákoaɾiŋ	'he was a bit tongue-tied'	(HH: 47)
d.	baʔánsiŋ	'I ribbed it'	baʔa-baʔánsiŋ	'I hurriedly ribbed it'	(HH: 46)
e.	máuʔ	'to have it in for'	mauʔ-máuʔ	'to threaten'	
f.	múɾiʔ	'frown'	muɾi-múɾiʔ	'angry looking' (v)	
g.	náu	'tell'	nau-náu	'instruct, teach'	
h.	nóɾuʔ	'know'	noɾu-nóɾuʔ	'think about'	
i.	míŋku	'converse'	miŋku-míŋku	'talk a bit about s.t. with s.o.'	

As with the stress patterns outlined in §2.1, it appears that coda consonants (which can only be nasals or the glottal stop) are irrelevant to syllable weight, as they do not contribute a mora when they occur in the reduplicant (the presence *vs.* absence of these consonants in the reduplicant will be explained below).

(23) *Inertness of codas*

a.	doɾéʔmaɾiŋ	'I was happy'	doɾeʔ-doɾéʔmaɾiŋ	'I was *very* happy'	(HH: 46)
b.	keémpansiŋ	'I planted it'	keeŋ-keémpansiŋ	'I planted it here and there'	(HH: 45)

The bimoraic shape of the reduplicant is consistent with the minimal-word phenomenon in the language noted above. Further evidence that the reduplicant is a prosodic word comes from stress, as both the base and reduplicant are stressed (as in *síma-simáɾiŋ*),[8] and from the phonotactics of nasals, in that syllabic nasals are only allowed word-initially, and syllabic nasals are permitted initially in both the reduplicant and base:

(24) *Syllabic nasals in reduplicant and base*

a.	m̩mááɾunsiŋ	'I fled'	m̩ma-m̩máɾunsiŋ	'I kept fleeing every which way'	(HH: 46)
b.	n̩tóŋ	'water'	n̩toŋ-n̩tóŋ	'to be/become liquid'	

The morphological structure of verbal forms is relevant to the shape that is derived in the reduplicant. As expected, bases with a monosyllabic, monomoraic root indicate that there is morphological overcopying in order to achieve a bimoraic foot in the reduplicant, as in (25), where the root in the base form is underlined. This will be relevant for the generalisations to be drawn regarding the strategies for copying root material, addressed below.

[8] This judgement was given by a single speaker for this single form, though the pattern is consistent with stress in other prosodic words. Given that stress in reduplicants is still under investigation, stress will not be marked on the reduplicant.

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(25)

a.	baʔánsiŋ	'I ribbed it'	baʔa-baʔánsiŋ	'I hurriedly ribbed it'	(HH: 46)
b.	simáɾiŋ	'I left the house'	sima-simáɾiŋ	'I more or less left the house'	(HH: 46)

According to Hurd & Hurd (1970), there are two types of reduplicative output in the language, based on the phonological properties of the stem. They note that verb roots consisting of a long vowel exhibit a pattern where the entire root is copied. In other words, if the root contains only a long vowel, then this long vowel will surface faithfully in the reduplicant:

(26) *Copying of roots containing only long vowels*

a.	tuúβuiŋ	'it flowed'	tuu-tuúβuiŋ	'it flowed here and there'	(HH: 45)
b.	toóʔpansiŋ	'I jabbed it'	too-toóʔpansiŋ	'I jabbed it repeatedly'	(HH: 45)
c.	muúntuiŋ	'it got dark on you'	muu-muúntuiŋ	'it just about got dark on you'	(HH: 45)
d.	iímuiŋ	'the smoke got in my eyes'	ii-iímuiŋ	'the smoke got in my eyes no matter where I went'	(HH: 45)

In addition to this shape-related fact, there are other markedness effects found in the reduplicant when the base includes these roots: for example, final glottal stops are deleted before other stops, even though glottal stop–stop sequences are phonotactically licit in lexical words; they are optionally deleted before nasals; and final nasals surface before vowels, but always as [ŋ] (implying that they are final in the prosodic word).

