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*The binarity effect in Kosraean reduplication**

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This paper offers a formal analysis of prefixing and suffixing reduplication in Kosraean. The prosodic shape of each affix is sensitive to the form of the stem, giving rise to multiple prosodic variants. In particular, its prefix illustrates the binarity effect, in which the reduplicant is binary if and only if the base is binary. Curiously, the suffix is not subject to the same generalisation, but still follows from the same formal analysis. Both affixes also show additional curious effects of vowel-initial stems. Using an optimality-theoretic approach, I will show that the prosody of both affixes is a function of the prosodic structure of the whole word rather than of a requirement that the affix fill a specified prosodic template. The analysis makes the binarity effect an example of a contextually weight-sensitive language, in which closed syllables are bimoraic only under certain morphological circumstances.

1 Introduction

This paper offers an account of the reduplicative system of Kosraean (Lee 1975), a Micronesian language spoken on the island of Kosrae, in the Eastern Caroline Islands.[1] Kosraean uses both prefixing and suffixing reduplication, for different morphological functions. Its prefix illustrates a phenomenon which I refer to as the BINARITY EFFECT, in which the reduplicant is binary if and only if the base is binary. The binarity effect is manifest in the appearance of a coda consonant in the prefix only where the base has two syllables, as in [**fur**-furok] 'to turn again and again' *vs.* [**fo**-foʃ] 'to emit smoke'. In addition, the suffix is not subject to the same generalisation, but still follows from the same formal analysis.

This pattern sheds new light on the Prosodic Morphology hypothesis (McCarthy & Prince 1986) and Generalised Template Theory (McCarthy

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[1] Kosraean is also known as Kusaiean, the name used in Lee (1975, 1976). I adopt Kosraean as the name of the language, following Good (1989), Rehg (1991, 1993) and Bender *et al*. (2003). Note that orthographic *sr* represents [ʃ].

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& Prince 1999). On the one hand, the shape of each reduplicative morpheme is closely linked to the prosodic structure of the language, but on the other, a formal analysis cannot rely on a templatic operation or constraints. In addition, the system offers an example of contextual weight-sensitivity.

Research on the phonological structure of reduplicative affixes shows a tendency for reduplication to produce affixes that fit independently motivated prosodic categories such as syllables and feet (Moravcsik 1978, Suzuki 1984, Williams 1984, McCarthy & Prince 1986, Steriade 1988). This has motivated analytical accounts such as the prosodic template (McCarthy & Prince 1986), in which the reduplicant is underlyingly a prosodic element, and the templatic operation, in which a rule or constraint requires an underlyingly empty reduplicant to associate to a prosodic element. Analyses of reduplication that use a templatic morpheme include Hayes & Abad (1989), Mutaka & Hyman (1990), Janda & Joseph (1991), Peng (1991), Blain (1992), Stevens (1994) and Wee (1995). Research that applies a templatic constraint to reduplication within an optimality-theoretic approach includes McCarthy & Prince (1993b), Blevins (1996), Meyerhoff & Reynolds (1996), Thurgood (1997), Downing (1998, 2000), Kager (1999), Kenstowicz & Banksira (1999), Crowhurst & Hewitt (2000) and Fitzgerald (2000). Crowhurst (2004) maps reduplicants to prosodic elements with alignment constraints rather than with constraints requiring templatic satisfaction.

Advancements in the optimality-theoretic approach to prosodic morphology suggest that apparent templatic effects in reduplication can be attributed to general constraints of morphological alignment rather than constraints specific to reduplicative morphemes (Urbanczyk 1996, 1999, Carlson 1997, Spaelti 1997, Gafos 1998, Alderete *et al*. 1999, Hendricks 1999, 2001, McCarthy & Prince 1999, Ussishkin 1999, 2000, Walker 2000, Yip 2001, Kennedy 2002, Nelson 2003). These analyses characterise the relationship between reduplication and prosodic elements as an example of the emergence of unmarked prosody.

This paper uses a non-templatic approach to the Kosraean system, in which the prosodic structure of the reduplicant is sensitive to the prosodic structure of the base. In §2, I describe the reduplicative paradigm in detail, and in §3 I introduce some background on Kosraean syllable structure. §4 provides an analysis using an optimality-theoretic approach. §5 discusses implications of the system, and addresses a variant subpattern in which the binarity effect is not observed.

2 Kosraean reduplication

In this section, I describe the Kosraean reduplicative system, which uses two distinct reduplicative morphemes: a prefix, as in [**fur**-furok] and [**fo**-foʃ], and a suffix, as in [mutul-**tul**] 'to blink' and [mɨsɛ-**sɛ**] 'frayed'. I call the prefix the iterative and the suffix the denotative, both after

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Harrison (1973). All Kosraean data in this paper are from Lee's reference grammar (1975) or dictionary (1976).

The prefix/suffix distinction handles a formative contrast among monosyllabic roots: CVC reduplicates with an initial CV, as in [**fo**-foʃ], or totally, as in [pʌk-**pʌk**] 'sandy'. The generalisation is that the former are prefixed and the latter are suffixed.

This section provides examples of the prefix and suffix patterns. I first show how consonant-initial forms are prefixed and suffixed. I then exemplify the reduplication of vowel-initial monosyllables, followed by vowel-initial polysyllables.

I provide additional examples of each subpattern of the prefix in (1): initial reduplication adds a CV string to monosyllabic bases (1a), and to disyllabic bases with vowels that are adjacent (1b) or separated by a glide (1c). Other disyllabic bases receive a CVC prefix (1d).[2]

(1) *Initial reduplication*

a.	fosr	[foʃ]	'smoke'
	fofosr	[**fo**-foʃ]	'to emit smoke'
	kahl	[kæl]	'to touch'
	kahkahl	[**kæ**-kæl]	'to touch repeatedly'
	long	[loŋ]	'to step'
	lolong	[**lo**-loŋ]	'to step repeatedly'
	srihng	[ʃɨŋ]	'itch'
	srihsrihng	[**ʃɨ**-ʃɨŋ]	'(to etch a) tattoo'
	srihk	[ʃɨk]	'small'
	srihsrihk	[**ʃɨ**-ʃɨk]	'very small'
b.	moul	[moul]	'alive'
	momoul	[**mo**-moul]	'not completely dead'
	foul	[foul]	'smell'
	fofoul	[**fo**-foul]	'to emit smell'
c.	fiyoh	[fijɔ]	'to sweat'
	fifiyoh	[**fi**-fijɔ]	'sweating'
	fiyac	[fijɛ]	'grey hair'
	fifiyac	[**fi**-fijɛ]	'to turn grey'

