

# Optimal iambs in Kashaya

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This paper presents the three major ways that iambs play a role in Kashaya phonology: iambic lengthening, reshuffling of vowel length, and location of stress. Contrasting analyses of the phenomena are given in an ordered-rule Lexical Phonology approach and in constraint-based Optimality Theory. It is shown that only a nonderivational approach based on surface constraints succeeds in unifying the metrical motivation of lengthening and reshuffling. To account then for the location of stress without recourse to cyclicity, it is necessary to formalize analogy among output forms as a constraint on the uniform exponence of stress.

## 0. Introduction

There are three important ways in which iambic rhythm – a light syllable followed by a heavy syllable – is enforced in Kashaya metrical phonology. First, basic foot structure within the word is iambic, and in a string of light syllables this leads to iambic lengthening of alternate syllables. Second, when the sequence Cvvcv arises in an appropriate context, the syllable weight ‘flips’ to make a perfect Cvvcv iamb. Third, the placement of stress is determined by iambic structure, which need not correspond to the basic lexical footing since the domain of stress is phrasal. In this paper I compare a ordered-rule analysis of these phenomena, in a Lexical Phonology framework (cf. Kiparsky 1982), with a constraint-based approach in Optimality Theory (= OT; Prince & Smolensky 1991, 1993), and conclude that only the OT analysis succeeds in achieving a unified account of the role of iambs in the language. Since the hallmark of this approach is its ability to capture in formal terms the sort of conspiracy exemplified by iambicity in Kashaya, it is an obvious choice in theoretical tools. In addition, we will see that the necessary rejection of intermediate representations leads to a need for a more sophisticated view of the interaction of morphology and phonology than the original form of OT provides, supporting arguments for output-output correspondences. Within this enriched version of OT, the Kashaya facts can be captured in a more effective manner than is possible in rule-based Lexical Phonology.

## 1. Iambic lengthening

In Kashaya, a Pomoan language of northern California, two light syllables – each being short open Cv – are disfavored in immediate sequence. Subject to restrictions addressed below, the underlying sequence CvCv is converted to CvCv̄ (cf. Oswalt 1961, 1988; Buckley 1994a, b). This process is widespread cross-linguistically, and is termed Iambic (or Rhythmic or Alternate) Lengthening, because it occurs only in languages with iambic foot structure, and functions to maximize the quantity distinction light–heavy which defines the ideal iamb; see Hayes (1995) and Buckley (1996) for examples and general discussion.

In traditional terms, Kashaya, like (nearly) all iambic languages, builds feet from left to right (cf. Hayes 1985, 1995). There are no secondary stresses in the language, but the iterativity of foot construction is amply demonstrated by Iambic Lengthening. In the examples in this paper, foot structure is indicated using parentheses. For reasons addressed below, I assume that degenerate (monomoraic) feet are freely permitted. Each word in (1) consists of a root and multiple suffixes; note that the location of surface vowel length in suffixes depends on the rhythmic structure of the word: compare in (1a,b) the lengths of the vowels in *-mul-*, *-ad-*, and *-uced-*.<sup>1</sup>

- (1) a. kel-mul-ad-uced--u  
 → (kél)(mula):(duce):(du) 'keep peering around' [220]
- b. mo-mul-ad-uced--u  
 → (momú):(ladu):(cedu) 'keep running around' [220]
- In (1a), the first syllable is closed and heavy, and cannot serve as the first syllable in a branching iamb (which must be light); therefore a nonbranching foot must be created. In (1b), however, the first syllable is light and a branching iamb is possible. This leads to the different locations of vowel length. Further examples of Iambic Lengthening follow.
- (2) a. kel-aq<sup>w</sup>-iç--i  
 → (kelá):(qočí) 'peer out!'
- b. kel-alooq<sup>w</sup>-iç--i  
 → (kelá):(loqo):(čí) 'look back up!' [200]
- c. kel-maq<sup>w</sup>-iç--i  
 → (kél)(maqo):(čí) 'peek backwards!' [202]
- (3) a. kel-ad-uced--u  
 → (kelá):(duce):(du) 'keep peering' [220]

- b. kel-ad-uwad-uced--u  
 → (kelá):(duwa):(duce):(du) 'keep peering here and there' [221]
- (4) a. w-aq-ad-uced--u  
 → (waqá):(duce):(du) 'keep going out' [227]
- b. w-aqac-ed-uced--u  
 → (waqá):(cedu):(cedu) 'keep going up' [227]

Stress, shown by an acute accent, normally falls on the first foot of the word (but see below for systematic exceptions). The stresses included here reflect the pronunciation of a word in isolation; see section 5 for discussion of phrasally determined stress.

The reader will perhaps have noticed that the word-final vowels in (1b), (2a), and (4b) do not undergo Iambic Lengthening, even though they are located in the strong branch of an iamb. Superficially this failure of application resembles that found in many iambic languages, whereby word-final vowels are exceptions to Iambic Lengthening (e.g. Hayes 1995, Buckley 1996). Kashaya also avoids final long vowels, but that fact is not adequate to explain the full range of facts. Specifically, Kashaya suffixes can be divided into two sets: those which permit Iambic Lengthening, and those which do not. Due to the morphology of the language, every verb ends in a suffix which is non-lengthening. Thus *-u* and *-i* belong to the set of non-lengthening suffixes, and this accounts for the fact that they have not undergone Iambic Lengthening in the examples above. Members of the non-lengthening set uniformly occur to the right of members of the lengthening set, so that one can define the domain of Iambic Lengthening as a substring of the word which includes the left edge but never the right edge of the word. The double hyphen (--) is used here to indicate the end of the lengthening domain, i.e. it introduces the first suffix in the word which belongs to the non-lengthening set; any subsequent suffixes are also non-lengthening.<sup>2</sup>

That this failure to lengthen is a property of suffixes, rather than just a fact about the end of the word, is demonstrated by suffixal vowels which, unlike those in (1) to (4), are not in word-final position. The following examples illustrate several suffixes that fail to undergo lengthening even when they are in the appropriate metrical position, and the relevant vowel is non-final in the word. Again, I indicate the division between the two types of suffixes by the double hyphen. The non-final vowels which do not lengthen are underlined.

added. After the second round of morphology, Lengthening does not reapply. Two words from (5) are illustrated below.

- (9) a. MORPHOLOGY 1  
(lengthening suffixes) mo + mac mo + mac + ed  
b. PHONOLOGY  
(Footing and Lengthening) (moma:) <c> (moma:) (ce) <d>  
c. MORPHOLOGY 2  
(non-lengthening suffixes) (moma:) c + eti (moma:) (ce) d + ela  
d. PHONOLOGY  
(Footing only) (momá:) (ceti) (momá:) (cede) (la)

This approach relies on the assumption that phonological rules can apply between morphological operations – i.e. to an intermediate representation – but much recent work in the framework of Optimality Theory has placed this assumption in doubt (cf. Prince & Smolensky 1991, 1993). Specifically, there is much to be gained if ordered rules are replaced with constraints on surface representations which are evaluated all at once. An example of a complication created by intermediate representations is the need for ad hoc final-consonant extrametricality in (9b), to permit Iambic Lengthening in intermediate *momac*: without extrasyllabicity, the vowel in the closed syllable /mac/ would remain short (cf. Buckley 1995a, b). We will see in section 3 strong evidence from Kashaya that only the constraint-based analysis can capture the overall facts effectively, and so I begin now by analyzing the simple footing pattern using constraints.

