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EDGE-INTEGRITY and Epenthesis*

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This paper provides an optimality theoretic analysis of epenthesis patterns in Karam and Southeastern Pomo. I show that the constituent internal epenthesis pattern in both languages, by which vowels are epenthesized following the initial consonant and preceding the final consonant, is closely tied with the distribution of marked syllable types, i.e. $(V)_\sigma$ and $((C)VC)_\sigma$ at the edges of a morphological unit, the stem in Karam and MWd in Southeastern Pomo. I propose that these properties are derived through the interaction of syllable structure constraints and faithfulness constraint, EDGE-INTEGRITY, which demands the edge segments of a morphological unit to appear at the edgemost positions invariantly in the input and the output. It is argued that this is to satisfy Edge-Demarcation, a general function of phonology, which is to demarcate morphological constituency, by marking the beginning and the ending of the relevant morphological unit in phonology.

1. Introduction

Although it is well known that epenthesis of a segment is prosodically motivated by syllable well-formedness conditions, there is no consensus on how to determine the epenthetic sites (Blevins 1995 and references therein). In this paper I present case studies of epenthesis in Karam and Southeastern Pomo, in which morphological structure plays a crucial role in determining the position of epenthetic vowels.

These languages show interesting similarities with regard to epenthesis; first, vowels are epenthesized to break unsyllabifiable consonant clusters. Second, in both languages, epenthesis is always internal to a morphological constituent, in the sense that epenthetic vowels always follow the initial consonant, as in #CC… → #C***v***C…, while they precede the final consonant, as in …CC# → …C***v***C#.[1] I will show that the constituent internal epenthesis is driven by a constraint EDGE-INTEGRITY, which demands that a morphological unit preserve its integrity or coherence by marking the edges, forcing the morphological unit to preserve its edge segments in their underlying positions; in other words, the presence of the underlying edge segments in their original positions demarcates the edges of a morphological unit. Epenthetic vowels cannot appear

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[1] Throughout the paper, epenthesized vowels are in boldface, underlined and italicized.

in this position, i.e. at the edges, since they are not a part of the morphological constituent in question.

Thirdly, the distribution of marked syllable types, such as onsetless syllables and closed syllables, is highly restricted in both languages; for example, in Karam onsetless syllables are allowed only stem-initially, while closed syllables are restricted to stem-final positions. In Southeastern Pomo, epenthetic vowels do not appear in a closed syllable, although the language allows CVC syllables in general. Still, they may appear in CVC syllables, if and only if it is a word final syllable. I will show that EDGE-INTEGRITY is intriguingly related to the asymmetrical distribution of marked vs. unmarked syllable types in these languages. The analysis of the epenthesis patterns of these languages will be couched in Optimality theory (McCarthy and Prince 1993a,b, 1995).

2. Epenthesis in Karam

Karam shows a relatively simple epenthesis pattern. Vowels are epenthesized to break numerous consonant clusters. Word-internally, $(CV)_\sigma$ is the only permissible syllable, with the exception of word edges. The distribution of marked and unmarked syllable types at the edges and non-edges of a morphological unit justifies a need to refer to its integrity at the edges in phonology.

2.1 Syllable structure and epenthesis: the data

Karam is a language spoken in the Bismarck-Scharader Ranges on the northern border of the Western Highlands District of Australian New Guinea. Pawley (1966) reports that Karam speakers numbering some 10,000 to 14,000 occupy several valleys both on the Ramu and the Jimi falls of the ranges at the time.

The maximal syllable in Karam consists of at most one onset consonant and one coda consonant, as in (1a-b). Onsets are optional stem-initially as in (1c), while they are obligatory elsewhere. Codas are allowed only stem-finally as in the final syllable in (1d) and (1e). There are no vowel sequences within a word, and no lexical morpheme ends with a vowel. Possible syllables in the initial, medial, and final positions in a word are given in (2), in which the # stands for a stem/word boundary.

(1)	a. /cec/	t^{y}ét^{y}	‘clothes’
	b. /wel/	wél	‘oil’
	c. /a^{ŋ}g/	á^{ŋ}k	‘to make a sound’
	d. /sawan/	sa.wán[2]	‘personal name’
	e. /a^{m}bay/	a.^{m}báy	‘they have gone’

(2) Syllable Inventory

a.	.CV.	anywhere
b.	#V…, #CV	stem-initially
c.	…CVC#, …CV#	stem-finally

Karam exhibits abundant epenthesis. According to Pawley (1966), there are numerous consonant clusters underlyingly, up to as many as 8 consecutive consonants. However complex onsets and codas are not allowed at surface, and vowels are epenthesized to break them. The following examples illustrate epenthesis into word initial clusters in (3-4), medial clusters in (5), and final clusters in (6-7). The examples in (8) show epenthesis of a vowel into the initial and final clusters. Epenthetic vowels are boldfaced, italicized, and underlined.

(3) #CCV…

a. /klam/	k***ʌ***.lám	‘Karam’
b. /^{m}bnep/	^{m}b***ə***.nép	‘a man only’
c. /nŋak/	n***ɨ***.ŋák	‘he perceived’

[2] Karam shows final stress pattern: stress falls on the final vowel of a stem and/or a word, as is shown in (a-b). The examples in (c-d) show that stress does not distinguish epenthetic vowels from underlying vowels with regard to stress assignment: stress is strictly morpheme/word final.

a. /nŋak/	n***ɨ***.ŋák.	‘he perceived’
b. /^{ŋ}ge^{m}bkop/	^{ŋ}ge.^{m}b***o***.ɣóp.	‘he could have done’
c. /etp/	e.r***ɨ̂***p.	‘what’
d. /^{n}dnk/	^{n}d***ɨ***.n***ɨ̂***k. ‘I held’	

(4) #CCCV…

/^{m}bk^{n}don/	^{m}b**o̲**.ɤ**o̲**.^{n}dón	‘yonder across valley’

(5) …VCCV..

/^{ŋ}ge^{m}bkop/	^{ŋ}ge.^{m}b**o̲**.ɤóp	‘he could have done’

(6) …VCC#

/etp/	e.r**ɨ̲́**p	‘what’

(7) …VCCC#

/awaknŋ/	a.wa.ɤ**ɨ̲**.n**ɨ̲́**ŋ	‘while he was coming’

(8) #CCV…VCC#

a. /m^{n}dejt/	m**ɨ̲**.^{n}de.d^{y}**ɨ̲́**r	‘while he remained’
b. /kneyaknŋ/	k**ɨ̲**.ne.ya.ɤ**ɨ̲**.n**ɨ̲́**ŋ	‘while they slept’

The examples in (9)-(10) show lexical forms which consist of consonants only (consonantal stems, henceforth). Vowels are inserted to break the clusters. The examples in (9) are minimal utterances in the language, consisting of a single consonant. Only nasals and prenasalized consonants appear as a single consonant stem. Note that the single consonant is in the onset of the epenthetic vowel. The examples in (10) are consonantal stems of more than one consonant. They are realized with abundant epenthetic vowels at the surface.