[2] Data are presented as follows: forms in tables are cited in Kosraean orthography as they appear in Lee (1975, 1976). The forms in (1)–(6) are taken from Lee (1975: 32–33, 216–224) and from Lee (1976). An additional phonetic representation is provided, based on Lee (1975: 4–5) and Bender *et al*. (2003), to avoid confusion introduced by digraphic representations. Digraphs are represented as follows: *ac* = [ɛ], *ng* = [ŋ], *ah* = [æ], *sr* = [ʃ], *ih* = [ɨ], *oh* = [ɔ] and *uh* = [ʌ]. I use this representation in the text; for example, [pʌʃæk] rather than *puhsrahk*. Syllable boundaries are included in the phonetic transcription, following Lee's generalisations; particularly, CC → C.C (1975: 29–30). Deviations from the Onset Maximisation Principle (Pulgram 1970: 47–48, Hooper 1972: 534, Vennemann 1972: 7–8) are noted where relevant.

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d. tahfong	[tæfoŋ]	‘to mistake’
tahftahfong	[**tæf**-tæfoŋ]	‘to make lots of mistakes’
furok	[furok]	‘to turn’
furfurok	[**fur**-furok]	‘to turn little by little’
fule	[fule]	‘to wring’
fulfule	[**ful**-fule]	‘to twist little by little’
mihsac	[mɨsɛ]	‘to be frayed’
mihsmihsac	[**mɨs**-mɨsɛ]	‘being frayed’
kihpat	[kɨpat]	‘to break’
kihpkihpat	[**kɨp**-kɨpat]	‘breaking’
puhsrahk	[pʌʃæk]	‘to slop’
puhsrpuhrsahk	[**pʌʃ**-pʌʃæk]	‘slopping’

(2) shows examples of suffixed forms. All forms here receive either a CV or CVC suffix, depending on whether the base has a final vowel or consonant. Note that I include CV roots here; we will see that reduplicating these produces CVCV regardless of whether we consider them to be prefixed or suffixed.

(2) *Final reduplication*

lahs	[læs]	‘coral’
lahslahs	[læs-**læs**]	‘lots of coral’
puhk	[pʌk]	‘sand’
puhkpuhk	[pʌk-**pʌk**]	‘sandy’
yot	[jot]	‘stone’
yotyot	[jot-**jot**]	‘lots of stones’
srihng	[ʃɨŋ]	‘itch’
srihngsrihng	[ʃɨŋ-**ʃɨŋ**]	‘to cut’
srihk	[ʃɨk]	‘small’
srihksrihk	[ʃɨk-**ʃɨk**]	‘delicate, selective’
fa	[fa]	‘fern’
fafa	[fa-**fa**]	‘covered with ferns’
nu	[nu]	‘coconut’
nunu	[nu-**nu**]	‘lots of coconuts’
sra	[ʃa]	‘leaf’
srasra	[ʃa-**ʃa**]	‘lots of leaves’
sranom	[ʃanom]	‘juice’
sranomnom	[ʃanom-**nom**]	‘juicy’
mutul	[mutul]	‘to blink’
mutultul	[mutul-**tul**]	‘to blink’
kihpat	[kɨpat]	‘to break’
kihpatpat	[kɨpat-**pat**]	‘broken’

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suwohs	[suwɔs]	'straight'
suwohswohs	[suwɔs-**wɔs**]	'strict, inflexible'
puhsrahk	[pʌʃæk]	'to slop'
puhsrahksrahk	[pʌʃæk-**ʃæk**]	'sloppy'
fiyoh	[fijɔ]	'to sweat'
fiyohjoh	[fijɔ-**jɔ**]	'sweaty'
fiyac	[fijɛ]	'grey hair'
fiyacyac	[fijɛ-**jɛ**]	'grey-haired'
mihsac	[mɨsɛ]	'to be frayed'
mihsacsac	[mɨsɛ-**sɛ**]	'frayed'

The claim that there are two distinct reduplicative affixes in Kosraean is also supported by roots that are attested with either affix, as seen in pairs like [**kɨp**-kɨpat] 'breaking' ~ [kɨpat-**pat**] 'broken', [**mɨs**-mɨsɛ] 'being frayed' ~ [mɨsɛ-**sɛ**] 'frayed' and [**pʌʃ**-pʌʃæk] 'slopping' ~ [pʌʃæk-**ʃæk**] 'sloppy' (Lee 1975: 221). Examples of monosyllables going either way are rare but still attested: [**ʃɨ**-ʃɨŋ] 'tattoo' ~ [ʃɨŋ-**ʃɨŋ**] 'slap' and [**ʃɨ**-ʃɨk] 'very small' ~ [ʃɨk-**ʃɨk**] 'delicate, selective'.

Similar phonological generalisations also apply to vowel-initial roots. Like consonant-initial monosyllables, vowel-initial monosyllables are split into two groups: they either reduplicate fully, as in [ek-ek] 'to rub repeatedly', or with an intrusive glide, as in [af-jaf] 'rainy'. This distinction is not predictable from the segmental content of the base, since there are homophonous pairs like [ek] 'change' and [ek] 'rub', which reduplicate as [ekjek] and [ekek] respectively. The prefix/suffix distinction allows us to generalise that the glide appears only in suffixed forms. I provide more examples of reduplicated vowel-initial forms in (3).

