Marginal phonology: Phonotactics on the edge[1]

ELLEN BROSELOW

Abstract

As has long been recognized, the isomorphism between word edges and word-internal syllable edges is far from perfect. This paper examines the fit between an Optimality-Theoretic account of edge/interior asymmetries, using position-specific faithfulness constraints to protect edges or interiors of morphological constituents, and the actual typology of attested edge/interior asymmetries. A detailed analysis of the Indonesian language Balantak, in which the first member of a CC cluster is severely restricted unless that first C is root-final, is compatible with the positional faithfulness account, but is problematic for accounts that explain greater freedom at edges solely in terms of licensing by higher prosodic structure or by phonetic context. I argue that a theory of edge/interior asymmetries must incorporate two possible functions of phonotactic restrictions: to facilitate recovery of segmental contrasts, and to facilitate the parsing of strings into morphemes.

1. Introduction: Edge-interior asymmetries

One argument for including the syllable in phonological representations appeals to parallels between medial phonotactics and the phonotactics of word

1. This work was supported by in part by NSF grant SBR-9729108 to the author and Daniel Finer and by funding from the Nederlandse Organisatie voor Wetenschappelik Onderzoek NWO. Portions of this paper were presented at the 8th Manchester Phonology Meeting, UK, May 2000, the 8th Biennial Workshop on Phonology, University of Utrecht, June 2000; 6th Annual SWOT (South Western Optimality Theory) Conference, USL Los Angeles, April 2001; and at SUNY Stony Brook, March 2001. I am grateful to those audiences, particularly Yoonjung Kang and Ricardo Bermudez-Otero, and to an anonymous reviewer for valuable comments and suggestions. Special thanks to Jon MacDonald for suggesting the title.

The Linguistic Review 20 (2003), 159–193 0167–6318/03/020-0159

margins. For example, Kahn (1976) argues that the word-internal consonant sequences judged possible by English speakers are just those that can be decomposed into a word-final coda and word-initial onset. Thus, restrictions on possible syllables provide a unified account of the unacceptability of word-final **tk#,* word-initial **#kp*, and word-internal **tkp.*

However, as has long been recognized, the isomorphism between word edges and word-internal syllable edges is far from perfect. Considering the match between left word edge and word-internal onsets, we find both Guhang Ifugao, where all words begin with consonants but word-internal syllables may lack onsets (Landman 1999), and the mirror image Axininca Campa, where word-initial vowels are possible but word-internal syllables begin only with consonants (Spring 1990, McCarthy and Prince 1993a, Kager 1999). Comparing the right edge of words with word-internal codas, we find both Diyari (McCarthy and Prince 1994, Landman 1999, Wiltshire 2003), in which words must end in vowels but internal codas are possible, and conversely, many languages that allow a wider range of structures at right edge than in word-internal preconsonantal position, including Kamaiurá (Everett and Seki 1985, McCarthy and Prince 1993a, Wiltshire 2003), Diola-Fogny (Sapir 1965, Ito 1986, Piggott 1999, Kager 1999), and Misantla Totonac (MacKay 1991).[2]

This lack of universal isomorphism between word margins and syllable margins has spawned a panoply of theoretical proposals, most of which focus on cases involving greater freedom at the right edges of words. The various proposals differ with respect to the three fundamental assumptions whose convergence makes asymmetry between word edges and syllable edges problematic: (i) that phonotactic constraints are a function of restrictions on syllable positions; (ii) that prosodic structure is strictly layered (Selkirk 1981, Nespor and Vogel 1986), with all segments contained within syllables; and (iii) that restrictions on syllable structure are uniformly applied, regardless of the position of the syllable in the word. Analyses of edge/interior asymmetries range from accounts that maintain all three assumptions by assuming abstract representations in which final consonants are onsets to a degenerate syllable (e.g., Kaye, Lowenstamm and Vergnaud 1990), to those that abandon the connection between syllables and phonotactics altogether, appealing to functional principles of perceptual salience (Steriade 1999, Blevins 2003). Between these poles are proposals that give up the assumption of strict layering, allowing consonants at edges to be extraprosodic or attached directly to the prosodic word (Steriade 1982, Ito 1986, Rubach and Booij 1990, Hung 1994, Goad and Brannen in press, among many others); or that abandon the uniform application of syllable

2. See Blevins (1995) for a summary of various patterns.

structure restrictions across the word by making special licensing provisions at word edge (Piggott 1999), or by incorporating positional faithfulness constraints that enforce greater faithfulness at constituent edges (alignment and anchoring, McCarthy and Prince 1993b and 1995b, Wiltshire 2003). These various treatments serve almost as a guidebook to the history of generative phonology, with a shift over time from focus on derivations in rule-based phonology to focus on representations in autosegmental phonology and on violable, interacting surface constraints in Optimality Theory. To date, no consensus has emerged as to the best account of edge/interior asymmetries, making this an area where examination of cross-linguistic variation may be useful in choosing among competing accounts.

In this paper, I examine the fit between the array of attested right edge/interior patterns and an Optimality-Theoretic account of phonotactics that uses position-specific faithfulness constraints to override the effects of otherwise high ranking coda markedness constraints. The focus is on two types of languages: those that allow coda consonants only at edges (CVCVC) or internally (CVCCV); and those that allow single consonants in both internal and edge codas (CVCCVC), but exhibit a greater range of place and/or manner contrasts in one position than in another. I begin in Section 2 with a brief survey of the types of relationships found between the right edges of words and the codas of word-internal syllables, and examine the match between the attested patterns and the patterns predicted by free ranking of coda markedness constraints, position-specific faithfulness constraints, and general faithfulness constraints. In Section 3, I present a case study of one language, Balantak, that exhibits a greater range of contrasts at the right edges of stems than elsewhere, a pattern that is problematic for accounts that tie the location of greater contrast solely to the edges of prosodic constituents or to phonetic context. Section 4 presents a comparison of alternative approaches to edge/interior asymmetries with respect to predictions concerning the location and type of greater contrast, and predictions for areas beyond phonotactics, such as the abstractness of representations, the weight of final consonants, and the expected infixation patterns. I conclude that a theory of phonotactics must recognize the role of phonotactic restrictions in facilitating the parsing of a string into morphemes (reflected in anchoring constraints), as well as in facilitating the recoverability of segmental contrasts.

2. Typology and constraints

We will first consider the match between the simplest type of markedness, the presence vs. absence of syllable codas. We begin with symmetrical patterns then move on to edge/interior asymmetries.

2.1. *Coda vs. no coda*

2.1.1. Symmetrical patterns (coda/no coda). For cases in which consonant sequences cannot form complex onsets, the standard assumption is that intervocalic CC sequences are divided into a coda followed by an onset.[3] If words consist simply of possible syllables, we therefore expect symmetry between word-final and preconsonantal positions. Languages maintaining such symmetry are indeed attested: Hawaiian and Zulu (Grijzenhout and van Rooy 2000), for example, have no consonant sequences and no word-final consonants, while Manam has both CC sequences and single word-final consonants (Piggott 1999).[4] We can describe the symmetrical possibilities in terms of the ranking of the familiar markedness constraint NoCoda (syllables must not have codas) with respect to the block of faithfulness constraints. These possibilities are outlined in the chart below. Where NoCoda outranks all faithfulness constraints (M≫F), all syllables are open; and where faithfulness constraints dominate NoCoda (F≫M), all occurring codas will be preserved:

(1) Symmetrical patterns, Interiors (I) vs. Right Edges (E)

	Inside	Edge	Language	Ranking	Syllable description
I = E	a. U V.CV *VC.CV	U V# *VC#	Hawaiian	NoCoda≫F	uniformly open
	b. U, M V.CV VC.CV	U, M V# VC#	Manam	F≫NoCoda	uniformly faithful (open or closed)
	c. M *V.CV VC.CV	M *V# VC#	—	—	uniformly closed

I know of no language corresponding to (1c), in which all syllables have codas. This gap is expected, since it would require a constraint favoring closed over open syllables in all positions. Such a constraint has been explicitly rejected on typological grounds (Prince and Smolensky 1993, Kager 1999).[5]

---

3. As a reviewer pointed out, another logical possibility is that one of the two consonants is ambisyllabic.
4. As discussed below, all codas in Manam, both word-internally and word-finally, are restricted to nasals, requiring another markedness constraint, Coda=Nas, ranked above faithfulness constraints.
5. Hammond (1999) proposes a constraint that requires all syllables to be bimoraic, and this constraint could have the effect of inducing codas if accompanied by a highranking constraint banning long vowels; however, the need for a constraint requiring uniform bimoraicity is not well established.

