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WEIGHT-BY-POSITION BY POSITION *

ABSTRACT. This paper proposes an Optimality-Theoretic (Prince and Smolensky 1993) account of variable closed syllable weight. It is shown here that contextually-dependent weight, as Hayes (1994) calls it, is a consequence of simultaneously comparing monomoraic and bimoraic parses of closed syllables for constraint satisfaction. The weight of closed syllables is a consequence of constraint interaction that determines the moraicity of coda consonants. These constraints are shown to conflict with higher ranking metrical constraints leading to contextually-dependent weight.

Two types of constraint interaction are discussed here: (1) closed syllables are light, but contextually heavy to satisfy some higher ranking constraint and (2) closed syllables are heavy, but are contextually light for the same reason. The behavior of closed syllables with respect to the constraint hierarchy is contrasted with the behavior of vowels in the same context. The independent behavior of long vowels and closed syllables is shown here to follow from the different Correspondence constraints (McCarthy and Prince 1995) that determine the weight of vowels and closed syllables.

0. INTRODUCTION

Cross-linguistically, closed syllables vary with respect to their contribution to stress assignment. In Moraic Phonology, McCarthy and Prince (1986) attribute the heaviness of closed syllables to the moraicity of the coda consonant, which, along with the vowel, makes the syllable bimoraic. Languages in which closed syllables are light do not have moraic codas and so closed syllables pattern with monomoraic syllables. As McCarthy and Prince note, the weight of closed syllables contrasts with the inherent heaviness of long vowels, which are bimoraic. The difference between syllables with long vowels and those with coda consonants is characterized by Hayes' (1989) Weight-by-Position which assigns a mora to a coda consonant. In languages with Weight-by-Position closed syllables pattern with

* We thank John McCarthy for many helpful comments and suggestions. This paper has also benefitted from discussions with Stuart Davis, Beth Hume, Greg Lamontagne, David Odden, Alan Prince, and Cheryl Zoll. Also, a special thanks to Michael Kenstowicz and the NLLT reviewers for their comments and suggestions. We also wish to thank audiences at Indiana University, University of Iowa, and University of Massachusetts. This research was partially supported by postdoctoral fellowship #752-93-0421 from the Social Science and Humanities Research Council of Canada.

Natural Language and Linguistic Theory **17:** 499–540, 1999.

long vowels, and in languages without Weight-by-Position closed syllables pattern with short, open (monomoraic) syllables.

(1)

Language	*Light*	*Heavy*
Mongolian, Huasteco	CV, CVC	CV:
Latin, Choctaw	CV	CVC, CV:

The assignment of Weight-by-Position has been considered parametric (Hayes 1989, Goldsmith 1990, Zec 1995), thus eliminating the possibility of variable closed syllable weight within a single language. However, such variation is reported in Yupik (Rice 1988, 1993; Hayes 1994, 1995) and English (Kager 1989). Context-dependent weight, as Hayes calls it, is particularly problematic for a parametric view of Weight-by-Position since it requires reference to specific contexts. Making Weight-by-Position context-sensitive misses a generalization since it fails to reveal any connection between particular contexts and weight assignment. A parametric or rule-based approach is therefore descriptive at best.

The problem of variable closed syllable weight disappears with the Parallelism assumption of Optimality Theory (Prince and Smolensky 1993), which requires simultaneously comparing monomoraic and bimoraic parses of closed syllables for constraint satisfaction. The weight of closed syllables is, in general, a consequence of the interaction of independently motivated constraints which determine the moraicity of coda consonants. Context-dependent weight is due to more complex interactions involving metrical constraints. For example, the constraint hierarchy is best satisfied by, say, the bimoraic parse in a particular environment when the monomoraic parse in that same environment violates some higher ranking metrical constraint. Away from the pressure of the higher ranking constraint, the monomoraic parse best satisfies the constraint ranking.

Two types of constraint interactions are discussed here: (1) closed syllables are light, but contextually heavy to satisfy some higher ranking constraint and (2) closed syllables are heavy, but contextually light to satisfy some higher ranking constraint. The influence of a metrical constraint on the weight of the coda consonant is an example of what Prince and Smolensky (1993) call “anti-bottom-up” construction since a metrical constraint influences a syllable structure constraint in violation of the prosodic hierarchy. It will be shown that this is easily accounted for in an Optimality-Theoretic analysis where different metrifications and syllabifications are compared simultaneously.

The behavior of closed syllables with respect to the constraint hierarchy is contrasted with the behavior of vowels in the same context. The hierarchy that leads to contextually heavy closed syllables does not necessarily lead to contextually long vowels. The independent behaviors of open and closed syllables are shown here to follow from metrical constraints interacting with constraints that determine the length of vowels and the weight of closed syllables.

This paper begins with an analysis of syllable weight in Optimality Theory. The difference between vowel length and consonant weight, which is crucial here, is shown to follow from the interaction of different constraints. Contextual heaviness and lightness are examined in the two sections that follow. The paper concludes with a discussion of the typological variation that arises from the interaction of the constraints pertaining to weight and metrical structure.

1. Syllable Weight in Optimality Theory

Syllable weight is the consequence of the interaction of constraints that determine the weight of vowels and coda consonants. Vowels are underlyingly moraic (Hyman 1985; Hayes 1989; Pulleyblank 1994), whereas coda consonants are moraic by satisfying syllable wellformedness constraints (Sherer 1994; Zec 1995). This difference between vowels and coda consonants means that the two types of moraic segments are sensitive to different constraint interactions. Since a vowel's mora is part of the underlying representation, it is evaluated for input/output faithfulness in terms of Correspondence (McCarthy and Prince 1995), which captures faithfulness by requiring every segment of the input to have a correspondent in the output and vice versa. Although Correspondence constraints apply to segments, McCarthy (1995) extends Correspondence to weight (see also Hammond 1997; Sprouse 1996). This means that the distribution of weight in the output corresponds as faithfully as possible to the distribution in the input. The following weight Correspondence constraint is used here.

(2) WT-IDENTITY: (McCarthy 1995)
Monomoraic input vowels are monomoraic in the output.
Bimoraic input vowels are bimoraic in the output.

WT-IDENTITY ensures that the weight of a vowel in the input is identical to the vowel's weight in the output. This faithfulness constraint interacts with the syllable structure constraint No Long Vowels (NLV), a prohibition against bimoraic vowels (Rosenthall 1997). A language has long vowels due to WT-IDENTITY dominating NLV, as shown in (3a). A language with only short vowels has the reverse ranking shown in (3b).

(3) a. Language with long vowels
WT-IDEN » NLV, /CV:CV/

	WT-IDEN	NLV
CV.CV.	*!	
☞ CV:.CV.		*

b. Language without long vowels
NLV » WT-IDEN, /CV:CV/

	NLV	WT-IDEN
☞ CV.CV.		*
CV:.CV.	*!	

Of course, an input like /CV:CV/ would never be posited for a nonalternating surface form like [CV.CV.] in a language without long vowels. This is an example of Stampean Occultation (see Prince and Smolensky 1993 and Itô et al.'s (1995) Lexical Optimization).

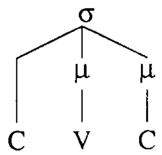
The weight of closed syllables, following Sherer (1994), is due to conflict between a constraint that demands weight for codas and a constraint prohibiting coda weight. Sherer proposes $^*\mu$/CONSONANT as the constraint that prohibits a moraic coda consonant and *APPEND(to-σ) as the constraint that prohibits a coda consonant linked directly to the syllable node, thus prohibiting weightless codas.[1] The interaction of these constraints provides the two types of closed syllable weight (see Broselow et

[1] Moraic codas in some languages are limited to consonants of a certain degree of sonority. Zec (1988, 1995) proposes that moraic consonants follow from subset relations based on the sonority hierarchy, i.e., liquids $\subset$ nasals $\subset$ obstruents. A language with moraic nasals must have moraic liquids, but not necessarily vice versa. In Optimality Theory, Zec's subset relation can be interpreted as a harmony scale (along the lines of Prince and Smolensky's Harmonic Nucleus Scale): μ/liquid $>$ μ/nasal $>$ μ/obstruent. This scale states that moraic liquids are more harmonic than moraic nasals which are more harmonic than moraic obstruents. This harmony scale can be inverted into a constraint ranking: $^*\mu$/obstruent $\gg$ $^*\mu$/nasal $\gg$ $^*\mu$/liquid. Since languages with restrictions on moraic codas are not discussed here, this scale is characterized as $^*\mu$/CONSONANT.

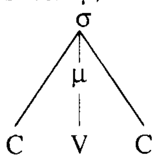
al., 1997 for an alternative representation of nonmoraic coda consonants).[2] To illustrate this, consider the following candidates for the input /CVC/.

(4) Constraints for Syllable Codas:
*μ/CONS: no moraic coda consonants
*APPEND: no nonmoraic syllable appendix

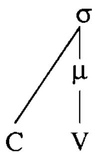
a. satisfies: *APPEND — violates: *μ/CONS



b. satisfies: *μ/CONS — violates: *APPEND



c. satisfies: *APPEND, *μ/CONS — violates: MAX-IO



A language in which closed syllables are light, (4b), prohibits moraic codas, that is, *μ/CONS dominates *APPEND. Conversely, a language in which closed syllables are heavy, (4a), has the reverse ranking so surface violations of *μ/CONS occur at the expense of satisfying *APPEND. The absence of coda consonants altogether is due to satisfying *APPEND and *μ/CONS, and violating Max-IO since there is a segment in the input that is not in the output. The constraint rankings required for the optimality of

[2] Based on duration studies of closed syllables, Broselow et al. propose that a coda consonant in a light, closed syllable shares a mora with the preceding vowel, whereas a coda in a heavy syllable is linked to a separate mora. The monomoraicity of a closed syllable is ensured by NOSHAREDMORA, which is similar in function to *APPEND(to-σ). Sherer (1994) proposes a family of *APPEND constraints: *APPEND(to-μ), *APPEND(to-σ), and *APPEND(to-PrWd). NOSHAREDMORA is the same as *APPEND(to-μ). Since no phonetic claims are being made about subphonemic timing in syllables here, we are assuming the more traditional representations for light and heavy syllables as a matter of execution.

each case in (4) are shown in (5). Moraic coda consonants are indicated by bold in all tableaux.