(3) *Reduplication of vowel-initial monosyllables*

a. ek	[ek]	'to rub'
ekek	[**ek**-ek]	'to rub repeatedly'
el	[el]	'to turn'
elel	[**el**-el]	'to look around'
acsr	[ɛʃ]	'current of water'
acsracsr	[**ɛʃ**-ɛʃ]	'flowing'
il	[il]	'to grind, grate'
ilil	[**il**-il]	'to grind, rub (INTRANS)'
ing	[iŋ]	'to hurry'
inging	[**iŋ**-iŋ]	'to scurry, bustle'
ip	[ip]	'piece'
ipip	[**ip**-ip]	'in pieces'
ir	[ir]	'out of place'
irir	[**ir**-ir]	'twisted, warped'
ol	[ol]	'hole, pore'
olol	[**ol**-ol]	'lots of holes'

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on	[on]	'to sing'
onon	[**on**-on]	'to keep on singing'
uk	[uk]	'to blow'
ukuk	[**uk**-uk]	'to blow (INTRANS)'
b. af	[af]	'rain'
afyaf	[af-**jaf**]	'rainy'
ef	[ef]	'to fade'
efyef	[ef-**jef**]	'faded'
ek	[ek]	'to change'
ekyek	[ek-**jek**]	'to keep on changing'
eng	[eŋ]	'wind'
engyeng	[eŋ-**jeŋ**]	'windy'

In polysyllabic vowel-initial roots, we see prefixation of a VC element,[3] which Lee (1975: 218–219) describes as syllabified by itself.[4] Examples are provided in (4); I place syllable boundaries only in the first four forms, as these are the only ones Lee's grammar discusses. The remainder of forms are from Lee's dictionary.

(4) *Prefixed vowel-initial disyllables*

ipihs	[ipɨs]	'to roll'
ipipihs	[**ip**.i.pɨs]	'to roll bit by bit'
olang	[olaŋ]	'to open'
ololang	[**ol**.o.laŋ]	'to open again and again'
ewuh	[ewʌ]	'to lift'
ewewuh	[**ew**.e.wʌ]	'to lift little by little'
usri	[uʃi]	'to sprinkle'
usrusri	[**uʃ**.u.ʃi]	'to sprinkle off and on'
ahlko	[ælko]	'blood vessel'
ahlahlko	[**æl**-ælko]	'heavily veined'
ahngon	[æŋon]	'to bother, poke'
ahngahngon	[**æŋ**-æŋon]	'to bother or disturb continually'
ikihl	[ikɨl]	'to rock, roll'
ikikihl	[**ik**-ikɨl]	'to rotate'
imihs	[imɨs]	'to drag along'
imimihs	[**im**-imɨs]	'to drag (INTRANS)'

[3] The fact that such forms do not have an intrusive glide is consistent with the generalisation that vowel-initial monosyllables receive an intrusive glide only when suffixed. One exception to this pattern is *alyalu* 'have overriding beliefs based in traditional values', which appears to be derived from *alu* 'ceremony, rite'.

[4] Lee does not transcribe glottal stops for medial onsetless syllables, but the presence of them would not disrupt the analysis in §4.

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isong	[isoŋ]	'to stick in, cram'
isisong	[**is**-isoŋ]	'to push in gradually'
isracsr	[iʃɛʃ]	'to laugh'
isrisracsr	[**iʃ**-iʃɛʃ]	'to laugh continuously'
utuhk	[utʌk]	'to carry'
utututhk	[**ut**-utʌk]	'to carry around'

Vowel-initial polysyllables receive suffixes in a manner parallel to those of consonant-initial polysyllables. That is, they receive a CVC or CV suffix, depending on whether the base has a final consonant. All examples in (5) are from Lee (1976).

(5) *Suffixed vowel-initial disyllables*

ahlong	[æloŋ]	'tide'
ahlonglong	[æloŋ-**loŋ**]	'low tide'
eka	[eka]	'coral'
ekaka	[eka-**ka**]	'having much coral'
erar	[erar]	'rattling sound'
erarrar	[erar-**rar**]	'to shake, rattle'
inut	[inut]	'god, spirit'
inutnut	[inut-**nut**]	'magic'
okah	[okæ]	'root'
okahkah	[okæ-**kæ**]	'rooty'
orahk	[oræk]	'to crawl, creep'
orahkrahk	[oræk-**ræk**]	'to crawl around'
osak	[osak]	'to limp, hop'
osaksak	[osak-**sak**]	'moving with a limp'

A last trait to acknowledge is a variable subpattern that affects only the prefix of polysyllables (1975: 218–219). In the variant pattern, disyllables reduplicate with a light syllable, yielding forms like [**e**-ema] and [**fu**-furok]. I return to this variable pattern in §5, at which point it will be clear that only a small adjustment is required to handle forms such as these.

3 Kosraean syllable structure

In this section, I describe several phonological properties of Kosraean in detail, particularly its tolerance of coda consonants, its lack of contrastive vowel length and its stress pattern. Each of these bears relevance to the analysis developed in §4.

Kosraean allows medial syllables to be closed by any single consonant of its inventory, but only in derived forms. This is observed in reduplicated

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forms like [**ful**-fule] 'to twist little by little', [**kɨp**-kɨpat] 'to fall gradually' and [**tæf**-tæfoŋ] 'to make lots of mistakes', and in other morphologically complex forms like [top.kɛ.kɨn] 'to turn over' and [æk.fo.ko] 'to make strong'. I provide more forms with medial codas in (6).

(6) *Kosraean coda consonants*

katkat	[kat.kat]	'a bird'
puhkpuhk	[pʌk.pʌk]	'sandy'
lahsrkahkihn	[læʃ.kæ.kɨn]	'to pour out'
topkackihn	[top.kɛ.kɨn]	'to turn over'
loksahki	[lok.sæ.ki]	'to stifle'
lihpacrongrong	[lɨ.pɛ.roŋ.roŋ]	'sounds of waves'
ahkfoko	[æk.fo.ko]	'to make strong'
ahkmihnini	[æk.mɨ.ni.ni]	'to make thin'
ngalngalis	[ŋal.ŋa.lis]	'RED+to bite'
emema	[em.e.ma]	'RED+to taste'

There is additional evidence for a Kosraean tolerance of coda consonants in a truncation pattern that affects derived verbs. I provide examples in (7); the truncation pattern has the effect of reducing suffixed polysyllables to two syllables.