(9)

a. /^{m}b/	^{m}b**ə̲́**	‘man’
b. /m/	m**ə̲́**	‘taro’
c. /^{n}d/	^{n}d**ə̲́**	‘hold’

(10)	a. /ms/	mɨ̲́s	‘outside’
	b. /cm/	t^{y}ɨ̲́m	‘bow’
	c. /ll/	lɨ̲́l[3]	‘having placed’
	d. /k^{m}bc/	kɨ̲.^{m}bɨ̲́t^{y}	‘inner leaf of bamboo’
	e. /^{n}dnk/	^{n}dɨ̲.nɨ̲́k	‘I held’
	f. /nŋnk/	nɨ̲.ŋɨ̲.nɨ̲́k	‘I saw’
	g. /kjkl/	kɨ̲.^{n}d^{y}ɨ̲.ɣɨ̲́l	‘tattoo’
	h. /pkpnp/	øɨ̲.ɣɨ̲.βɨ̲.nɨ̲́p	‘I might have hit’
	i. /nŋnknŋ/	nɨ̲.ŋɨ̲.nɨ̲.ɣɨ̲.nɨ̲́ŋ	‘while I was booking’
	j. /kt^{ŋ}gnknŋ/	kɨ̲.rɨ̲.^{ŋ}gɨ̲.nɨ̲.ɣɨ̲.nɨ̲́ŋ	‘when I was leaving’

Epenthesis into consonantal stems suggests a simple epenthesis pattern: CV syllables are built word-initially and medially, and CVC syllables, word-finally. In the stems with two consonants, #C_1C_2#, a vowel is inserted between the two consonants, resulting in #C_1**v̲**C_2#, as in (10a) through (10c). In tri-consonantal clusters, #$C_1C_2C_3$#, two vowels are inserted: between C_1 and C_2, and between C_2 and C_3, as in #C_1**v̲.**C_2**v̲**C_3#, as in (10d) and (10e). A quadri-consonantal cluster #$C_1C_2C_3C_4$# is realized as #C_1**v̲.**C_2**v̲.**C_3**v̲.**C_4# as in (10h).

Notice that only a core syllable type, $(CV)_{\sigma}$, is allowed, with the exception of the last syllable, which is invariantly closed. The generalization seems to extend to longer consonant clusters. The number of vowels inserted is one less than the number of consonants. Each epenthetic vowel heads a core syllable, $(CV)_{\sigma}$, except for the final syllable. Thus the cluster of seven consonants, (10j) /kt^{ŋ}gnknŋ/ ‘when I was leaving’ is realized as [kɨ̲.rɨ̲.^{ŋ}gɨ̲.nɨ̲.ɣɨ̲.nɨ̲́ŋ], with six vowels, in which only the final syllable is closed, while all the rest are core CV syllables.

The same pattern holds with the forms with underlying vowels, as illustrated in (3) through (8). The final consonant is always in the coda position; otherwise, consonant clusters are broken by inserted vowels such that each syllable results in a core syllable

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[3] Geminates are not allowed in Karam, thus two identical consonants are always broken by an intervening epenthetic vowel.

type, $(CV)_{\sigma}$. One thing worth pointing out is that onsetless syllables are allowed only in the stem initial position as in (1c): no epenthetic vowels head an onsetless syllable.

The quality of an epenthetic vowel is predictable from its neighboring segments. First, epenthetic vowels take on the quality of the rightmost underlying vowel. Thus preceding /e/, the epenthetic vowel is either [e], [ɛ] or [ə], as in (11a). Preceding /o/, the epenthetic vowel is either [o] or [ə] as in (11b). Preceding /a/, the epenthetic vowels are either [ʌ] or [ə] as in (11c). Preceding glides /y, w/, the epenthetic vowels are realized as homorganic high vowels [i] and [u] respectively, as in (11d) and (11e).[4] Otherwise the epenthetic vowels are either [ɨ] or [ə], as shown (11f) as well as in a consonantal stem of four consonants (11g).

(11)	a. /^{m}b^{m}bek/	^{m}be^{m}bé^{y}k ~ ^{m}bə^{m}bé^{y}k	'the man here, this man'
	b. /^{m}bk^{n}don/	^{m}bo.ɤo.^{n}dón	'yonder across valley'
	c. /klam/	kʌ.lám ~ kə.lám	'Karam'
	d. /^{m}bya^{n}d/	^{m}bi^{y}.yánt	'my husband'
	e. /mwo^{ŋ}g/	mu.wóg	'taro garden'
	f. /nŋnk/	nɨ.ŋɨ.nɨ́k	'I saw'
	g. /etp/	e.rɨ́p	'what'
	h. /kneyaknŋ/	kɨ.ne.ya.ɤɨ.nɨ́ŋ	'while they slept'

2.2 Proposal: EDGE-INTEGRITY

Let us recapitulate the generalizations about the syllable structure in Karam. I will then show that the epenthetic pattern and the epenthetic sites are derived from the interaction of the constraints employed to explain the syllable structure and the distribution of syllable types in Karam.

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[4] One more complication emerges with regard to the alternation of glides and high vowels. When the glides appear in the word-final or penultimate position, they are realized as homorganic high vowels bearing stress. Thus, /nwk/ → [núk] 'he, she', /^{m}byn/ → [^{m}bín] 'woman', /mlwk/ → [mulúk] 'nose', /sa^{m}by/ → [sa^{m}bí^{y}] 'pitpit category'.

First, Karam does not allow onsetless syllables with an exception of the stem initial position. Nor does it have any lexical form with vowel hiatus. Although no active phonological process is attested to amend the putatively anomalous VV sequence, this gap in lexical forms suggests a strong involvement of the constraint ONSET (McCarthy and Prince 1993a, Prince and Smolensky 1993), such that onsets are required, except for stem-initially. Second, codas are prohibited except for a stem final position. It is evident that the constraint NOCODA is active at surface, seeing that there is no consonant cluster word-medially which is not broken up by a vowel, either by an underlying or an epenthetic vowel. Again this has a exceptional clause: except stem-finally.

Clearly, the core CV syllable is the working syllable as well as the optimal syllable in Karam, with an exception of the initial and final positions of a stem. In other words, although marked syllable types, such as $(V)_\sigma$ and $(CVC)_\sigma$, do surface in Karam, they are restricted to the edges of a stem, resulting in *initial onsetless syllables and final closed syllables.* It is clear that they are under the reign of a different condition. I propose that this restricted distribution of marked syllable types at the edges is driven by a constraint, EDGE-INTEGRITY (Kang, to appear), which requires that the segments at the edges of a morphological unit should have a correspondence, as in (12).

(12) EDGE-INTEGRITY(MCAT; EDGE)

A segment S_i at the Left/Right edge of morphological constituent M in the input should have a correspondent in the output, and a segment S_o at the Left/Right edge of morphological constituent M in the output should have a correspondent in the input.
Domain: MCat = {Root, Stem, Affix, MWd}

This is a faithfulness constraint on the segments at the edges of a morphological unit, which requires that the edge segments of a morphological unit be preserved and appear at the edge. It requires that if a segment is at the left or right edge of a morphological unit in the input, its correspondent should appear at the left or right edge of the morphological unit respectively in the output, and if a segment is at the edge of the output, its correspondent should also appear in the input. It is a bi-conditional faithfulness requirement, demanding correspondence from input and to output, as well as from output to input. EDGE-INTEGRITY specifies a relevant morphological unit, and the relevant edges, which can be either left, right or both. If there is no specification of an edge, the default is both edges simultaneously. The following configurations show those in which EDGE-INTEGRITY is violated.

(13)	a.	#XY…	→	#**Z**XY…	(Z is inserted at the left edge)
		…XY#	→	…XY**Z**#	(Z is inserted at the right edge)
	b.	#**X**Y…	→	#Y…	(X is deleted at the left edge)
		….X**Y**#	→	…X#	(Y is deleted at the right edge)

The configuration in (13a) involves epenthesis: if a segment is inserted at the edges of a morphological unit, it will violate EDGE-INTEGRITY. (13b) involves deletion: if an edge segment deletes, it also violates EDGE-INTEGRITY.

The role of EDGE-INTEGRITY and its interaction with other syllable structure constraints in Karam is demonstrated in tableaux (14)-(18). First, tableaux (14) and (15) show the interaction of ONSET and NOCODA with DEP-IO, a constraint militating against epenthesis. Tableau (14) is a case of the onsetless initial syllable, and tableau (15) is a case of final closed syllable.