### 1.2. Optimality Theory analysis

In a framework where we cannot appeal to *momaced* as an INTERMEDIATE representation, we must be able to refer to it as a SUBSTRING of the surface representation within which Iambic Lengthening applies, and outside of which it does not. In the example below, I show this domain in the input representation with curly brackets (10a); inside this domain, the strong syllable of an iamb is lengthened in the output, but outside of it no Lengthening occurs (10b). This then captures the difference between /ma/, which is inside the domain and lengthens, and /de/, which is outside the domain and does not lengthen.

- (5) a. mo-mac-ed--ela 'I keep running in there' [247]  
→ (momá:)(cede)(la)  
b. du:cic--ela 'I know' [T 324]  
→ (dú:)(cicé)(la)  
(6) a. sí--p<sup>h</sup>ila 'if [it] happens' [T 196]  
→ (síp<sup>h</sup>í)(la)  
b. dabane--p<sup>h</sup>ila 'if [you] discard' [T 326]  
→ (dabá:)(nep<sup>h</sup>í)(la)  
c. t-ala-meč--t<sup>h</sup>i-p<sup>h</sup>ila 'if [you] don't climb down' [279]  
→ (talá:)(me')(t<sup>h</sup>i-p<sup>h</sup>í)(la)  
(7) a. sí--śuw-wa 'what] can [we] do?' [262]  
→ (síśú)(wa)  
b. ho<sup>h</sup>-ala--śuw-em 'it would warm [us] up' [T 272]  
→ (ho<sup>h</sup>á:)(laśú)(wem)  
c. qom-qa--śuw-em 'should bathe [him]' [T 194]  
→ (qóm)(qaśú)(wem)  
(8) a. sí-yic--'cic-t<sup>h</sup>i-mi-ya-em 'they never used to do [that]' [233]  
→ (síyí)(ci')(t<sup>h</sup>imí)(yam)  
b. mo-mac-ed--eti 'although he kept running in there'  
→ (momá:)(cede)(ti)

The basic generalization is that Iambic Lengthening affects the strong branch of an iambic foot, but only within the root and the 'lengthening' set of suffixes.

### 1.1. Lexical Phonology analysis

The difference in behavior between the two sets of suffixes can be analyzed in a Lexical Phonology model (e.g. Kiparsky 1982) by the interleaving of phonology and morphology. Based on multiple phonological properties, Buckley (1994a) argues that the non-lengthening suffixes are those added in levels 4 and 5 of the lexicon, and that Iambic Lengthening is no longer active at these levels. The root and lengthening suffixes, on the other hand, are all present by the end of level 3. More schematically, the analysis requires three stages: first the lengthening suffixes are added to the root; then Iambic Lengthening applies; and then the non-lengthening suffixes are

- (10) a. Input {momaced}ela  
 b. Output {momá:}(cedə)(la).

More specifically, I will show that this difference can be attributed to the interaction of constraints on (i) the weight of the strong branch of an iamb, and (ii) the maintenance of underlying vowel length.

First, however, we must be able to generate the foot structure on which Lengthening is based. In traditional terms, the iambs of Kashaya are constructed from left to right. In a surface analysis, there is no notion of directionality; instead, we must refer to the alignment of feet (McCarthy & Prince 1993). As Crowhurst & Hewitt (1995) show, the precise manner in which a directionally based generalization such as 'left-to-right foot construction' translates into the alignment framework depends on whether degenerate (monomoraic) feet are permitted. Consider the following schematic examples.

- (11) *No degenerate feet* *With degenerate feet*
- Left alignment*  $(\sigma \sigma)(\sigma \sigma)(\sigma \sigma)$   $(\sigma)(\sigma \sigma)(\sigma \sigma)$   
 = LEFT-TO-RIGHT = right-to-left  
 construction construction
- Right alignment*  $\sigma(\sigma \sigma)(\sigma \sigma)$   $(\sigma \sigma)(\sigma \sigma)(\sigma)$   
 = right-to-left = LEFT-TO-RIGHT  
 construction construction

Notice that neither the choice of alignment, nor whether degenerate feet are permitted, corresponds uniquely to directionality.

I illustrate the workings of alignment using the examples from (11) which include degenerate feet. In (12a), the first foot is perfectly aligned with the left edge; the second is misaligned by 1 syllable, since only a nonbranching foot separates it from the edge; the third is misaligned by three syllables. This yields a total misalignment of 4 – the total violations of the alignment constraint. For (12b), on the other hand, the fact that the first foot is branching yields a higher total of 6. Therefore (a) is a better representation from the point of view of leftward alignment.

- (12) *Left alignment*
- a.  $(\sigma)(\sigma \sigma)(\sigma \sigma)(\sigma \sigma)$   
 0 1 3 total violations = 4

- b.  $(\sigma \sigma)(\sigma \sigma)(\sigma)$   
 0 2 4 total violations = 6

Conversely, since (b) ends in a nonbranching foot, this representation is better under rightward alignment, as demonstrated in (13).

- (13) *Right alignment*
- a.  $(\sigma)(\sigma \sigma)(\sigma \sigma)$   
 4 2 0 total violations = 6
- b.  $(\sigma \sigma)(\sigma \sigma)(\sigma)$   
 3 1 0 total violations = 4

In this way, when degenerate feet are permitted – so that all syllables are footed, and potentially count against alignment – directionality and alignment have the opposite correlation from that found when degenerate feet are prohibited.

Based on the Kashaya data given so far, we could adopt either of the translations of left-to-right directionality seen in (11). Later, however, I show that it is RIGHT alignment that must be used to account for the complex metrical pattern of the language (cf. (56)), and so it is the approach in (13b) that is adopted here. Of course, this means also that degenerate feet must be freely permitted in Kashaya. Supporting evidence for this position is that the language has stressed words consisting of a single mora – e.g. verbs which have undergone elision and (where relevant) word-final shortening.

- (14) a. ca-i → (cá) 'stay!' [D]  
 b. 'i-i → (ʔ) 'be!' [D]  
 c. qa-i → (qá) 'leave (him)!' [B 312]

Naturally, to receive a stress, these words take a degenerate foot. See also (37) and (38) below for examples of stressed degenerate feet.

As noted, the alignment constraint relevant to feet in Kashaya refers to the right edge of the stress domain. I have given only single-word examples, but as shown in section 5, Kashaya stress is assigned to the phrase. In anticipation of this fact I formulate the constraint as follows.

- (15) ALIGNR Align(Ft, R; PhP, R)  
 Align the right edge of each foot with the right edge of a phonological phrase.