(7) *Verbal truncation for suffixed polysyllables*

a. suhnakuhnuhl → saknal 'to respect him'
[sʌnak$_{RT}$+ʌn$_{TRANS}$+ʌl$_{3OBJ}$] [sak.nal]

b. lihpackuhnuhl → luhpnguhl 'to hurl him'
[lɨpɛk$_{RT}$+ʌn$_{TRANS}$+ʌl$_{3OBJ}$] [lʌp.ŋʌl]

Kosraean vowel length is not contrastive; Lee (1975: 16–17, 30–31) shows that vowel length is predictable.[5] Because of this, I follow Good

[5] Lee (1975: 16) gives one minimal pair, but also summarises the predictability of vowel length (1975: 30–31). The minimal pair is distinguished by the length of the vowel [i] in the first syllable: 'when the two words *sifac* 'its head' and *sifac* 'a fish' are compared, we notice that the first vowel of the word *sifac* 'a fish' is longer than that of the first vowel of the word *sifac* 'its head'' (1975: 16; note that *ac* represents [ɛ]). A second generalisation is that 'low vowels always occur long' (1975: 16). Lee later expands on the distribution of long and short vowels: 'monosyllable words always contain a long vowel. In two-syllable words, the vowel in the first syllable can be short, but not the vowel in the second syllable' (1975: 30). This seems to be the default situation, and all exceptions to it (long vowels in the initial syllable and short vowels in non-initial syllables) are principled.

The conditions under which long vowels may occur in initial syllables are evident from the transcriptions in Lee's description of the Kosraean sound system (1975: 7–39), which are notated for vowel length. These indicate that an initial vowel in a polysyllabic form can only be long if it is low or occurs in a prefix (or both); this includes reduplicated forms like *ipip* [iːpiːp] 'lots of parts'. Crucially, Bender *et al.* (2003: 21) transcribe *sifac* 'a fish' (a member of the above minimal pair) as (*sii*)-*fɛ*; presenting it as a morphologically complex form.

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(1989) and Rehg (1993) in assuming that all Kosraean vowels are phonologically monomoraic. Consequently, the representations in this paper are not notated for vowel length.

Lee (1975: 33) describes Kosraean stress assignment as follows: primary stress occurs on the penultimate syllable, with secondary stress on the antepenult in three-syllable forms. The placement of primary stress is important for the analysis in §4, as it is crucial to prevent the final syllable from being parsed as a bimoraic foot. This is achieved with the constraint NON-FINALITY (NON-FIN; Prince & Smolensky 1993, Hayes 1995), defined in (8).

(8) NON-FIN
Word-final syllables do not bear stress.

Whether a syllable is closed has no bearing on the placement of stress. For example, forms like [mɨsɛ-sɛ] and [mutul-tul] will have similar stress assignment: [mɨsɛ́-sɛ] and [mùtúl-tul], despite open syllables in the former and closed syllables in the latter. This suggests that Kosraean coda consonants do not contribute to syllable weight. In fact, I argue in §4 that coda consonants are moraic only in prefixed reduplicants. Non-moraic coda consonants violate WEIGHT-BY-POSITION (WT-BY-POS; Hayes 1989), as defined in (9).

(9) WT-BY-POS
Every coda consonant is associated to a mora.

The non-moraic status of coda consonants follows from the higher ranking of constraints like NON-FIN[6] and FOOTBINARITY (FTBIN; McCarthy & Prince 1986, Prince & Smolensky 1993), as defined in (10). This formalisation of FTBIN specifies the moraic level of analysis.

(10) FTBIN
Feet are bimoraic.

NON-FIN and FTBIN correctly predict that disyllables are always bimoraic, with penultimate stress, regardless of the presence of coda consonants. For example, NON-FIN forces [mɨ.sɛ], [mu.tul] and [æl.ko] to have stressed initial syllables, and FTBIN prevents their coda consonants from being moraic. Of these constraints, only NON-FIN is undominated;

The conditions under which short vowels may occur in non-initial syllables are stated directly: 'in a complex word which has a prefix … a short vowel can occur in the second syllable' (Lee 1975: 31).

Initial vowels in polysyllables are therefore long if (a) they are low or (b) they are in a prefix. Non-initial vowels may be short only if they are root-initial. Even with this complication, length remains entirely predictable.

[6] An anonymous reviewer suggests dropping NON-FIN in favour of an alternative in which the non-moraic nature of coda consonants is attributed directly to a constraint *MORAICC. However, there are aspects of the analysis in §4 that will independently require NON-FIN.

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FtBin is violated in some three-syllable forms, but is still active in the reduplicative system, as the analysis in the following section illustrates.

4 Analysis

In this section I provide an analysis of both reduplicative affixes in Kosraean. §§4.1 and 4.2 handle the prefix and suffix respectively for consonant-initial roots. Vowel-initial roots are treated in §§4.3 and 4.4.

4.1 Analysis: consonant-initial iteratives

For the iteratives of consonant-initial roots, there are three subpatterns: the CV prefix of monosyllables, as in [**fo**-foʃ], the CV prefix of hiatic roots, as in [**fu**-fuon], and the CVC prefix of other disyllables, as in [**fur**-furok] and [**ful**-fule]. The variant pattern, which renders the prefixes of polysyllables as (C)V, is addressed in §5.

The quantity of the prefix responds to the quantity of the root, since longer roots create longer prefixes. Because of the contrast in shape between open prefixes like [fo-] and closed ones like [fur-], I propose that codas in CVC reduplicative prefixes are moraic. Analysing stem-final consonants as non-moraic, in violation of Wt-by-Pos, the generalisation is that monomoraic roots like [foʃ] receive monomoraic prefixes, while bimoraic roots like [furok] receive bimoraic prefixes. This is an instantiation of the binarity effect: the prefix is binary if and only if the root is binary.

The analysis at its core will use foot structure to account for the emergence of the binarity effect in the Kosraean prefix. Wherever the base is bimoraic, it is footed by itself, and the prefix then receives its own foot. Wherever the base is monomoraic, it shares a foot with the prefix. The prefixing pattern is thus modelled as an emergence of FtBin.

Treating monosyllables first, the constraints presented in §3 predict an open-syllable prefix. There are several possible prosodic representations of *[**foʃ**-foʃ], but none can emerge over [**fo**-foʃ]. For example, if *[**foʃ**-foʃ] has a bimoraic prefix and a monomoraic base, FtBin is violated. If both the prefix and base are monomoraic, too many violations of Wt-by-Pos result. Last, if the prefix and base comprise separate bimoraic feet, a violation of Non-fin is incurred, since stress would occur on both syllables. The ranking thus chooses the less faithful [**fó**-foʃ] over all possible structures for *[**foʃ**-foʃ], as summarised in the tableau in (12). Note that Non-fin, FtBin and Wt-by-Pos must outrank Max-BR, as defined in (11), to ensure that the less faithful form emerges.