2.1.2. Asymmetrical patterns (Coda/NoCoda). Structures found at right edges are not always the same as those found in preconsonantal position. For example, Kamaiurá (Everett and Seki 1985, McCarthy and Prince 1993a), Luo, and Yucatec Maya (Harris and Gussmann 1998) have word-final consonants but no CC sequences anywhere. Conversely, Diyari (Austin 1981), Thargari (Klokeid 1969), Pitjantjatjara and PittaPitta (Wiltshire 2003), and Telugu and Italian (Harris and Gussmann 1998) have only vowel-final words, but do allow CC sequences within a word. And Yapese has no vowel-final words, but permits both open and closed syllables within a word (Jensen 1977, Piggott 1999).[6] Considering these patterns in terms of syllable structure markedness, we find the enforcement of stronger standards of markedness both at interiors and at edges:

(2) Right edge more marked
   a. Kamaiurá, Luo, Yucatec Maya
      (i) Final syllables: Coda possible
      (ii) Nonfinal syllables: Coda not possible
   b. Yapese
      (i) Final syllables: Coda required
      (ii) Nonfinal syllables: Coda possible

(3) Right edge less marked
   Diyari, Thargari, Pitjantjatjara, PittaPitta, Telugu, Italian
   (i) Final syllables: Coda not possible
   (ii) Nonfinal syllables: Coda possible

Asymmetries in edge/interior markedness can be induced by faithfulness or markedness constraints specific to position. I will assume the following:

(4) Position-specific constraints
   a. ANCHOR-R (GRW): A segment at the right edge of the grammatical word in the output has a correspondent at the right edge of the grammatical word in the input (no epenthesis or deletion at the edge; McCarthy and Prince 1995a).
   b. I-O CONTIGUITY: The correspondents of a contiguous input string must be contiguous in the output, and vice versa (no medial epenthesis or deletion; McCarthy and Prince 1994).
   c. FINAL-C: Prosodic words must end in consonants (McCarthy and Prince 1994).

6. Jensen (1977) points out that borrowed words (such as *doolaa* 'dollar') may end in long vowels.

Position-specific faithfulness constraints (ANCHOR and CONTIGUITY) mandate faithful realization of some portion of a constituent, either the edge or the interior. Ranking ANCHOR above the general markedness constraints would give us the Kamaiurá pattern, in which only edge syllables are immune to the NOCODA constraint:

(5) Kamaiurá pattern

	/CVCCVC/	ANCHOR-R	NOCODA	FAITH
a.	CVCCVC		**!	
b.	CVCV	*!		**
c. ☞	CVCVC		*	*
d.	CVCCV	*!	*	*

Normally, the ranking NOCODA>>MAX,DEP in Diyari would require all syllables to end in vowels, even if this requires deletion or insertion of segments. But if NOCODA is dominated by I-O CONTIGUITY, which forbids insertion or deletion inside a word, only final syllables can be forced to conform to the NoCoda requirement (McCarthy and Prince 1994):

(6) Diyari pattern

	/CVCCVC/	I-O CONTIG	NOCODA	FAITH
a.	CVCCVC		**!	
b.	CVCV	*!		**
c.	CVCVC	*!	*	*
d. ☞	CVCCV		*	*

A third source of asymmetry is (4c): FINAL-C; ranked above NOCODA, this derives the Yapese pattern, in which codas are not only allowed in word-final position (as in Kamaiurá), but are actually required in this position:

(7) Yapese pattern

	/CVCCVC/	FINAL-C	NOCODA	FAITH
a.	CVCCVC		**!	
b.	CVCV	*!		**
c. ☞	CVCVC		*	*
d.	CVCCV	*!	*	*

As Wiltshire (2003) argues, FINAL-C may be active on phrase edges, rather than word edges: the Atampaya dialect of the Australian language Uradhi requires phrase-final but not word-final or word-medial syllables to be closed.

We can now examine the fit between the patterns of asymmetrical syllable types predicted by free ranking of the constraints discussed to this point, and attested asymmetries. Logically possible patterns of open and closed syllables within a word are summarized in the following chart:

(8) Asymmetrical patterns, Interior Codas (I) vs. Right Edges (E)

		Structure inside word	Structure at word edge	Language	Ranking	Syllable description (by position in word)
I ⊂ E	a.	U V.CV *VC.CV	U,M V# VC#	Kamaiurá	Anchor ≫NoCoda ≫F	edge: open or closed; inside: open
	b.	M *V.CV VC.CV	U, M V# VC#	—	—	edge: open or closed; inside: closed
I ⊃ E	c.	U, M V.CV VC.CV	U V# *VC#	Diyari	Contig ≫NoCoda ≫F	edge: open; inside: open or closed
	d.	U, M V.CV VC.CV	M *V# VC#	Yapese	Final-C ≫F ≫NoCoda	edge: closed; inside: open or closed
I ≠ E	e.	U V.CV *VC.CV	M *V# VC#	?	Final-C ≫NoCoda ≫F	edge: closed; inside: open
	f.	M *V.CV VC.CV	U V# *VC#	—	—	edge: open; inside: closed

The chart in (8) shows three gaps. The lack of languages like (8b) and (8f) is expected in the absence of a constraint that would require all syllables to be closed in all positions. However, a potentially problematic gap in (8) is type (8e), which generally forbids closed syllables, but requires all words to end in consonants. A constraint set containing NoCoda and Final-C predicts that such a language should be possible, derived from the ranking Final-C ≫NoCoda≫F. It is of course difficult to determine whether the absence of a particular pattern represents a gap in the data set, an accidental gap in human languages, or an impossible pattern. If (8e) is not in fact a possible human language, this gap points to the need for a revision of the theory.[7] In

7. A reviewer suggests an alternative account in which NoCoda is replaced by a family of constraints relativized to prosodic domains and universally ranked NoCoda-PWd≫NoCoda-Ft≫NoCoda-Syll, following Wiese's (1996) similar treatment of Onset. This system

the absence of conclusive evidence, I will put this question aside to focus on accounting for attested patterns. At this point we turn to a different sort of asymmetry involving not the presence vs. absence of codas, but rather the range of contrasts found in coda segments.[8]

2.2. *Single C coda: Wider contrast vs. narrower contrast*

Even where languages allow codas in both word-internal and word-final syllables, markedness constraints specific to consonant sequences may induce asymmetries between the possible contrasts found in the different positions. For example, Rose (2000) proposes (following Vennemann 1972, among others) a constraint called SYLLABLE CONTACT, which requires that "the first segment of the onset of a syllable must be lower in sonority than the last segment in the preceding syllable" (Rose 2000: 401). High ranking of this constraint will rule out word-internal codas of low sonority, reducing manner contrasts in word-internal but not word-final codas. This pattern is exemplified by Eastern Ojibwa, in which internal CC is limited to nasal-stop or fricative-stop, while final consonants are unrestricted (Piggott 1999). Conversely, internal codas may show a wider range in place of articulation than word-final consonants, due to a constraint requiring sonorant-obstruent clusters to agree in place of articulation. Such a pattern is familiar, being attested in Japanese, in Selayarese (Mithun and Basri 1986), and in Lardil (Hale 1973), in which only word-final nasals have a single place of articulation, while internal coda nasals agree in place with a following consonant.[9] A similar pattern is found in the Western Australian language Martuthunira, which restricts final nasals to alveolar and palatal, but permits labial, velar, and lamino-dental nasals as the first member of a homorganic cluster (Dench 1995). We can therefore assume a constraint AGREEPLACE: nasals must share place with a following obstruent. Adding the

---

would predict that we should find another pattern, one that is to my knowledge also unattested: a language in which codas can appear in foot-initial syllables but not in foot-final ones, consistent with the ranking NOCODA-PWD, NOCODA-FT≫F≫NOCODA-SYLL. This would predict the existence of a language in which only alternate syllables can have codas. Interestingly, whether a syllable has a coda would be logically independent of whether the syllable is stressed, since in a language with iambic feet, it would be the stressed syllable that would be foot-final and therefore codaless.

8. Wiltshire (2003) points out that Leti requires phrase-final syllables, but not syllables in other positions, to be open. She accounts for this pattern with a constraint requiring phrase edges to align with a vowel. Following the approach above, we could account for this by relativizing the contiguity constraint to the phrase level.
9. The Selayarese pattern is often described as requiring that codas must be placeless; in such an account, the word-final velar nasal is placeless at some level of analysis (Piggott 1999).

syllable contact constraint and the nasal agreement constraint to our repertoire therefore predicts two types of contrast asymmetries:

(9) Asymmetrical patterns: Wider range of manners at right edge (E)

	Inside	Edge	Language	Ranking	Description
I ⊂ E (manner)	U V.CV VN.TV VS.TV	U,M V# VC#	Eastern Ojibwa	SyllContact ≫F ≫Coda Markedness	edge: more contrasts

(10) Asymmetrical patterns: Wider range of places in interior Codas (I)

	Inside	Edge	Language	Ranking	Description
I ⊃ E (place)	U, M V.CV VC.CV	U Vn# *Vm#	Lardil	AgreePlace ≫Coda Markedness ≫F	edge: fewer contrasts

We may find similar asymmetries with respect to constraints requiring agreement in voicing. For example, Catalan allows only voiced obstruents in coda, except that coda obstruents will agree in voicing with an immediately following voiced obstruent (Beckman 1998).

However, asymmetries induced by agreement constraints and syllable contact constraints do not exhaust the types of attested asymmetries. In Malayalam, the only word-final consonants are [m] and [n], but word-internal CC sequences may begin with other consonants (e.g., *cuřuļmuţi* 'curly hair' (Mohanan 1989)).[10] This situation is reminiscent of the Diyari case, in which Contiguity protects internal segments from the effects of markedness constraints. For Malayalam, we can assume that the relevant coda markedness constraint is the following:

(11) Coda=Nas: Codas must be nasal.