On verb stems not consisting of only a long vowel, the reduplicant will systematically shorten an initial long vowel, and final consonants will be deleted.

(27) *Reduplication of roots not containing only long vowels*

a.	naákoʔpansiŋ	'I twirled it'	nako-naákoʔpansiŋ	'I gave it a twirl'	(HH: 46)
b.	beétoʔ	'to pull'	beto-βeétoʔ	'rubbery'	
c.	maáɾe	'revulsed'	maɾe-maáɾe	'frightening, upsetting'	
d.	moóu	'reef'	mou-moóu	'many reefs'	

Thus, the following generalisations can be made. Reduplication yields a bimoraic reduplicant. It strives to copy only the root. If there is not enough material in the root, then it overcopies, likely a minimal word effect. A long vowel seems to be tolerable only if it is the only vowel in the root. What this means is that a long vowel needs to be counted as a unit, for cases where it shortens. Sequences of non-identical vowels, on the other hand, count as two separate syllables. In addition, there is evidence that creating a long vowel by reduplication is not disallowed over a juncture (as in (22c) *ama-amako-aɾiŋ* or (26d) *ii-iimuiŋ*). Therefore, it is not the case that adjacent identical vowels are disallowed, which argues in favour of the reduced reduplicant vowels being a single long vowel.

There are two things to note regarding vowel shortening. The first is that there is a separate set of processes that are triggered by a base, depending on whether it exclusively has a long vowel, or not. Since no other vowel sequences trigger this difference, this argues strongly for the grammar identifying long vowels as a single unit, while sequences are not. This suggests that long vowels constitute a single syllable associated with two moras (à la Hayes 1989). The second point is that in the cases of roots that are not exclusively made up of a long vowel, there is a process which reduces long vowels to short vowels in the reduplicant. This is a classic Emergence of the Unmarked effect (McCarthy & Prince 1994), but it crucially does not affect sequences of non-identical vowels (i.e., deletion affecting one vowel in a sequence; that is, $CV_1V_2CV_x \rightarrow CV_1CV_x$).[9] This is consistent with Lathroum's (1991)

[9]A possible alternative analysis relies on the idea that reduplication copies as much of the root as possible. If there is an initial long vowel in the root which constitutes two moras, and yet another vowel in the root which follows, under this view, reduplication will compress the long vowel into a short one, as they are identical in features, so the reduplicant suffers no loss of segmental information from the base. This essentially would be in order to maximise the copying of the second vowel. There are

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analysis of the language, whereby the nucleus of the reduplicant syllable is simplified. The fact that each type of reduplication also has different effects when it comes to consonants (and whether they are retained or not) indicates that the grammar must be sensitive to this length distinction. The overall generalisation, then, appears to be that reduplication can include either a single syllable with a single long vowel, or two syllables with a short vowel each (a sequence of vowels). Thus, reduplication provides evidence for long vowels being a structural unit. This, however, is only one step toward establishing that long vowels constitute a single syllable.

3.2. Truncation

Additional supporting evidence for long vowels constituting a single syllable comes from patterns of truncation, a phenomenon common in many dialects of Naasioi. While the minimal word in Naasioi appears to be bimoraic, truncated forms and hypocoristics appear to also be disyllabic. In these cases, truncation cannot yield forms which consist only of a long vowel. Names can be truncated to disyllabic structures (stress remains peninitial in the name, and initial in the hypocoristic):

(28)		*Name*	*Hypocoristic*		
	a.	Paranani	Para	[páɾa]	
	b.	Dukoro	Duko	[dúko]	
	c.	Oriansi	Ori	[óɾi]	
	d.	Koivo	Koi	[kói]	
	e.	Taudidi	Tau	[táu]	
	f.	Muutenu’	Muute	[muúte]	(*Muu)
	g.	Koovo	—		(*Koo)

The resulting forms are bimoraic, and can consist of two syllables, or of a sequence of two non-identical vowels (by hypothesis two syllables). However, while a name like *Koivo* can truncate to [koi], the truncation of a hypothetical name *Koovo* to *[koo] is rejected (and indeed no truncation is possible with this name). Names with long vowels in their first syllable exhibit this pattern in (28f) and (28g).