(11) Max-BR

Every segment in the base has a correspondent in the reduplicant.

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(12)

foʃ+ITER	NON-FIN	FTBIN	WT-BY-POS	MAX-BR
a. μμ μμ | | | | (**foʃ**)(foʃ)	*!			
b. μμ μ | | | (**foʃ**-foʃ)		*!	*	
c. μ μ | | (**foʃ**-foʃ)			**!	
☞ d. μ μ | | (**fo**-foʃ)			*	*
e. μ μ μ | | | (**fo**)(**ʃi**-foʃ)		*!		

The representation of *[**foʃ**-foʃ] in which both codas are moraic could also be eliminated with a constraint *MORAICC instead of with NON-FIN. In this case, *MORAICC would have to be ranked above WT-BY-POS. However, the next step in the analysis shows that the *MORAICC approach is inadequate, because disyllabic bases like [furok] crucially require NON-FIN.

The iterative form of the disyllabic root [furok] also motivates the addition of a size-restricting constraint to the hierarchy. FTBIN ensures that the prefix is bimoraic, but will not choose between the disyllable prefix of *[**furo**-furok] and the optimal [**fur**-furok]. To prevent the disyllabic prefix from emerging, I use the prosodic-alignment constraint ALL-*σ*-RIGHT (ALL-*σ*-R), defined in (13), as a size restrictor, following Spaelti (1997), Walker (1998) and Kennedy (2002). ALL-*σ*-R has an emergent effect in the prefix by preferring a monosyllabic prefix like [fur-] over a disyllabic one like *[furo-].

(13) ALL-*σ*-R
All syllables are final.

Ussishkin (2000), Kager (2001) and McCarthy (2003) offer alternatives to the use of prosodic alignment as a means of size restriction. Though formally distinct, these approaches share with this account the penalisation of syllable structure; as such, any of them could replace ALL-*σ*-R here without disrupting the core of the analysis.

The role of ALL-*σ*-R is shown in (14); it rules out the disyllabic prefix of *[**furo**-furok]. Meanwhile, FTBIN rules out the monomoraic prefix in (14b) [**fu**-furok]; the fact that this is an optional variant is addressed in §5. FTBIN also rules out (14c) [**fur**-furok], which has a non-moraic consonant

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in the prefix. Although there is no evidence yet for the ranking of ALL-σ-R, we will see that it must be above FTBIN.[7]

(14)

furok+ITER	NON-FIN	ALL-σ-R	FTBIN	WT-BY-POS
a. μ μ μ μ (**fu**.**ro**)(fu.rok)		***!		*
b. μ μ μ (**fu**)(fu.rok)		**	*!	*
c. μ μ μ (**fur**)(fu.rok)		**	*!	**
☞ d. μμ μ μ (**fur**)(fu.rok)		**		*
e. μ μ μμ (**fu**-fu)(rok)	*!	**		

Tableau (14) also shows the importance of including NON-FIN in the analysis; without it, (14e) would be a problematic candidate. The alternative of using *MORAICC instead of NON-FIN to limit consonant moraicity fails here, because it cannot distinguish (14d) from (14e), both of which incur a single violation. In contrast, the footing of the final syllable in (14e) forces stress to occur on the final syllable, in violation of NON-FIN.

Most disyllables receive iterative prefixes in the same way; for example, the hierarchy predicts [**ful**-fule] in a manner parallel to [**fur**-furok]. However, disyllabic roots with adjacent vowels do not receive bimoraic prefixes. For example, [moul] is [**mo**-moul] in the iterative, not *[**mou**-moul]. This effect follows if we maintain a ranking of ALL-σ-R over FTBIN, which is illustrated in (15).[8]

(15)

moul+ITER	ALL-σ-R	FTBIN	WT-BY-POS
a. μ μ μ μ (**mo**.**u**)(mo.ul)	***!		*
☞ b. μ μ μ (**mo**)(mo.ul)	**	*	*

It should be clear that CV roots like [sa] will be predicted to reduplicate exactly as [foʃ]; that is, by creating a CV syllable and combining it with

[7] Including ALL-σ-R in the system will not spoil the result for monosyllabic roots like [foʃ], since no competitor in tableau (12) violates it less than the actual form does.

[8] A faithfulness constraint such as IDENT-BR[cons] is also required to bar the base [u] from having a glide as its reduplicative correspondent.

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the root to create a single foot. For [sa-sa], neither FTBIN nor WT-BY-POS is violated.

The various forms of the iterative prefix thus follow from a common constraint hierarchy. Monosyllables receive CV prefixes in order to satisfy both FTBIN and WT-BY-POS. Disyllables receive CVC prefixes for the same reason, plus the additional effect of ALL-σ-R, which also applies to roots with vowels in hiatus. In the next section, I show how the analysis allows the denotative suffix not to observe the binarity effect.

4.2 Consonant-initial denotatives

With the constraint hierarchy established for the iterative prefix, it is now possible to test whether the system predicts the particular forms of the denotative suffix. There are three subpatterns to handle, repeated in (16). The suffix is CVC, as in [mutul-**tul**]and [pʌk-**pʌk**], unless the root is vowel-final, as in [mɨsɛ-**sɛ**].

(16) *Denotative subpatterns*

mutul	'to blink'	mutul-**tul**	'to blink'
pʌk	'sand'	pʌk-**pʌk**	'sandy'
mɨsɛ	'to be frayed'	mɨsɛ-**sɛ**	'frayed'

The analysis requires several more constraints to capture these patterns. The current system nearly predicts [mutul-**tul**], but a competing candidate, *[mu.tul-**tu**], has fewer violations of WT-BY-POS. I therefore introduce the ANCHOR constraint defined in (17). The form *[mu.tul-**tu**] violates ANCHOR because its outermost reduplicative segment [u] is not a correspondent of the outermost segment of the base.