(5) a. CVC is heavy

*APPEND » *μ/CONS, /CVC/

		*APPEND	*μ/CONS
(4a) ☞	CV**C**		*
(4b)	CVC	*!	

b. CVC is light

*μ/CONS » *APPEND, /CVC/

		*μ/CONS	*APPEND
(4a)	CV**C**	*!	
(4b) ☞	CVC		*

c. no CVC

*μ/CONS, *APPEND » MAX-IO, /CVC/

		*μ/CONS	*APPEND	MAX-IO
(4c) ☞	CV			*
(4a)	CV**C**	*!		
(4b)	CVC		*!	

The use of constraint interaction to determine coda weight does not affect coda markedness as discussed by Prince and Smolensky since a coda consonant, moraic or not, always incurs a constraint violation. An input like /CVCV/ is always optimally parsed as [CV.CV.] regardless of the ranking of *μ/CONS and *APPEND.

(6) ONSET, *μ/CONS, *APPEND, /CVCV/

		ONSET	*μ/CONS	*APPEND
☞	CV.CV.			
	CV**C**.V.	*!	*	
	CVC.V.	*!		*

Open syllables are obligatory in every language, whereas the presence of closed syllables is determined by one of the constraint rankings in (5).

2. Contextually Heavy Syllables

This section considers cases where closed syllables are generally light, but heavy under certain conditions. The variable weight of closed syllables is shown to follow from the ranking in (5b) interacting with other constraints. In brief, the ranking in (5b), as shown, leads to nonmoraic codas. A higher ranking constraint $\mathbb{C}$ that dominates (5b) leads to variable weight by the following interaction. If a candidate violates *APPEND and the higher ranking $\mathbb{C}$, the $^*\mu$/CONS violation is most harmonic, as in (7a). However, if all candidates of an input tie with respect to $\mathbb{C}$, as in (7b), the candidate with $^*\mu$/CONS violation is fatal and the *APPEND violation is most harmonic.

(7) a. $\mathbb{C}$ » *μ/CONS » *APPEND, /input$_i$ /

	$\mathbb{C}$	*μ/CONS	*APPEND
cand$_1$	*!		*
☞ cand$_2$		*	

b. $\mathbb{C}$ » *μ/CONS » *APPEND, /input$_j$ /

	$\mathbb{C}$	*μ/CONS	*APPEND
☞ cand$_1$			*
cand$_2$		*!	

Variable weight occurs as a consequence of conflict between a metrical constraint $\mathbb{C}$ and the constraints determining the weight of the coda. Interactions with the four constraints in (8) are discussed.

(8) EDGEMOST: (Prince and Smolensky 1993)
Main stress lies at the left/right edge of the word.

NONFINAL: (Prince and Smolensky 1993)
The head foot of the prosodic word must not be final.

FOOTBINARITY (FTBIN): (Prince and Smolensky 1993)
Feet are binary at some level of analysis (μ, σ).[3]

WEIGHT-TO-STRESS PRINCIPLE (WSP): (Prince 1990)
If heavy, then stresssed.

The ranking schema in (7) is shown to account for the distribution of heavy closed syllables in Chugach, Goroa, Eastern Ojibwa, and Mongolian,

[3] FOOTBINARITY, as used here, does not distinguish between Mester's (1994) maximal and minimal bimoraicity of feet.

which all have closed, heavy syllables arising from the influence of a metrical constraint.[4] Chugach and Goroa are examples of languages with heavy closed syllables as a consequence of satisfying the EDGEMOST constraint. Eastern Ojibwa and Mongolian are examples of contextually heavy closed syllables to satisfy NONFINAL and FOOTBINARITY, respectively.

2.1. *Satisfying* EDGEMOST

The analysis of closed syllable weight in the Pacific Yupik dialect of Chugach (Leer 1985) relies on Kager's (1993) and Hayes' (1995) analysis of Chugach stress. To begin, the data in (9) show that closed syllables and long vowels pattern together insofar as both are stressed word-initially. Short open syllables, on the other hand, are not stressed in this position.

(9)a.	*Initial CV*	
	mu.lú.kú:t.	'if you take a long time'
	a.kú.tar.tu.nír.tuq.	'he stopped eating akutaq'
	pa.lú.liá.qa.	'the fish pie I'm making'
b.	*Initial CV:*	
	tá:.ta.qá.	'my father'
	ná:.qu.ma.lú.ku.	'apparently reading it'
	ná:.ma.cí.quá.	'I will suffice'
c.	*Initial CVC*	
	án.ci.qu.kút.	'we'll go out'
	ág.ku.tár.tuá.nga.	'I'm going to go'
	íq.llu.kí:.nga.	'she lied to me'

The stress pattern in Chugach can be characterized as a left-to-right ternary pattern as seen in examples like [a.kú.tar.tu.nír.tuq.]. According to Kager (1993) and Hayes (1995), the amphibrachic pattern is accounted for by an iambic foot and weak local parsing, which allows a light syllable to be skipped between feet. The iambic foot is bimoraic, either one heavy syllable or two light syllables.

(10) {mu.lú.}{kú:t.}
{ná:.}qu.{ma.lú.}ku.
{pa.lú.}{liá.}qa.

[4] Not all cases of variable weight reported in the literature are discussed here; only cases that exemplify (7) are shown (see Hayes 1995 for cases of more complex weight scales and other cases of variable closed syllable weight).

As noted by Hayes, the variable weight of closed syllables is evident from the fact that closed syllables that are not word-initial do not attract stress, whereas non-initial long vowels and diphthongs in (10) do attract stress. For example, in [{a.kú.}tar.{tu.nír.}tuq.] the closed syllable [tar] is not stressed and skipped as is a light syllable in the same context. The variable weight of closed syllables, that is, heavy when initial and light when non-initial, can be characterized by the following generalization: the demand for the word-initiality of stress forces a closed syllable to behave as heavy.

The heaviness of initial closed syllables is a consequence of the ranking schema in (7). In Chugach, the particular constraint that interacts with the coda weight constraints concerns the alignment of initial stress with the left edge of the word. This is actually the End Rule (Prince 1983), which, in Optimality-Theoretic terms, is EDGEMOST – a type of alignment (McCarthy and Prince 1993b). In order to avoid confusion, alignment of main stress is described by EDGEMOST (following Prince and Smolensky 1993) rather than ALIGN, which refers to the foot edge. The conflict between EDGEMOST and the coda weight constraints is easily illustrated. A non-moraic coda in an initial closed syllable means that the stress falls on the second syllable and so the stress is not coincidental with the word edge. An initial heavy closed syllable, on the other hand, satisfies EDGEMOST since stress falls on the first syllable. Therefore, EDGEMOST dominates $^*\mu$/CONS.[5]

(11) EDGEMOST » *μ/CONS » *APPEND, /anciqukut /

	EDGEMOST	*μ/CONS	*APPEND
{an.cí.}qu.kut	*!		*
☞ {**án**.}ci.qu.kut		*	

The interaction between EDGEMOST and the coda weight constraints can only affect the word-initial syllable. Once outside of this position, EDGEMOST (as a form of the End Rule) is irrelevant since it only concerns the initial foot. As a result, the $^*\mu$/CONS violation is fatal. Consider the word [a.kú.tar.tu.nír.tuq.] from (9a). The word-initial sequence of light

[5] Following Kager (1994), weak local parsing in Optimality Theory is a consequence of conflict between ALLFEETLEFT, which ensures contiguous, exhaustive parsing and *FTFT, which prohibits contiguous feet. Heavy syllables disturb the weak local parsing pattern due to the ranking WEIGHT-TO-STRESS ≫ *FTFT ≫ ALLFEETLEFT.

syllables means that EDGEMOST is violated by all candidates. Therefore, any candidate with a non-initial, bimoraic closed syllable is nonoptimal.

(12) EDGEMOST » *μ/CONS » *APPEND /akutartunirtuq/

	EDGEMOST	*μ/CONS	*APPEND
☞ {a.kú.}tar.{tu.nír.}tuq.	*		*
{a.kú.}{tár.}tu.nir.tuq.	*	*!	

The heaviness of word-initial closed syllables in Chugach illustrates how variable weight is accounted for in Optimality Theory. Given the ranking schema in (7) (and exemplified in (11) and (12)), a violation of the low ranking *APPEND incurs a violation of the higher ranked EDGEMOST and so the *μ/CONS violation is most harmonic. Away from word-initial position, all candidates tie with respect to EDGEMOST and so the *μ/CONS violation is fatal.

In contrast to closed syllables, word-initial open syllables do not attract stress by surfacing as bimoraic. For example, a form like /muluku:t/ 'tent' is footed as [{mu.lú.}{kú:t.}] with an EDGEMOST violation. A long vowel in initial position would satisfy EDGEMOST, but this is precisely where open and closed syllables differ with respect to constraint interaction since vowel length is subject to WT-IDEN, not *μ/CONS. The fact that word-initial, short vowels do not surface as long shows that weight Correspondence is satisfied. Therefore, WT-IDEN dominates EDGEMOST.

(13) WT-IDEN » EDGEMOST, /muluku:t/

	WT-IDEN	EDGEMOST
☞ {mu.lú.}{kú:t.}		*
{mú:.}lu.{kú:t.}	*!	

EDGEMOST can be satisfied by any candidate that has an initial bimoraic syllable. Another candidate to consider for /muluku:t/ is [{múl.}lu.{kú:t.}] where there is a geminate, thus satisfying the ranking WT-IDEN $\gg$ EDGEMOST. A candidate with a geminate is nonoptimal and this follows from *GEMINATE (a constraint prohibiting multiply-linked root nodes) dominating EDGEMOST.[6]

[6] Leer notes that gemination in the word-initial syllable occurs only when an initial light syllable is followed by a heavy syllable, *u.lúa* → *úl.lúa* 'its tongue'. This is known as Pre-Long Strengthening by which a L H sequence surfaces as H H. For an Optimality-Theoretic analysis of Pre-Long Strengthening, see Bakovic (1997). The fact that Pre-Long Strengthening creates a geminate rather than a long vowel is not addressed by Bakovic and cannot be accounted for by the ranking proposed here. Also Kager's (1993) account of this phenomenon cannot in principle distinguish gemination from vowel lengthening because both a long vowel and a geminate produce the same syllable-internal trochee.