This constraint is obeyed in all positions in Manam, as discussed above, where it outranks all faithfulness constraints. The Malayalam asymmetrical pattern can be derived by ranking both the positional faithfulness Contiguity constraint and the featural faithfulness constraint Ident[Nasal] above Coda=Nas. For a medial coda, Contiguity rules out moving the nasal out of coda position, and Ident[Nas] prevents change to a non-nasal consonant:

10. Mohanan uses this fact, among others, to argue that internal consonant sequences comprise onsets (at surface level) in Malayalam. See Broselow, Chen, and Huffman (1997) for counterarguments, but see also Steriade (1999), who argues in favor of the onset analysis.

(12) Medial C protected

/VlmV/	CONTIG	IDENTNAS	CODA=NAS	MAX(C)
a. ☞ VlmV			*	
b. VnmV		*!		
c. VmV	*!			*

CONTIGUITY is irrelevant, however, to final non-nasals, leaving them subject to deletion (or insertion of a following vowel):

(13) Final C unprotected

/…Vl/	CONTIG	IDENTNAS	CODA=NAS	MAX(C)
a. …Vl			*!	
b. …Vn		*!		
c. ☞ …V				*

Thus, we can derive the wider/narrower contrast asymmetry from the ranking edge-specific faithfulness, featural faithfulness≫coda markedness, general faithfulness:

(14) Asymmetrical patterns: Wider range of manners in interior codas (I):

	Inside	Edge	Language	Ranking	Description
I ⊃ E (manner)	c. U, M V.CV VC.CV	U Vn# *Vt#	Malayalam	Contig, Ident[Nas]≫ ≫Coda Markedness, F	edge: fewer contrasts

Just as CONTIGUITY protects marked codas in internal positions, ANCHOR protects marked codas in final position. Therefore we predict the existence of cases in which final codas display a wider range of place and/or manner contrasts than internal codas, resulting from the ranking of ANCHOR and IDENT constraints over coda markedness constraints. The next section discusses such a case.[11]

11. An additional type of positional faithfulness, proposed by Beckman (1998), protects entire syllables in privileged positions. Beckman discusses a number of cases in which initial onsets, nuclei, and codas of word-initial syllables show a wider range of segment types than is seen in non-initial syllables. Thus, a constraint mandating faithfulness to word-initial syllables is one potential source of inventory asymmetries. Beckman does not propose a parallel constraint protecting final syllables, and indeed, it appears to be word-final consonants, rather than onsets or nuclei of word-final syllables, that enjoy privileged status.

3. Case study in wider right edge contrast: Balantak

Balantak, a member of the Saluan subgroup of Central Sulawesi languages of Indonesia, is of particular interest because it exemplifies another variable in edge/interior asymmetries: the location of wider contrast in Balantak is not the right edge of the word, but the right edge of the root.[12] The Balantak case will therefore be useful in comparing the predictions of different approaches to edge protection, such as those that tie contrast to prosodic constituency or to the recoverability of perceptual cues in particular phonetic contexts. My discussion of the phonotactics of Balantak relies mainly on the insightful accounts of Busenitz and Busenitz (1990, 1991) and Busenitz (1994), and on confirmation of their descriptions by Hasan Basri after consultation with native speakers of Balantak.

3.1. Balantak phonotactics

Comparing the range of consonants that occurs prevocalically with those that occur word-finally in Balantak, we see that word-final position is slightly more restrictive, disallowing voiced obstruents and glides:

(15) Balantak consonants

Prevocalic	Word-final
p, t, k, ʔ[13]	p, t, k, ʔ
b, d, g	(*b, d, g)
m, n, ŋ	m, n, ŋ
s, l, r, j, w	s, l, r (*j, w)

The set of consonants allowed in morpheme-internal codas, however, is much smaller. Morpheme-internally, all CC sequences consist of a nasal followed by a homorganic obstruent:

(16) Morpheme-internal: Homorganic nasal-obstruent

gampal	‘underlayer’
lense	‘empty’
pintuŋ	‘dark’
uŋgak	‘hornbill bird’

12. Himmelmann (1991) makes the same claim for another Central Sulawesi language, Totoli, which is a member of the Tomini-Tolitoli subgroup.
13. Glottal stop occurs intervocalically but not word-initially.

Arguing against an analysis of these nasal-obstruent sequences as single segments, Busenitz and Busenitz (1991: 31) claim that "the syllable break falls between the two consonants."

CC sequences across prefix-stem boundaries are also restricted to homorganic nasal-obstruent, a restriction supported by alternations. A nonhomorganic nasal-obstruent sequence is repaired by place assimilation of the nasal, as in (17):

(17) Prefix-root: Nasal-obstruent input

/piŋ+osoʔ/	[piŋ+osoʔ]	'wash hands (imperative)'
/niŋ+borek/	[nimborek]	'lied'
/saŋ+kau/	[saŋkau]	'one tree'
/miŋ+sapit/	[minsapit]	'hidden'
/saŋ+taaʔ/	[santaaʔ]	'one word'
/toŋ+giok/	[toŋgiok]	'unintentionally move'

When the prefixal nasal is followed by a sonorant, either the nasal is deleted, as in (18a), or a vowel is inserted between the nasal and the sonorant, as in (18b):

(18) Prefix-root: Nasal-sonorant input

a. Nasal deleted

/saŋ+wuras/	[sawuras]	'one seed'
/saŋ+loloon/	[saloloon]	'one thousand'
/miŋ+noa/	[minoa]	'to breathe' (B&B: 'to breath')

b. Vowel inserted

/mVŋ+roŋor/	[moŋoroŋor]	'to hear'
/mVŋ+juŋgot/	[muŋujuŋgot]	'to shake'

The choice of consonant deletion vs. vowel insertion depends on whether the prefixal vowel is fixed or is a copy of the stem vowel; insertion of a copy vowel is tolerated if vowel copy is independently required to fill in the vocalic portion of the prefix (see Pater 2002 for an analysis of these facts).

A third type of problematic CC sequence involves a prefix-final glottal stop followed by any consonant. In this case, the glottal stop is deleted:

(19) Prefix-root: Glottal stop-consonant input

/moʔ+aleʔ/	[moʔaleʔ]	'to garden'
/moʔ+tokol/	[motokol]	'to lie down'

When we turn our attention to root-suffix combinations, however, we find a significantly wider range of freedom in the first member of a CC sequence. In fact, any consonant, with the exception of voiced obstruents or glides, is possible in root-final position, regardless of the following context; the only prohibition is against two identical consonants:

(20) Root-suffix

a. Nasal-final roots

/laigan+ku/	[laiganku]	'my house'
/wuruŋ+ta/	[wuruŋta]	'our (inclusive) language'
/laigan+mai/	[laiganmai]	'our house'

b. Other C-final stems

/nuur+ku/	[nuurku]	'my coconut'
/siok+ta/	[siokta]	'our (inclusive) chicken'
/bantil+kon/	[bantilkon]	'inform (benefactive)'

c. Identical consonants

/susum+muu/	[susumuu]	'your (plural) fish'
/dampas+si/	[dampasi]	'(will be) free later'

The pronunciation of the sequences in (20a, b) is not confined to careful speech, according to Busenitz and Busenitz (confirmed by Hasan Basri in interviews with native speakers):

> Note that with these [consonant-initial] suffixes, sequences other than nasal-obstruent consonants occur across morpheme boundaries. Where nasal and non-homorganic sequences do occur, no assimilation has been noted in normal speech. (Busenitz and Busenitz 1991: 42)

In sum, then, we find an asymmetric distribution of possible contrasts in different positions:

(21) Summary

a. Morpheme-internal codas: Nasal sharing place with following obstruent.
   Codas in prefix: Nasal sharing place with following obstruent.
b. Root-final codas (word-final or not): Any consonant other than voiced stops or glides (except no identical adjacent Cs).

Because both word-final and root-final positions harbor a wider range of contrasts than are found elsewhere, Balantak provides a test case for distinguishing the typological efficacy of different accounts of right edge markedness.

3.2. Analysis

To account for Balantak phonotactics, we first require markedness constraints on coda position:

(22) Coda Constraints

a. NoCoda[VoiObs]: Codas must not contain voiced obstruents.
b. NoCoda[Glide]: Codas must not contain glides.
c. Coda=nas: Codas must be nasal.
d. NoCodaPlace: Codas must not have independent place.

The first two are undominated, but the constraints against non-nasal codas and codas with independent place are violated in root-final position. I assume that consonants are protected at right root edges by an Anchor constraint, ranked among the coda markedness constraints; this constraint refers specifically to the right edge of the root, requiring the root-final segment to be syllable-final as well:

(23) Anchor-R root, syll: The right edge of the root must coincide with the right edge of a syllable.
NoCoda[VoiObs], NoCoda[Glide] $\gg$ Anchor
$\gg$ Coda=Nas, NoCodaPl

3.2.1. Failure of place assimilation in stem-final position. Anchor is irrelevant to morpheme-internal and prefix-final codas, which are restricted to nasals sharing place with the following consonant:

(24) Hypothetical root /saŋtaaʔ/ *or* (actual) prefix + root:

/saŋ+taaʔ/ 'one word'	Anchor-R root, σ	MAX-C	No Coda Place	Ident Place
a. saŋ. t aaʔ vel cor			*!	
b. ☞ san.taaʔ[14] cor				*
c. san. taaʔ cor cor			*!	*
d. sa taaʔ		*!		