(17) ANCHOR
The edgemost (outermost) segment of the reduplicant is a correspondent of the edgemost segment of the base.[9]

[9] Note that this formalisation of ANCHOR differs from standard uses, following McCarthy & Prince (1995), where its formalisation specifies right and left edges. ANCHOR here specifies only peripheral edges, thus conflating ANCHOR-L and ANCHOR-R. Its effect is equivalent to that of the constraint called ANCHORING in McCarthy & Prince (1993b), whose definition conjoins statements about prefixing and suffixing reduplicants:

(i) ANCHORING
In R + B, the initial element in R is identical to the initial element in B.
In B + R, the final element in R is identical to the final element in B.

ANCHOR (17) and ANCHORING both capture Marantz's (1982) generalisation of 'edge-in' association, while not allowing opposite-edge anchoring, in which prefixes are right-anchored or suffixes are left-anchored. See Nelson (2003) and Riggle (2003) for a discussion of opposite-edge anchoring effects.

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Another competitor, *[mu.tu.l-**ul**], also has fewer violations of WT-BY-POS, but can be ruled out because the morpheme boundary does not occur at a syllable boundary. To capture this, I use alignment (McCarthy & Prince 1993a) to require that morphemes align to syllable boundaries, as formalised in (18).

(18) ALIGN(μ, σ)
Every morpheme edge coincides with a syllable boundary.

We are not yet in a position to clarify the rank of ALIGN(μ, σ) in any more detail, but as we will see in the discussion of vowel-initial forms, it must be ranked below ANCHOR. The inclusion of ALIGN(μ, σ) will not have any undesired effects for the iterative prefix in §4.1, since the prefix and base always meet at a syllable boundary.

Tableau (19) summarises the analysis of the iterative of [mutul]. A totally reduplicated candidate like *[mutul-**mutul**], (19b), incurs one too many violations of ALL-σ-R. Three of the remaining competitors are segmentally all [mu.tul-**tul**], but have different foot structures. In one version, (19c), the suffix occurs in its own bimoraic foot, whose head violates NON-FIN. The final foot in (19d) violates FTBIN by having a medial moraic [l]. The best form is thus (19e), in which both [l] codas of the form are non-moraic, in violation of WT-BY-POS.

(19)

mutul+DENOT	NON-FIN	ANCHOR	ALL-σ-R	FTBIN	ALIGN(μ, σ)
a. $\mu\ \mu\ \mu$ (mu)(tul-**tu**)		*!	**	*	
b. $\mu\ \mu\ \ \mu\ \mu$ (mu.tul)(**mu**.**tul**)			***!		
c. $\mu\ \mu\ \ \mu\mu$ (mu.tul)(**tul**)	*!		**		
d. $\mu\ \ \mu\mu\ \ \mu$ (mu)(tul-**tul**)			**	**!	
☞ e. $\mu\ \mu\ \mu$ (mu)(tul-**tul**)			**	*	
f. $\mu\ \mu\ \mu$ (mu)(tu.l-**ul**)			**	*	*!

ANCHOR is also active in the denotative of [mɨsɛ], as tableau (20) shows. Again, full reduplication, (20a), incurs too many violations of ALL-σ-R. Another competitor is the form in (20b), *[mɨ.sɛ-**mɨs**], which maximises more of the base than the actual [mɨ.sɛ-**sɛ**], (20c), but which violates the higher-ranked constraints ANCHOR and WT-BY-POS.

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(20)

mɨsɛ+DENOT	ANCHOR	ALL-σ-R	FTBIN	WT-BY-POS	MAX-BR
a. $\mu\ \mu\quad \mu\ \mu$ (mɨ.sɛ)(**mɨ.sɛ**)		***!			
b. $\mu\ \mu\quad \mu$ (mɨ)(sɛ-**mɨs**)	*!	**	*	*	ɛ
☞ c. $\mu\ \mu\ \mu$ (mɨ)(sɛ-**sɛ**)		**	*		mɨ

The last denotative subpattern is seen in the complete reduplication of monosyllables, as in [pʌk-**pʌk**]. ALIGN(μ, σ) rules out the form *[pʌ.k-**ʌk**], while ANCHOR takes care of the competitor *[pʌk-**pʌ**], as shown by tableau (21).

(21)

pʌk+DENOT	ANCHOR	FTBIN	ALIGN(μ, σ)	WT-BY-POS
a. $\mu\quad \mu$ (pʌk-**pʌ**)	*!			*
b. $\mu\quad \mu$ (pʌ.k-**ʌk**)			*!	*
☞ c. $\mu\quad \mu$ (pʌk-**pʌk**)				**

The constraint hierarchy developed so far makes accurate predictions for the shapes of both the iterative prefix and the denotative suffix. Kosraean is subject to a tendency for bimoraicity to emerge in the reduplicative context. This structure accounts for the basic quantitative difference between the prefixes of [**fo**-foʃ] and [**fur**-furok]. This tendency is not categorical, however, as iteratives like [**fu**-fuon] show. Furthermore, though it initially looks like the suffixing pattern is not subject to FTBIN in the same way, as forms like [mutul-**tul**] and [mɨsɛ-**sɛ**] suggest, their tolerance of FTBIN violations is not a specific property of the denotative morpheme; instead, it is a consequence of constraints like ANCHOR, ALL-σ-R and ALIGN(μ, σ).

The fact that it is possible to obtain the various subpatterns using a single constraint hierarchy makes the analysis successful: the two affixes are subject to a shared set of restrictions, and their prosody is a consequence of general constraints specific to neither. However, to this point only consonant-initial roots have been considered, and the set of vowel-initial reduplicative subpatterns still needs to be incorporated into the analysis.

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4.3 Vowel-initial iteratives

There are two subpatterns of vowel-initial iteratives. Monosyllables and disyllables both have a VC prefix, but syllabify it differently: the morpheme boundary in [**o**.**n**-on] is within a syllable, whereas in [**ip**-ip**s**], the prefix is syllabified by itself (Lee 1975: 218–219). In other words, vowel-initial iteratives observe the binarity effect: monomoraic roots receive monomoraic suffixes, and bimoraic roots receive bimoraic suffixes. At issue here is the rank of ONSET, defined in (22), which [**ip**-ip**s**] violates internally, while [**o**.**n**-on] does not.

(22) ONSET
Syllables have onsets.