For the time being, we will remain concerned only with phrases consisting of a single word.

The existence of feet in the first place is due to constraints which require foot structure. The most important of these simply requires that every syllable be incorporated into a foot.

(16) **PARSESYL** Every syllable must be parsed by a foot.

Every foot that is not at the absolute left edge fails in perfect alignment, and induces a violation of **ALIGNR** (cf. (13)). In order to get the effect of iterative footing it is necessary to rank **PARSESYL** over **ALIGNR** (McCarthy & Prince 1993). This fact is illustrated in the following tableau. I use the word from (2b) since the lengthening/non-lengthening suffix distinction does not enter into the picture. The underlying form of the word is given in the upper left corner.<sup>3</sup>

(17)

keladucedu	PARSESYL	ALIGNR
a. $\text{ke}^{\text{a}}$ (kelá:) (duce:) (du)		*, ***, **
b. ke (ladú:) (cedu)	*!	**
c. keladu (cedú)	*!***	

To prevent a form such as (17c) from winning – which has perfect satisfaction of **ALIGNR** but is clearly wrong empirically – the ranking shown is crucial. For convenience, violations of **ALIGNR** are shown for each foot, starting from the right and separated by a comma; but the total violations for each candidate are what matter. There is no evidence that anything but iambic feet are present in Kashaya, so throughout this paper I assume the undominated constraint **FtFORM(Iamb)**, and consider no candidates which include trochees.

As shown in (13), using **ALIGNR** to achieve the effect of left-to-right footing requires that we permit degenerate feet. In languages that avoid degenerate feet, the constraint **FtBIN** is responsible (Prince & Smolensky 1993).

(18) **FtBIN** A foot is binary under moraic or syllabic analysis.

This formulation entails that in a monosyllabic foot, that syllable must be bimoraic. In Kashaya, however, since degenerate feet are necessary to make **ALIGNR** function properly, **PARSESYL** must dominate **FtBIN**.

(19)

keladucedu	PARSESYL	FtBIN
a. $\text{ke}^{\text{a}}$ (kelá:) (duce:) (du)		*
b. (kelá:) (duce:) du	*!	

Now let us turn to the actual derivation of Iambic Lengthening. The basic effect is to achieve a perfect or canonical iamb, which consists of a light (and unstressed) syllable followed by a heavy (and possibly stressed) syllable. Hayes (1985, 1995) has argued convincingly that while trochaic feet tend toward symmetry, i.e. branches of equal weight, iambs tend toward asymmetry. I take this to be a result of the following constraint on the shape of iambs.

(20) **ASYM** In a branching iamb, the strong branch must be heavy.

**ASYM** is ranked lower than **ALIGNR**; see (26) for proof. Notice in (21) that the location of feet is determined by **PARSESYL** and **ALIGNR**, while **ASYM** secondarily determines the internal composition of those feet.

(21)

keladucedu	PARSESYL	ALIGNR	ASYM
a. (kelá) (duce) (du)		*, ***, **!	*!
b. (kelá:) (duce) (du)		*, ***, **!	*!
c. $\text{ke}^{\text{a}}$ (kelá:) (duce:) (du)		*, ***, **	
d. (kelá:) (du) (cedu)		** , ***!	*
e. (kelá:) ducedu	*!***	***	

Since (21a-c) violate **ALIGNR** equally, determination of the optimal candidate passes on to **ASYM**, which favors (c).

Given the existence of the constraint **ASYM**, which enforces Lengthening, there must be something which prevents Lengthening from occurring in the non-lengthening domain. This function is served by a Correspondence constraint (McCarthy & Prince 1994, 1995), which requires in this case a correspondence between the quantity of a segment in the input (short or long), and its quantity in the output.<sup>4</sup>

(22) Q-IDENT The quantity of each input segment is identical to its output quantity.

The difference between lengthening and non-lengthening suffixes is quite simply a matter of which constraint wins: ASYM or Q-IDENT. In Optimality Theory, the winning constraint is the higher-ranked one. Since the winner differs across the two domains, there must be a different constraint ranking in those domains. Following Buckley (1994a, b), I assume the existence of CONSTRAINT-DOMAINS to which constraints can be particularized. For present purposes, I label the lengthening domain 1, and the non-lengthening domain 2, as schematized below.<sup>5</sup>

(23) { root + lengthening suffixes }<sub>1</sub> { non-lengthening suffixes }<sub>2</sub>

Suppose there are two Q-IDENT constraints, one for each domain. Q-IDENT<sup>(1)</sup>, for the lengthening domain, is ranked below ASYM; while Q-IDENT<sup>(2)</sup>, for the non-lengthening domain, dominates ASYM to prevent Iambic Lengthening.

(24) Q-IDENT<sup>(2)</sup> » ASYM » Q-IDENT<sup>(1)</sup>

Violations of Q-IDENT<sup>(2)</sup> are counted only for segments located within C-domain 2, while violations of Q-IDENT<sup>(1)</sup> are counted only for those in C-domain 1. The underlying form, with domains labeled, is shown in the upper left corner of the tableau for ease of reference.

(25)

{kelala} <sub>1</sub> {p <sup>h</sup> ila} <sub>2</sub>	Q-IDENT <sup>(2)</sup>	ASYM	Q-IDENT <sup>(1)</sup>
a. (kelá) (lap <sup>h</sup> i) (la)		**!	
b. $\text{ɛʃ}$ (kelá:) (lap <sup>h</sup> i) (la)		*	*
c. (kelá:) (lap <sup>h</sup> i:) (la)	*!		*

Although in (25c) iambic structure is perfectly satisfied, it happens at the expense of preservation of underlying vowel length in the suffix *-p<sup>h</sup>ila*, subject to high-ranking Q-IDENT<sup>(2)</sup>. In (b), iambic structure is met only within the domain where low-ranked Q-IDENT<sup>(1)</sup> is violated, making it the optimal compromise. Form (a) is not optimal because it fails to satisfy ASYM even within domain 1.

Not only is Q-IDENT<sup>(1)</sup> low-ranked relative to ASYM, in fact it never plays any role in choosing candidates. Any form that Q-IDENT<sup>(1)</sup>

might favor is ruled out by ALIGNR, which dominates ASYM and therefore necessarily Q-IDENT<sup>(1)</sup>.

(26)

{kelaqočí} <sub>1</sub> {í} <sub>2</sub>	Q-IDENT <sup>(2)</sup>	ALIGNR	ASYM	Q-IDENT <sup>(1)</sup>
a. (kela) (qočí)		**	**!	
b. $\text{ɛʃ}$ (kela:) (qočí)		**	*	*
c. (kela:) (qočí:)	*!	**		*
d. (kela:) (qo:) (čí)		*, **!		**
e. (ke:) (laqo:) (čí)		*, **!*		**
f. (ke:) (la:) (qo:) (čí)		*, **!, ***		***

As illustrated in (26d-f), every long vowel must, by constraints on foot form, lead to a new foot: there cannot be two long vowels in a single iamb. And every new foot adds violations of ALIGNR. This is why ALIGNR makes Q-IDENT<sup>(1)</sup> superfluous.<sup>6</sup> In order to keep the tableaux as simple as possible, violations of Q-IDENT within domain 1 are not marked anywhere in the tableau; violations of Q-IDENT within domain 2 are marked in a column headed Q-IDENT<sup>(2)</sup>, as in (55) below. In the text, I will generally refer to the constraint as Q-IDENT.