Although vowels do not lengthen to satisfy EDGEMOST, all stressed open syllables (except final ones) surface as long due to iambic lengthening.

(14) {ta.qú:.}ma.{lu.ní}
{a.kú:.}tar.{tu.nír.}tuq.
{ná:.}{qu.lú:.}ku.

Closed syllables in this environment also surface as heavy, although there is no phonetic effect since the segmental composition of the syllable does not change (cf. Broselow, Chen and Huffman 1997 for a discussion of a phonetic effect on vowel length in closed syllables as a function of metrical stress). The enhancement of stressed syllables in iambs can be attributed to Prince's (1990) Iambic Quantity constraint (see also Hung 1994; Bakovic 1997) stated in (15) where |S| and |W| mean absolute weight.

(15) Iambic Quantity:
In a rhythmic unit [W S], $|S| > |W|$, preferably

Iambic Quantity, which ensures that the strong branch of an iamb has greater prominence than the weak branch, must dominate WT-IDEN since underlying short vowels surface as long vowels. Iambic Quantity, by transitivity, must dominate $*\mu$/CONS so stressed closed syllables are bimoraic.

The difference between word-initial closed and open syllable weight in Chugach is due to the ranking of EDGEMOST between WT-IDEN and $*\mu$/CONS. Since EDGEMOST is ranked below WT-IDEN, weight Correspondence is paramount (i.e., no lengthening), compelling surface violations of EDGEMOST. However, EDGEMOST dominates the coda weight constraints so the heaviness of closed syllables varies.

Variable closed syllable weight is clearly problematic for parametric or rule-based approaches to Weight-by-Position. As Hayes (1994) claims, the only way to account for this phenomenon is to allow for weight to be assigned only in certain environments. Alternatively, weight can be assigned as a repair strategy for violated metrical constraints. The relation between closed syllable weight and EDGEMOST in Chugach is an example of what Prince and Smolensky call "anti-bottom-up" construction because a metrical constraint influences a syllable well-formedness constraint. This type of interaction is problematic in procedural approaches to constituent construction in which constituents are built in accordance with the prosodic hierarchy, that is, moras are grouped into syllables, syllables into feet, and feet into words. The only way coda weight can be sensitive to a metrical constraint in a procedural approach is if coda weight is assigned after metrification or coda weight is assigned at initial syllabification with specific reference to context. No such problems arise in the Optimality-Theoretic analysis proposed here. Closed syllable weight is determined by output constraints (in the ranking EDGEMOST $\gg$ $^*\mu$/CONS $\gg$ *APPEND) that are harmonically satisfied by comparing candidate syllabifications and metrifications with both bimoraic and monomoraic parses of closed syllables. In the Optimality-Theoretic approach, "anti-bottom up construction" in Chugach is not an issue because there is no procedural constituent construction. The anti-bottom-up effect is due to the ranking EDGEMOST $\gg$ $^*\mu$/CONS, that is, conflict between a metrical constraint and a syllable well-formedness constraint.

Contextual heaviness of closed syllables can occur at the right edge as well. In this case, closed syllables are light except at the right edge where they are heavy to satisfy higher ranking metrical constraints. Goroa (Hayes 1980, based on Seidel 1900) has this distribution of heavy closed syllables. Stress in Goroa falls on the leftmost long vowel, (16a), or a final closed syllable, (16b), or on the penultimate syllable, (16c).

(16)a.	dú:gnuno:	'thumb'
	gogomá:ri	'short'
	girambó:da	'snuff'
	heninàu	'young'
b.	adúx	'heavy'
	axemís	'hear'
c.	oromíla	'because'
	amrámi	'ivory arm ring'
	idirdána	'sweet'

Goroa stress can be characterized by a bimoraic foot that is placed on the leftmost long vowel or at the right edge of the word. Since a word-final closed syllable is stressed, it must be heavy. However, a closed syllable is light in any other position.

The lightness of closed syllables follows from the ranking $^*\mu$/CONS $\gg$ *APPEND. The contextual heaviness of closed syllables follows from the metrical constraints FOOTBINARITY and EDGEMOST-R dominating the coda weight constraints.

(17)
FTBIN, EDGEMOST-R » *μ/CONS » *APPEND, /axemis/

	FTBIN	EDGEMOST-R	*μ/CONS	*APPEND
a. ☞ a.xe.{mís.}			*	
b. a.{xé.mis.}		*!		*
c. a.xe.{ḿıs.}	*!			*

(17b), with a light closed syllable, has penultimate stress in violation of EDGEMOST-R. The $*\mu$/CONS violation in (17a) is compelled by satisfying EDGEMOST-R.

Away from the right edge of the word, closed syllables are light since a non-final, heavy closed syllable does not harmonically satisfy EDGEMOST-R. WSP must be satisfied for reasons mentioned below.

(18)
WSP » EDGEMOST-R » *μ/CONS » *APPEND, /amrami/

	WSP	EDGEMOST-R	*μ/CONS	*APPEND
a. {á**m**.}ra.mi.		**!	*	
b. a**m**.{rá.mi.}	*!	*	*	
c. {ám.ra.}mi.		**!		*
d. ☞ am.{rá.mi.}		*		*

Long vowels and closed syllables are stressed differently in Goroa since the leftmost long vowel is stressed. This means that WSP must be high ranking. If closed syllables are heavy in non-final position, then these syllables should be stressed. Therefore, closed syllables can only be heavy word-finally.

The distribution of heavy closed syllables in Goroa is similar to Chugach. Closed syllables in both languages are heavy under the duress of assigning stress to a word edge. This distribution follows from the coda weight constraints dominated by EDGEMOST. In neither language does a vowel lengthen to satisfy EDGEMOST, hence, WT-IDEN must dominate EDGEMOST.

2.2. *Satisfying Other Constraints*

Having seen that interaction between EDGEMOST and the coda weight constraints accounts for contextually heavy closed syllables, it is reasonable to ask what other metrical constraints can cause this distribution. In this section, prohibiting word-final stress in Eastern Ojibwa (Kaye 1973;

Piggott 1980, 1983; Halle and Vergnaud 1987; Hung 1994; Hayes 1995) and word minimality in Khalka Mongolian (Street 1963; Steriade 1990) are shown to lead to contextually heavy closed syllables.

In Eastern Ojibwa, Piggott (1983) notes that long vowels cannot be structurally equivalent to closed syllables since only the former must be stressed.

(19)a.	minógì	'he is growing well'
	namádabì	'he sits'
b.	bó:nì:	'he alights'
	mí:niwì	'it bears fruit'
c.	mindídò	'he is big'
	askánizì	'he is thin'

Since stress in (19a) (words containing open syllables) falls on even-numbered syllables from left-to-right, Piggott proposes that the appropriate foot is an iamb. The closed syllables in (19c) must be monomoraic for they fall on the weak branch of the iamb, e.g., [{min.dí.}dò.]. This means that the ranking for coda consonants in Eastern Ojibwa must be $^*\mu$/CONS $\gg$ *APPEND.

There is one environment in which closed syllables do attract stress. Disyllabic words with an initial closed syllable are stressed on the initial syllable, (20a), whereas an initial open syllable, (20b), is not stressed.

(20)a.	góndà	'those'
	níndà	'these'
	bángì:	'few'
b.	nikí	'Canada goose'
	miší	'firewood'

Closed syllables in disyllabic words are heavy and attract main stress, otherwise word-final stress would be predicted in (20a).

The variability of closed syllable weight involves the constraints required for stress. In Eastern Ojibwa, NONFINAL, which prohibits the foot from falling at the right edge of the word, is dominated by FOOTBINARITY.[7] This accounts for the fact that main stress is final only in

[7] Although main stress is only final in disyllabic words with the shape /CVCV/, Piggott notes that all polysyllabic words have word-final secondary stress. What is indicated as secondary stress might not be stress at all, according to Hayes (1995) and Hung (1994). Hayes notes that a word-final stress is suspect because it would require a degenerate foot in a stress clash environment and Ojibwa does not have degenerate feet. Therefore, the word-final stress is likely to be phonetic, which Hung claims is due to the absence of vowel reduction.

disyllabic forms, as in (20b). Maintaining NONFINAL in these cases would mean a degenerate foot. The ranking FTBIN $\gg$ NONFINAL ensures all feet are binary at the expense of a word-final stress.

In words with an initial closed syllable, (20a), NONFINAL and FTBIN are satisfied by a bimoraic syllable which makes a binary foot. NONFINAL (and FTBIN), therefore, dominates $^*\mu$/CONS. The influence of NONFINAL on the coda weight ranking is seen by comparing the outputs for a trisyllabic and a disyllabic word.

(21) a. NONFINAL » *μ/CONS » *APPEND, /mindido/

		NONFINAL	*μ/CONS	*APPEND
☞	{min.dí.}dò.			*
	{mín.}di.dò.		*!	

b. NONFINAL » *μ/CONS » *APPEND, /ninda/

		NONFINAL	*μ/CONS	*APPEND
	{nin.dá.}	*!		*
☞	{nín.}dà.		*	

The different outputs for different word sizes are a consequence of the influence of NONFINAL. In the trisyllabic form (21a), NONFINAL is satisfied by both candidates so the $^*\mu$/CONS violation is fatal, but in a disyllabic form, (21b), the violation of the lower ranking *APPEND incurs a violation of the higher ranking NONFINAL. Therefore, the $^*\mu$/CONS violation is most harmonic.

Altering syllable weight to satisfy NONFINAL must be limited to closed syllables; that is, vowel lengthening and gemination do not occur even though Eastern Ojibwa has both long vowels and geminates. From the final stress in disyllabic words, *GEMINATE dominates NONFINAL so a stress aligned at the right edge is preferred to any weight alternation in the first syllable.

(22) WT-IDEN, *GEM » NONFINAL » *μ/CONS, /niki/

		WT-IDEN	*GEM	NONFINAL	*μ/CONS
	{ní:.}ki.	*!			
	{ník.}ki.		*!		*
☞	{ni.kí.}			*	

Eastern Ojibwa, like other languages with contextually heavy closed syllables, has the ranking schema in (7) (demonstrated in (21)) where a metrical constraint dominates the coda weight constraints.