Ranked above ALIGN(μ, σ), ONSET predicts VC iteratives to reduplicate like [**o**.**n**-on], as tableau (23) shows. The inclusion of ONSET also does not overpredict glide insertion, as in a competitor like *[**jo**.**n**-on]. This form is poorly anchored: its outermost segment [j] is not a correspondent of anything in the base. This confirms the suggestion of §4.2 that ANCHOR outranks ALIGN(μ, σ), as ONSET ranks critically between the two.

(23)

on+ITER	ANCHOR	FTBIN	ONSET	ALIGN(μ, σ)	WT-BY-POS
a. μ μ | | (**on**.on)			**!		**
b. μ μ | | (**o**-.on)			**!		*
☞ c. μ μ | | (**o**.**n**-on)			*	*	*
d. μ μ | | (**jo**.**n**-on)	*!				

For vowel-initial disyllables like [ip**s**], the prediction of the constraint hierarchy is accurate, and illustrates the binarity effect seen in consonant-initial iteratives. Because of the high rank of ALL-σ-R, the prefix for [ip**s**] can contain at most one vowel. Moreover, because of the high rank of FTBIN, the prefix must be bimoraic, since the base is itself a foot, leaving the prefix in a foot of its own. The only option is thus to make the prefix [ip], with a moraic [p] to achieve binarity. I illustrate this in (24); an important note is that to prevent [(**i**)(**p**-ip**s**)] from emerging, ONSET ranks below FTBIN, which matches the placement of ONSET for [**o**.**n**-on] in tableau (23).

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(24)

ipɨs+ITER	ALL-σ-R	FTBIN	ONSET	ALIGN(μ, σ)	WT-BY-POS
a. $\mu\ \mu\ \mu\ \mu$ (**i**.**pɨs**)(i.pɨs)	***!		**		**
b. $\mu\ \mu\ \mu\ \mu$ (**i**.**pɨ**)(i.pɨs)	***!		**		*
c. $\mu\ \ \mu\ \mu$ (**i**)(**p**-i.pɨs)	**	*!	*	*	*
d. $\mu\ \mu\ \mu$ (**i**)(i.pɨs)	**	*!	**		*
☞ e. $\mu\mu\ \mu\ \mu$ (**ip**)(i.pɨs)	**		**		*

Vowel-initial roots thus derive iterative prefixes just like consonant-initial ones. Monosyllabic bases share a foot with a monomoraic prefix, as in [**o**.**n**-on]. For disyllables, however, the base must comprise its own foot, leaving the prefix stranded, and consequently footed by itself, as in [(**ip**).(i.pɨs)]. This is another example of the binary effect: the prefix is binary if and only if the base is binary. In the next subsection, I show how the one remaining subpattern, denotatives for vowel-initial roots, follows from the same constraint set.

4.4 Vowel-initial denotatives

We have seen that consonant-initial iteratives exhibit the binarity effect, and vowel-initial roots follow the same pattern. Vowel-initial denotatives also mirror the suffixing pattern of consonant-initial roots. Recall that I use the prefix/suffix distinction to handle the otherwise unpredictable appearance of an intrusive glide in some reduplicated VC stems. That is, all VC-VC forms are analysed as prefixed, and their form is predicted by the extended hierarchy of §4.3. In contrast, all VC-[j]-VC forms are analysed as suffixed, and I argue here that the hierarchy predicts this result.

For the denotative of [af], three competitors satisfy FTBIN; however, the lack of a glide creates a violation of ONSET (25b) or of ALIGN(μ, σ) (25c). Another competitor, [af-.**jaf**] (25a), has a moraic medial coda, creating a trimoraic foot in violation of FTBIN.

The segmentally identical optimum, [af-.**jaf**] (25d), contains a medial extrametrical coda, and thus forms a bimoraic foot. Furthermore, its intrusive glide does not violate ANCHOR: the outermost consonant of the suffix is [f], and is a correspondent of the edgemost Base [f], so the form is

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well anchored. In other words, the intrusive glide is only possible under the following conditions: it is part of the reduplicant, and it is not at the periphery. Necessarily, then, it can only occur in the suffix of VC roots, as summarised in (25).

(25)

af+DENOT	ANCHOR	FTBIN	ONSET	ALIGN(μ, σ)	WT-BY-POS
a. $\mu\mu$ μ | | | (af-.**jaf**)		*!	*		*
b. μ μ | | (af-.**af**)			**!		**
c. μ μ | | (a.f-**af**)			*	*!	*
☞ d. μ μ | | (af-.**jaf**)			*		**

In disyllabic forms, there is no risk of creating an onsetless suffix. Thus we see forms like [osak-**sak**] and [inut-**nut**]. These receive denotatives exactly like other disyllables such as [mutul-**tul**], as discussed in §4.2.

5 Discussion

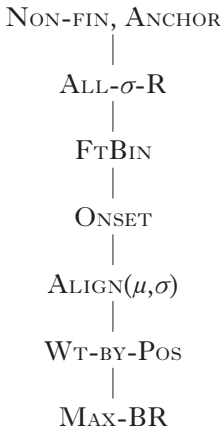
The constraint hierarchy developed here covers the range of reduplicative subpatterns in Kosraean. The shape of the reduplicant is consistently predictable from two facts: the shape of the root to which it attaches, and its position as a prefix or suffix.

The prefix exemplifies the binarity effect, whereby it is bimoraic if and only if the base is bimoraic. Wherever the prefix is bimoraic, its second mora is a consonant, as in [(**fur**)(furok)] and [(**ip**)(ipɨs)]. The prefix is monomoraic for monomoraic bases, as in [(**fo**-foʃ] and [(**o**.**n**-on)], and for roots with internal vowel sequences, as in [(**fu**)(fuon)].

The suffix, in contrast, is always monomoraic, to avoid creating more than one additional syllable. Its shape is always CV(C), where the second consonant appears only if the base has a final consonant; thus we see [mɨsɛ-**sɛ**] and [mutul-**tul**]. The suffix has an intrusive glide if the base is VC, as in [af-**jaf**]. Although the suffix does not show the binarity effect, both affix paradigms follow from a single constraint hierarchy that incorporates a high rank of NON-FIN and ANCHOR, as well as a visible effect of FTBIN and ALL-σ-R. The full constraint hierarchy is summarised in (26).