The following list summarizes the crucial constraint rankings. The reference in each case is to a pair of candidates crucially distinguished by the ranking.

- (28) FtFORM (undominated)  
 PARSESYL » ALIGNR (17a, b)  
 PARSESYL » FtBIN (19a, b)  
 ALIGNR » ASYM (26b, d)  
 Q-IDENT<sup>(2)</sup> » ASYM (25b, c)

The next list summarizes all the constraints given so far, in an overall ranking consistent with the requirements of (28). The reference is to the place where the constraint is defined.

- (29) FtFORM(Iamb) (16)  
 PARSESYL (22)  
 Q-IDENT<sup>(2)</sup> (15)  
 ALIGNR (20)  
 ASYM (18)  
 FtBIN (18)

We now turn our attention to cases where even high-ranked PARSE<sub>SYL</sub> is violated – namely, when the first syllable of the word is unfooted.

## 2. Extrametricality

It is not the case in Kashaya that iambic rhythm always begins counting from the absolute left edge of the word. Rather, the word-initial syllable is regularly excluded from foot structure as long as the verb root extends beyond that first syllable: that is, as long as excluding the first syllable from foot structure does not result in the complete non-footing of the root. The examples in the preceding section have short roots (e.g. *kel-*, *mo-*, *w-*, *t-*), so that this extrametricality is not permitted.<sup>7</sup> In the examples below, however, the root (henceforth indicated in boldface) is at least two syllables long. As a result, the first syllable is not footed – its extrametricality is indicated by angled brackets – and Iambic Lengthening begins in the third syllable.

- (30) a. **bimucid**-uced--u  
 → <bi>(muci):(duce):(du) 'used to eat' [T 98]  
 b. **caqham**-ala-w-ibic--  
 → <ca>(q<sup>h</sup>amá):(lawi):(bi) 'start to cut downward' [194]  
 c. **libut**-ad--u  
 → <li>(butá):(du) 'keep whistling' [B 173]  
 d. **bo** o-t-ad--un  
 → <bo>(otá):(dun) 'while hunting' [T 98]  
 e. **šivey**-ibic-ed--em  
 → <ši>(weyi):(bice):(dem) 'when new growth starts' [T 150]
- Certain verbs in Kashaya take a monosyllabic prefix; necessarily, the root then extends at least to the second syllable. In such cases, initial-syllable extrametricality affects the prefix, not the root, and so extrametricality is found regardless of the length of the root itself.
- (31) a. **chi-**<sup>2</sup> **dic**-mac-adad--u  
 → <ch<sup>i</sup>>(dích):(macá):(dadu) 'pick up while going in' [229]  
 b. **chi-**<sup>2</sup> **dic**-ad-ala--w  
 → <ch<sup>i</sup>>(dicá):(dalaw) 'pick up while moving down' [209]
- (32) a. **du**-**kil**-ic--i  
 → <du>(kilf):(cí) 'point at yourself' [230]

- b. **ph<sup>i</sup>-**<sup>2</sup> **fa**-m-aqac-ed--un  
 → <ph<sup>i</sup>>(famá):(qace):(dun) 'whenever she looked up from here' [T 152]  
 c. **do**-**hqotol**-ic-ed--a-em  
 → <doh>(qotó):(licé):(dam) 'couldn't get around' [T 82]  
 d. **do-**<sup>2</sup> **qo**<sup>2</sup> **di**-yić-ed--u  
 → <do<sup>2</sup>>(qó<sup>2</sup>):(diyi):(ćedu) 'fix themselves up' [T 208]

The fact that domain 2 suffixes do not undergo Iambic Lengthening is of course unchanged in words that have an initial extrametrical syllable.

- (33) a. **cahno**--ph<sup>i</sup>la  
 → <cah>(nop<sup>h</sup>i):(la) 'when he is sounding off' [T 196]  
 b. **du**-**htay**--ela  
 → <duh>(tayé):(la) 'I am touching it' [106]  
 c. **qa**-**ne**--mela  
 → <qa>(nemé):(la) '[we] bit' [T 208]  
 d. **ph**-**a**-**nem**--éti  
 → <ph<sup>a</sup>>(nemé):(ti) 'even though he hit'  
 e. **da-**<sup>2</sup> **fa**--t<sup>h</sup>i-ba  
 → <da>(fat<sup>h</sup>i):(ba) 'when he didn't find' [T 154]  
 f. **ša**-**hma**--bi-na  
 → <šah>(mabi):(na) 'must have covered' [314]

To account for the lack of extrametricality in monosyllabic, unprefix roots in the Lexical Phonology approach, we need only apply a rule of Syllable Extrametricality before suffixes are added; the Non-Exhaustiveness Condition prevents an entire domain from being marked extrametrical, so that only stems of at least two syllables will undergo the rule (cf. Franks 1989, Buckley 1994b, Hayes 1995). This Condition permits application to a root like *libut-* but not *kel-*.

- (34) **Root** libut kel  
**Syllable Extrametricality** <li>but - (\*<kel>)  
**Further morphology** <li>but-ad-u kel-ad-u  
**Footing** <li>(butá):du (kelá):du

Once again, the Lexical Phonology analysis relies crucially on an intermediate stage. In this case that stage is different from the one required for Iambic Lengthening in (9), which does include many suffixes.

In Optimality Theory, the equivalent of Syllable Extrametricality is a constraint which prevents a syllable from being footed. Various formulations of this constraint are possible (cf. Prince & Smolensky 1993, McCarthy & Prince 1993); one in terms of alignment is given below in (35). In effect this constraint requires that every foot be preceded by a syllable. Since a foot on the first syllable will not be preceded by another syllable, that initial syllable is left unfooted.

- (35) NONINITIAL      Align(Ft, L; Syl, R).  
Align the left edge of every foot with the right edge of a syllable.

As shown in (36), NONINITIAL must dominate PARSESYL, since its basic effect is to prevent the first syllable from being parsed.

(36)

	{libutad} <sub>1</sub> {u} <sub>2</sub>	NONINITIAL	PARSESYL	ALIGNR
a.	(libú:) (tadu)	*!		**
b.	li (butá:) (du)		*	*
c.	li (bú) (tadu)		*	*!*

Candidate (36a) violates high-ranked NONINITIAL, and is rejected; (b) and (c) both leave just one syllable unparsed, violating PARSESYL equally. The choice between them is made by ALIGNR, which prefers that the branching foot be as far to the left as possible, so that (b) is the optimal form.