What this indicates is that hypocoristics may consist of a sequence of two vowels, but not a single long vowel. The implication is that a hypocoristic must comprise not only two moras, but two syllables. This pattern is reminiscent of patterns found in Japanese, which also makes extensive use of bimoraic feet, and in which minimal words are bimoraic, but minimal stems are disyllabic (Itô 1990). This cannot be construed as a restriction on truncated forms that disallows segments with branching vocalic nodes, as this is clearly counterexemplified by forms like [muúte]. A more straightforward account – the one adopted here – treats the truncation as prosodic (McCarthy & Prince 1986; Weeda 1992; Downing 2006).

3.3. Syllable-optimising allomorphy

One diagnostic for syllable structure discussed by Hyman (2011) is the existence of syllable-optimising allomorphies. This would include cases which involve stems that select a C-initial suffix in the context following a vowel, and a V-initial suffix following a consonant. This would point toward syllable optimisation, even if it is an emergent phenomenon (à la Mascaró 2007), as the phonology is selecting allomorphs which avoid vowel hiatus and which provide a best onset without creating a coda. This state

mechanical problems with this analysis, though. With trimoraic roots (without long vowels) and larger, the copying procedure must evidently ‘give up’, and settle for the first two distinct moras, leaving the third mora uncopied. It is not clear what advantage there would be to compressing the long vowels, given that segmental information is not entirely copied, anyway. In addition, the analysis would not capture the difference in consonant copying found in roots with short vs long vowels. The problem is that this is a rather baroque solution to account for the facts, when the phenomenon clearly resembles Emergence of the Unmarked.

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of affairs obtains in the variation observed in the Naasioi number marking paradigm. Each overt allomorph of the number suffix is consonant-initial when following a vowel, for example, *-de* (DU), *-di* (PL). However, the allomorphs are vowel-initial when following a consonant, for example, *-e* (DU), *-i* (PL). This is consistent with a syllable-optimising allomorphy.

3.4. Consonantal distributions

One argument that Naasioi has syllable structure – not just moraic structure – comes from consonantal distributions. Naasioi allows only a limited set of consonant clusters, all intervocalic, aside from cases involving syllabic nasals. The first member of each cluster can be a nasal (assimilated to the place of a following stop) or a glottal stop: [ʔp ʔt ʔk ʔb ʔd ʔm ʔn mp nt ŋk]. The distributions of both the glottal stop and the nasal will be presented as evidence for syllable structure.

Hurd & Hurd (1970) claim that the distribution of glottal stop is limited to the syllable coda. There are several cases of intervocalic glottal stop [VʔV], and there is very little independent evidence for syllabification in these forms. However, given that glottal stop is not licit word-initially, and is licit both word-finally and before consonants, this suggests that it is a syllable coda. The fact that there are no *Nʔ sequences would also support the analysis of the glottal stop as a coda, as nasals can precede other stops. In addition, there is a set of allomorphs, the distribution of which supports the analysis of glottal stop as a syllable coda. According to Hurd & Hurd (1970), all class-1 verbs have the properties of phonological words. Relevant to this discussion, this means they all end in vowels, glottal stops or nasals. The indefinite object marker, which is used with class-1 stems in a detransitivised interpretation (e.g., backgrounding the object) is *-k* following vowels (as in (29a)) and -∅ following nasals (as in (29b)). The class-1 verb subject suffixes which obligatorily follow the indefinite object marker are *-am* (1st person), *-i* (2nd person) and *-u*/*-aa* (3rd person, subject to allomorphic variation). Thus, an indefinite object marker will always be followed by a vowel. This appears to be an optimising type of allomorph selection (as per Mascaró 2007), as *-k* would provide an onset for a following syllable, and -∅ would allow the nasals to surface as onsets. As it happens, *-k* surfaces after a glottal stop (29c). The fact that glottal stop patterns with vowels in this respect suggests that it cannot be syllabified as an onset; if it could, the -∅ allomorph would be expected.