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(26) *Constraint hierarchy*



An implication of the analysis is that the binarity effect could extend to longer forms: those with odd numbers of moras will have monomoraic prefixes, and likewise even-numbered roots will have bimoraic prefixes. Unfortunately this is difficult to test in Kosraean, because there are no examples of roots longer than two syllables reduplicating. In addition, the activity of the truncation pattern exemplified in (7) might obscure the prediction, in that reduplicating a three-syllable form could trigger truncation, rendering the base disyllabic.[10]

Some aspects of the Kosraean paradigm deserve additional comment. For example, Lee (1975: 218–219) describes a variant pattern by which certain subsets have a different realisation: in particular, the iterative for all disyllables variably is monomoraic. Thus, instead of [**fur**-furok] and [**ip**-ip~~i~~s], we see [**fu**-furok] and [**i**-ip~~i~~s]. Crucially, this variant pattern does not apply to vowel-initial iterative forms like [**o.n**-on], in which the reduplicative consonant is not a coda, and it does not apply to any suffixed forms. The means of arriving at this system is minimal: these are the only subpatterns which reduplicate using moraic consonants. The constraint forbidding moraic consonants is *MORAICCODA, as defined in (27).

(27) *MORAICCODA

Moraic consonants are forbidden.

The variant pattern of Kosraean reduplication is a system in which *MORAICCODA outranks FTBIN, which contrasts with the system devel-

[10] A second interesting prediction is that a polysyllabic root with an initial CVC and final CV, such as a hypothetical /fulko/, would receive a bimoraic prefix. This results from pressure of FTBIN to keep the base bimoraic. However, this prediction requires either a constraint requiring syllable integrity or one forbidding consonants to bear stress, both of which would rule out a competitor such as [(fu-fu)(l.ko)]. Regardless, CVCCV stems are not attested.

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oped in §4. This variant system rules out the moraic coda consonants of [**fur**-furok] and [**ip**-ipɨs], instead deriving [**fu**-furok] and [**i**.ipɨs]. The variant system correctly leaves [**on**-on] unchanged, because the consonant in its reduplicant is not moraic. It also does not affect any denotative suffixed forms, since none of them has any moraic consonants. The following tableaux offer an illustration.

(28)

ipɨs+ITER	ALL-σ-R	*MORAICCODA	FTBIN	ALIGN(μ, σ)	WT-BY-POS
a. μ μ μ μ | | | | (**ipɨ**)(ipɨs)	***!				*
b. μ μ μ | | | (**i**)(**p**-ipɨs)	**		*	*!	*
☞ c. μ μ μ | | | (**i**)(ipɨs)	**		*		*
d. μμ μ μ | | | | (**ip**)(ipɨs)	**	p!			*

(29)

furok+ITER	ALL-σ-R	*MORAICCODA	FTBIN	WT-BY-POS
a. μ μ μ μ | | | | (**furo**)(furok)	***!			*
☞ b. μ μ μ | | | (**fu**)(furok)	**		*	*
c. μμ μ μ | | | | (**fur**)(furok)	**	r!		

An alternative account of Kosraean reduplication is provided by Raimy (2000), who uses the derivational Linear Precedence model to handle the iterative prefix. Raimy is right to use Kosraean as evidence against a templatic model of reduplication, but his account only covers the bimoraic prefixing subset exemplified by [**fur**-furok] and [**ip**-ipɨs]. The real problem with a templatic approach for Kosraean is that it cannot handle the quantitative contrast between the prefixes of [**fo**-foʃ] and [**fur**-furok]. Indeed, Raimy's approach, which makes no use of prosodic structure, requires some amendment to handle this pair, and cannot give a clear account of why the variant *MORAICCODA pattern only affects the [furok] and [ipɨs] prefixing subsets.

A plausible alternative constraint-based analysis of the system is to attribute the shape alternation in the prefix to an avoidance of full base–reduplicant identity. In particular, this approach would posit that the prefix for a monosyllabic root like /foʃ/ must be an open syllable, as in

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[**fo**-foʃ], because a closed syllable would be identical to the base. However, this alternative introduces a number of additional issues. First, it would have trouble with the fact that the suffix is an acceptable exact copy of the base in monosyllabic bases, as in [pʌk-**pʌk**]. Second, it would also have trouble with the fact that only the prefix in [**on**-on] and not the suffix in [af-**jaf**] can be an exact copy of the base in vowel-initial monosyllables. Third, and most crucially, it could not handle the closed-syllable prefixes of vowel-initial polysyllables like [**ip**-ipɨs], nor could it possibly restrict the variant subpattern to polysyllabic iteratives.

The analysis of the Kosraean prefix bears out the prediction made by a non-templatic model of prosodic morphology that patterns like the binarity effect are possible. Another imaginable instantiation of the binarity effect is a situation of full copy, in which the reduplicant is simply an exact copy of the base. In such a system, the prefix always has the same number of syllables as the base. Though here it would be true that the prefix would be binary if and only if the base were as well, the binarity effect in this case is epiphenomenal. Kosraean's binarity effect is more informative about the relationship between reduplication and prosody, since it emerges from the ability of the base and affix to share a foot in a partial reduplicative paradigm.

A last thing to note is the apparent emergence of coda tolerance in Kosraean prefixing. Coda consonants are otherwise seen only word-finally and at morpheme junctures. Given the focus of Steriade (1988) and McCarthy & Prince (1994) that reduplicants tend to have less marked syllabic structure, it may seem strange that coda consonants would appear in reduplicative affixes. However, the coda consonants here are a red herring: prosodically the bimoraic prefixes can be seen as unmarked in the sense that they satisfy Wt-by-Pos, which is not clearly true of non-reduplicative coda consonants in Kosraean.

In fact, the violability of Wt-by-Pos makes Kosraean a unique example of a contextually weight-sensitive language (Hayes 1994, Rosenthall & van der Hulst 1999), in which CVC syllables are heavy only under certain prosodic conditions, rather than counting uniformly as light or heavy. In Kosraean, syllable weight does not affect stress placement; primary stress is always on the penult, regardless of syllable closure. Even so, the weight of CVC syllables depends on mitigating factors of morphological alignment and foot binarity. In non-reduplicative forms, CVC syllables are light, suggesting a violable rank for Wt-by-Pos – but in prefixing reduplication, CVC syllables are heavy, a consequence of the binarity effect and its role in creating binary prefixes.

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