(14) /a$^{\text{ŋ}}$g/ → á$^{\text{ŋ}}$k 'to make a sound'

/a$^{\text{ŋ}}$g/	DEP-IO	ONSET
☞ a. á$^{\text{ŋ}}$k		*
b. ℂá$^{\text{ŋ}}$k	*!	

(ℂ represents an epenthetic consonant.)

(15) /sawan/ → sa.wan 'personal name'

/sawan/	DEP-IO	NO-CODA
☞ a. sa.wán		*
b. sa.wa.n𝕍́	*!	

(𝕍 represents an epenthetic vowel.)

(16) DEP-IO >> ONSET, NOCODA

The constraint ranking given in (16), in which DEP-IO dominates both ONSET and NOCODA, follows from the fact that no phonological modification, such as epenthesis, is made to save the violation of ONSET in (14) and NOCODA in (15). However there *is* epenthesis in Karam. Word-medially vowels are epenthesized to break even a cluster of two consonants, as is in tableau (17).

(17) Ranking conflict?: NOCODA >> DEP-IO

/ᵑgeᵐbkop/ → ᵑge.ᵐb<u>***o***</u>.ɣóp 'he could have done'

/ᵑgeᵐbkop/	NOCODA	DEP-IO
☞ a. ᵑge.ᵐb<u>***o***</u>.ɣop	*	*
b. ᵑgeᵐp.ɣop	**!	

Epenthesis into a simple cluster of two consonants in tableau (17) shows that DEP-IO is dominated by NOCODA.[5] It is better to have an additional vowel than to have an additional violation of NOCODA. In other words, epenthesis occurs to avoid a closed syllable stem-internally, while it does not apply stem-initially nor finally.

This asymmetry is inexplicable with the analysis given so far. It is even more obvious if we consider tableau (18) with an additional candidate (18b), in which the

[5] Since *COMPLEX is never violated I will not include it in the tableau for the expository convenience.

candidates (a) and (b) are on tie with regard to NOCODA and DEP-IO, although the candidate (a) is the desirable winner.

(18) Ranking Indeterminacy

/ᵑgeᵐbkop/	NOCODA	DEP-IO
(☹) a. ᵑge.ᵐb**o**.ɤop	*	*
b. ᵑgeᵐp.ɤo.ß**o**	*	*

It is clear that a coda is allowed in the final syllable, while it is prohibited elsewhere. EDGE-INTEGRITY proposed in (12) comes into the picture as a dominant constraint. The definition of EDGE-INTEGRITY in Karam is given in (19).

(19) EDGE-INTEGRITY(STEM)

If S_i is the leftmost/rightmost segment in the input, then its correspondent should be the leftmost/rightmost segment in the output. If S_o is the leftmost/rightmost segment in the output, then its correspondent should be the leftmost/rightmost segment in the input.
Domain: Stem

In tableau (20), the violation of EDGE-INTEGRITY is fatal for candidate (20b) (=18b). The domination of NOCODA by EDGE-INTEGRITY forces the final consonant to appear in the coda position. In a non-edge position, where EDGE-INTEGRITY does not have a jurisdiction, the violation of NOCODA is saved by epenthesis, resulting in the unmarked CV syllable type, as is shown by the failed candidate (20c).

(20) EDGE-INTEGRITY >> NOCODA[6] >> DEP-IO

/^{ŋ}ge^{m}bkop/	EDGE-INT	NOCODA	DEP-IO
☞ a. ^{ŋ}ge.^{m}b**_o_**.ɤop		*	*
b. ^{ŋ}ge^{m}p.ɤo.β**_o_**	*!	*	*
c. ^{ŋ}ge^{m}p.ɤop		**!	

The relative ranking between EDGE-INTEGRITY and ONSET is determined by the fact that consonants are not inserted to onsetless syllables. This follows from the constraint hierarchy, in which EDGE-INTEGRITY dominates ONSET, as shown in tableau (21).

(21) EDGE-INTEGRITY >> ONSET[7] >>DEP-IO

/a^{ŋ}g/	EDGE-INT	ONSET	DEP-IO
☞ a. á^{ŋ}k		*	
b. ℂá^{ŋ}k	*!		*

(ℂ stands for an inserted consonant.)

Even though syllables structure conditions, such as ONSET and NOCODA, are dominated by EDGE-INTEGRITY, their role is not trivial. When EDGE-INTEGRITY is inevitably violated, it is syllable structure conditions and their relative ranking that

[6] Another candidate [^{ŋ}ge.^{m}b**_o_**.ɤo.pɨ́] will be trivially out due to the fatal violation of EDGE-INTEGRITY.

[7] The interaction of ONSET and DEP-IO needs more remarks. It is hard to tell if there is a separate constraint militating against the insertion of a consonant, which dominates ONSET, as well as EDGE-INTEGRITY, since there is no word-internal vowel hiatus in lexical forms in Karam. However in the lack of crucial evidence against the proposed analysis, I will assume that DEP-IO is dominated by ONSET as well as by NO-CODA. It is worth pointing out that the analysis proposed here has a conceptual advantage.

determine the epenthetic site. This is clearly illustrated in tableau (22), from the epenthesis into a mono-consonantal stem.

(22) /ᵐb/ → ᵐbə̲́ 'man'

/ᵐb/	EDGE-INT	ONSET	NOCODA
☞ a. ᵐbə̲́	*		
b. ə̲́ᵐp	*	*!	*

EDGE-INTEGRITY is violated by both candidates, due to the presence of the epenthetic vowel either in the final position (22a) or in the initial position (22b). The decision depends on syllable structure well-formedness conditions, and the only consonant is syllabified in the onset.

This is a striking result, considering that there is no lexical form consisting of a monosyllable $(CV)_\sigma$ in Karam, while there are $(VC)_\sigma$ monosyllabic forms. The unmarked $(CV)_\sigma$ word form emerges through the interaction of syllable structure constraints and EDGE-INTEGRITY, in particular in a situation where EDGE-INTEGRITY does not interfere with syllable structure constraints.

The strict constituent internal epenthesis is forced given the constraints proposed so far and their ranking, as is evident from the evaluation of a consonantal stem /nŋnk/ 'I saw' in tableau (23). Candidate (a) is chosen as optimal despite violation of syllable well-formedness conditions. The candidates (c) and (d) are excluded due to the fatal violation of EDGE-INTEGRITY.

(23) /nŋnk/ → nɨ̱.ŋɨ̱.nɨ̱́k ‘I saw’

/nŋnk/	EDGE-INT	ONSET	NOCODA	DEP-IO
☞ a. nɨ̱.ŋɨ̱.nɨ̱́k			*	***
b. nɨ̱ŋ.nɨ̱́k			**!	**
c. nɨ̱.ŋɨ̱.nɨ̱.kɨ̱́	*!			****
d. ɨ̱n.ŋɨ̱.nɨ̱́k	*!	*	*	***

The constraints and their relative ranking proposed so far to analyze vowel epenthesis in Karam is given in (24).

(24) EDGE-INTEGRITY
|
{ONSET, NOCODA}
|
DEP-IO

Notice that the final syllable of a stem is the only syllable allowed to have a coda, given that EDGE-INTEGRITY dominates NOCODA. Also the initial syllable is the only position in which onsetless syllables are allowed, for EDGE-INTEGRITY also dominates ONSET. Only CV syllables are allowed elsewhere. In the proposed analysis based on EDGE-INTEGRITY, it is nicely captured in a uniform way that the marked syllable types are restricted to the margins of a morphological unit only, where morphological requirement of demarcating the edges and preserving the constituency as integral as possible wins over phonological markedness considerations. Resorting to extraprosodicity of a final consonant, in this case, will require invoking extraprosodicity for the initial vowel as well. This line of analysis fails to capture the robust generalization that marked syllable types are allowed only at the edges, making it nothing but an accident at best.