Now that we have encountered extrametricality in Kashaya, we can see further evidence of the low ranking of FtBIN. In disyllables where the root extends into the second syllable (and therefore extrametricality is permitted), stress falls on the final syllable. This pattern is most easily illustrated with nouns, so several are included here.

- (37)
- |    |                     |   |          |              |
|----|---------------------|---|----------|--------------|
| a. | ma <sup>h</sup> a-i | → | <ma>('á) | 'eat!' [163] |
| b. | šiyó                | → | <ši>(yó) | 'forest' [V] |
| c. | duwe                | → | <du>(wé) | 'night' [V]  |
- (38)
- |    |                     |   |                         |             |
|----|---------------------|---|-------------------------|-------------|
| a. | cahci-i             | → | <cah>(cí)               | 'sit down!' |
| b. | ho <sup>h</sup> t'ó | → | <ho <sup>h</sup> >(t'ó) | 'head' [V]  |
| c. | wehke               | → | <weh>(ké)               | 'otter' [V] |

Note that while the words in (37) could in theory be treated by revo-cation of extrametricality, with the foot structure (CvCv), the initial heavy syllables of (38) show that this is not what happens: the syllable structure CvCCv cannot be forced into a single iamb because then the weak branch would contain a heavy syllable, in violation of the Weight-to-Stress Principle (e.g. Prince 1991). Rather, what happens is that the first syllable is extrametrical, and the second takes a degenerate foot: <CvC>(Cv). This fact indicates that NONINITIAL » FtBIN, which further predicts that even in (37) the structure is <Cv>(Cv).

(39)

Candidates	NONINITIAL	PARSESYL	FtBIN
a. (cáh) (cí)	*!	*	
b. ca <sup>h</sup> h (cí)		*	*
c. (ma <sup>h</sup> á)	*!		
d. ca <sup>h</sup> h (á)		*	*

Although (39c) fares better than (d) by every constraint except NONINITIAL, the ranking established by (a,b) shows that (d) is in fact the correct representation.

Of course, NONINITIAL is always violated in words with a root no larger than one syllable, because in such cases the first syllable is footed; most of the words given in section 1 are of this type. Without intermediate representations, however, we cannot appeal to the Non-Exhaustiveness Condition to block extrametricality, as in (22). Rather, a constraint must prevent the complete exclusion of the root from foot structure. I assume the following formulation.<sup>8</sup>

- (40) Ft-Root      The root is dominated by a foot. (The root overlaps with a foot).

The intuition is that the morphological head of the word is too important to be excluded from higher prosodic structure. Ft-Root must obviously be ranked over NONINITIAL, as illustrated in the tableau below, where the root is *kel*.

(41)

	{kelad} <sub>1</sub> {u} <sub>2</sub>	Ft-Root	NONINITIAL
a.	ca <sup>h</sup> h (kelá:) (du)		*
b.	ke (ladú)	*!	



In the interpretation of this constraint, only a syllable which is HEADED by material in the root satisfies the requirement of inclusion in the next higher level of prosodic structure, the foot. That is, the fact that the /l/ of the base serves as onset of a syllable in the foot in (b) is insufficient. An alternative formulation is that a root vowel must be included in a foot.

When the root is at least disyllabic, Ft-ROOT and NONINITIAL can both be satisfied. This fact is illustrated by (42b) in the following tableau, an expansion of (36). In the new candidate (42d), it is technically Ft-ROOT which is fatal, even though lower-ranked PARSESYL also disfavors the candidate relative to the winning form.

(42)

{libutad}_1{tu}_2	Ft-ROOT	NONINITIAL	PARSESYL	ALIGNR
a. (libú:) (tadu)		*!		**
b. <sup>ɛ</sup> li (butá:) (du)			*	*
c. li (bú) (tadu)			*	**!
d. libu (tadú)	*!		**	

The next tableau, (43), illustrates that when a monosyllabic root is preceded by a prefix, the two constraints Ft-ROOT and NONINITIAL are again satisfied in the optimal candidate (b).

(43)

{duki:li}_1{li}_2	Ft-ROOT	NONINITIAL	PARSESYL	ALIGNR
a. (duki:) (li:ci)		*!		**
b. <sup>ɛ</sup> du (ki:li:) (ci)			*	*
c. du (ki) (li:ci)			*	**!

Since it is the word-initial prefix which is excluded from foot structure, the root itself is easily footed. While the Lexical Phonology analysis illustrated in (34) makes use of the prefix and root as an intermediate constituent in accounting for when Syllable Extrametricality can apply, the constraint analysis refers directly to the root alone, in the form of the constraint Ft-ROOT; the role of the prefix simply falls out from the nature of the constraints and the morphology.

In this section I have demonstrated the following additional constraint rankings.

- (44) NONINITIAL » PARSESYL (36a,b)  
 FtROOT » NONINITIAL (41a,b)
- This leaves us with the overall ranking shown.
- (45) FtFORM(Iamb) (40)  
 FtROOT (40)  
 NONINITIAL (35)  
 PARSESYL  
 Q-IDENT<sup>(2)</sup>  
 ALIGNR  
 ASYM  
 FtBIN

We move now from an examination of how the location of feet determines nondistinctive vowel length by Iambic Lengthening, to the way in which foot structure in Kashaya can determine the location of distinctive vowel length as well.

3. Foot Flipping

A remarkable indication of the pressure in Kashaya for iambic rhythm is found in the process that Buckley (1994a, b) calls Foot Flipping. When the leftmost sequence of the word is CvvCv, the vowel lengths in the two syllables are 'flipped' or reversed, resulting in the perfect iamb CvCvv. (The segmental features are unchanged).

- (46) a. di:c-aq<sup>w</sup>-i:c-i → (di:c:)(qo:ci) 'take a message out!' [202]  
 b. di:c-aq<sup>w</sup>-i:c--ela → (di:c:)(qo:cé)(la) 'I took a message out'  
 c. t'et-ibic--' → (t'eti:)(bi') 'stand up' [193]  
 d. da:qa-ç--al → (daqa:)(çál) 'that liking' [T 326]  
 e. ça:çid--u → (çaci:)(dú) 'keep leaving'

In addition to the flipping of vowel lengths, notice that the stress falls on the second foot, rather than on the first one as is normally the case in Kashaya.

The same reversal of vowel length holds true when the first syllable is extrametrical. In this situation, CvvCv following the extrametrical syllable is flipped, and stress is similarly shifted.

- (47) a. **muna:ic-id-u** 'ba → <mu>(naci:)(dú')(ba) 'would be too shy' [B 185]  
 b. **miku:t-ad-e:** → <mi>(kuṭa:)(dé:) 'keep humming' [283]  
 c. **qašo:q-w-ad-u** → <qa>(šoqo:)(dú) 'be getting well' [213]  
 d. **šu-ṭa-yi'ed-u** → <šu>(ṭoyi:)(cédu) 'keep peeling' [212]  
 e. **mu-bo:k-ibic--'** → <mo>(boki:)(bi') 'start to rise' [D].

What (46) and (47) have in common is that the sequence CvvCv is in a position to be footed, but in creating the foot the impossible iamb CvvCv is changed to the perfect iamb CvCvv.