14. This form will tie with [saŋkaaʔ], while can be ruled out either by positional faithfulness (faithfulness to onset) or by stem faithfulness; see also Wilson (2001) for a targeted constraint approach to a similar problem in Diola-Fogny.

ANCHOR will crucially protect root-final nasals from deletion, or from insertion of a following vowel. If we also assume that ANCHOR enforces crisp alignment, in which association with the relevant syllable must be exclusive (Ito and Mester 1995), this constraint will also prevent the nasal from sharing the place features of the following consonant (25b, d):[15]

(25) root + suffix:

/wuruŋ+ta/ 'our (incl.) language'	ANCHOR-R (CRISP) ROOT, SYLL	MAX-C	NO CODA PLACE	IDENTPLACE
a. ☞ wuruŋ. ta vel cor			*	
b. wuru n.t a cor	*!			*
c. wurun. ta cor cor			*	*!
d. wuruŋ. ka vel	*!			
e. wuru. ta	*!	*		

Even if the nasal changes its place features to match the place of the following consonant, as in (25c), it still violates the constraint that forbids a nasal from being sole owner of any place feature, and therefore the most faithful candidate, (25a), wins.

3.2.2. Tolerance of nonnasal consonants in root-final position. The next fact to account for is the occurrence of nonnasal consonants in root-final position, since elsewhere, the only possible CC sequences are nasal-obstruent. If IDENT[NAS] outranks CODA=NAS and DEP, MAX, preconsonantal nonnasal consonants inside a morpheme will be deleted or will have a vowel inserted after them:

15. But see Bakovic and Keer (2000) for arguments that crisp alignment predicts unattested contrasts in syllabification.

(26) Hypothetical root

/gasta/	ANCHOR-R ROOT, SYLL	ID[NAS]	CODA=NAS	DEP, MAX	NOCODA [PLACE]	ID[PLACE]
a. gasta			*!		*	
b. ☞ gata, gasata				*		
c. ganta		*!			*	

But a root-final nonnasal (whether word-final or before a consonant-initial suffix) will be protected from deletion or vowel insertion by ANCHOR, and from nasalization by IDENT[NAS], leaving retention of the final consonant as the best option:

(27)

/wuras/ 'seed'	ANCHOR-R ROOT, SYLL	ID[NAS]	CODA=NAS	DEP, MAX	NOCODA [PLACE]	ID[PLACE]
a. ☞ wuras			*		*	
b. wura, wurasa	*!			*		
c. wuran		*!			*	

3.2.3. Tolerance of nasal-sonorant across root-suffix boundary. A further oddity of root-final consonants is that they may be followed by a sonorant, whereas elsewhere nasals may be followed only by obstruent consonants. Again, the proper ranking of ANCHOR and faithfulness constraints with respect to the relevant markedness constraint will serve to shut off avenues to change for a root-final nasal, though not to nasals in other positions:

(28) Hypothetical root

/sanlon/	ANCHOR-R ROOT, SYLL	IDENT[SON]	*NAS-SON	MAX(C)
a. saŋ.lon			*!	
b. ☞ salon				*

(29) Prefix + root

/saŋ+loloon/ 'one thousand'	ANCHOR-R ROOT, SYLL	IDENT [SON]	*NAS-SON	MAX(C)
a. saŋloloon			*!	
b. ☞ saloloon				*

(30) Root + suffix

/laigan+mai/ 'our house'	ANCHOR-R ROOT, SYLL	IDENT [SON]	*NAS-SON	MAX(C)
a. ☞ laigan mai			*	
b. laigamai	*!			
c. laiganbai		*!		

3.2.4. Tolerance of final nasals in suffixes. The rankings developed above serve to protect root-final place and manner contrasts, while narrowing down codas within a morpheme and at the right edge of a prefix to nasals lacking independent place specification. However, we do find place contrasts among word-final nasals; the Balantak inventory includes suffixes ending in both [n] and [m], violating NOCODAPLACE. However, if DEP and MAX are ranked above NOCODAPLACE, a nasal in absolute final position has no option but to have an independent place specification, assuming that a placeless nasal is unpronounceable. Thus, the best option is to keep the original specification of the suffix nasal:

(31) Root+suffix

/tatapi+kon/ 'wash, benefactive'	ANCHOR-R ROOT, SYLL	CODA =NAS	DEP(V), MAX(C)	NOCODA PLACE	IDENT PLACE
a. ☞ tatapikon				*	
b. tatapiko, tatapikono			*!		
c. tatapikoŋ				*	*!

3.3. Summary

We have seen that the wider range of contrasts in stem-final consonants can be described as an effect of the ranking of Anchor constraints with other constraints. A stem-final consonant is protected from deletion, from vowel insertion, and from assimilation via place-sharing by high-ranked ANCHOR. Because all coda place is prohibited, there is no advantage to changing the place of root-final consonants, and change of manner is prohibited by high-ranking manner identity constraints. Consonants in prefixes and within morphemes are not so protected, and markedness constraints therefore restrict codas in positions other than root-final to nasals sharing place with a following obstruent. We should note that the greater range of contrasts in root-final vs. prefix-final consonants could not be derived via the ranking ROOTFAITH ≫ AFFIXFAITH, since it is only segments at the edge of the root that are privileged: codas within the root are subject to the same stringent constraints as prefixal codas.

Because ANCHOR is a constraint ranked among other constraints, it need not protect all possible consonants at right edge. Indeed, it must be ranked below the constraints banning final voiced obstruent codas (there are no roots like hypothetical [*wurad, *wuraw]) and sequences of identical obstruents. Similarly, because a root-final consonant forms an onset to a following vowel, ANCHOR must be ranked above DEP(C) to prevent the realization of /CVC+V/ as the well-aligned but unfaithful [CVC.CV].

The ANCHOR constraint therefore provides an account of the rather complex phonotactic patterns of Balantak, including the greater freedom at the right edge of stems. In the following section I outline alternative approaches, and consider how they fare in describing the range of possible edge/internal asymmetries.

4. Alternative approaches: The nature of edge protection

To this point I have developed an account of edge/interior asymmetries in Balantak that relies on an Anchor constraint to prevent right edge segments from being moved out of edge position. However, this is but one of many ways to account for right edge freedom. In this section I will compare various proposals and try to tease apart their differences, particularly with respect to typological predictions. We can identify three major classes of approaches:

(i) Positional Faithfulness Approaches: The Anchor approach outlined above confers immunity to otherwise general markedness constraints on segments at edges. This immunity to markedness appears to be a property of final segments, not of final syllables, since the onsets and nuclei of word-final segments do not appear to enjoy special privileges (in contrast, Beckman 1998 argues that we often find greater possibilities for contrast in all members of word-initial syllables). Non-OT positional faithfulness approaches are also possible, such as the ‘remote licensing’ of Piggott (1999) which allows prosodic word edges to license segments that violate general restrictions on coda position.

(ii) Representational approaches: These approaches assume representations that put final consonants outside the province of general coda constraints. Final consonants have variously been analyzed as onsets to following (phonetically unrealized) vowels (Kaye, Lowenstamm and Vergnaud 1990, Goad and Brannen in press, etc.); as outside the prosodic structure entirely, at least at presurface levels (as in, e.g., Ito 1986); as attached directly to higher constituents such as the prosodic word (Steriade 1982, Hung 1994, Rubach and Booij 1990, among others); or as members of syllable appendices or minor syllables (McCarthy 1979, Bye and de Lacy 2000, among others).

(iii) Perceptual Cue Approaches: A third approach to right edge freedom is to give up the assumption that phonotactic restrictions have their source in abstract prosodic structure. On this account, phonotactic patterns reflect the fact that contrasts are more likely to be found in contexts in which they are most perceptible: the cues for consonantal contrasts are more salient before a vowel or resonant consonant than before an obstruent (Steriade 1999, Blevins 2003). Thus, what has traditionally been labelled onset position (prevocalic or preresonant) is simply the position where consonantal contrasts are most likely to be perceived; what has traditionally been labelled coda position (preconsonantal) is the position where cues to contrast are obscured. The asymmetry between interior coda position and word-final position is therefore not a problem for this account– rather, it is expected, because phonetic cues are presumably more easily recovered in final position than before a following consonant.