The constituent internal epenthesis in Karam, is also driven and regulated by EDGE-INTEGRITY; the initial and final segments are required to appear in the initial and final positions in the input as well as in the output. Thus the stray, unsyllabified consonant in the initial position is parsed as an onset of an inserted vowel, while the final one is parsed as a coda of an inserted vowel. The distribution of syllable types is intriguingly correlated with the epenthetic site of a vowel: the analysis based on EDGE-INTEGRITY captures this general pattern in a straightforward way.

The interaction between EDGE-INTEGRITY and syllable structure constraints are worth a discussion. Note that the effect of ONSET is reinforced by EDGE-INTEGRITY, since the initial consonant of a morphological unit should always appear in the initial position of a syllable, which is the onset. On the other hand NOCODA is in conflict with EDGE-INTEGRITY and is forcefully violated under the pressure of EDGE-INTEGRITY. A marked closed syllable type in a word-final position is a result of the high-ranking constraint, EDGE-INTEGRITY in this case.

However the role of EDGE-INTEGRITY can be decoupled from ONSET. When a stem begins with a vowel, this initial vowel is forced to appear in the underlying position, although it results in an onsetless syllable. Here ONSET is also gratuitously violated under the pressure of EDGE-INTEGRITY. The appearance of a marked onsetless syllable in this position is again due to EDGE-INTEGRITY.

EDGE-INTEGRITY unifies the fact that marked syllables appear at the edges and only at the edges. Syllable structure conditions are violated under pressure of EDGE-INTEGRITY at both edges; the appearance of marked syllable types at the edges is an epiphenomenona of EDGE-INTEGRITY. When EDGE-INTEGRITY is not at stake, syllable structure conditions emerge. This is true in the non-edge positions: the unmarked syllable type, $(CV)_\sigma$ is chosen as optimal without any interruption, as shown in the case of mono-consonantal stems, which results in a CV syllable type epenthesis.

In the Correspondence model of Optimality Theory (McCarthy and Prince 1995), the constraint family of Generalized Alignment has been re-interpreted as a part of the faithfulness constraint family regulating the correspondence of edge segments: ANCHOR-IO. It is proposed to subsume the generalized alignment constraint family (McCarthy and Prince 1995, 1998, Kager 1999).

EDGE-INTEGRITY is an instance of a faithfulness constraint at the edges of a morphological unit. In this sense, it is different from the constraint ANCHOR-IO. The proposal of EDGE-INTEGRITY on a par with alignment constraints amounts to proposing to decompose ANCHOR into its structural markedness component and the faithfulness component at edges of morphological/grammatical constituents: ANCHOR does not subsume alignment constraints. Rather the faithfulness requirement through the correspondence relationship between input and output is regulated by EDGE-INTEGRITY, and alignment constraints regulate the relationship between grammatical and prosodic constituents.

3. Epenthesis in Southeastern Pomo

Southeastern Pomo exhibits a striking similarity to Karam with regard to epenthesis in two respects: first, epenthesis is strictly constituent internal. Second, epenthetic vowels appear only in a core CV syllable type word-initially and medially.

On the other hand, Southeastern Pomo shows intriguing differences from Karam. First, it allows the $(CVC)_\sigma$ syllable type not only word finally but also word medially. Secondly, it imposes a stricter restriction on epenthetic vowels than on underlying vowels, regarding which syllable types they may appear in. Thirdly, it shows non-minimal epenthesis. For example, /ca-l-q-m-q-t/ 'many are rolling it' is realized as [cal.q***a***.m***a***.q***a***t] with three epenthetic vowels instead of two epenthetic vowels, *[cal.q***a***m.q***a***t]. The syllables headed by an epenthetic vowel are not the possible maximal syllable in the language but a core syllable $(CV)_\sigma$. Fourth, conditions on the word final syllables differ form word medial syllables such that even an epenthetic vowel appears in a closed syllable in the word final position.

I will show that the morphological constituent internal epenthesis pattern falls from the constraint EDGE-INTEGRITY in Southeastern Pomo, just as in Karam. In addition, I propose that the peculiar behavior of epenthetic vowels in Southeastern Pomo comes from a special condition on these vowels, which requires them to head an unmarked core syllable type $(CV)_\sigma$. I propose that this is an emergence of the unmarked syllable type in a derived structure.

3.1 Epenthesis: Data

Southeastern Pomo is one of the seven Pomoan languages, spoken near San Francisco, California. It is classified as one of the Hokan language stock within the Hokan-Cahuiltecan group of the Hokan-Siouan superstock (Sapir 1951). Possible syllables in Southeastern Pomo are CV(V), CVC, CCVC[8], as is shown in (25). Onsets are obligatory in Southeastern Pomo: it does not allow vowel hiatus (Moshinsky 1974:12), nor does it have vowel initial words. There is no word-minimality requirement, as is shown by a monosyllabic word with a short vowel (25a). Syllable weight does not play any role in stress, either, since both CV syllables and CVC syllables are stressed. The distribution of syllable types, namely $(CV)_\sigma$ or $(CVC)_\sigma$ syllables, is not restricted in any particular position in a word, nor is related with stress.

(25)	a. CV	t’ó	‘neck’
	b. CVC	ʔík’	‘choking’
	c. CCVC	ʔkét	‘grab something’
	d. CVC.CV	cín.qa	‘hang something up’
	e. CV.CVC	mó.loq	‘skeleton’
	f. CVC.CVC	wél.kic’	‘mean, vicious’
	g. CV.CV.CV	cá.du.wa	‘north’
	h. CVC.CV.CV	sóm.li.lu	‘hat’
	i. CV.CVC.CV	c’ú.wal.bu	‘thumb’
	j. CVC.CV.CVC	nán.ta.c’it	‘think’
	k. CVC.CVC.CVC	c’úb.c’ùb.kit	‘sharp, pointed’

According to Moshinsky (1974), as a result of the historical deletion of vowels in pre-Southeastern Pomo, which deletes vowels in prefixes and suffixes, many CV affixes were reduced to the shape C. The consonantal affixes or suffixes often result in consonant

[8] CCVC syllables are usually found from consonant prefixes. Word-internally it is often alternate with an epenthesis of a vowel. See the variations in (26a) below.

clusters, which are broken up by epenthetic vowels at surface.[9] An example of epenthesis is shown in (26), in which vowels are epenthesized after the prefix /ʔ-/, and between two consonantal suffixes /-k/ and /-t/.

(26) /ʔ-t̩'at-k-t/ ʔ***ə***.t̩'át.k***i***t 'crack (an egg)'

Epenthesis of a vowel preceding the first underlying vowel is optional, whether it is a cluster of two root initial consonants or a cluster of a prefix and a root initial consonant. More examples are shown in (27). Since there is no case of more than two consonants in this position, the epenthesis pattern is analyzed straightforwardly, as insertion of a vowel after the first consonant of a consonant cluster.

(27) Epenthesis (Optional) (M 1974:21-23)

a. /ʔke/	ʔ***i***.ké ~ʔ***e***.ké	'to catch'
b. /mwata/	m***u***.wá.ta	'talk!'
c. /ʔšon-k/	ʔ***ə***.šón***i***k	'to guess'
d. /ʔ-t'ut-k-t/	ʔt'út.k***i***t	'get a man down, wrestling'

Abundant consonantal clusters of up to five consecutive consonants are observed from a sequence of consonantal suffixes. (28) shows a mono-consonantal suffix following a vowel final root. There is no epenthesis in this case, and the final consonant is syllabified in the coda position.