Note that CvvCvC – where the last consonant is in the coda – does not undergo Flipping (48a-d). The reason is that it is not possible here for the length of the first syllable to be transferred to the second: the maximal syllable in Kashaya is CvC, and Flipping would result in \*CvvC. The same facts, and reasoning, hold for CvvCvv, where the second syllable is similarly heavy (48e).

- (48) a. **di:é-i** 'ba  
 → (di:)(é')(ba) 'cause to bring a message out'  
 b. **di:é-aq-qa-w**  
 → (di:)(cáh)(qaw) 'cause to bring a message out here' [B 187]  
 c. **qa:muč--ba**  
 → (qa:)(muč)(ba) 'after leaving each other' [B 187]  
 d. **buwi-c-iḥ--thu-**  
 → <bu>(wi:)(ci')(thu) 'don't keep stringing beads!' [B 187]  
 e. **miku:t--e:**  
 → <mi>(ku:)(té:) 'be humming' [282]

In this case the stress also falls on the second foot in the word; in fact the shift in stress that occurs in conjunction with Foot Flipping is clearly related to that found in (48), without Flipping. How exactly to capture this relationship is a central question in the analysis of Kashaya metrical phonology.

### 3.1. Lexical Phonology analysis

Buckley (1994a,b) proposes a serial analysis whereby a rule of Foot Extrametricality applies to any foot BEGINNING with Cvv, thereby uniting Cvv and (underlying) CvvCv; but that rule must apply before the foot is altered by Foot Flipping (removing the crucial trigger). I use « » for an extrametrical foot, and continue to use < > for an extrametrical syllable.

- (49) i. *Foot Construction* (di:) (cáh) (qaw) (di: éa) (qo éi)  
 ii. *Foot Extrametricality* «di:» (cáh) (qaw) «di: éa» (qo éi)  
 iii. *Foot Flipping* – «di éa:» (qo éi)

This approach entails temporary creation of the otherwise ill-formed 'anti-*iamb*' CvvCv; further, the analysis requires the ad hoc rule Foot Flipping which converts it to a true iamb AFTER application of Foot Extrametricality.<sup>9</sup>

Similar ordering is required with Closed-Syllable Shortening. Notice in (50) that the first foot is skipped for stress, even though on the surface it does not contain a long vowel.

- (50) a. **di:é-wač-a-emu** → «dič» (wačá)(mu) 'what they say (is)' [T 192]  
 b. **da-li-t-qa--w** → <da>«liṭḥ»(qáw) 'let wave with the hand' [103]

This indicates that (ill-formed) superheavy CvvC must persist until Foot Extrametricality applies, after which it undergoes shortening.

- (51) i. *Foot Construction* (di:č) (wačá) (mu) <da> (lí:ṭḥ) (qaw)  
 ii. *Foot Extrametricality* «di:č» (wačá) (mu) <da> «li:ṭḥ» (qáw)  
 iii. *Shortening* «dič» (wačá) (mu) <da> «liṭḥ» (qáw)

For more discussion of this pattern, see Buckley (1991, 1994a, b, 1997). To cover the three patterns Cvv (48), CvvCv (46), and CvvC (50), Foot Extrametricality must be formulated with reference to the dubious generalization "begins with Cvv". Thus the ordered-rule analysis is problematic in several regards, and the same will be true of any serial account which attempts to derive the stress behavior directly from underlying length.

### 3.2. Optimality Theory analysis

Fortunately, a more principled analysis is possible using constraints. An important insight is that the alternations in vowel length found with the verb roots above do not need to be analyzed as 'flipping' per se, whereby a mora actually moves from one syllable to another. Rather, the shift can be seen as underlying indeterminacy in the association of the mora, which is resolved by metrical and syllabic well-formedness. In roots that undergo Foot Flipping, the language learner observes that sometimes the first vowel is long, but at other times the second vowel is long. A straightforward interpretation of this alternation is that while moras are normally linked to

vowel features in the input, roots like *di:c:* with an apparent initial long vowel actually have a short vowel followed by an unlinked mora.<sup>10</sup>

(52)  $\mu \mu$   
|  
d i c̣

The mora is part of the root morpheme, but is not underlyingly linked to any segment. With suffixes added, we arrive at the following input representation for (46a).

(53)  $\mu \mu \mu \mu \mu \mu$   
| | | | | |  
d i c̣ a q o c̣ i

There are two basic surface realizations possible. In one, the floating mora is associated to the same vowel /i/ as the preceding mora, as in (54a); in the second, it is associated to the following /a/, as in (54b). (Syllable structure is ignored here).

(54) a.  $\mu \mu \mu \mu \mu \mu$   
| / | | | | |  
d i c̣ a q o c̣ i

b.  $\mu \mu \mu \mu \mu \mu$   
| \ | | | | |  
d i c̣ a q o c̣ i

The choice between these forms is made by the existing constraint ALIGNR, as shown in the following tableau. Henceforth, in segmental transcriptions, I use the raised period [̣] to indicate a floating mora in the underlying representation; the colon [:] indicates a linked

(55)

{di-čaqoç̣}_1{ṭi}_2	Q-IDENT <sup>[2]</sup>	ALIGNR	ASYM
a. (di:) (čaqo:) (c̣i)		*, **†*	
b. [ɛ̣] (diča:) (qoç̣i)		**	*
c. (diča:) (qoç̣i)	*!	**	

The choice between (55a-b) corresponds to that shown in (54). The pressure exerted by ALIGNR for feet at the left edge to be branching causes the floating mora to link to the second syllable, resulting in a perfect iamb.

The next example shows especially clearly that rightward alignment is the necessary approach to Kashaya feet. The two promising candidates, (56a-b), are identical in all respects except for the location of vowel length and corresponding foot boundaries. It is (b), with better rightward than leftward alignment, which wins.

(56)

{miku-ɬad}_1{e:}_2	NONINITIAL	PARSESYL	ALIGNR
a. mi (ku:) (ɬadé:)		*	**!
b. [ɛ̣] mi (kuɬa:) (dé:)		*	*
c. (miku:) (ɬadé:)	*!		**

In (56b) above, the optimal candidate has no degenerate foot, while a losing competitor (a) does. But this is by no means always the case. The next tableau, (57), presents a word which differs from that in (55) in having one more syllable. Here, it is the winning candidate (57b) which has a degenerate foot, while the competitor in (a) has none.

(57)

{di-čaqoç̣}_1{ela}_2	Q-IDENT <sup>[2]</sup>	ALIGNR	ASYM
a. (di:) (čaqó:) (éla)		** , ***†*	*
b. [ɛ̣] (diča:) (qoç̣é) (la)		*, ***	*
c. (diča:) (qoç̣é:) (la)	*!	*, ***	

The point of this comparison is to emphasize that ALIGNR performs its function perfectly well regardless of the number of syllables in the word. The major success of the constraint-based analysis is precisely this: the same constraint needed to determine foot structure in simple cases – namely, ALIGNR – serves as the motivation for Foot Flipping. The fact that these processes had to be stated as utterly separate rules under the Lexical Phonology analysis constitutes a strong argument in favor of the constraint-based approach.