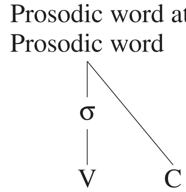
The Balantak case is potentially a good one for teasing apart the different analyses of right edge freedom. First, because the range of stem-final consonants in Balantak is more restricted than the range of onsets (voiced obstruents and glides occur only prevocalically), the hypothesis that final consonants are onsets to unrealized vowels is not a good fit for this case (see Piggott 1999 for similar arguments for some other languages). Second, because the location of greater freedom in Balantak is the edge of a morphosyntactic constituent, rather than a prosodic constituent, this case is difficult for accounts that link freedom to the edges of prosodic words. Furthermore, because a wide range of contrasts in Balantak are licensed at the end of a stem, regardless of phonetic context, this case does not lend itself to a pure perceptual cue licensing approach. In the following sections I will compare the different approaches to edge/interior asymmetries in terms of their predictions concerning the location and type of contrasts. I will also consider predictions beyond phonotactics, such as the sorts of grammar they presuppose (for example, grammars involving abstract representations or more than two levels of representation), and the functional motivation for particular types of position-sensitive constraints.

4.1. *Location of protected contrasts*

Free ranking of markedness, faithfulness, and position-specific faithfulness Anchor constraints predicts the possibility of languages allowing a greater range of contrast at the edges of words or stems than are permitted in word-internal codas (Kamaiurá, Balantak). Similarly, the position-specific CONTIGUITY constraint predicts the possibility of a greater range of contrasts in internal codas (Diyari, Malayalam). In this section I compare the Anchor account with alternative approaches to edge/interior asymmetries.

4.1.1. Licensing by prosodic word and location of contrast. Perhaps the most prevalent representational analysis of right edge freedom assumes that final consonants may be licensed not only by the syllable, but also by some higher level prosodic constituent (Steriade 1982, Hung 1994, McCarthy 2002, and many others):

(32) Prosodic word attachment



This analysis leads us to expect a greater range of freedom at the edges of prosodic constituents, but not inside prosodic constituents. The CVCCV pattern instantiated in Diyari, Thargari, Pitjantjatjara, PittaPitta, Telugu, and Italian will therefore require some alternative explanation. Furthermore, because it is higher prosodic structure that licenses edge segments, we should not expect to find greater contrast at the edges of morphosyntactic constituents such as stem. In contrast, accounts based on alignment and anchor constraints may refer to the edges of both morphosyntactic and prosodic constituents. Thus, because the location of greatest freedom in Balantak is the edge of the stem, not the prosodic word, this case appears problematic for the PWd licensing account, unless it can be demonstrated that the edge of the stem is also the edge of the prosodic word. I will now consider (and reject) that possibility.

The first question to ask is whether the edge of a stem in Balantak is necessarily coterminous with the edge of a prosodic constituent. An obvious place to look for evidence in favor of this hypothesis is the stress system; if we find that suffixes fall outside the domain of stress, while prefixes fall inside the stress domain, we could reasonably conclude that the unit prefix+stem constitutes a prosodic word.

In fact, the stress facts argue for the opposite conclusion. Balantak stress is quite regular. In single morphemes the penultimate syllable bears stress, with a secondary stress falling on each alternate syllable to the left of the penult. Suffixes fall inside the stress domain, as in (33b):

(33) Penultimate stress

a. Single morphemes

wúruŋ	'language'
líŋkoŋ	'fern'
bakókoʔ	'machete'
kaʔápu	'cook'
mòroʔóne	'male'
bòlusúkon	'durian'

b. Stem+Suffix

wurúŋ+ta	'our (incl.) language'
kaan+ón+ku	'eaten by me'

In contrast, a single prefix receives stress, even when it falls directly before the main stressed syllable, leading to contrasts between monomorphemes and prefix plus stem combinations:

(34) Prefixal Stress

σ+σσ

nìm+béla 'wounded'

vs. monomorphemes *bakókoʔ* 'machete'; *wurúŋ+ta* 'our (incl.) language'

With a sequence of prefixes, secondary stress falls on the penultimate syllable counting from the rightmost prefix (vowel sequences, Busenitz and Busenitz (1991: 31) argue, are heterosyllabic). Prefixal stress may interfere with the general pattern of alternating stress, producing both clashes and lapses:

(35) Prefix sequences

a. σ+σ+σσσ

nò+ton+tokúi 'castrated' (**notòntokúi*)

b. σ+σ+σσ+σ

màm+pa+paté+i 'to try to get' (**mampàpatéi*)

As Busenitz and Busenitz (1991: 30–31) point out, these facts suggest that prefixes define a prosodic word domain: "On verbal forms, a single prefix, or a combination of prefixes together, function, for stress purposes, as independent – but more weakly stressed – PW's." Therefore, if we expect to find greater freedom of contrast at any point, it would be the right edge of the prefix, rather than the right edge of the stem. Busenitz and Busenitz explicitly note the discrepancy between the phonotactics and the stress facts:

> In the matter of stress, prefixes rather than suffixes, function more like words; however, we will note in the discussion of morphophonemics below that prefixes have phonotactic restrictions similar to those found intramorphemically while (some) suffixes exhibit features like those found across word boundaries. (Busenitz and Busenitz (1991: 45, Note 5))

This discrepancy is a problem for accounts that attempt to tie phonotactic generalizations to prosodic constituency, as well as for stratal accounts allowing different rankings at different levels. In a stratal analysis we might assume a grammar of the following sort, in which markedness is enforced in Level 1 (with CodaMarkedness as a cover term for constraints determining possible coda consonants) but overridden in Level 2 by higher ranked faithfulness constraints:[16]

(36) Stratal analysis

Level 1:	Stems, and Stems with Prefixes
	CodaMarkedness $\gg$ Faith
Level 2:	Suffixes
	Faith $\gg$ CodaMarkedness

While it would be possible in such an account to assign prefix stress at Level 1 and stress to stem+suffix(es) at Level 2, this would leave the phonotactics as the sole argument for these levels. Thus, the Balantak facts are problematic for accounts that link edge asymmetries solely to prosodic structure.

4.1.2. Perceptual cue licensing and location of contrast. The perceptual cue approach predicts greater contrast in positions in which the phonetic context makes cues to contrast most recoverable. One of the most attractive features of this approach is that it ties the expression of particular contrasts to the positions in which they will be most salient. It includes a hierarchy of positions that favor the realization of consonantal contrasts whose cues lie mainly in their release: the most favorable position is prevocalic, followed by pre-resonant consonant, followed by word-final. Such contrasts are least likely to be maintained preceding an obstruent. However, while most positions are characterized by their phonetic context, word-final position is not: in fact, word-final consonants may well be followed by obstruents in connected speech. Therefore, cue licensing must admit grammatical factors as well as phonetic factors.

16. I am grateful to Ricardo Bermúdez-Otero for suggesting this analysis to me.

The CVCCV pattern of Diyari and other languages is problematic for the cue licensing approach. And the Balantak case is clearly incompatible with an account that relies solely on phonetic context, because stem-final consonants occur in precisely the same phonetic contexts as the more restricted set of morpheme-internal consonants. This is in fact simply a more obvious manifestation of the problem of word-final consonants, and suggests that the maintenance of contrast may be phonologized, with grammatical context playing a role alongside phonetic context.

It is indeed possible to protect stem-final consonants in a perceptual cue licensing analysis of Balantak, by means of high-ranked Output-Output constraints that demand correspondence between the suffixed and nonsuffixed forms. Thus, we could assume that stem-final consonants, even those followed by a suffixal consonant, are privileged by their correspondence to forms in which the stem-final consonant occurs in word-final position:

(37) /wuruŋ+ta/

base: [wuruŋ]	IDENT Place/_V	O-O [place]	NOCODAPLACE	IDENT PLACE
a. ☞ wuruŋta			*	
b. wurunta		*!		*
c. wuruŋ-ka	*!			*

However, once reference to grammatical structure is built in to the perceptual cue approach, it becomes difficult to distinguish this from the Anchor approach in terms of empirical coverage of phonotactic distributions.[17]

The functional motivation of the perceptual cue licensing approach is quite clear: segments are sequenced in ways that facilitate recoverability of segmental contrast. The Anchor approach, in contrast, can be understood as responding to a different functional motivation: segments are sequenced in ways that facilitate identification of word and/or morpheme boundaries. Balantak listeners, for example, should readily identify a *kt* sequence as not only necessarily heteromorphemic, but as necessarily spanning either two words, or a stem plus suffix (see McQueen 1998 for evidence that listeners make use of this sort of knowledge in parsing continuous speech). Both factors (the need to recover both segmental and morphological information) undoubtedly play a role in language, and the ideal model must reflect both.

17. One possible empirical difference is that the perceptual cue approach requires that the stem be able to occur in absolute final position, unsuffixed (that is, in a position in which the cues for the final consonant are recoverable). This prediction is not shared by the Anchor approach, which requires only that the stem edge coincide with a syllable edge. Unfortunately, I did not have access to sufficient data to test this hypothesis.

4.2. Types of protected contrasts

4.2.1. Featural faithfulness vs. segmental faithfulness. The typology developed in Sections 2 and 3 includes a wide range of possible edge/interior asymmetries. The obvious question to ask is whether there is any pattern that is not predicted by the ranking of ANCHOR/CONTIGUITY with respect to general markedness and faithfulness constraints.