Contextual heaviness can also occur as a consequence of interaction with FOOTBINARITY, particularly with respect to word minimality. In other words, closed syllables are metrically light but there are words that are [CVC]. As noted by Steriade (1990), this is the case in Khalka Mongolian (Street 1963). Stress in Khalka Mongolian is assigned to the leftmost syllable containing a long vowel, otherwise it is assigned to the initial syllable. Closed syllables do not attract stress and pattern with short, open syllables. Closed syllables are light due to the ranking $^*\mu$/CONS $\gg$ *APPEND. However, there is a minimal word effect in Khalka Mongolian: words are minimally CVV or CVC, but not CV. Closed syllables are patterning with long vowels insofar as both satisfy FOOTBINARITY, which is the constraint dictating word size. This is illustrated with [mál] 'livestock'.

(23) FTBIN » *μ/CONS » *APPEND, /mal/

	FTBIN	*μ/CONS	*APPEND
{mál.}	*!		*
☞ {má**l**.}		*	

The candidates in (23) need not be distinguishable phonetically. The evidence for moraic codas is drawn from word-minimality, which is best characterized as a bimoraic minimum.

The coda weight ranking in longer words is harmonically satisfied with a *APPEND violation. This is evident in Khalka Mongolian stress which follows from conflict between a constraint that assigns stress to a heavy syllable (WEIGHT-TO-STRESS) and the demand for stress to occur at the left edge (EDGEMOST-L). The stress ranking (WSP $\gg$EDGEMOST) does not conflict with the coda weight ranking ($^*\mu$/CONS $\gg$ *APPEND) so a $^*\mu$/CONS is never harmomic.

The languages discussed in this section have a distribution of heavy syllables that follows from the general ranking schema $\mathbb{C} \gg {}^*\mu$/CONS $\gg$ *APPEND. The only difference is the metrical constraint that dominates the coda weight constraint ranking. This is predicted by the Optimality-Theoretic tenet that cross-linguistic variation is due to constraint ranking. The range of typological variation in this case depends on the number of metrical constraints that can be substituted for $\mathbb{C}$. As for the metrical constraints discussed so far, the following rankings are predicted.

(24) a. FTBIN $\gg$ *μ/CONS $\gg$ *APPEND
e.g., Mongolian

b. EDGEMOST $\gg$ *μ/CONS $\gg$ *APPEND
e.g., Chugach, Goroa

c. WSP $\gg$ *μ/CONS $\gg$ *APPEND
no interaction

d. NONFINAL $\gg$ *μ/CONS $\gg$ *APPEND
e.g., Eastern Ojibwa

The only unattested ranking involves WSP. Such a ranking cannot exist because a language in which closed syllables are light, closed syllables cannot attract stress. WSP actually cannot conflict with the coda weight constraints.

3. CONTEXTUALLY LIGHT SYLLABLES

Relating the contextual heaviness of closed syllables to constraint ranking predicts that by a change in the ranking of the coda weight constraints languages should also have contextually light syllables; these are proposed by Kager (1989) and Rice (1995). In other words, closed syllables are heavy except when under the duress of satisfying higher ranking constraints. This means that the ranking for closed syllable weight is *APPEND $\gg$ *μ/CONS and contextual lightness follows from this ranking being dominated by some constraint $\mathbb{C}$ demanding that CVC counts as light. Of the metrical constraints EDGEMOST, FOOTBINARITY, WSP, and NONFINAL, the first one does not conflict with the ranking for bimoraic codas to compel contextually light syllables. Closed syllables are bimoraic regardless of the ranking of EDGEMOST.

WSP and NONFINAL, on the other hand, conflict with the ranking for heavy closed syllables. The interaction with WSP is seen in Kashmiri, where closed syllables are light in the environment of other heavy syllables, namely, long vowels. The conflict between NONFINAL and the coda weight constraints, shown in Palestinian Arabic, means that a language has heavy syllables except word-finally where closed syllables are light to avoid being footed. This is consonant extrametricality as a consequence of constraint interaction.

3.1. *Interaction with* WEIGHT-TO-STRESS

Contextually-light closed syllables are found in Kashmiri, which has an unbounded stress pattern (Bhatt 1989; Kenstowicz 1993). According to Bhatt (1989), stress falls on the leftmost long vowel (25a) or, if there is no long vowel, stress falls on the initial syllable (25c). Word-final syllables, however, are never stressed (neither Bhatt nor Kenstowicz supplies glosses).

(25)a. pʰa.rá:.gaθ.
mu.sí:.baθ.
a.yó:.gyə.ta:.
b. ná:.ra:.yan.
ní:.ra:.zan.
c. pʰí.ki.ri.
tsá.ri.pop.
pá.ha.ra.da.ri:.

Stress placement in Kashmiri is a consequence of interaction between WSP and EDGEMOST, where the former must dominate the latter since a long vowel compels stress to surface away from the left edge.

(26) WSP » EDGEMOST, /musi:baθ/

	WSP	EDGEMOST
mú.si:.baθ.	*!	
☞ mu.sí:.baθ.		*

Closed syllables, shown in (27), behave similarly to long vowels. The leftmost, non-final, closed syllable is stressed

(27) ba.gán.dar.la.din. yu.ni.vár.si.ti. mu.kád.di.ma.

The heaviness of closed syllables follows from the coda weight ranking *APPEND ≫ *μ/CONS, which dominates EDGEMOST, otherwise initial stress is predicted in (27).

The contextual lightness of closed syllables is seen in words that have a long vowel, as in (28).

(28) am.rí:.ka. kun.tə́:.jih.
mas.rá:.wun. kad.ná:wun.

The initial closed syllable should receive stress because such a candidate would satisfy both WSP and EDGEMOST. However, word-initial stress would mean that a long vowel is not stressed, thus violating WSP. The fact that the long vowels in (28) are stressed (in violation of EDGEMOST) indicates that the word-initial closed syllables are monomoraic. The contextual lightness of closed syllables follows from WSP dominating the coda weight constraints.

(29)

WSP » *APPEND » *μ/CONS, EDGEMOST /masra:wun/

		WSP	*APPEND	*μ/CONS	EDGEMOST
	mas.rá:.wun.	*!		*	*
☞	mas.rá:.wun.		*		*
	más.ra:.wun.	*!	*		
	más.ra:.wun.	*!		*	

The *APPEND violation in (29) is inconsequential since all other candidates violate WSP. However, in (30), where there are no long vowels, the *APPEND violation is fatal.

(30)

WSP » *APPEND » *μ/CONS, EDGEMOST /yunivarsiti/

		WSP	*APPEND	*μ/CONS	EDGEMOST
☞	yu.ni.vár.si.ti.			*	**
	yú.ni.var.si.ti.		*!		
	yú.ni.var.si.ti.	*!		*	
	yu.ni.vár.si.ti.		*!		**

The ranking WSP $\gg$ *APPEND $\gg$ *μ/CONS is harmonically satisfied by a light closed syllable when there is a long vowel because all other candidates violate WSP. Since a closed syllable is light only when there is a heavy syllable elsewhere in the word, closed syllable weight is determined globally. In the absence of long vowels, closed syllables are heavy due to harmonic violations of *μ/CONS. Kashmiri, therefore, exhibits contextually light syllables based on the ranking $\mathbb{C} \gg$ *APPEND $\gg$ *μ/CONS.

This ranking also predicts that in words with two non-final, closed syllables only the leftmost is heavy.

(31)

WSP » *APPEND » *μ/CONS, EDGEMOST, /bagandarladin/

	WSP	*APPEND	*μ/CONS	EDGEMOST
bá.**gan**.**dar**.la.din.	*!*		**	
☞ ba.gá**n**.dar.la.din.		*	*	*
ba.gan.dá**r**.la.din.		*	*	**!
bá.gan.da**r**.la.din.	*!	*	*	
bá.gan.dar.la.din.		**!		

Although heavy syllables appear in one environment and closed syllables are light elsewhere, Kashmiri is a case of contexually light syllables, as opposed to contextually heavy syllables. Long vowels, on the other hand, do not shorten under the duress of satisfying WSP. Hence, WT-IDEN is undominated along with WSP.

Klamath (Barker 1964) has a distribution of heavy syllables similar to Kashmiri. Klamath stress is placed on the rightmost long vowel, or on the rightmost closed syllable if there are no long vowels, or on the antepenultimate syllable if there are no closed syllables (see Halle and Vergnaud 1987, Hayes 1995 for analyses of Klamath).

(32)a. ga:.nó:.la. ‘finishes grinding’

b. gat.bám.bli. ‘returns home’

c. ča.t’á:.wip.ga. ‘is sitting in the sun’

The penultimate syllable in (32b) must be bimoraic, otherwise antepenultimate stress is predicted; hence, *APPEND $\gg$ *μ/CONS. As in Kashmiri, closed syllables are light only when in the environment of long vowels. This follows from WSP $\gg$ *APPEND $\gg$ *μ/CONS $\gg$ EDGEMOST-R. The difference between the two languages with respect to heavy closed syllable distribution is the word edge at which stress is assigned.

The distributions of heavy closed syllables and long vowels differ because the relevant constraints are ranked differently with respect to some metrical constraint. The difference between vowels and coda consonants is that the former are underlyingly moraic. Underlying geminates, like vowels, are moraic. This correctly predicts that there are languages where syllables closed by geminates are heavy, but closed syllables are light (see Davis 1994). Also there are languages where underlying geminates do not pattern with long vowels (see Selkirk 1990 and Tranel 1991). According to Davis, these geminates are not moraic.

3.2. *Consonant Extrametricality as Variable Weight*

A contextually light closed syllable commonly occurs at the right edge of a word. This is traditionally analyzed as consonant extrametricality; that is, a closed syllable at the right edge of a word does not participate in stress assignment. Another way to view consonant extrametricality is that a closed syllable at the right edge is metrically light so that it cannot be stressed in contrast to final long vowels which, being bimoraic, are metrically heavy and must be stressed (see Davis 1987 and Rice 1995 for analyses of English word-final, secondary stress on long vowels). In this section, consonant extrametricality in Palestinian Arabic is analyzed as a consequence of metrical constraints compelling monomoraic, final, closed syllables.