## 3.2.1. Phonologically blocked Flipping

Consider now the case illustrated in (48), where the vowel length surfaces in the root, i.e. there is no Flipping. This occurs when the rightward potential docking site of the floating mora is a heavy syllable. There is no room for the floating mora in a syllable that is already bimoraic, so it must link to the same vowel as the preceding mora, i.e. within the root. Consider the following input.

(58)  $\mu \mu \mu \mu$   
 $| \quad | \quad | \quad |$   
 $di \acute{c}i'ba$

Here we find a consonant cluster, /'b/. The first of these consonants must syllabify as a coda (there are no onset clusters), where according to the moraic structure of the language it must bear a mora itself. That makes a total of two moras in the syllable, with no room for the floating mora.

(59) a.  $\sigma \quad \sigma \quad \sigma$   
 $\backslash \quad \wedge \quad |$   
 $\mu \mu \mu \mu \mu$   
 $| / | | | |$   
 $di \acute{c}i'ba$

b. \*  $\sigma \quad \sigma \quad \sigma$   
 $| / \wedge \quad |$   
 $\mu \mu \mu \mu \mu$   
 $| \backslash | | | |$   
 $di \acute{c}i'ba$

The form in (59b) must be rejected because it violates the well-motivated constraint that limits syllable size to a maximum of two moras.

(60) BIMORA A maximum of two moras is permitted in a syllable.

While some languages seem to violate BIMORA, it is clearly a very important cross-linguistic tendency (cf. Hayes 1989), which holds strongly in Kashaya.<sup>11</sup>

To avoid a bimoraic syllable, but maintain the long vowel, the coda would have to be eliminated from the syllable. This could be accomplished either by deleting the consonant (*dici:ba*) or by inserting a vowel which permits the consonant to syllabify as an onset (*dici:iba*). Neither of these candidates wins, due to the following constraints.

- (61) MAX Every input segment corresponds to an output segment. (Do not delete).  
 DEP Every output segment corresponds to an input segment. (Do not insert).

MAX and DEP are fundamental faithfulness constraints on segments, which resist changes to the basic underlying string; see McCarthy & Prince (1995). Their role in the analysis, and that of BIMORA, are illustrated below in (62).

(62)

	{di- $\acute{c}i'$ }_1 ba _2	BIMORA	MAX	DEP	ALIGNR
a.	(di:) ( $\acute{c}i'$ ) (ba)				* **
b.	(di $\acute{c}i:$ ) (ba)	*!			*
c.	(di $\acute{c}i:$ ) (ba)		*!		*
d.	(di $\acute{c}i:$ ) ( $\acute{c}iba$ )			*!	**

Candidate (62b) is the same as that diagrammed in (59b). We know independently that MAX dominates DEP – that the ban on deletion is stronger than the ban on epenthesis – because unsyllabifiable consonant clusters are resolved by epenthesis (Buckley 1994a).

## 3.2.2. Some further details

In the interest of thoroughness, I now discuss several other conceivable candidates given the input shown in (58). For example, we must prevent the floating mora from simply being deleted, yielding \**dici'ba*.

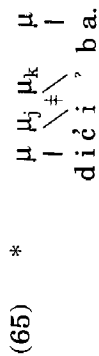
(63) \*  $\mu \mu \mu \mu$   
 $| \quad | \quad | \quad |$   
 $di \acute{c}i'ba \rightarrow di \acute{c}i'ba$

Obviously, this calls for a faithfulness constraint such that an underlying mora must be present in the output.

(64) MAX( $\mu$ ) Every mora of the input has a correspondent in the output.

This constraint is an adaptation of simple MAX in (61), which governs segments rather than moras. For illustration, see (69c).<sup>12</sup>

Consider now a more complex example. I would normally attribute the presence of a mora over a coda consonant to the operation of a constraint analogous to the Weight-by-Position rule of Hayes (1989). But imagine instead that the mora underlyingly linked to the /i/ in the second syllable ( $\mu_k$ ) shifts over to the coda consonant. This then makes it possible for the floating mora ( $\mu_j$ ) to link to the vacated vowel /i/, which remains short since it has lost its original mora – so BIMORA is unviolated. The result would again be \**dici* 'ba, though by rather different means.

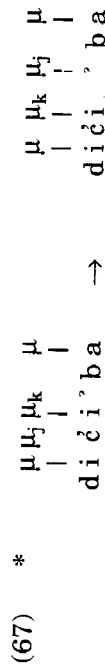


In this derivation, the features linked to  $\mu_k$  have changed from /i/ to /r/, and it is this fact which rules out the candidate. I assume that the underlying associations between vowels and moras are respected, by means of a constraint I call MORA-IDENT (after the HEAD-IDENT of McCarthy 1995).

(66) MORA-IDENT The features linked to a mora in the input are identical to those in the output.

This candidate appears in (69b) below; MORA-IDENT also figures in section 3.2.6.

Finally, there is another way in which \**dici* 'ba could be derived without deletion: by simply moving the floating mora over the mora which follows it, so that it can link to the coda consonant.



This output is ill-formed because the order of elements on a tier must be maintained between input and output (McCarthy & Prince 1995, McCarthy 1995).

(68) LINEARITY The linear order of elements in the input is identical to that in the output.

It appears that LINEARITY is never violated in Kashaya, i.e. there is no metathesis.

The following tableau illustrates the three constraints just out-

lined. Although the fairly complex moraic derivations cannot easily be shown in segmental notation, subscripts are given which correspond to those in the more explicit representations above.

(69)

	(di- $\acute{c}i$ ' <sub>1</sub> ) <sub>1</sub> (ba) <sub>2</sub>	LINEARITY	MAX( $\mu$ )	MORA-IDENT	ALIGNR
a.	$\acute{c}i$ (di:) ( $\acute{c}i$ ' <sub>1</sub> ) (ba)				* , **
b.	(di $\acute{c}i$ ' <sub>j</sub> ) <sub>k</sub> (ba)			*!	*
c.	(di $\acute{c}i$ ' <sub>k</sub> ' <sub>j</sub> ) (ba)		*!		*
d.	(di $\acute{c}i$ ' <sub>k</sub> ' <sub>j</sub> ) (ba)	*!			*

I have not investigated the relative rankings of the top three constraints in this tableau. What matters is that they all dominate ALIGNR, as (69) shows.

### 3.2.3. Morphologically blocked Flipping

In addition to its ad hoc nature, a further disadvantage of the serial Lexical Phonology analysis in (49) is that Iambic Lengthening and Foot Flipping are treated as independent rules, and it is a complete coincidence that the domains of the two rules are identical. For example, notice in the following pair of words that the suffix *-mela* resists Iambic Lengthening (70a) as well as Foot Flipping (b).