It is important to note first of all that we have been assuming a specific type of positional faithfulness, one which demands that a segment at some input position have a correspondent at some output position. These constraints alone do not specify whether particular features of these correspondents must be identical. However, additional sorts of positional faithfulness are possible: specifically, IDENTITY constraints demanding faithful realization of a particular feature in a particular position. As Steriade (1999) points out, such constraints may make unfortunate predictions. For example, if a language has the familiar M≫F pattern, where the markedness constraint bans [+aspirated] segments, then aspiration contrasts will be suppressed in all positions. However, if we allow edge-specific featural faithfulness constraints such as IDENT[ASP](RIGHT EDGE), free ranking of this constraint predicts languages in which an aspiration contrast is possible only at the right edge. This counterintuitive pattern would arise from the familiar asymmetry ranking of (position-specific)F≫M≫F:

(38) Final aspiration with EdgeFaith

	/pʰokʰotʰ/	IDENT[ASP]-RIGHTEDGE	*[ASP]	IDENT[ASP]
a.	pʰokʰotʰ		**!*	
b. ☞	pokotʰ		*	**
c.	pokot	*!		***

Thus, allowing edge faithfulness constraints that refer to specific features predicts that edges may exhibit a contrast that is suppressed in all other positions, both onsets and codas. In contrast, as Steriade points out, the perceptual cue approach would explicitly connect the nature of a contrast with the positions in which it is most salient, disallowing aspiration contrasts in final position unless such contrasts are also attested in positions where the contrast is more recoverable.

This is indeed a compelling argument. However, note that the typology developed above, which includes anchor and contiguity constraints but no position-specific identity constraints, avoids this type of overgeneration. Anchor constraints cannot by themselves protect edge segments from general segment markedness considerations: ANCHOR does not care whether a segment is aspirated or unaspirated, just so long as it is present at the right edge. If *[ASP] is ranked above IDENT[ASP], aspirated segments will not surface, regardless of the ranking of ANCHOR:

(39) Final aspiration with ANCHOR

	/$p^h ok^h ot^h$/	ANCHOR-R STEM, SYLL	*[ASP]	IDENT[ASP]
a.	$p^h ok^h ot^h$		*!**	
b.	$pokot^h$		*!	**
c. ☞	pokot			***
d.	poko	*!		**

Thus, it is impossible to protect a contrast at right edge that is suppressed in all other positions, both onset and coda, so long as we avoid constraints that demand featural identity at edges.[18]

4.3. *Predictions beyond phonotactics*

4.3.1. The nature of representations. The different approaches to accounting for edge/interior asymmetries are embedded in particular models of the grammar which potentially have far-ranging consequences beyond the area of phonotactics. For example, the assumption that final consonants are onsets entails fairly abstract surface representations containing unpronounced segments. The assumption that final consonants are extraprosodic relies on multiple levels of representation, assuming that pronounced segments must at some level be incorporated into prosodic structure. Both these accounts are incompatible with models like standard OT, which assumes only two levels of representation: inputs and surface representations that hug the phonetic ground fairly closely.

Analyses in which final consonants may attach directly to the prosodic word also make a fairly strong prediction about possible representations: they make possible a contrast between consonants contained within a syllable and extrasyllabic consonants. For example, a word-final consonant in a language like English would presumably be contained in a syllable coda, while a word-final consonant in Kamaiurá, which has no word-internal codas, would be extrasyllabic. Independent evidence for a contrast between coda consonants and extrasyllabic word-final consonants (that is, independent of phonotactics) is hard to come by (though see Piggott 1999, Goad and Brannen in press).

18. See Prince and Tesar (1999) and Zoll (1998) for discussion of other potentially problematic aspects of featural positional faithfulness constraints.

One potential independent argument for extrasyllabicity comes from languages in which final consonants are weightless. Thus, word-final consonants in Egyptian Arabic do not count for the purposes of stress assignment, and because Egyptian Arabic also allows two consonants at the right edge of a phrase, but not in phrase-internal codas, we might conclude that these two facts are a reflection of the same phenomenon, the extrasyllabicity of right edge consonants. However, right edge freedom and lack of final consonant weight are not necessarily correlated. Levantine Arabic dialects, for example, allow no consonant sequences at right edge, but still assign no independent weight to final consonants (Broselow, Chen, and Huffman 1997). Therefore, the existence of final weightless consonants does not necessarily argue for extraprosodicity.

A potentially compelling argument for extraprosodicity, however, involves contrasts that we have not considered, in which the number of consonants at word edges exceeds the number of consonants permitted in internal syllable margins (as in English, Hammond 1999). In representational analyses, these 'extra' consonants may be extraprosodic or occupy degenerate syllables or appendices. A positional faithfulness approach can account for 'extra' consonants that arise as a result of suffixation (through a combination of positional faithfulness constraints and morpheme realization constraints), but monomorphemic cases are more difficult. Any complete analysis of edge/interior asymmetries will need to take these cases into account, though they are beyond the scope of this paper. I now turn to areas beyond phonotactics, which may, I argue, provide arguments for the positional faithfulness approach.

4.3.2. Infixation. In this section I consider a particular pattern of affixation, illustrated by Kamaiurá, in which the reduplicant appears as a suffix after a vowel-final stem and as an infix before a stem-final consonant:

(40) Kamaiurá PreFinalC pattern
(Everett and Seki 1986, McCarthy and Prince 1993b):

a.	*ohuka*	ohuka-*huka*	'he laughed/he kept laughing'
b.	*apot*	apo-*apo*-t	'I jump/I jump repeatedly'
		(*apot-*apot*)	

Because Kamaiurá is a also a language which allows codas only in word-final position, it is tempting to ascribe both these facts to the same cause: final consonants are outside the core prosodic structure. These facts would then constitute evidence for an extrasyllabic analysis of final consonants. However, as McCarthy and Prince (1993a) have pointed out, we would expect final consonant extraprosodicity to hold across all processes of the language; thus, all suffixes should manifest the PreFinalC pattern. But in fact, final consonants in a language may typically function as extraprosodic for some suffixes and some processes but not for others. Nor is there a necessary correlation between placement of an affix before the final consonant and greater range of contrasts at the right edge (Chamorro, for example, has the first but not the second).

McCarthy and Prince (1993a, b) analyze the PreFinalC pattern as an effect of the ranking of phonological markedness constraints above constraints on morpheme position, such as RIGHTMOST, which requires the reduplicative affix to be realized at the right edge of the word:

(41) Infixation as Markedness ≫ Edgemost (McCarthy and Prince 1993)

	/ohuka+RED/	NOCODA	RIGHTMOST
a. ☞	ohuka-*huka*		
b.	ohuk-*huk*-a	*!	*
	/apot+RED/		
c.	apot-*apot*	**!	
d. ☞	apo-*apo*-t	*	*

The infixed reduplicant *apo-apo-t* incurs fewer violations of NOCODA than the suffixed form *apot.-apot.*with complete reduplication. (The form *apo.t-a.pot.*, in which the stem-final consonant syllabifies as onset to the reduplicative suffix, can be ruled out by high-ranking SYLLABIC ROLE, which requiring corresponding segments in the base and reduplicant to occupy the same syllabic position. This constraint is violated by *apo.t-a.pot.* because [t] is an onset in the the stem and a coda in the suffix.)

An alternative analysis of this infixation pattern, however, would compel infixation by a high-ranked ANCHOR constraint requiring the right edge of the stem to coincide with the right edge of a syllable, or a prosodic word – that is, just the sort of anchor constraint we used to derive right edge phonotactic freedom. This constraint is satisfied under suffixation to a vowel-final stem, as in *ohuka-huka.* But with a consonant-final stem, infixing reduplication provides the best means of satisfying both anchoring constraints and phonological well-formedness:

(42) Infixation as ANCHOR≫EDGEMOST

	/ohuka +RED/	ANCHOR-R STEM, SYLL	NOCODA	RIGHTMOST
a. ☞	ohuka-*huka*			
b.	ohuk-*huk*-a		*!	*
	/apot+RED/			
c.	apot.-*apot.*		**!	
d.	apo.t-*apot.*	*!		
e. ☞	apo-*apo*-t.		*	*

The positional faithfulness account would then connect right edge phonotactic freedom with the PreFinalC infixation pattern, in that both would be an effect of ranking ANCHOR above other constraints.

We should note that an Anchor account of infixation is required independently, since infixation sometimes produces structures that are *more* marked than would be produced by affixation at the edge. In Choctaw, for example, the passive morpheme is realized as an infixed [l]. In words beginning with a vowel, the affix appears after that vowel. In consonant-initial words, the affix also occurs after the vowel, triggering insertion of a copy vowel to create well-formed syllables (McCarthy and Prince 1995b):

(43) Choctaw passive (McCarthy and Prince 1995b)

	Active	Passive	
a.	abani	albani (*labani)	'to barbeque'
b.	hokči	holokči	'to plant'

Note that the account of infixation as phonological markedness≫edgemost constraints does not go through in this case. Prefixation of [l] to vowel-initial words would clearly result in a syllabically better-formed word. There is also no clear phonological motivation for infixation of the passive morpheme in consonant-initial forms, since the infix cannot be incorporated into a syllable unless a vowel is inserted – and there is no obvious reason why it should be better to insert a vowel inside the stem, rather than at the beginning: **lohokči* would fare equally well in terms of syllabic well-formedness, and better in terms of contiguity. Facts like these, then, appear to demand an account of infixation in terms of anchoring (though in this case, it is anchoring of the stem to the edge of the prosodic word):

(44) Infixation as ANCHOR≫EDGEMOST

	/l+abani/	ANCHOR-L STEM, PWD	*COMPLEX MARGIN	LEFTMOST (-L- AFFIX)	NOCODA	DEP(V)
a.	labani	*!				
b. ☞	albani			*	*	
c.	abanil			**!***	*	
	/l+hokči/					
d.	lohokči	*!			*	*
e. ☞	holokči			**	*	*
f.	hokčil			***!**	**	

Thus, cases like the Choctaw passive argue that at least some infixation must be a result of at least some sorts of anchoring constraints (see also Ussishkin 1999).