(29) a. oó-k-i-ai
look-INDF-2-IMM.FUT
'Look!' (HH: 51)

b. baʔnán-∅-i-ai
sit-INDF-2-IMM.FUT
'Sit (down)!' (HH: 51)

c. duúʔ-k-u-iŋ
wash-INDF-3-IMM.PST
'He washed.' (HH: 48)

The distribution of nasals is perhaps stronger evidence for syllable structure. Hurd & Hurd (1970) note that the alveolar and velar nasals are in complementary distribution, with the velar occurring only word-finally and before [k].

(30) *n/ŋ alternations*

a. nániŋ 'person'
b. naníŋka 'two people'
c. nanínu 'real person'
d. nanínuŋ 'individual'

In clusters, nasals assimilate in place of articulation to a following stop. What can be deduced from these interacting sets of patterns is that place features are banned in the coda; that is, that the syllable

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coda does not independently license place features (Itô 1989). The velar nasal surfaces in word-final position presumably because it lacks place features – a common analysis of Spanish and other languages (Harris 1983, 1984; Trigo 1988; Baković 2000). Thus, rather than a disparate set of environments for place neutralisation (i.e., preceding consonants and word-finally), the two sets of patterns converge if [ŋ] is restricted to the syllable coda. If the line of reasoning established by Hooper (1972), Kahn (1976) and Selkirk (1982) is followed, the environments which trigger place neutralisation involve the syllable coda. The moraic analysis of Hyman (1985) would be highly dependent on linear phonotactic licensing statements to account for the fact that placeless nasals must be licensed pre-consonantally and word-finally, whereas a syllable-based approach reduces these environments to a single position, namely the coda. The number of environments for the glottal stop is larger and more diverse, as it occurs intervocalically, pre-consonantally and word-finally. As argued above, these environments can be subsumed under the syllable coda.

One additional related piece of evidence for syllable structure concerns the sequencing of nasals in the language. While nasals can occur pre-consonantally in word-medial position, they are limited to occurring before stops in these positions. Syllabic nasals occur word-initially. It is only in these contexts that a nasal–nasal sequence is tolerated (as in (31)), as underlying nasal sequences normally result in deletion of the first nasal (as in (32); see Hurd & Hurd 1970: 65; Hurd 1977: 114).

(31) *Nasal sequences with syllabic nasals*

a. m̩máuʔ 'many'

b. n̩náʔ 'carry a person on one's back'

(32) *Nasal deletion in sequences with underlying non-initial nasals*

a. [moʔmínaβiŋ]
móʔmiŋ-naβiŋ
'vine, rope'-CLF
'a vine' (HH: 114)

b. mantón-t-a-maaŋ
feel-2-1-PRS.PROG
'I feel you.'

c. [mantómuiŋ]
mantón-m-u-iŋ
feel-1-3-IMM.PST
'He felt me.'

These facts are difficult to capture straightforwardly under an analysis without syllables. If these distributions are attributed to the 'syllabic' nasal being dominated by a mora, this runs into the problem that all segments are ultimately dominated by moras in Hyman's (1985; 2011) analysis, as in (21a). The mora-only analysis would be forced to posit that nasal–nasal sequences are prohibited, which is generally true, except in cases with a syllabic nasal. If an exception is made allowing a nasal after the first nasal associated with a mora, this predicts that $VN_1.N_2V$ sequences should also be allowed if N_1 happens to be the first nasal in the word, but such sequences are in fact banned. So the mora-only analysis would be forced to posit a strictly linear licensing condition: (only) nasals in initial position license a following nasal. In contrast, the syllable-based analysis allows the second nasal in $\#N_1.N_2$ sequences because N_1 is not a coda; medial $VN_1.N_2V$ sequences are prohibited because the nasals in them are coda–onset sequences. The only stipulation required is that syllabic nasals are limited to word-initial position in Naasioi, which is a well-established pattern found cross-linguistically (Bell 1978: 160–161). While both approaches are potentially descriptively adequate, in the syllable-based approach the patterns fall out from normal licensing conditions on syllable structure.