Prince and Smolensky capture the effects of extrametricality (Hayes 1980, 1982, 1995) with the NONFINAL constraint (see also Hung 1994). As noted by Prince and Smolensky, NONFINAL is formally quite different from extrametricality, which prohibits the final syllable from being metrically parsed. NONFINAL, on the other hand, concerns the well-formedness of the stress peak with respect to its position and so the constraint is stress-specific. This conceptual shift in the relation between stress and the word-final syllable means that word-final closed syllables cannot be stressed because they are nonoptimal stress peaks rather than being marked for nonparticipation in stress assignment. This is shown here to follow from their monomoraicity.

Palestinian Arabic (Brame 1973, 1974; Kenstowicz and Abdul-Karim 1980) has a quantity-sensitive stress system for which Hayes (1995) proposes a moraic trochee. This foot accounts for the equivalence of a closed heavy syllable and two light syllables. This is seen in (33) where a closed penultimate syllable is stressed or if the penultimate is light, the antepenultimate syllable is stressed.

(33)	a.	fí.him.	‘he understood’
		?á.na.	‘I’
	b.	bá:.rak.	‘he blessed’
		mák.tab.	‘office’
		ḍa.ráb.na.	‘he hit us’
		ka.táb.na.	‘we wrote’

c. zá.la.me. ‘man’
ḍá.ra.bo. ‘he hit him’
bá.ka.ra. ‘cow’

The heaviness of closed syllables can be established based on the description of stress given above. If codas do not contribute weight, closed penultimate syllables could not attract stress; since they do (e.g., [ḍa.ráb.na.]) closed syllables must be heavy. The ranking of the coda weight constraints, therefore, is *APPEND ≫ *μ/CONS.

(34) *APPEND » *μ/CONS, /ḍarabna/

	*APPEND	*μ/CONS
☞ ḍa.rá**b**.na.		*
ḍá.rab.na.	*!	

Turning to stress, the word-final light syllables in (33c) are excluded from bearing stress due to conflict between NONFINAL and ALIGN-R (Foot, R, PrWd, R). The satisfaction of NONFINAL compels an ALIGN violation so the trochee cannot be coincidental with the word edge.[8]

(35) NONFINAL » ALIGN, /zalame/

	NONFINAL	ALIGN
☞ {zá.la.}me.		*
za.{lá.me.}	*!	

NONFINAL also interacts with the ranking in (34), thus providing another case of ℂ dominating the coda weight ranking to produce variable weight. NONFINAL clearly conflicts with *APPEND since a *APPEND violation means that the final syllable is monomoraic. Satisfying *APPEND ensures that the final syllable is bimoraic and can be footed in satisfaction of WSP.[9] Satisfying WSP compels a NONFINAL violation. A surface viola-

8 Quadrisyllabic words have initial stress, which Hayes attributes to foot extrametricality and left-to-right footing. To ensure initial stress with quadrisyllabic words, ALIGN-LEFT and NONFINAL must dominate ALIGN-RIGHT. FOOTBINARITY must be undominated as well so the penultimate syllable does not get footed. Pentasyllabic words have antepenultimate stress, which follows from this ranking with EDGEMOST-RIGHT ensuring that the rightmost foot receives main stress.

9 Since secondary stress is not reported in Arabic dialects, WSP is interpreted as “if heavy, then it is a foot”. Evidence for the heaviness of unstressed closed syllables is seen in Cairene Arabic (Prince 1990) where the location of main stress at the right edge depends on a trochaic parse (either H or L L) from the left edge.

tion of *APPEND means that the final syllable can be left unfooted without violating WSP.

(36)

WSP, NONFINAL » *APPEND » *μ/CONS, /maktab/

		WSP	NONFINAL	*APPEND	*μ/CONS
a.	{mak.}{táb.}		*!		**
b.	{mák.}tab.	*!			**
c. ☞	{mák.}tab.			*	*
d.	{mák.}{tab.}		*!		
e.	{mák.tab.}		*!	**	

Only (36c) satisfies the higher ranking metrical constraints. (36a, d, e) violate NONFINAL since the foot edge coincides with the word edge and (36b) has a violation of WSP since there is a heavy syllable that is not footed.

The ranking in (36) follows the schema for variable weight in (7). A violation of the low ranking *μ/CONS incurs a violation of the higher ranked NONFINAL (or WSP) and so the *APPEND violation is most harmonic. If all candidates tie with respect to NONFINAL, the *APPEND violation is fatal. This is actually demonstrated in (34) repeated below with the foot boundaries included.

(37) NONFINAL » *APPEND » *μ/CONS, /darabna/

		NONFINAL	*APPEND	*μ/CONS
	{dá.rab.}na.		*!	
☞	da.{ráb.}na.			*

An alternative to the monomoraicity of word-final closed syllables is that word-final closed syllables are bimoraic, but ignored by the satisfaction of NONFINAL. This candidate is mentioned above (see (36b)) and would follow from ranking NONFINAL above WSP. Prince and Smolensky propose this ranking for Latin, which has final long vowels that cannot be stressed. However, there is evidence that both WSP and NONFINAL in Palestinian Arabic are high ranking, thus forcing monomoraic, word-final closed syllables. The lightness of word-final closed syllables contrasts with word-final stress on superheavy syllables in (38), which must be bimoraic.

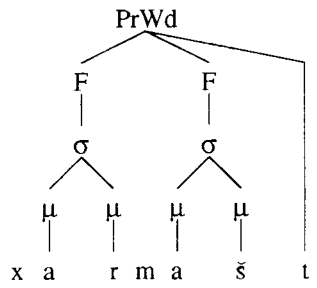
(38)

ka.tábt.	'wrote-1ps'	xar.mášt.	'scratched'
da.rást.	'studied-1ps'	ba:.rákt.	'gave blessing-3fs'
ba.ná:t.	'girls'		

The difference between heavy and superheavy syllables is that the latter cannot be monomoraic. There are a number of candidate syllabifications to consider for final CVCC sequences. One is that the sequence is syllabified tautosyllabically as a complex coda. Alternatively, the final CVCC sequence is syllabified as a heavy syllable followed by an extraprosodic consonant. This is the syllabification proposed here.

Following Rubach and Booij (1990), the extraprosodic consonant is an appendix to the prosodic word, hence it is not part of the foot (see also Wiltshire 1992; Hung 1994 for analyses of word-final appendices in Cairene Arabic). This is shown in the syllabification of [xarmášt].

(39)



The extraprosodic consonant violates *APPEND(to-PrWd) and is forced by a constraint on the maximum size of the syllable.[10] Since an extraprosodic consonant is appended to the prosodic word, the rightmost foot satisfies NONFINAL because it is not aligned with the right edge of the word.[11] For final CVCC sequences, NONFINAL does not exert the pressure that forces

[10] A syllable appendix is assumed to be preferred to a prosodic word appendix. This follows from the fixed ranking *APPEND(to-PrWd) $\gg$ *APPEND(to-σ). The extraprosodic consonant must be compelled by satisfying a constraint on syllable size; namely, syllable size is restricted to a binary branching rime found in more enriched representations of the syllable (Levin 1985; Kaye 1989). This means that a syllable can maximally contain: (1) a long vowel, (2) a vowel plus a moraic consonant, or (3) a vowel plus a nonmoraic consonant. This constraint (call it SYLLABLESIZE) dominates the *APPEND constraints and *μ/CONS.

[11] Extraprosodicity can also be represented catalectically, i.e., [xar.máš.t*.] (see Burzio 1994 for a discussion of catalexis in English). In either representation, the final consonant forces a dealignment between the foot and the edge of the word. According to Abu-Mansour (1995) and Broselow (1992), superheavy syllables also occur word-medially in Palestinian Arabic, e.g., [mift.xir.] 'proud', [ba:l.to.] 'coat'. Word-medial superheavy syllables violate SYLLABLESIZE, whereas word-final ones do not. This follows from the ranking MAX-IO $\gg$ SYLLABLESIZE $\gg$ *APPEND(to-PrWd) $\gg$ *APPEND(to-σ) $\gg$ *μ/CONS.

a harmonic *APPEND(to-σ) violation; therefore, the postvocalic consonant is moraic, as shown in (40).

(40) NONFINAL » *APPEND(to-σ) » *μ/CONS,/xarmašt/

		NONFINAL	*APPEND (to-σ)	*μ/CONS
a.	{xa**r**.}{mášt.}	*!	*	**
b.	{xá**r**.}mášt.		*!*	*
c. ☞	{xa**r**.}{máš.}t.			*
d.	{xá**r**.}máš.t.		*!	*

Candidate (40a) violates NONFINAL and candidates (40b, d) violate *APPEND(to-σ). (40c), with a consonant appended to the prosodic word, is most harmonic.

The difference between final heavy and superheavy syllables is a consequence of the constraint ranking in (40) with the addition of WSP.

(41)

a. WSP, NONFINAL » *APPEND(to-σ) » *μ/CONS, /maktab/

		WSP	NONFINAL	*APPEND (to-σ)	*μ/CONS
	{ma**k**.}{tá**b**.}		*!		**
	{má**k**.}{ta**b**.}		*!		
	{má**k**.}ta**b**.	*!			**
☞	{má**k**.}tab.			*	*

b. WSP, NONFINAL » *APPEND(to-σ) » *μ/CONS, /xarmašt/

		WSP	NONFINAL	*APPEND (to-σ)	*μ/CONS
	{xa**r**.}{mášt.}		*!	*	**
	{xá**r**.}mašt.	*!		*	**
☞	{xa**r**.}{máš.}t.				**
	{xár.maš.}t.			*!*	
	{xá**r**.}maš.t.			*!	*
	{xá**r**.}mašt.			*!*	

The equivalence between final CV and final CVC syllables (in contrast to nonfinal CVC and CV: syllables) is a consequence of constraint ranking. As shown in (41a), final closed syllables in Palestinian Arabic must be monomoraic to satisfy both NONFINAL and WSP. This is an example of $\mathbb{C} \gg$ *APPEND $\gg$ *μ/CONS that produces contextually light syllables. Weight is not simply ignored by the metrical constraints because heavy syllables are stressed (by WSP) as seen in the behaviour of CVCC sequences.[12]

Hayes (1994) discusses two other cases of variable closed syllable weight that are not discussed in detail here, but deserve to be mentioned. One is Cahuilla where closed syllables are monomoraic. These syllables become heavy due to Intensification which adds a mora to the first syllable, e.g., [čexiwen] → [čexxiwen] 'it is very clear', [welnet] → [wellnet] 'very mean one'. The mora appears to be a prefix that cannot link to the vowel and so it links to the consonant resulting in a geminate. This follows from the ranking WT-IDEN $\gg$ $^*\mu$/CONS $\gg$ *APPEND. The second case is Latin where heavy closed syllables can be light in metrical scansion, e.g., *gubĕrnābunt* 'they will reign' (Allen 1973). Mester (1994) proposes that these contextually light closed syllables are a consequence of prosodic trapping, which is due to conflict between FOOTBINARITY and metrical parsing. This is evident in *gubĕrnābunt* which is LHHH and so it should be parsed as L{H}{H}⟨H⟩ leaving the initial syllable unfooted, that is, prosodically trapped. The contextual lightness of a closed syllable follows from ensuring that the open syllable is footed while maintaining a bimoraic trochee. Prosodic trapping can lead to heavy syllables as well. Kenstowicz (1994) argues that gemination in Savo Finnish is triggered by LH sequences in standard Finnish, e.g., *pólliisi* 'police' (cf. *póliisi* Standard Finnish).