(28) …V-C# → …VC)$_\sigma$

a. /ʔ-ke-t/	ʔkét	'grab something'
b. /ʔ-ta-n/	ʔtán	'a hand'

[9] According to Moshinsky (1974:26-28), the quality of the vowel is predictable from the articulatory features of the preceding consonant. [a] appears after the peripheral consonants [q,m], and [i] appears after [t,d,i,l,c,k]. Although it is an interesting issue itself, I will leave a detailed analysis open, since the quality of the epenthesized vowel is not crucial to the proposed analysis.

The following examples illustrate vowel epenthesis to consonantal clusters resulting from sequencing of consonantal suffixes. In (29), an epenthetic vowel is inserted between the two final consonants, breaking the cluster.

(29) …VC_1-C_2#, …V-C_1-C_2 # → …V)$_\sigma$(C_1***v***C_2)$_\sigma$

a. /ci-q-t/	cí.q***a***t	'carry a lot of things away'
b. /m-xe-c'-t/	mxé.c'***i***t	'it has an odor'
c. /ʔ-sat-t/	ʔsá.t***i***t	'feel something with hands'
d. /b-tok'-t/	btó.k'***i***t	'woodpecker pecks'

In clusters of three consonants, an epenthetic vowel appears between the last two consonants C_2 and C_3, resulting in two closed syllables word finally, as in (30).

(30) …VC_1-C_2-C_3#, …V-C_1-C_2-C_3 # → …VC_1)$_\sigma$(C_2***v***C_3)$_\sigma$

a. /myel-k-t/	myél.k***i***t	'many are watching'
b. /č'e-m-q-t/	č'ém.q***a***t	'he stuck n in the ground'
c. /s-k'ot-l-t/	sk'ót.l***i***t	'he shoveled all day'
d. /x̩-qa-b-k-t/	x̩qáb.k***i***t	'break in a color'

In clusters of four consonant in (31), two vowels are epenthesized, one after C_2 and the other between the last two consonants, C_3 and C_4.

(31) …VC_1-C_2-C_3-C_4#, …V-C_1-C_2-C_3-C_4# → …VC_1)$_\sigma$(C_2***v***)$_\sigma$(C_3***v***C_4)$_\sigma$

a. /cil-m-k-t/	číl.m***a***.k***i***t, *čí.l***i***m.k***i***t	'a breeze is blowing' (M1974:35)
b. /b-lit-k-q-t/	blít.k***i***.q***a***t	'stick out the tongue'
c. /kt'al-k-c'-t/	kt'ál.k***i***.q***a***t	'clap once'
d. /s-wo-t-k-q-t/	swót.k***i***.q***a***t	'dissolve'

Crucially, an epenthetic vowel does not appear between C_1 and C_2. If it did, the penultimate syllable with an epenthetic vowel would have been a closed syllable, as in *[čí.l***i***m.k***i***t] from /cil-m-k-t/ 'a breeze is blowing'. Instead the actual output form has an open penultimate syllable, as in [číl.m***a***.k***i***t]. The inexistence of *[čí.l***i***m.k***i***t] warrants explanation.

The examples in (32) show a non-minimal epenthesis pattern: three vowels are epenthesized resulting in two open syllables and a final closed syllable to break up a cluster of five consonants.

(32) …VC_1-C_2-C_3-C_4-C_5, …V-C_1-C_2-C_3-C_4-C_5 → …$VC_1)_\sigma(C_2\underline{v})_\sigma(C_3\underline{v})_\sigma(C_4\underline{v}C_5)_\sigma$

a. /ca-l-q-m-q-t/	cál.q***a***.m***a***.q***a***t, *cal.q***a***m.q***a***t	'many are rolling it along'
b. /ʔyot'-q-m-q-t/	ʔyót'.q***a***.m***a***.q***a***t	'three refuse'

Notice the syllables resulting from epenthesis are open syllables, not the maximal permissible $(CVC)_\sigma$ syllables in the language. This is evident from the ill-formed output *[cál.q***a***m.q***a***t] from /ca-l-q-m-q-t/ 'many are rolling it along' in (32a). This pattern strongly suggests some restriction on the epenthetic vowels, which should be strong enough to rule over the minimal epenthesis.

It is worth pointing out again that the distribution of a closed syllable is not necessarily connected to stress or any particular position in a word, as was illustrated in the forms in (25) where epenthesis is not involved: $(CVC)_\sigma$ syllables are not restricted either to the final nor initial syllable.

This is also true with the forms where epenthesis is involved. The examples in (32) clearly show that closed syllables may appear in the middle of a word, without necessarily bearing stress. Also, a stem initial, stressed syllable is not necessarily a closed syllable, either, seeing that initial stressed syllables are open in (33).

(33) Di- or tri-syllabic stems

a. /ʔa noyoc-k-d-t cale/	ʔa. nó.yoc.k***i***.d***i***t. ca.le	'I'm drowning'
b. /t'a tawal-k-q-hine/	t'a.tá.wal.k***i***.q***a***.hi.ne.	'he ought to work'
c. /hulacu-q-m-t/	hú.la.cuq.m***a***t	'many are getting drunk'

The data renders the following generalizations. First, there is a distributional disparity between underlying vowels and epenthetic vowels, such that epenthetic vowels may occur in open syllables only, except in word final syllables. This is a peculiar property of epenthetic vowels considering that the language allows the closed syllable type $(CVC)_{\sigma}$. The position of epenthetic vowels in quadri-consonantal clusters in (32) and the non-minimal epenthesis pattern in (33) strongly support the hypothesis that epenthetic vowels cannot appear in a closed syllable. On the other hand, underlying vowels may head any syllable types, even when they are not in a root or word initial syllable or a stressed syllable, as in (34).

Second, epenthesis is not minimal in Southeastern Pomo. This is closely tied with the distributional restriction mentioned above. In (32a), /ca-l-q-m-q-t/ 'many are rolling it along' is realized as [cál.q***a***.m***a***.q***a***t], not as *[cál.q***a***m.q***a***t]. Considering that closed syllables are allowed, there is no reason why *[cál.q***a***m.q***a***t] should be ruled out, while [cál.q***a***.m***a***.q***at***] is accepted. It is evident that *[cál.q***a***m.q***a***t] is bad due to the non-final closed syllable *(q***a***m)$_{\sigma}$ with the epenthetic vowel [a], since epenthetic vowels can not appear in a closed syllable, except word finally.

Finally, the peculiarity of the word final syllable needs an explanation. As mentioned above, epenthetic vowels are allowed to head a closed syllable only in a word final position. When there are two consonants word finally, as in (29), an epenthetic vowel is inserted between them, having the final consonant in the coda. Crucially it does not take the word final consonant as an onset.

3.3 Proposal

3.1.1 The emergence of the unmarkedness

This section shows that optimality theoretic analysis using EDGE-INTEGRITY provides us with a straightforward explanation of the epenthesis pattern in Southeastern Pomo, without recourse to positing levels or derivational stage specific requirements.

One of the crucial generalizations to be explained is that epenthetic vowels occur only in open syllables, with an exception of word final syllables, which will be explained separately. Considering that closed syllables are more marked than open syllables, this amounts to saying that epenthesis is possible only if it results in the unmarked, optimal syllable $(CV)_\sigma$. In other words, derived structure exhibits a more rigid markedness requirement: epenthetic vowels may appear only in the unmarked CV syllable. On the other hand underlying vowels are not constrained by such a requirement: they may appear in any syllable type permitted in the language. I propose that this is a case of *the emergence of the unmarked syllable type in derived structure*. The basic intuition is that the markedness constraint, militating against a marked syllable type, i.e. a closed syllable, applies asymmetrically depending on whether a vowel is underlying or not. When a vowel does not have an underlying correspondent, that is, when it is inserted, it is regulated by a markedness constraint more rigidly.