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3.5. *Constraints on sequences*

One final piece of evidence for syllables involves restrictions on vowel sequences. As Hyman (1985, 2011) notes for Gokana, long sequences of vowels are possible, including long sequences of identical vowels. Naasioi also allows for extensive sequences of vowels; however, there are restrictions on identical vowel sequences. A search of the Naasioi dictionary reveals that there are no sequences of three identical vowels. There is only one headword with an *uuu* sequence, *biuung* 'sling for slinging stones', and one headword *piuung* 'Doppler effect / whizz' with an alternative pronunciation *piuuung*. These words are likely related, and also likely onomatopoetic. It is noteworthy that my consultants reject the forms with three vowels, and instead volunteer forms with two. It thus appears that there is a prohibition on trimoraic identical sequences.

There are also very few opportunities to derive sequences of vowels morphologically, as the right conditions are not normally present in the relevant roots and affixes (cf. Hyman 2015 for a related phenomenon in Gokana). For instance, Hurd & Hurd (1970: 43) note that class-2 bound verb stems do not end in a vowel, and it can be further noted that the most internal suffixes for class-3 and class-4 stems are consonant-initial. The structure of affixes appears to conspire against stacking identical vowels, and in cases where this might otherwise be possible, it is largely averted by allomorphy. For instance, [b] optionally surfaces as an allomorph of ∅ for the 3rd person direct object person suffix after vowel-final verb stems, which seems to reflect an emergent preference for a syllable onset (Mascaró 2007). In contexts where the optional [b] does not surface, or where no object is present, forms with three identical vowels such as [n̩ka-aa-mauŋ] 'they carry' are possible. Baava Pirung speakers produce the form as [n̩kaamauŋ], with vowel deletion, and South Naasioi speakers produce it with an epenthetic glottal stop breaking up the sequence: [n̩kaaʔamauŋ].

An analysis can be entertained whereby any derived sequences of identical vowels undergo fusion, forming a single syllable (Poser 1985). This appears to be the case for many morphologically derived long vowels in Naasioi. Under the mora-only approach, the prohibition outlined above would be explained as a prohibition on sequences of three moras dominating a single vocalic node. This could be nuanced, such that long vowels are created through fusion, and where the addition of an extra mora is prohibited (see Hyman's 2011: 71–73 discussion of how maximal prosodic stem shapes in Gokana could be represented). However, under this theory, the prohibition appears largely stipulative. A more straightforward explanation would interpret the prohibition as holding over two adjacent syllables (one bimoraic, one monomoraic) with identical vowels, or simply as a ban on trimoraic syllables (Prince 1990). In other words, fusion would fail in the event it would create a trimoraic syllable, and is resolved in South Naasioi by the insertion of a consonant, and in Baava Pirung by deleting the extra mora.

3.6. *Summary*

This section has presented arguments that long vowels constitute a structural unit and that they are tautosyllabic. Additional independent evidence for syllables comes in the form of segmental distributions and an onset-promoting allomorphy in the verbal morphology. Thus, there are independent pieces of evidence in Naasioi for syllable structure above and beyond the level of the mora. While there are questionable non-syllable explanations for each of these phenomena, they collectively receive a straightforward analysis with syllables.