A potential source of interaction between metrical constraints and coda weight is the satisfaction of prosodically defined templates in Prosodic Morphology (McCarthy and Prince 1986, 1990a,b, 1994b). For example, Ponapean reduplication (Rehg and Sohl 1981) exhibits what McCarthy and Prince (1994b) call quantitative complementarity which means that a light base takes a heavy reduplicative prefix and a heavy base takes a light prefix. CVC roots pattern with CV roots by taking a heavy prefix, e.g., /pa/ → [pa:.pa.] 'weave', /lal/ → [lal.lal.], *[la.lal.] 'make a sound'. Closed syllables are exhibiting variable weight: they are light except when satisfying a prosodically defined template. The coda weight ranking in Ponapean is $^*\mu$/CONS $\gg$ *APPEND, and variable weight (following McCarthy and Prince 1994b) is due to a condition that ensures that the output contains one and only one foot (plus a syllable).

[12] Final CVCC sequences in Latin (unlike Palestinian Arabic) do not attract stress. Latin differs from Palestinian Arabic insofar as the head of the foot cannot fall on the final syllable. This can be accounted for by Hung's (1994) RHYTHM constraint, which ensures a peak on the metrical grid is followed by a trough. In other words, a stressed syllable must be followed by a stressless syllable. In Latin, RHYTHM dominates EDGEMOST so a final CVCC cannot be stressed. Palestinian Arabic has the reverse ranking.

Reduplicative morphology would appear to be another environment for variable closed syllable weight. One a priori possibility is a language in which closed syllables are heavy in the base, but are light in the reduplicant. Such a language does not appear to occur: the reduplicant is either a bimoraic closed syllable or an open syllable. This follows from the Generalized Template theory of reduplication proposed by McCarthy and Prince (1994a, 1995). Crucially, invariant structure in reduplication is determined by constraint satisfaction, not prosodic templates. The only requirement for the reduplicative template is whether it is a stem or an affix (which is maximally a syllable). Consider a word that is CVCCV. If the reduplicant is a closed syllable, MAX-BR (McCarthy and Prince 1995) is high ranking. Since *APPEND dominates *μ/CONS to account for heavy syllables in the base, the ranking MAX-BR $\gg$ *APPEND $\gg$ *μ/CONS ensures that all codas are moraic. If MAX-BR is low ranking, then neither a moraic or nonmoraic coda is harmonic. The reduplicant is an open syllable. This is a case of the emergence of the unmarked (McCarthy and Prince 1995).

(42) a. reduplicant = bimoraic closed syllable
MAX-BR » *APPEND » *μ/CONS, /CVCCV/

	MAX-BR	*APPEND	*μ/CONS
CV-CVC.CV.	*!		*
CVC-CVC.CV.		*!	*
☞ CVC-CVC.CV.			**

b. reduplicant = open syllable
*APPEND » *μ/CONS » MAX-BR, /CVCCV/

	*APPEND	*μ/CONS	MAX-BR
☞ CV-CVC.CV.		*	*
CVC-CVC.CV.	*!	*	
CVC-CVC.CV.		**!	

No ranking is harmonically satisfied by a light closed syllable as the reduplicant when the base has a heavy closed syllable. Hence, no such language is possible. Proposing a constraint that ensures the identity of coda weight between base and reduplicant does not produce the unattested case. This constraint (call it IDENCODAWEIGHT-BR) is never harmonically violated in any ranking with *APPEND $\gg$ *μ/CONS. The candidate with a moraic coda in both the base and the reduplicant is most harmonic because IDENCODAWEIGHT-BR and *APPEND do not conflict.

To summarize, contextually light closed syllables occur as a consequence of conflict with metrical constraints. Both Kashmiri and Palestinian Arabic have the general ranking schema $\mathbb{C} \gg$ *APPEND $\gg$ *μ/CONS with the only difference being the relevant metrical constraint. As mentioned in 3.0., not all constraints conflict with the ranking for heavy closed syllables. From (43), it is evident that there is no ranking of EDGEMOST-R that predicts variable weight.

(43)
EDGEMOST, *APPEND » *μ/CONS » NONFINAL, /CVCVC/

	EDGEMOST	*APPEND	*μ/CONS	NONFINAL
ˈCV.CVC.	*!	*		
☞ CV.ˈCVC.			*	*
CV.ˈCVC.		*!		*

Any ranking of EDGEMOST-R produces an optimal candidate with a bimoraic closed syllable.

Contextually light syllables under the pressure of foot binarity are found in Latin (Mester 1994). According to Mester, word-final closed syllables undergo iambic shortening, e.g., canis → canĭs 'dog'. Following Prince and Smolensky's analysis of iambic shortening, this is due to high ranking FTBINARITY and NONFINAL, which, in the proposal here, must dominate the ranking *APPEND $\gg$ *μ/CONS.

The possible rankings of metrical constraints and coda weight discussed in this section are listed below.

(44)a. WSP $\gg$ *APPEND $\gg$ *μ/CONS
e.g., Kashmiri, Klamath

b. NONFINAL $\gg$ *APPEND $\gg$ *μ/CONS
e.g., Palestinian Arabic

c. FTBIN $\gg$ *APPEND $\gg$ *μ/CONS
e.g., Latin

d. EDGEMOST $\gg$ *APPEND $\gg$ *μ/CONS
no interaction

Contextually light closed syllables eliminate consonant extrametricality. In Optimality Theory, there is no need to stipulate extrametricality: it follows from harmonic violations of *APPEND under the duress of satisfying NONFINAL, which is a constraint on metrical well-formedness.

The typology based on constraint ranking predicts closed syllables are contextually heavy word-initially or word-finally. This follows from EDGEMOST-LEFT/RIGHT dominating the coda weight ranking for light, closed syllables, as in Chugach and Goroa. Contextually light syllables only occur at the right edge, as in Palestinian Arabic. The absence of contextually light syllables word-initially is predicted by (44d). Since

*APPEND ≫ *μ/CONS, closed syllables are heavy. Assume an iambic language like (45a), EDGEMOST is satisfied so there is no variable syllable weight.

(45)a. {′CV**C**.}{CV.′CV.}CV.
{CV.′CV.}{′CV**C**.}CV

b. {CVC.′CV.}{CV.′CV.}
{CV.′CV.}{′CV**C**.}CV

A contextually light, word-initial syllable is shown in (45b). However, no constraint ranking predicts these metrical parses. If it is assumed that there is a preference for disyllabic feet forcing a monomoraic parse of the initial syllable, the word-medial heavy syllable must be light as well. Therefore, there is no variable weight.

4. LENGTH AND CODA WEIGHT

The discussion of variable weight so far has concentrated on closed syllable weight, whereas vowel weight (except for iambic lengthening in Chugach) is constant. This is due to the ranking of $\mathbb{C}$ with respect to WT-IIDEN, *μ/CONS, and *APPEND. The interactions among the syllable weight constraints and metrical constraints can be formalized as a general ranking schema in which the terms are VOWELLENGTH, which is the ranking for vowel length, and CODAWEIGHT, which is the ranking for heavy or light closed syllables.

(46) VOWELLENGTH

WT-IDEN ≫ NLV	(vowels are long or short)
NLV ≫ WT-IDEN	(vowels are short)

CODAWEIGHT

*APPEND ≫ *μ/CONS	(closed syllables are heavy)
*μ/CONS ≫ *APPEND	(closed syllables are light)

The languages discussed in the preceding sections display the general ranking VOWELLENGTH ≫ $\mathbb{C}$ ≫ CODAWEIGHT, that is, satisfying the constraint responsible for vowel length (WT-IDEN) is paramount and so compels a violation of $\mathbb{C}$ while $\mathbb{C}$ compels a violation of the coda weight constraints. In other words, vowel length does not change under the duress of $\mathbb{C}$, but closed syllable weight does. Chugach not only has this general ranking, but it also has an instance of the ranking $\mathbb{C}$ ≫ VOWELLENGTH ≫ CODAWEIGHT: this accounts for the distribution of heavy syllables due to iambic lengthening. A language, like Chugach, that exhibits two distributions of syllable weight is not surprising since two metrical constraints, $\mathbb{B}$ and $\mathbb{C}$, can interact with vowel length and closed syllable weight, i.e., $\mathbb{B} \gg$ VOWELLENGTH $\gg \mathbb{C} \gg$ CODAWEIGHT.

Since cross-linguistic variation is due to different rankings of the same set of constraints, the interaction between metrical constraints and syllable weight constraints creates a typology of languages. Given the three elements VOWELLENGTH, CODAWEIGHT, and $\mathbb{C}$, there are four types of languages based on the rankings in (47).[13]

(47) a. VOWELLENGTH $\gg \mathbb{C} \gg$ CODAWEIGHT
b. VOWELLENGTH, CODAWEIGHT $\gg \mathbb{C}$
c. $\mathbb{C} \gg$ VOWELLENGTH, CODAWEIGHT
d. CODAWEIGHT $\gg \mathbb{C} \gg$ VOWELLENGTH

As mentioned above, the ranking in (47a) is the focus of sections 2 and 3. In this section, the other three language types are discussed.