We now return to Balantak, which, like Kamaiurá, has greater freedom at right edges than in internal codas. Balantak also exhibits the PreFinalC infixation pattern. The second person possessive morpheme attached to a vowel-final stem yields a copy of the final vowel followed by [m]:

(45) Balantak 2nd singular possessive: Vowel-final stems

a.	tama	tama-*am*	'your father'
b.	tambue	tambue-*em*	'your green beans'
c.	kopi	kopi-*im*	'your coffee'

With stems ending in a consonant, however, the second person possessive is marked by a copy vowel preceding the final consonant:

(46) Balantak 2nd singular possessive: Consonant-final stems

a.	sarat	sara-*a*-t	'your foot'
b.	wewer	wewe-*e*-r	'your water'
c.	witis	witi-*i*-s	'your calf (of leg)'

Busenitz and Busenitz (1991) argue that vowel sequences are heterosyllabic, pointing out that there are no restrictions on sequences of vowels, and that words with VV sequences, such as *óe* 'rattan' and *káan* 'to eat,' satisfy the requirement that words be minimally disyllabic. Thus, forms like (45a) *tama-am* can be syllabified so that the stem-final vowel is also syllable-final. This would not be true for a VC suffix attached to a consonant-final stem, however, which is presumably why (46a) *sara-a-t* is preferred to a suffixed candidate **sarat-am*.

There is, however, one class of consonant-final stems which do take the suffixed form of the second person possessive: stems ending in glottal stop:

(47) Balantak 2nd singular possessive: Stems ending in [ʔ]

a.	*aleʔ*	*aleʔ*-em	'your garden'
b.	*waaʔ*	*waaʔ*-am	'your ear infection'
c.	*oriiʔ*	*oriiʔ*-im	'your poles'

If the glottal stop is syllabified as an onset to the suffix-initial vowel, these forms violate the ANCHOR-R (STEM, SYLLABLE) constraint. But according to Busenitz and Busenitz (1991), glottal stop can never be an onset. Glottal stop never occurs word-initially, and "when a single consonant occurs intervocalically, native speaker intuition views this consonant as an onset for the following vowel . . . The only exception is the glottal consonant. It alone seems to function as closure for the preceding vowel" (Busenitz and Busenitz 1991: 31). Thus, since stem-final glottal stop must syllabify with the preceding vowel, glottal-final stems pattern with vowel-final stems in terms of satisfying ANCHOR:

(48)	a.	Vowel-final:	ta.ma.]*am.*	'your father'	(tama+2PS)
	b.	Oral C-final:	sa.ra.*a*t.]	'your foot'	(sarat+2PS)
			*sa.ra.t]*am*		
	c.	Glottal-final:	a.leʔ.]*em.*	'your garden'	(aleʔ+2PS)

The reader is referred to Broselow (2001) for a complete analysis of these facts (and to Pater (2002) for an alternative analysis).[19]

The cooccurrence of right edge freedom and PreFinalC infixation in Kamaiurá and Balantak suggests that this infixation pattern might be more likely in languages in which the phonotactics establish a high rank for ANCHOR-R. Of course, neither PreFinalC nor right edge freedom necessarily implies the presence of the other, since the first is a reflection of ANCHOR≫EDGEMOST, and the second of ANCHOR≫coda constraints. However, we might expect to find some statistical correlation, since by transitivity of ranking, evidence for ranking ANCHOR above ConstraintX also constitutes evidence that ANCHOR outranks all constraints dominated by X. Therefore, subtle constraint interactions might in fact be sufficient to place ANCHOR above both coda constraints and edgemost constraints.

One additional question to consider involves the typological predictions of the ANCHOR ≫ EDGEMOST account of infixation. McCarthy and Prince (1993a) point out that the Markedness ≫ EDGEMOST account of infixation predicts that no morpheme with a segmentally specified shape can have the PreFinalC distribution, because PreFinalC placement of a fixed shape morpheme cannot improve phonological markedness. In the *apo-apo-t* case, for example, infixation allows us to avoid NOCODA violations only because the shape of the reduplicant depends on the shape of that portion of the stem to which it is adjacent. In contrast, the ANCHOR≫EDGEMOST account predicts that the PreFinalC pattern should be possible for one fixed suffix shape, VCV:

19. Pater ascribes the fact that glottal stop allows suffixation to the transparency of glottal stop with respect to copying. On this account the fact that glottal stops cannot be onsets is unconnected to the fact that glottal-final stems allow suffixation, while other consonant-final stems require infixation.

(49) ANCHOR-R≫EDGEMOST

	hypothetical /ohuka+imi/	ANCHOR-R STEM, SYLLABLE	NOCODA, ONSET	RIGHTMOST
a. ☞	ohuka.imi		*	
b.	ohuki.mi.a.		*	*!
	/apot+imi/			
c.	apo.ti.mi	*!		
d. ☞	apo.i.mit.		**	*

This does indeed seem like a counterintuitive result, though of course we cannot rule out the possibility that such a pattern exists in some language. Note that for this pattern to emerge, however, we need a conjunction of numerous factors: it is crucial first, that the alignment constraint outrank phonological markedness constraints, and second, that faithfulness constraints outrank markedness; otherwise, we would expect to see simplification of VCV to decrease markedness, giving for example *ohukami, apotmi*.

To summarize the discussion thus far, we have seen that the analysis of right edge consonants as extrasyllabic would lead us to expect that all suffixes in a language with right edge freedom should exhibit the PreFinalC distribution pattern. This is, as McCarthy and Prince (1993a) have pointed out, clearly too strong a prediction. In contrast, the anchoring account connects PreFinalC with right edge freedom causally, but does not predict that they must cooccur, only that the probability of their cooccurrence is probably somewhat greater than chance.

It is not clear that the perceptual cue approach makes any predictions about the PreFinalC pattern. In fact, it is difficult to explain the PreFinalC pattern by reference to perceptual salience of contrasts: because the position in which most consonant contrasts are heard most easily is prevocalic, there is no apparent advantage to infixation in *apo-apo-t* as opposed to suffixation in **apot-apot*.

4.4. Summary

The chart below summarizes the different predictions of three representative approaches to right edge freedom. The positional faithfulness approach assuming Anchor constraints allows a greater range of contrasts at the right edges of constituents (either morphosyntactic or prosodic). As we have seen, Balantak exemplifies this pattern.

(50) Predictions of different approaches

	Positional faithfulness assuming anchor constraints	Representational assuming PWd attachment	Perceptual cue assuming no C contrast before obstruent
location of right edge markedness	edges of morphosyntactic or prosodic constituents	edges of higher prosodic constituents	before vowel, resonant, or word boundary
type of right edge markedness	protects against deletion at edges; featural change possible depending on ranking of Ident constraints	protects against deletion and featural change at edges	protects against deletion and featural change in phonetic contexts that maximize perceptual salience of particular features

5. Conclusion

I have examined asymmetries in the range of contrasts found at edges and in interiors of words and stems, with particular attention to cases in which the right edge allows greater freedom than is found in preconsonantal positions before a consonant. I identified three families of approaches to the problem of these asymmetries: one which maintains uniform syllable structure but enforces greater faithfulness at constituent edges, one which assigns a representation in which final consonants are not in coda position, and one which looks to phonetic context rather than prosodic structure for the explanation of phonotactics. These different approaches represent different schools of thought in phonology, ranging from reliance on formal representations to appeal to functional principles. The Balantak data suggest that our theory must allow for protection of contrast not only at the edges of prosodic constituents, or in phonetically favorable contexts, but also at the edges of morphosyntactic constituents such as stems. This makes good functional sense: the preservation of marked sequences at morpheme boundaries should facilitate the parsing of speech. Ultimately, any theory of phonotactics must recognize two functions served by constraints limiting the possible sequencing of segments: to facilitate the recoverability of segmental contrasts, and to facilitate the decomposition of the speech stream into morphemes.

Stony Brook University

References

Austin, Peter (1981). *A Grammar of Diyari, South Australia*. Cambridge: Cambridge University Press.

Bakovic, Eric and Ed Keer (2000). Review of Rene Kager, Harry van der Hulst, and Wim Zonneveld (eds.), *The Prosody-Morphology Interface*. *Phonology* 17: 484–494.

Beckman, Jill (1998). Positional Faithfulness. Ph.D. dissertation, University of Massachusetts at Amherst. GLSA: Amherst, MA.