4. Violations of syllable integrity

The results from §§2 and 3 combine to form a type of 'incoherence', where two different types of prosodic unit are referenced by different operations in the phonology. The claim advanced here is that Naasioi syllables can involve long vowels, but that syllables are ignored in the construction of feet, which is computed only over moras. The prediction is that there may be pockets in the grammar where

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the moras of a long vowel are parsed by different feet, or, more conservatively, where only one mora of a bimoraic syllable is parsed by a foot. Employing the generalisations already drawn from stress and from the allomorphy of the present progressive suffix, it will be demonstrated that such violations of syllable integrity occur in Naasioi. In cases where there is an odd number of syllables in a stem and the long form *-maaŋ* surfaces, the long vowel in this suffix will violate syllable integrity: for example, [bakíaaʔemaaŋ] 'you're stealing it' would be parsed (ba.kí)(aa)(ʔe.ma)⟨aŋ⟩.

The existence of these structures lends support to Everett's (1998) claim that syllable integrity is a violable constraint. One way of interpreting syllable integrity is not as a monolithic constraint, but rather as an epiphenomenon of the interaction of metrical constraints with alignment constraints. Given the definition in (1), syllable integrity appears to prevent syllables from extending beyond foot boundaries. In essence, it is a prohibition on syllable edges being misaligned with respect to foot edges. Generalised Alignment (McCarthy & Prince 1993a) provides the mechanisms to encode this as a violation of constraints requiring the alignment of the edges of two prosodic categories. Thus, syllable integrity can be decomposed into a series of alignment constraints, following a proposal by Kennedy (2003: 66). Importantly, the constraints must involve universal quantification over foot edges and existential quantification over syllable edges, as in (33) and (34):

(33) ALIGN(Ft, L, σ, L) (henceforth abbreviated ALIGN-L): For every left edge of a foot, there exists a left edge of a syllable

(34) ALIGN(Ft, R, σ, R) (henceforth ALIGN-R): For every right edge of a foot, there exists a right edge of a syllable

All other things being equal, ALIGN-L and ALIGN-R will each be violated when moras of a syllable are parsed into different feet: one violation for the right syllable boundary misaligned with the right edge of a foot, and the same for the left edge. While these two alignment constraints can be combined into one (as suggested by Kennedy 2003), the directional variant which will be violated each time in Naasioi is ALIGN-R. This is because final syllables with long vowels – and hence with an extrametrical final mora – will only incur a violation of ALIGN-R, and not trigger a violation of ALIGN-L. Given that the grammar can be economically modelled with ALIGN-R, it is employed in the tableaux below to illustrate how syllable integrity violations are registered. The ranking here is otherwise the same as in (18) and (19). This illustrates that along with FT-BIN, ALIGN-R favours a candidate with exhaustive binary feet, (35a) (ba.ki)(aa)(ʔe.ɾe)⟨maŋ⟩, over one with a degenerate foot plus extrametrical mora, (35b) (ba.ki)(aa)(ʔe.ɾe)(ma)⟨aŋ⟩, in cases involving allomorphy.

(35) *Even-count stems*

bakiaaʔede {maŋ, maaŋ}	NONFINALITY	PARSE-μ	FT-BIN	ALIGN-R
☞ a. (ba.ki)(aa)(ʔe.ɾe)⟨maŋ⟩		*		
b. (ba.ki)(aa)(ʔe.ɾe)(ma)⟨aŋ⟩		*	*!	*
c. (ba.ki)(aa)(ʔe.ɾe)(maaŋ)	*!			
d. (ba.ki)(aa)(ʔe.ɾe)⟨maaŋ⟩		**!		

(36) *Odd-count stems*

bakiaaʔe {maŋ, maaŋ}	NONFINALITY	PARSE-μ	FT-BIN	ALIGN-R
☞ a. (ba.ki)(aa)(ʔe.ma)⟨aŋ⟩		*		*
b. (ba.ki)(aa)(ʔe.)⟨maaŋ⟩		**!	*	
c. (ba.ki)(aa)(ʔe.ma)(aŋ)	*!		*	*
d. (ba.ki)(aa)(ʔe.maaŋ)	*!		*	
e. (ba.ki)(aa)(ʔe.maŋ)	*!			