How do we capture this intuition formally in phonology? In Optimality Theory (McCarthy and Prince 1995), the crucial difference between epenthetic vowels and underlying vowels is captured in such a way that the former does not have any underlying correspondent, since they are not morphologically affiliated. By definition, they invariably violate a faithfulness constraint DEP-IO, which requires that every output segment have an input correspondent. I propose that this violation puts the epenthetic vowels under a more rigid influence of the markedness constraint NOCODA. This can be directly captured using a local conjunction of the constraints (Smolensky 1995, Itô and Mester 1998).[10] The proposed constraint is shown in (34).

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[10] The definition of Local Conjunction of Constraint proposed by Smolensky (1995), and restated in Itô and Mester (1998:10) is as follows.

Local Conjunction of Constraints (Itô and Mester 1998)

a. Definition
Local conjunction is an operation on the constraint set forming composite constraints:
Let C_1 and C_2 be members of the constraint set *Con*. Then their local conjunction $C_1\&C_2$ is also a member of *Con*.

b. Interpretation
The local conjunction $C_1\&C_2$ is violated if and only if both $*C_1$ and $*C_2$ are violated in some domain δ.

c. Ranking (Universal)
$C_1\&C_2 >> C_1$
$C_1\&C_2 >> C_2$

(34) Local Conjunction of constraints: [DEP-IO & NOCODA]$_\sigma$

The conjoined constraint is violated if and only if both DEP-IO and NOCODA are simultaneously violated within a local domain of the syllable. The basic interpretation is that if a vowel violates a faithfulness constraint DEP-IO, then it cannot appear in a syllable with a coda.

The idea behind the emergence of the unmarkedness is to capture the generalization that across languages, segments which do not have an underlying correspondent are regulated by a more rigid markedness constraint, especially with regard to the emergence of the unmarked features or segments in Reduplication (McCarthy and Prince 1994, Alderete et al. 1999). When markedness constraints are dominated by faithfulness constraints, we do not see their effects at surface at all. However in a derived structure, that is, when relevant faithfulness constraints between the input and the output are not at stake, those markedness requirements do surface. This follows from the fact that the structure free from the reign of IO-Faithfulness constraints is regulated directly by markedness constraints, resulting in an unexpected unmarked structure at surface.

The intuition behind the restriction on epenthetic vowels in Southeastern Pomo partly falls into this: epenthetic vowels, being a derived structure, are more rigidly regulated by a markedness constraint. What is different from featural unmarkedness is that the epenthetic segment violates a faithfulness constraint DEP-IO, and the structure we are evaluating is not present in the input. the relevant markedness constraint, which calls for the local conjunction of constraints, does not constrain the input-output correspondence or identity, but the surface prosodic structure.

3.3.2 Final closed syllables: EDGE-INTEGRITY

Let us turn to the question of the word final syllables. In Southeastern Pomo, the word final consonant, if any, should be parsed as a coda. This is true even when the syllable is headed by an epenthetic vowel. Thus epenthesis is always constituent internal. An initial CC cluster is syllabified as #C***v***C… regulated by ONSET, while a word final CC cluster is syllabified as …C***v***C#, not *C***v***C***v***# in spite of NOCODA. This pattern has an exact parallel in Karam, discussed in the previous section.

I propose that what is driving this is EDGE-INTEGRITY, the requirement that the edge segments remain in their underlying positions, as in Karam. Word initially ONSET guarantees that this requirement is satisfied. That is, the role of this constraint is obscured by ONSET in Southeastern Pomo. Word-finally, however, EDGE-INTEGRITY overrides the effect of NOCODA. Due to this conflict with NOCODA, the role of EDGE-INTEGRITY is more prominent at the right edge of a constituent, word finally, in Southeastern Pomo. The definition of Edge-Integrity in Southeastern Pomo is as in (35). This is interpreted as referring to both edges of a morphological word, as in Karam.

(35) EDGE-INTEGRITY(MWD)

If S_i is the leftmost/rightmost segment in the input, then its correspondent is the leftmost/rightmost segment in the output. If S_o is the leftmost/rightmost segment in the output, then its correspondent is the leftmost/rightmost segment in the input.
Domain: MWd

3.4 Analysis

This section provides an optimality theoretic analysis of the epenthetic pattern of Southeastern Pomo. The constraints relevant determining the syllable structure of Southeastern Pomo are ONSET, NOCODA, MAX-IO and DEP-IO. First, ONSET requires that syllables have an onset. It is undominated in Southeastern Pomo, seeing that there is no word beginning with a vowel, nor a VV sequence. NOCODA prohibits syllables from having a coda. DEP-IO is a constraint militating against epenthesis, and MAX-IO militates against deletion. Since clustering of consonants is resolved by epenthesis of vowels, MAX-IO dominates DEP-IO. Tableau (36) illustrates the interaction of constrains where no epenthesis is involved. Note that there is no deletion nor epenthesis to save the violations of NO-CODA, when only a single consonant is in the coda. This yields the ranking of MAX-IO, DEP-IO dominating NOCODA.

(36) MAX-IO, DEP-IO >> NOCODA

wél.kic' 'mean, vicious'

/welkic'/	MAX-IO	DEP-IO	NOCODA
☞ a. wel.kic'			*
b. wel.ki	* !		
c. wel.ki.c'***i***		*!	

As for the relative ranking between MAX-IO and DEP-IO, the way consonant clusters are resolved settles the issue. In tableau (36), the choice of the candidate (a) tells us that it is better to insert a vowel than delete a consonant to syllabify a consonant cluster, yielding DEP-IO being dominated by MAX-IO. The constraint hierarchy established so far is given in (38).

(37) Max-IO >> Dep-IO

/ci-q-t/ cí.q***a***t 'carry a lot of things away'

/ci-q-t/	MAX-IO	DEP-IO
☞ a. ci.q***a***t		*
b. ciq	* !	

(38) MAX-IO, ONSET >> DEP-IO >> NOCODA

Regarding the consonant clusters and epenthesis, the interaction of DEP-IO and NOCODA brings up an interesting conflict in their relative ranking. As is illustrated in the constraint hierarchy in (39), DEP-IO dominates NOCODA. This ranking seems to hold when epenthesis is minimal at the cost of closed syllables, as is illustrated in tableau (40). It is better to have less violations of DEP-IO with closed syllables than to insert more vowels: the candidate (a) is optimal in spite of more violation marks of NOCODA, because it fares better with regard to higher-ranked DEP-IO than the others.

(39) /cil-m-k-t/ → č́il.m***a***.k***i***t, *č́i.l***i***.m***a***.k***i***t ‘a breeze is blowing’

/cil-m-k-t/	DEP-IO	NOCODA
☞ a. cil.m***a***.k***i***t	a, i	**
b. ci.l***i***.m***a***.k***i***t	i, a, i!	*
c. ci.l***i***.m***a***.k***i***.t***i***	i, a, i!,i	

However, a problem arises where the epenthesis is not minimal: the constraint hierarchy, DEP-IO >> NOCODA, chooses a wrong candidate as optimal in this case, as shown in tableau (40). The candidate (40a) is wrongly chosen as a winner under the given ranking with less violation of DEP-IO than the other candidates, in spite of a more severe violation of NOCODA.