The ranking in (47b) predicts that there are languages where both vowel length and closed syllable weight are invariable and compel a violation of some metrical constraint. This ranking is seen in Siberian Yupik (Jacobson 1985, Lipscomb 1992) where only long vowels are stressed initially and word-initial short, open syllables and closed syllables are unstressed.

(48)	á:ng.qagh.llágh.llang.yúg.tuq.	'he wants to make a big ball'
	ang.yágh.llagh.llúng.yug.tuq.	'he wants to make a big boat'
	a.té.pik.	'real name'
	qa.yá:.ni.	'in his kayak'

Closed syllables behave as light in all positions so the coda weight ranking is $^*\mu$/CONS $\gg$ *APPEND, as it is in the Chugach dialect. Word-initial closed syllables are also monomoraic since they are not stressed. The principal coda weight constraint, $^*\mu$/CONS, dominates EDGEMOST in addition to *APPEND. This gives the ranking CODAWEIGHT $\gg \mathbb{C}$

[13] Labelling the interaction between $^*\mu$/CONS and *APPEND as CODAWEIGHT does not imply that these constraints must be in an immediate dominance relation in the constraint ranking. A ranking like WT-IDEN, $^*\mu$/CONS $\gg \mathbb{C} \gg$ *APPEND is equivalent to CODAWEIGHT $\gg \mathbb{C}$. Some cases here have rankings like $^*\mu$/CONS $\gg \mathbb{C}$, *APPEND.

and, since EDGEMOST is violated and vowels do not surface as long, VOWELLENGTH (that is WT-IDEN $\gg$ NLV) also dominates $\mathbb{C}$.

(49) a. WT-IDEN » EDGEMOST, /atepik/

	WT-IDEN	EDGEMOST
☞ a.té.pik.		*
á:.te.pik.	*!	

b. *μ/CONS » EDGEMOST, /angyaghllaghllangyugtuq/

	*μ/CONS	EDGEMOST
áng.yágh . . .	*!	
☞ ang.yágh . . .		*

Siberian Yupik and Chugach differ with respect to the ranking of $^*\mu$/CONS and EDGEMOST. Recall from section 2.1 that the Optimality-Theoretic analysis of Chugach eliminates the problem of anti-bottom-up construction. Siberian Yupik mimics the bottom-up construction of procedural approaches since in a procedural approach there is no need for a post-metrical syllabification rule for this language.

Surface violations of other metrical constraints also occur under the duress of satisfying the constraints on vowel length and coda weight. These are shown below. Here, as with (47a), not all metrical constraints conflict with VOWELLENGTH and CODAWEIGHT.

(50)a. WT-IDEN, *APPEND $\gg$ $^*\mu$/CONS, NLV $\gg$ WSP
Description: closed syllables are heavy
length contrast
WSP violated: bimoraic syllables are unstressed
Example: Gooniyandi

b. NLV, $^*\mu$/CONS $\gg$ *APPEND, WT-IDEN $\gg$ FTBIN
Description: closed syllables are light
no length contrast
FTBIN violated: degenerate feet, no minimal word
Example: Selepet

In Gooniyandi (Kager 1992), stress is characterized by a disyllabic trochee at the left (and right) edge of the word. Heavy syllables (CVV and CVC) regularly occur on the weak branch of the foot in violation of WSP, e.g., [{bá.bo:}{ddó:.nggo:.}] ‘to the bottom’, [{já.mbin.}{bá.ro:}] ‘type of fish’. Heavy syllables in words with an odd number of syllables are stressed in positions where light syllables are not stressed, e.g., [{ngá.dda}{nyó:}] 'mother', [{gó:.ro:}{ngál}] 'Christmas Creek'. Selepet, another language with syllabic trochees (Hayes 1995), lacks long vowels, but has closed syllables. There appears to be no evidence for moraic codas. Furthermore, according to McElhanon (1970, p. 15) "all structural syllable types may individually constitute one-syllable words" so there is no minimal word. There are also optional degenerate feet in words with an odd number of syllables. Therefore, FTBIN violations are more harmonic than altering syllable weight. The ranking VOWELLENGTH, CODAWEIGHT $\gg \mathbb{C}$ predicts that syllable weight does not alter to parse prosodically trapped syllables. This is the case in Malayalam (Mohanan 1986) where an initial LH sequence is stressed on the heavy syllable.

The common feature of the rankings in (47c, d) is $\mathbb{C} \gg$ VOWELLENGTH, which will be demonstrated first. This ranking predicts that there are languages in which vowel quantity is altered to satisfy a constraint. This is demonstrated in section 2.1 with Chugach iambic lengthening which is due to IAMBIC QUANTITY $\gg$ WT-IDEN. In general, the change in vowel quantity can be an underlying long vowel surfacing as short or an underlying short vowel surfacing as long. An example of the latter type of interaction is found in Chamorro (Chung 1983) as shown by Prince (1990). Chamorro has a process of lengthening stressed, open, penultimate syllables.

(51)a. /nana/ {ná:.}na. 'mother'

b. /igadu/ {í.ga.}du. 'liver'

Prince proposes that open syllable lengthening is a consequence of satisfying foot binarity and the nonfinality of stress. If the foot cannot include the final syllable, the foot in a disyllabic word would be degenerate. A long vowel, however, creates a binary foot. In the trisyllabic form (51b), foot binarity and nonfinality are both satisfied so there is no lengthening. Penultimate lengthening in Chamorro is accounted for in Optimality Theory by surface violations of vowel weight Correspondence under the duress of satisfying higher ranked metrical constraints, that is, FTBIN, NONFINAL $\gg$ WT-IDEN.

(52) FTBIN, NONFINAL » WT-IDEN, /nana/

		FTBIN	NONFINAL	WT-IDEN
	{ná.}na.	*!		
☞	{ná:.}na.			*
	{ná.na.}		*!	

The interaction of NONFINAL and WT-IDEN raises an interesting possibility for the distribution of vowel length at the end of the word. There are two ways to prohibit stressed long vowels: (1) NONFINAL $\gg$ WSP; hence the final syllable is not footed irrespective of weight (as in Latin and Kashmiri), or (2) to prohibit word-final long vowels. The latter phenomenon occurs in Axininca Campa (McCarthy and Prince 1993a; Hung 1994; Hayes 1995). According to McCarthy and Prince, Axininca Campa has iambic stress, but stress cannot fall on the word-final syllable (which forces a trochaic parse for disyllabic words). There is also a prohibition against word-final long vowels in polysyllabic words (Payne 1981), but word-final diphthongs, on the other hand, are stressed.

(53)	/siranta:/	siránta 'boulder'	nosiranta:ti	'my boulder'
	cf.		á:tài	'we will go'

McCarthy and Prince, as well as Hung, attribute shortening to WSP and NONFINAL, which, in terms of weight Correspondence, dominate WT-IDEN. This is illustrated in (54), adapted from McCarthy and Prince (p. 156).[14]

(54) WSP » NONFINAL » WT-IDEN, /siranta:/

	WSB	NONFINAL	WT-IDEN
☞ {sir.án.}ta.			*
{si.rán.}ta:.	*!		
{si.rán.}{tà:.}		*!	

Chamorro and Axininca Campa illustrate surface violations of vowel weight Correspondence, but the status of coda weight in these languages makes it difficult to demonstrate the ranking in (47c). A case of (47c) is Palestinian Arabic, which, in Section 3.1 is shown to have the ranking NONFINAL $\gg$ CODAWEIGHT, namely, NONFINAL $\gg$ *APPEND $\gg$ *μ/CONS. Hayes (1995) notes that word-final long vowels are curiously absent, except for some morphologically complex forms. The absence of word-final long vowels can be accounted for by the dominance of NONFINAL. If such vowels occurred, they would be stressed by WSP. Therefore, neutralization of the length contrast word-finally can be attributed to the prohibition against word-final stress, that is, the satisfaction of NONFINAL. The ranking NONFINAL $\gg$ WT-IDEN accounts for this. Final long vowels in Palestinian Arabic differ from long vowels in final

14 McCarthy and Prince (1993a) intepret NONFINAL to restrict stress placement as opposed to the placement of the foot boundary (cf. Prince and Smolensky 1993) so a disyllabic word, e.g., /sawo:/ → [{sá.wo.}] 'my cane', satisfies NONFINAL.

CVVC superheavy syllables (e.g., [ba.ná:t.] 'girls'), which are stressed. The long vowel in this case is not final because the extraprosodic consonant de-aligns the foot edge and the word edge.[15] The difference between a word-final long vowel and a final CVVC sequence follows from the ranking in (55).

(55) a. WSP, NONFINAL » WT-IDEN, /bana:t/

	WSP	NONFINAL	WT-IDEN
i. ba.{ná:t.}		*!	
ii. ☞ ba.{ná:.}t			
iii. {bá.nat.}		*!	*
iv. {bá.na:.t.}	*!	*	

b. WSP, NONFINAL » WT-IDEN, /CVCVCV:/

	WSP	NONFINAL	WT-IDEN
i. ☞ {'CV.CV.}CV.			*
ii. CV.CV.{'CV:.}		*!	
iii. CV.{'CV.CV:.}	*!	*	

In (55a), candidate (ii), with the extraprosodic consonant, satisfies all relevant constraints. A final long vowel in (55b) violates either NONFINAL (ii) or WSP (iii), and so candidate (i) with the short vowel is most harmonic. For roots, the neutralization of the vowel length contrast word-finally in Palestinian Arabic is another example of Stampean Occultation since a final long vowel would never postulated for a root that is [CV.CV.CV.]. In cliticized words, on the other hand, there is an alternation between long and short, e.g., [ḍarabu] 'they hit', [ḍarabu:na] 'they hit us'. The ranking in (55b) accounts for the neutralization of length word-finally.