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In (36), the winning candidate (36a) violates syllable integrity because one half of the long vowel is parsed into a foot, while the other half is left extrametrical. In this case, the second half of the syllable is forced to be unparsed by virtue of being at the right edge of the word. It is, of course, possible that long vowels within words are also susceptible to syllable integrity violations, precisely when long vowels are in a position where they must be parsed by different feet. The example in (37) illustrates this, using the present progressive suffix to illustrate the additional right-edge violation:

(37) (taβé)(ema)⟨aŋ⟩
ta-β-ée-maaŋ
hit-3PL-RECP-PRS.PROG
'They are hitting one another.' (HH: 54)

Thus, syllable integrity violations are not restricted to the right edge, and forced only by NONFINALITY; they can occur throughout the Naasioi word. This can be seen in roots with long vowels in contexts where the footing would demand that each mora in a long vowel be parsed by a separate foot, such as the cases in (7); for example, (7c) [kemáaki] 'yesterday' would have the metrical structure (kemá)(a)⟨ki⟩. Returning to the alternative analysis involving trochaic feet and initial extrametricality sketched above, it becomes clear that the exact same set of parsing problems remain; that is, forms with initial long vowels must have their syllables split – one extrametrical, one footed. The analysis of the allomorphy with the present progressive suffix would remain unaltered, as it still presumably fluctuates in order to optimise the footing of the entire word (and not simply in response to the metrical structure at the right edge of the word). Otherwise, extrametricality and coerced initial syllable stress in disyllabic forms would apply as described above. The equivalence of the two approaches can be seen by comparing the structure of (36a) with its counterpart in the trochaic analysis, in which the word-medial long vowel would be split across two feet: ⟨ba⟩(kía)(aʔe)(maaŋ).

The conclusion to be drawn from this illustration, following Everett (1998), is that syllable integrity is a violable constraint of grammar, encoded here as constraints on foot and syllable alignment. What is important to note is that there is nothing special which forces a syllable integrity violation. All that is required is for FOOT-BINARITY to count moras (Prince & Smolensky 1993; Kager 2007), and for NONFINALITY to dominate PARSE-μ. Assuming that there is an independent level of representation which defines syllables, there is actually nothing more that is needed in the theoretical machinery in order to derive this state of affairs. What is required for the analysis is that FT-BIN must be dominated by PARSE-μ in order to achieve degenerate feet. However, the only thing that can coerce a degenerate foot is the threat of a NONFINALITY violation, meaning degenerate feet will only surface when there is no other possible metrification to rescue a stray mora. In fact, the theory might have *predicted* syllable integrity violations, given that a constraint like FT-BIN can prefer either syllabic or moraic binarity, and that prosodic category edges can be misaligned. In this way, syllable integrity violations are actually predicted by the basic ingredients of alignment and metrical theories.

The larger metrical or representational conclusion that can be drawn is that languages may allow feet to be calculated over moras, ignoring the role of syllable structure. This calls into question the universality of the syllable as the stress-bearing unit (Hayes 1995), though the claim that moras can be stress-bearing units has been made generally by Halle & Vergnaud (1987), and specifically with respect to cases of syllable integrity violations by Buller *et al.* (1993), Everett (1998), Cairns (2002), Cairns & Raimy (2009) and Kager & Martínez-Paricio (2019).

The relevant question to pose now is, What are the consequences of allowing grammars to violate syllable integrity? One is and Hyde's (2007) objection regarding multiple stresses on a single syllable. However, this objection is not relevant in Naasioi, as the constraints on syllable structure (which is maximally bimoraic) and foot structure (feet being maximally binary) would prevent any given syllable from having more than one stress, even setting aside the fact that word stress will culminate on only a single mora. NONFINALITY must be respected, even if this is at the expense of a foot well-formedness constraint that demands that feet have a right-prominent syllable, such as IAMB. In addition, PARSE-μ must be violated because of the demands of NONFINALITY, but this violation must be minimal: if extra

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moras are left unparsed (in an uneconomical fashion), this would defeat the force of the allomorphy. The end result is that syllable integrity violations emerge in longer forms when FT-BIN and NONFINALITY are both respected, and when a single mora is left unparsed. This means that syllable integrity violations will be minimal, and will be due to satisfaction of NONFINALITY and FT-BIN. These points are related to the other objection, that syllable integrity violations allow a tautosyllabic contrast in stress between v́v and vv́. Technically, no such contrast will ever surface in Naasioi, because stress is based entirely on position, and is predictable from the configuration of moras in a word. However, the prediction that both v́v and vv́ should be possible is in fact borne out when we look at long vowels in different positions, as in (6) and (7).