(40) /cal-q-m-q-t/ → cál.q***a***.m***a***.q***a***t, *cál.q***a***m.q***a***t ‘many are rolling’

/cal-q-m-q-t/	DEP-IO	NOCODA
☜ a. cal.q***a***m.q***a***t	a, a	***
(☹) b. cal.q***a***.m***a***.q***a***t	a, a, a!	**
c. ca.l***i***.q***a***.m***a***.q***a***t	i, a, a!, a	*

(☜ the wrong winner, ☹ the desired output)

To make matters worse, the situation does not improve by simply reversing the ranking of the two constaints, NOCODA and DEP-IO, in the constraint hierarchy, as is shown in the tableau (41). This time, we wrongly choose the candidate (c) as a winner over the desired optimal output (b), since the latter has one more violation mark of NOCODA by the initial closed syllable [cal].

(41) Non-minimal epenthesis: NOCODA >> DEP-IO ?

/cal-q-m-q-t/	NOCODA	DEP-IO
a. cal.q***a***m.q***a***t	***!	a, a
(☹) b. cal.q***a***.m***a***.q***a***t	**!	a, a, a
☜ c. ca.l***i***.q***a***.m***a***.q***a***t	*!	i, a, a, a

(☜ the wrong winner, ☹ the desired output.)

What needs to be done is to distinguish underlying vowels from epenthetic vowels, and allow only underlying vowels to head a closed syllable. This calls for the conjoined constraint of [DEP-IO&NOCODA]$_\sigma$, the conjunction of DEP-IO and NOCODA within a local domain of the syllable, proposed in the previous section. This is violated if and only if a vowel violates DEP-IO, and the syllable headed by the vowel violates NOCODA simultaneously. By definition, the conjoined constraint is ranked higher than the conjuncts. Tableau (42) shows the successful evaluation of /cal-q-m-q-t/ → [cál.q***a***.m***a***.q***a***t] by incorporating the conjoined constraint.

(42) [DEP-IO & NOCODA]$_\sigma$ >> DEP-IO >> NOCODA

/cal-q-m-q-t/	[DEP-IO & NOCODA]$_\sigma$	DEP-IO	NOCODA
a. ca$_1$l.q***a***$_2$m.q***a***$_3$t	a$_2$, a$_3$!	a$_2$, a$_3$	ca$_1$l, q***a***$_2$m, q***a***$_3$t
☞ b. ca$_1$l.q***a***$_2$.m***a***$_3$.q***a***$_4$t	a$_4$	a$_2$, a$_3$, a$_4$	ca$_1$l, q***a***$_4$t
c. ca$_1$.l***i***$_2$.q***a***$_3$.m***a***$_4$.q***a***$_5$t	a$_5$	i$_2$, a$_3$, a$_4$, a$_5$!	q***a***$_5$t

The candidate (42a) loses due to a fatal violation of the conjoined constraint, since both of the epenthetic vowels [a$_2$] and [a$_3$] are in a closed syllable. Each of the candidates (42b) and (42c) also incurs one violation of the conjoined constraint due to the final closed syllable [q***a***t]. Crucially though, they fare better than (42a). When they are on an equal footing with regard to the conjoined constraint, the candidate with a less violation of DEP-IO wins: the candidate (42b) is successfully chosen as an optimal output.

Two things need mentioning. First, in spite of the fact epenthesis is not minimal in Southeastern Pomo, the minimal epenthesis requirement does play a role. This is particularly clear when the candidates are tied with regard to the conjoined constraint, as is shown by the candidates (42b) and (42c). Second, the underlying vowel, [a_1] in the tableau (42), does not incur a violation mark of the conjoined constraint even in a closed syllable. This accounts for the asymmetry between epenthetic vowels vs. underlying vowels: only underlying vowels may appear in a closed syllable. It is better to have less epenthetic vowels, as long as the conjoined constraint is not violated. Underlying vowels do not violate the conjoined constraint even in a closed syllable, since they do not violate DEP-IO, and contribute to minimize the violation of DEP-IO. Epenthetic vowels, on the other hand, inevitably violate the conjoined constraint due to the violation of DEP-IO, and cannot appear in a closed CVC syllable. The difference between epenthetic and underlying vowels is readily accounted for in this analysis.

Now let us turn to the question of the final syllable. In (28) through (35), the final syllables are invariably closed, regardless of the fact that the final syllable is headed by an epenthetic vowel. In other words, epenthetic vowels occur in a closed syllable in spite of the violation of the conjoined constraint. This suggests that there is a stronger requirement forcing this violation. As proposed above, this is achieved by EDGE-INTEGRITY, which requires that the initial and the final segments of a word remain in their underlying positions.

The interaction of EDGE-INTEGRITY with other constraints, and its ranking with regard to the conjoined constraint in particular is given in (43). Notice that the candidate (43b) with an epenthetic vowel after the final consonant loses because of the fatal violation of EDGE-INTEGRITY, although it satisfies [DEP-IO & NOCODA]$_{\sigma}$. This, in turn, provides us with the constraint hierarchy, in which EDGE-INTEGRITY dominates [DEP-IO&NOCODA]$_{\sigma}$.

(43) EDGE-INTEGRITY >> [DEP-IO & NOCODA]$_\sigma$

/cal-q-m-q-t/ → cál.q***a***.m***a***.q***a***t, *cál.q***a***.m***a.***q***a***.t***i***

/cal-q-m-q-t/	EDGE-INT	[DEP-IO & NOCODA]$_\sigma$	DEP-IO	NOCODA
☞ a. ca$_1$l.q***a$_2$***.m***a$_3$***.q***a$_4$***t		a$_4$	a$_2$, a$_3$, a$_4$	ca$_1$l, q***a$_4$***t
b. ca$_1$l.q***a$_2$***.m***a$_3$***.q***a$_4$.***t***i$_5$***	*!		a$_2$, a$_3$, a$_4$, i$_5$	ca$_1$l

The relevant constraints and their ranking which account for epenthesis pattern in Southeastern Pomo are summarized in (44).

(44) Constraint Hierarchy in Southeastern Pomo

{EDGE-INTEGRITY, ONSET}
|
[DEP-IO & NOCODA]$_\sigma$
|
DEP-IO
|
NOCODA

3.5 Possible Alternatives

In this section, I go over possible analyses and a previous analysis of epenthesis in Southeastern Pomo and show that the proposed analysis using constraints is superior. In a derivational approach, epenthesis of a vowel would be handled by a rule inserting a vowel to support an unsyllabifiable consonant (cf. Broselow 1982, 1992, Itô 1986, 1989, Selkirk 1981, Steriade 1982). The epenthesis in Southeastern Pomo will be analyzed as follows: the syllabification applies to build CVC syllables, and then vowels are epenthesized to support the leftover consonants. To ensure that the final consonant is syllabified in the coda, it remains unsyllabified throughout the syllabification employing extrasyllabicity of the final consonant (cf. Itô 1986, 1989). After epenthesis, the final consonant is syllabified as the coda of the final vowel. This is summarized schematically in (45). Notice that epenthesis is analyzed by an ordered set of rules, such as Syllabification, Vowel epenthesis and Empty-C Deletion. The correct surface form is derivable in this analysis.