FOOTBINARITY is another constraint that can be satisfied at the expense of VOWELLENGTH or CODAWEIGHT violations. Khalkha Mongolian, discussed in 2.2, has monomoraic closed syllables, but CVC is a well-formed word. Khalkha Mongolian has underlying long vowels and since CVV is a well-formed word as well, but CV is not, FTBIN must dominate the ranking WT-IDEN ≫ NLV. This ranking ensures (through Stampean Occultation) that a CV input would never be postulated for a CVV word. Another example of (47c) is found in the Bornean language

[15] According to Broselow et al. (1997), the word-final consonant shares a mora with the long vowel. In this representation, the foot is aligned with the word edge. This means that the stressing of final CVCC and CVVC and the non-stressing of final CVC must be attributed to conflict between WSP and RHYTHM (see footnote 13). WSP dominates RHYTHM; hence final CVVC and CVCC syllables are not followed by a stressless syllable.

Uma Juman (Blust 1977, p. 76) where final closed syllables are stressed and word-final vowels are always long and stressed.

(56)	[ti.ηáη.]	'hornbill'	[bə.la.túp.]	'inflate'
	[da.rá:.]	'long'	[pə.vi.tí:.]	'make someone stand'

Since there is vowel lengthening, stress is not merely assigned to the right-most syllable, but rather there is a binary foot that must be aligned with the right edge of the word. Therefore, FTBIN and EDGEMOST-R dominate $^{*}\mu$/CONS $\gg$ *APPEND and NLV $\gg$ WT-IDEN.

Another potential case of altering vowel length involves initial open syllables surfacing as long vowels to ensure word-initial stress. This does not appear to occur; there is no language in which all initial syllables are long and stressed. The absence of such a language is partially predicted by the constraints considered so far. First, consider trochaic systems. Lengthening of the word-initial vowel is not predicted to occur because the initial syllable is stressed by trochaic footing and stress coincides with the left edge. A long vowel with a WT-IDEN violation is fatal.

(57) EDGEMOST, WT-IDEN, /CVCVCV/

Candidate	EDGEMOST	WT-IDEN
☞ {′CV.CV.}CV		
{′CV:.}CV.CV		*!

The absence of lengthening in a trochaic language is also predicted by Kager's (1993) theory of iambic lengthening because lengthening in a trochaic system would create a lapse. In an iambic system, the situation is more complex because an initial heavy syllable does provide a better alignment of stress and the word edge. Consider the candidate iambic parses for /CVCVCVCV/.

(58)a. {CV CV′}{CV CV′}

b. {′CV:}{CV CV′}CV

The two candidates differ with respect to the form of the initial iambic foot, L L in (58a) and H in (58b). The preference for the disyllabic iamb is attributed to a preference for a disyllabic parse of iambic feet (see Prince 1990).

4.1. *Nonoccurring Rankings*

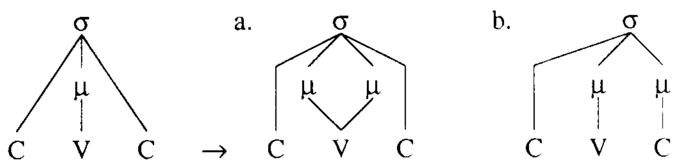
Some potential rankings based on the general schemas do not occur because not all metrical constraints conflict with CODAWEIGHT or

VowelLength. Furthermore, some particular rankings are indistinguishable from other rankings. These characteristics of constraint interaction contribute to the rarity of CodaWeight $\gg \mathbb{C} \gg$ VowelWeight, (47d), which predicts that there are languages in which closed syllables have unvarying weight, but vowel quantity does vary. CodaWeight and some metrical constraints do not interact so CodaWeight $\gg \mathbb{C}$ cannot be established. For example, $^*\mu$/Cons $\gg$ *Append cannot conflict with NonFinal, Edgemost, or WSP. If closed syllables are light, a final closed syllable cannot attract stress to compel a NonFinal violation. The ranking $^*\mu$/Cons $\gg$ *Append $\gg$ NonFinal $\gg$ Edgemost-R is indistinguishable from NonFinal $\gg$ $^*\mu$/Cons $\gg$ *Append $\gg$ Edgemost-R. The candidates with the NonFinal violations are never harmonic. The same applies to $^*\mu$/Cons $\gg$ *Append $\gg$ Edgemost-R $\gg$ NonFinal.

The inability to establish constraint conflict cannot fully account for the rarity of the ranking (47d), for there are cases where constraint conflict can be established but the predicted language still does not seem to exist. The problem lies in the ranking CodaWeight $\gg$ VowelLength which implies that satisfying a constraint that compels bimoraicity, /CVCCV/ is optimally realized at [CV:C.CV.] rather than [CV**C**.CV.]. Although [CV:C.] syllables are possible, they are not compelled by metrical constraints. The preference under the duress of satisfying some metrical constraint is to make the consonant moraic, i.e., [CV**C**.CV].[16] The basis for this preference can be seen by comparing the faithfulness violations incurred by adding a mora to a vowel and adding a mora to a consonant.

Examining the general ranking more abstractly, Wt-Iden and $^*\mu$/Cons violate MoraFaithfulness because a violation of either constraint adds a mora to the output that is not in the input. A Wt-Iden violation (in the case of a short vowel surfacing as long) incurs a NLV violation (59a). This requires additional structure in the form of an association line from the vowel to the syllable. A moraic coda (59b), on the other hand, does not require additional structure since both a moraic and a nonmoraic coda are linked to the syllable.

(59)



[16] One interaction that alters vowel length but not coda consonant weight is found in Menomini (Hayes 1995) where iambic lengthening lengthens a vowel in a closed syllable, e.g., /ke:mewan-k-en/ → [{ke:.}{me.wa:h.}ken.] 'whenever it rains'. However, the consonantal alternation complicates any account of the syllable structure.

Adding a mora to a vowel, therefore, violates *STRUCTURE (Prince and Smolensky 1993). This means that a constraint that compels the addition of a mora is best satisfied by adding a mora to a coda consonant since adding a mora to a vowel implies additional structure to achieve the same goal. Given the input /CVCCV/, which violates $\mathbb{C}$, a moraic coda is always more harmonic.

(60) $\mathbb{C}$ » MORAFAITH, *STRUC, /CVCCV/

Candidate	$\mathbb{C}$	MORAFAITH	*STRUC
CVC.CV.	*!		
CV:C.CV.		*	*!
☞ CVC.CV.		*	

A moraic coda is the minimal violation required to satisfy a metrical constraint since weight is added with minimal change. Hence, there is a preference for the ranking $\mathbb{C} \gg$ CODAWEIGHT.

The preference for CODAWEIGHT violations does not necessarily extend to open syllables since an open syllable can be made heavy by adding a mora to the vowel or to a consonant, which produces a geminate. In either case, syllable weight and structural constraints are violated.

(61) $\mathbb{C}$ » MORAFAITH, *STRUC, /CVCV/

Candidate	$\mathbb{C}$	MORAFAITH	*STRUC
CV.CV.	*!		
☞ CV:.CV.		*	*
☞ CVC$_i$.C$_i$V.		*	*

Therefore, there is no preferred faithfulness violation. The preferred candidate must be determined by other factors.

Since CODAWEIGHT violations are preferred under the duress of $\mathbb{C}$, there is also a preference for VOWELLENGTH to dominate CODAWEIGHT or not to conflict. Crucially, there is no preference for CODAWEIGHT to dominate VOWELWEIGHT. The rarity of (47d), which has CODAWEIGHT $\gg$ VOWELLENGTH, follows from the fact that this ranking involves a non-minimal constraint violation.

There is one context in which CODAWEIGHT appears to dominate VOWELLENGTH. In Choctaw (Lombardi and McCarthy 1991), for example, nouns are minimally CV:C even though Choctaw has closed syllables. A word-final consonant cannot be made moraic to satisfy word minimality (via FOOTBINARITY). Therefore, $*\mu$/CONS must dominate WT-IDEN. The ranking that accounts for long vowels in monosyllabic words but prohibits long vowels in closed syllables is $*\mu$/CONS $\gg$ WT-IDEN $\gg$ NLV, *APPEND(to-PrWd). Word minimality is precisely where a non-minimal violation is expected because heavy closed syllables are poor minimal words for they lack sufficient cues to indicate bimoraicity. A bimoraic vowel, on the other hand, is sufficiently salient.

Minimal constraint violation provides the basis for the absence of CODAWEIGHT dominating VOWELLENGTH. This, in turn, accounts for absence of the general ranking CODAWEIGHT $\gg \mathbb{C} \gg$ VOWELLENGTH. Minimal constraint violation can be insufficient in cases involving word-minimality. This appears to be a case where CODAWEIGHT dominates VOWELWEIGHT.

In summary, constraint ranking predicts that, besides cases of variable closed syllable weight, cases of variable vowel length occur as well; that is, vowel length is altered to satisfy a high ranking constraint. The combination of variable closed syllable weight and variable vowel length produces the language typology in (47). Not all constraint rankings are attested because in some cases no constraint conflict can be established. The absence of rankings involving CODAWEIGHT $\gg$ VOWELLENGTH is attributed to the fact that this ranking requires non-minimal constraint violations.

Some predicted rankings remain problematic because they do not characterize known languages; for example, prosodically trapped, open syllables become heavy by gemination rather than by vowel lengthening. This is not only a problem for Optimality Theory, but for any theory of metrical influence on syllable structure (see footnote 4). This might be unique to prosodic trapping. Cases of altering pretonic syllable weight (compelled by various constraints) can lead to long vowels, e.g., Cayuga (Prince 1983) where a stressed open syllable lengthens when followed by main stress, or long vowels and geminates, as in Tiberian Hebrew (McCarthy 1981).

5. CONCLUSION

The Optimality-Theoretic approach to closed syllable weight overcomes problems inherent in procedural approaches. Coda consonant weight is not a property that is either satisfied or not satisfied, rather it is a consequence of constraint interaction. The phenomenon of variable closed syllable weight follows from interactions with higher ranking metrical constraints which compel violations of the coda weight constraints. The weight of a coda is determined by simultaneously comparing candidate moraic and nonmoraic parses of the coda for constraint satisfaction. Without Parallelism and constraint ranking as defined by Optimality Theory, variable closed syllable weight cannot be accounted for in a principled way.

Cross-linguistic variation through constraint ranking leads to some interesting results. By reranking the coda weight constraints, consonant extrametricality turns out to be another type of variable closed syllable weight. It simply reflects contextually-light syllables under the duress of satisfying the nonfinality of stress. Finally, vowel length can behave independently of coda weight with respect to metrical constraints.

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Received 27 June 1997
Revised 10 February 1999

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