The theoretical problems raised by syllable integrity violations are most clearly evident in the constraints that are presumed to hold over the Prosodic Hierarchy. For instance, the most immediate problem is faced by the Strict Layering Hypothesis (Selkirk 1984). Strict layering demands that each layer of the hierarchy organise the layer below, and in this case, it is assumed that feet would organise syllables, and not skip a layer to organise moras. Thus, the syllable integrity violations outlined above appear to undermine certain principles thought to govern the prosodic hierarchy, as is also pointed out by Cairns (2002), Kennedy (2003) and Cairns & Raimy (2009), which still rely on the hard constraint of mora confinement (such that moras must be dominated by syllables). Weak Layering allows for non-exhaustive parsing at edges; however, in the current case study, the moras in question are not located at the periphery of the overall structure. Instead, it is an entire layer in the hierarchy which is systematically ignored by the level above. This is not an entirely novel state of affairs: a precedent exists in the metrical structure of Mohawk, where feet will ignore syllables (sometimes creating trisyllabic feet) if these syllables are weightless, as stress computes over moraic trochees (Piggott 1995). The effects associated with strict layering are normally encoded as a constraint on exhaustive parsing, which has been demonstrated to be violable (Selkirk 1996). As Kager & Martínez-Paricio (2019) claim, EXHAUSTIVITY (which under their definition prohibits the direct parsing of moras to feet) is violated in specific contexts in some languages. The case presented here is consistent with this notion of EXHAUSTIVITY being violated, specifically by metrical and parsing constraints. The end result could be a representation where moras dominate syllables (Kennedy 2003), or where a portion of the prosodic hierarchy is three-dimensional, with the syllable layer and the mora layer existing in parallel but not interacting with each other (Cairns 2002; Cairns & Raimy 2009). The more likely solution, sketched above, lies in the nature of constraint interaction, rather than in the representations themselves. In any case, what obtains is a state of affairs whereby an intermediate level in the prosodic hierarchy is systematically ignored for the purposes of one process (stress assignment, foot construction), but available for others (truncation, shortening).

5. Conclusion

The broad claim of this article has been that the metrical structure of Naasioi is built around bimoraic feet. The primary evidence for this is in the stress pattern of the language, and is supported by an allomorphy found with the present progressive suffix. Mora and syllable are not, however, co-extensive in the language. Evidence from reduplication and from hypocoristic formation indicates that long vowels are not only bimoraic, but tautosyllabic, and the distributions of consonants, an onset-promoting allomorphy, and restrictions on vowel sequences lend additional support to the claim that syllables are present in the language. Allomorphy in certain tense/aspect morphemes results in odd numbers of moras altogether, which suggests that the final mora is extrametrical, a conclusion supported by the stress patterns. An extrametrical mora is not in itself problematic; however, this is unexpected if moras do not coincide with syllables, because this would violate syllable integrity (Hayes 1995). The problem for syllable integrity is much more pervasive, though, as there are long vowels which can be parsed across different feet in potentially any position within the word.

While syllable integrity is often taken to be an inviolable constraint in grammar, recent research has suggested it may be violable in some languages. While the consequences of allowing syllable integrity

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to be freely violated can be severe in theoretical terms, these consequences are mitigated in Naasioi by the fact that a syllable can consist of maximally two moras. The end result is that while coercion can force syllables to be split, they will only be split into two, meaning the violation will be due to the satisfaction of higher-ranked constraints (Ft-Bin and Nonfinality), and will always be minimal. How other languages manage these types of violations remains an area for future research.

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