In spite of the apparent success of the derivational analysis in (46), it has an inherent problem: the theory on which it relies is too powerful. Note that the analysis is crucially dependent on the relative ordering of (CVC)$_\sigma$ syllabification at the pre-epenthesis stage and (CV)$_\sigma$ syllabification at the post-epenthetic stage. However nothing in the theory guarantees this order: this is a pure stipulation. We may well imagine the opposite case, such that in a hypothetical language (CV)$_\sigma$ syllabification applies to underlying vowels in a previous stage of syllabification, and (CVC)$_\sigma$ syllabification applies to epenthetic vowels at the later stage. However this type of epenthesis pattern is unattested as well as very unlikely (cf. Selkirk 1981, Broselow 1982).[11]

(45) Derivational analysis of Epenthesis: Southeastern Pomo

Underlying Representation /ca-l-q-m-q-t/ 'many are rolling'

(CVC)$_\sigma$ Syllabification[12]
Final consonant extrametricality
```
σ              Ex
/ | \          |
c a l  q m q   t
```

Vowel-Epenthesis
(CV)$_\sigma$ Syllabification
Final Consonant Adjunction
```
 σ     σ    σ     σ
/ | \  / \  / \   / | \
c a l q  a m  a  q  a  t
```

Surface Representation [cal.q***a***.m***a***.q***a***t]

---

[11] The so-called rime/coda style epenthesis as opposed to the onset style epenthesis does not have much bearing on the issue, since this does not mean that only epenthetic vowels are allowed in a closed syllable excluding the underlying vowels.

[12] Directional syllabification with a maximal template, either (C)CVC or CVC, is not a tenable analysis of the epenthetic pattern in Southeastern Pomo, in either a rule based analysis or a constraint based analysis (à la Itô 1989, Mester and Padgett 1994). Suppose that the syllabification in Southeastern Pomo goes Left-to-Right, and assume that the maximal syllable template is CCVC word initially and CVC word medially. The result will be *[cal.q***a***m.q***a***t]. In this case, the second syllable is realized as a closed syllable, which renders

In the constraint-based analysis proposed here, the fact that underlying vowels my appear in a wider context while epenthetic vowels can appear only in the unmarked structure is closely tied with the fact that epenthetic vowels are derived; this is captured in the grammar in a principled way via the constraint conjunction of a faithfulness constraint and a markedness constraint. Under this analysis, derived structures are more strictly regulated by the markedness constraint. The only possible scenarios in this analysis are either a markedness requirement is observed across the board, or it is observed more strictly by the derived structure, which is out of the jurisdiction of the faithfulness constraint. The third case, in which only underlying structure is more rigidly regulated excluding derived structure, cannot be expressed in the grammar.

In her analysis of Southeastern Pomo, Goodman (1990) proposes that the consonantal suffixes bring in a mora with them underlyingly as in (46a). The empty moras trigger the vowel epenthesis resulting in CV syllables in (46b). To ensure that the first syllable is closed in this case, she proposes a Syncope rule as in (46c), which deletes a vowel in an open syllable following a stressed syllable. The stranded consonant and its mora are resyllabified in the of the preceding stressed syllable.

(46) Goodman (1990)

a. Underlying representation

```
μ    μ   μ    μ      μ
/|
ca   l   q    m      q      (t)
```

b. μ→ CV Syllabification,
Epenthesis, Stress Rule

```
σ́     σ    σ    σ     σ     (Ex)
|     |    |    |     |      |
μ     μ    μ    μ     μ      |
/|    /\   /\   /\    /\     |
ca    l v  q v  m v   q v   (t)
```

---

a wrong output. The situation does not improve if we assume Right-to-Left syllabification, since it results in the same wrong output, *[cál.q***a***m.q***a***t].

c. Syncope

```
σ  → σ́ ___σ
≠
v
```

d. Resyllabification

```
  σ́     σ    σ    σ   (Ex)
  / \     |     |     |     |
 μ  μ   μ    μ     μ    |
 /|   |   /\    /\    /\    |
c a   l  q v  m v  q v  (t)
```

Although the analysis obviates the arbitrary well-formedness conditions on syllabification preceding and following epenthesis, the syncope rule does not hold across the board. First, underlying vowels do not undergo syncope even if they satisfy the structural description of the syncope rule. Thus disyllabic or tri-syllabic stems *do* have an unstressed vowel in an open syllable following the initial stressed open syllable as shown in (25) and (33). One example is repeated in (47). Note that syncope does not apply to this. Second, closed syllables are not restricted to the initial stressed syllables: they do appear word medially even when they are not stressed, as is shown by the third syllable [cuq] in (47). This shows that the crucial distinction to make is not stressed vs. unstressed syllables, but underlying vs. epenthetic vowels.

(47) /hulacu-q-m-t/ hú.la.cuq.m***a***t 'many are getting drunk'
*húl.cu.q***a***.m***a***t

Another problem with the analysis in (45) as well as in Goodman (1990) is how to deal with the final closed syllable even with an epenthetic vowel. The final consonant and the final syllable is treated separately from the rest, without any motivation. Extrasyllabicity of the final consonant is nothing but encoding the observation in the analysis. The systematic exceptional behavior of epenthetic vowels in the final position, that is, appearing in a closed syllable and patterning together with underlying vowels, is left unexplained. In the proposed constraint based analysis, this is nicely derived from EDGE-INTEGRITY, under which pressure, more marked syllable types are forcefully allowed in these particular positions, as a case of a general pattern in language, regardless of it being derived or underlying.

4. Conclusion: Edge-Integrity and Demarcation of Edges

This paper analyses the epenthesis patterns in two unrelated languages Karam and Southeastern Pomo. I showed that morphological structure plays a crucial role in determining epenthetic sites in both languages in that epenthesis is strictly morphological constituent internal: in Karam, the relevant morphological unit was the Stem, and in Southeastern Pomo, it was the Morphological Word (MWd).

I proposed that this pattern derived from the faithfulness requirement on the edges of segments of a morphological unit, which was implemented by the constraint EDGE-INTEGRITY. It requires that the relevant morphological unit preserve its integrity and constituency in phonology, by demarcating the edges. When it is suitably high ranking, the edge segments should be parsed in the underlying position of a corresponding prosodic unit.

The effect of EDGE-INTEGRITY is more readily observed at the right edge of a morphological unit, although it is a symmetrical requirement at both edges of a morphological unit, for NOCODA conflicts with EDGE-INTEGRITY. However the effect of EDGE-INTEGRITY was shown to be active at the left edge too. Karam provides a case in which ONSET conflicts with EDGE-INTEGRITY, in which case the latter dominates the former.

The critical role of this strong faithfulness requirement is further supported by the fact that unexpected marked syllable structures are allowed only at the edges: in Karam, onsetless syllables are allowed only in the initial position and closed syllables may appear only in the final position. In Southeastern Pomo, epenthetic vowels may appear in a closed syllable only word-finally. I have shown that this comes naturally from EDGE-INTEGRITY: syllable structure constraints are disrupted due to the strong requirement by EDGE-INTEGRITY. It is more important to parse underlying segments at the margins, even though this may result in a marked syllables structure, which is otherwise prohibited in the language.

What is the role of EDGE-INTEGRITY in phonology? I propose that it is a part of the general function of phonology, Edge-Demarcation, which demarcates morphological structure in phonology using phonological means. Phonology serves Morphology in the sense of Trubetzkoy (1939), in that phonological means are employed to mark a morphological constituency. This is achieved by various phonological means, ranging from demarcative stress, the distribution of features, and even thorough non-transparent phonological processes (Kang, to appear).

EDGE-INTEGRITY concerns the segments at the edges of a morphological unit: it requires that they be realized at the edge-most position invariantly throughout phonology, demarcating the beginnings and the endings of the relevant morphological unit. Constituent internal epenthesis in Karam and Southeastern Pomo exhibits the conflict between well-formed phonological structure vs. transparent morphological structure, where the conflict is resolved in such a way that phonological constraints are at hold at the edges of a morphological unit under the pressure of EDGE-INTEGRITY. It has been shown that the distribution of marked syllable types at the edges is restricted to the edge positions in general in both languages. The analysis using EDGE-INTEGRITY enables the unification of these apparently independent facts as derived from a general function of phonology, Edge-Demarcation.

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