Blevins, Juliette (1995). The syllable in phonological theory. In *The Handbook of Phonological Theory,* J. Goldsmith (ed.), 206–244. Cambridge, MA and Oxford, UK: Blackwell Publishers.

— (2003). The independent nature of phonotactic constraints: an alternative to syllable-based approaches. In *The Syllable in Optimality Theory*, Caroline Féry and Ruben van de Vijver (eds.), 375-404. Cambridge: Cambridge University Press.

Broselow, Ellen (2001). Uh-oh: Glottal stops and syllable organization in Sulawesi. In *Surface Syllable Structure and Segment Sequencing*, Elizabeth Hume, Norval Smith, and Jeroen van de Weijer (eds.), 77–90. Leiden: Holland Institute of Generative Linguistics.

Broselow, Ellen, Su-I Chen, and Marie Huffman (1997). Syllable weight: convergence of phonology and phonetics. *Phonology* 14: 47–82.

Busenitz, Robert L. (1994). Marking Focus in Balantak. In *Studies in Sulawesi Linguistics, Part III*, R. van den Berg (ed.), 1–15. NUSA: Linguistic Studies of Indonesian and Other Languages in Indonesia 36.

Busenitz, Robert L. and Marilyn J. Busenitz (1990). "Balantak [language text]." In *Sulawesi language texts,* Barbara Friberg (ed.), 7–22. Language Data, Asian-Pacific Series, 15. Ujung Pandang: Summer Institute of Linguistics.

— (1991). Balantak phonology and morphophonemics. In *Studies in Sulawesi Linguistics, Part II*, J.J. Sneddon (ed.), 29–47. NUSA: Linguistic Studies of Indonesian and Other Languages in Indonesia 33.

Bye, Patrick and Paul de Lacy (2000). Edge asymmetries in phonology and morphology. In Ji-Yung Kim and Masako Hirotani (eds.), *Proceedings of NELS 30*.

Dench, Alan (1995). *Martuthunira: A Language of the Pilbara Region of Western Australia. Pacific Linguistics* C-125. Canberra: The Australian National University.

Everett, Daniel and Lucy Seki (1985) Reduplication and CV skeleta in Kamaiurá. *Linguistic Inquiry* 16: 326–330.

Goad, Heather and Kathleen Brannen (in press). Syllabification at the right edge of words: Parallels between child and adult grammars. In *Issues in the Phonetics–Phonology Interface: Selected Papers from the Fourth HIL Phonology Conference*, Jeroen van de Weijer, Vincent van Heuven, and Harry van der Hulst (eds.). Amsterdam: John Benjamins.

Grijzenhout, Janet and Bertus van Rooy (2000) Second language phonology: Acquisition through gradual constraint demotion. Ms, Heinrich-Heine-Universität, Düsseldorf and Potchefstroomse Universiteit vir CHO, South Africa.

Hale, Kenneth (1973). Deep-surface canonical disparities in relation to analysis and change: An Australian example. *Current Trends in Linguistics* 11: 401–458.

Hammond, Michael (1999). *The Phonology of English: A Prosodic Optimality-Theoretic Approach.* Oxford: Oxford University Press.

Harris, John and Edmund Gussmann (1998) Final codas: why the west was wrong. In *Structure and Interpretation. Studies in Phonology*, E. Cyran (ed.), 139–162. Lublin: Folium.

Himmelmann, Nikolaus (1991). Tomini-Tolitoli sound structures. In *Studies in Sulawesi Linguistics, Part II,* J. J. Sneddon (ed.), 49–70. NUSA: Linguistic Studies of Indonesian and Other Languages in Indonesia, 33.

Hung, Henrietta (1994). The rhythmic and prosodic organization of edge constituents. Ph.D. dissertation, Rutgers University.

Itô, Junko (1986). Syllable theory in prosodic phonology. Ph.D. dissertation. GLSA: University of Massachusetts at Amherst.

Itô, Junko and Armin Mester (1995). Realignment. In *The Prosody-Morphology Interface*, René Kager, Harry van der Hulst, and Wim Zonneveld (eds.), 188–217. Cambridge: Cambridge University Press.

Jensen, John Thayer (1977). *Yapese Reference Grammar*. Honolulu: University of Hawaii Press.

Kahn, Dan (1976). Syllable-based generalizations in English phonology. PhD dissertation, MIT.

Kaye, Jonathan, Jean Lowenstamm, and Jean-Roger Vergnaud (1990). Constituent structure and government in phonology. *Phonology* 7: 193–231.

Kiparsky, Paul (1999). Paradigm effects and opacity. Ms., Stanford University.

Klokeid, Terry (1969). *Thargari Phonology and Morphology. Pacific Linguistics B-12.* Canberra: The Australian National University.

Landman, M. (1999). Morphological contiguity. Unpublished paper, University of Massachusetts at Amherst.

MacKay, Carolyn (1991). A grammar of Misantla Totonac. Unpublished doctoral dissertation, The University of Texas at Austin.

McCarthy, John (1979). On stress and syllabification. *Linguistic Inquiry* 10: 443–466.

— (2002). Optimal paradigms. ROA-485.

McCarthy, John and Alan Prince (1993a). Prosodic morphology I: Constraint interaction and satisfaction. Ms., University of Massachusetts at Amherst and Rutgers University.

— (1993b). Generalized alignment. In *Yearbook of Morphology 1993*, Geert Booij and Jaap van Marle (eds.), 79–153. Dordrecht: Kluwer.

— (1995a). Faithfulness and reduplicative identity. In *Papers in Optimality Theory. University of Massachusetts Occasional Papers in Linguistics 18*, Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk (eds.), 160–164. Amherst, MA: Graduate Linguistic Student Association.

— (1995b). Prosodic morphology. In A *Handbook of Phonological Theory*, John Goldsmith (ed.), 318–366. Cambridge, MA and Oxford, UK: Blackwell Publishers.

McQueen, James (1998). Segmentation of continuous speech using phonotactics. *Journal of Memory and Language* 39: 21–46.

Mohanan, Tara (1989). Syllable structure in Malayalam. *Linguistic Inquiry* 20: 589–625.

Nespor, Marina and Irene Vogel (1986) *Prosodic Phonology.* Dordrecht: Foris.

Pater, Joe (2002). Assimilation triggers metathesis in Balantak: Implications for theories of possible repairs in OT. Handout of talk presented at Cornell University.

Piggott, Glyne L. (1999). At the right edges of words. *The Linguistic Review* 16: 143–185.

Prince, Alan and Bruce Tesar (1999). Learning phonotactic distributions. Rutgers Optimality Archive.

Rose, Sharon (2000) Epenthesis positioning and syllable contact in Chaha. *Phonology* 17: 397–425.

Rozali, Latif, Asri Hente, Darwis Mustafa, and Ny. Nurhayati P. (1992). *Struktur Bahasa Balantak.* Jakarta: Pusat Pembinaan dan Pengembangan Bahasa, Departemen Pendidikan dan Kebudayaan.

Rubach, Jerzy and Geert Booij (1990). Edge of constituent effects in Polish. *Phonology* 7: 121–158.

Sapir, J. David (1965). *A Grammar of Diola-Fogny*. Cambridge: Cambridge University Press.

Selkirk, Elisabeth (1981). On the nature of phonological representation. In *The Cognitive Representation of Speech,* J. Anderson, J. Laver, and T. Meyers (eds.), 379–388. Amsterdam: North Holland.

Smolensky, Paul, Lisa Davidson, and Peter Jusczyk (2001). The initial and final states: Theoretical implications and experimental explorations of Richness of the Base. Rutgers Optimality Archive.

Spring, Cari (1990). Implications of Axininca Campa for prosodic morphology and reduplication. PhD dissertation, University of Arizona.

Steriade, Donca (1982). Greek prosodies and the nature of syllabification. PhD dissertation, MIT.

— (1999). Alternatives to syllable-based accounts of consonantal phonotactics. In *Proceedings of the 1998 Linguistics and Phonetics Conference*, O. Fujimura, B.D. Joseph, and B. Palek (eds.), 205–242. Prague: The Karolinum Press.

Tesar, Bruce and Alan Prince (1999). Learning phonotactic distributions. ROA-353.

Ussishkin, Adam (2000). Fixed prosodic effects in Austronesian: an Optimality-Theoretic account. In *Proceedings of the Austronesian Formal Linguistics Association* [AFLA], Miriam Klamer (ed.), 259–270. Amsterdam: Vrije Universiteit.

Vennemann, Theo (1972). On the theory of syllable phonology. *Linguistische Berichte* 18: 1–18.

Wiese, Richard (1996). *The Phonology of German*. Oxford: Oxford University Press.

Wilson, Colin (2001). Cluster neutralization and targeted constraints. *Phonology* 18: 147–197.

Wiltshire, Caroline (2003). Beyond codas: Word- and phrase-final alignment. In *The Syllable in Optimality Theory*, Caroline Féry and Ruben van de Vijver (eds.), 254–270. Cambridge: Cambridge University Press.

Zoll, Cheryl (1998). Positional asymmetries and licensing. Rutgers Optimality Archive, ROA-282.