- (70) a. **ba $\acute{t}i$ --mela** → <ba>(tímé)(la) 'we] camped' [T 168]  
 \* <ba>(tímé:)(la)
- b. **qá--mela** → <qá:>(melá) 'I left' [T 166]  
 \* <qame:>(lá)

Compare (70b), where Flipping is prevented, with *qáci:dú* in (46f), where the same root and syllable structure undergoes Flipping, since the suffix *-cid* belongs to domain 1.

Below are further examples where Foot Flipping fails to apply when it would entail lengthening a vowel in domain 2. (See (5) to (8) for confirmation that these suffixes do not permit Iambic Lengthening).

- (71) a. **sima-q--eti**  
 → <si><ma:>(qatí) 'although he's asleep' [B 192]  
 \* <si><maqa:>(tí)

- b.  $\text{p}^{\text{h}}\text{i} \text{ } ^{\text{h}}\text{y}\text{a}\text{-}\text{q}\text{-}\text{e}\text{l}\text{a}$   
 → < $\text{p}^{\text{h}}\text{i}$ >< $\text{y}\text{a}$ :>(qalá)  
 \*< $\text{p}^{\text{h}}\text{i}$ >< $\text{y}\text{a}\text{q}\text{a}$ :>(lá)
- c.  $\text{šo}\text{-}\text{f}^{\text{h}}\text{o}\text{-}\text{t}^{\text{h}}\text{i}\text{-}\text{p}^{\text{h}}\text{i}\text{l}\text{a}$   
 → < $\text{šo}$ >< $\text{f}^{\text{h}}\text{o}$ :>(t<sup>h</sup>i<sup>h</sup>p<sup>h</sup>ilá)(la)  
 \*< $\text{šo}$ >< $\text{f}^{\text{h}}\text{o}\text{t}^{\text{h}}\text{i}$ :>(p<sup>h</sup>ilá)

'I recognize it' [B 192]

'if [you] don't peel it'

Formally, this shared restriction on Iambic Lengthening and Foot Flipping is easy enough to state, by assigning both rules to the same lexical level (cf. Buckley 1994a). But this move provides no explanation as to WHY this correlation should obtain, and it is predicted that a similar language might have the same rules in different levels. I find this prediction to be dubious, given that both processes result in the same perfect iambic foot.

In the present analysis, on the other hand, it is the high-ranking status of Q-IDENT that accounts for both facts: Iambic Lengthening and Foot Flipping cause the introduction a long vowel, and Q-IDENT ensures that this not occur in domain 2. We have already seen that Q-IDENT dominates ASYM to account for the blocking of Iambic Lengthening; it must also dominate ALIGNR to account for the blocking of Foot Flipping.

(72)

	{ $\text{q}^{\text{h}}\text{a}$ ·}_1\{\text{m}\text{e}\text{l}\text{a}\}_2	Q-IDENT <sup>(2)</sup>	ALIGNR	ASYM
a.	$\text{q}^{\text{h}}\text{a}$ (qá:) (melá)		**	*
b.	(qáme:) (lá)	*!	*	

The explanation of the correlation is transparent in the constraint-based analysis: in both cases, creation of a long vowel in domain 2 is blocked by Q-IDENT. The special status of domain 2 is stipulated for a SINGLE constraint, which by itself accounts for the lack of both processes. Such an explanation is not possible in the ordered-rule approach, and this fact constitutes a powerful argument against it.

### 3.2.4. Closed-Syllable Shortening

The analysis developed so far also accounts quite easily for closed-syllable shortening, illustrated in (50). The following input has a cluster of two consonants, /w/, following the root vowel.

- (73)  $\mu\mu$   $\mu$   $\mu$   $\mu$   $\mu$   
 | | | | |  
 di é w a é a m u

In this context, the floating mora has not just two places to link, in the ways seen above – to the preceding (74a) or following (b) vowel – but it can also, as shown in (74c), serve as the mora for the coda consonant /č/.

- (74) a.  $\mu\mu$   $\mu$   $\mu$   $\mu$   $\mu$   
 | / | | | |  
 di é w a é a m u = \*(di:č)(wáča)(mu)
- b.  $\mu$   $\mu$   $\mu$   $\mu$   $\mu$   
 | \ | | | |  
 di é w a é a m u = \*(dič)(wáča)(čamu)
- c.  $\mu\mu$   $\mu$   $\mu$   $\mu$   $\mu$   
 | | | | |  
 di é w a é a m u = (dič)(wáča)(mu)

The form in (74a) is ruled out by BIMORA, as illustrated in (62b). The linking to the following vowel in (74b), by contrast, is well-formed syllabically. But it is not as well aligned as (74c), where the floating mora links to the coda consonant and pre-emptly Weight-by-Position (which I assume operates in (a) and (b)). Tableau (75) shows the superior alignment of (c).

(75)

	{ $\text{di}\text{-}\text{č}\text{w}\text{á}\text{č}$ }_1\{\text{a}\text{m}\text{u}\}_2	BIMORA	ALIGNR	ASYM
a.	(di:č) (wáča) (mu)	*!	*, ***	*
b.	(dič) (wá:) (čamu)		**, ***!	*
c.	(dič) (wáča) (mu)		*, ***	*

Recall that candidates such as (65) and (67), where an underlying mora also links to coda position, are rejected because of the constraints MORA-IDENT and LINEARITY; more precisely, the moras or their linkings had to be reshuffled somehow to make the coda linking possible, and this reshuffling is prohibited. In (74c), however, no reshuffling is necessary: the coda consonant is locally available to the floating mora, which links to it easily, and this linking results in the best

metrical representation. In addition, the derivation captures a reasonable intuitive interpretation of Closed-Syllable Shortening, that the coda consonant 'steals' the second mora of a long vowel. The only quirk in Kashaya is that the mora in question was never actually linked to the vowel.

3.2.5. Elision

By normal processes in the language, we expect  $\sqrt{V_1V_2}$  to become long  $[V_1:]$  by Elision, with complete loss of the features of the second vowel. This is what we find when Flipping is blocked, whether phonologically (76) or morphologically (77).

- (76) a. **mo-ibic--** → «mo:»(bí) 'run away' [193]
- b. **ca-ad--u** ba → «ca:»(dú) (ba) 'could fly' [B 189]
- c. **píla-acíc--qa** → <pí>«la:»(éíq<sup>h</sup>) 'they must have gone away' [B 187]
- d. **puh̄ti-aqac--** ? → <puh>«ti:»(qá) 'go up alone' [128]
- (77) a. **mo-aq--ela** → «mo:»(qalá) 'I'm running' [B 192]
- b. **mo-ad--eti** → «mo:»(detí) 'even though [it] was running' [T 196]
- c. **e<sup>h</sup>i-de-ad--u** → <e<sup>h</sup>i>«de:»(dú) 'carry along' [186]

The two adjacent vowels are, however, a common secondary source of Foot Flipping.

- (78) a. **mo-a<sup>h</sup>oq<sup>v</sup>-ic--i** → «molo:»(qočí) 'run up out here!' [200]
- b. **mo-ala--th<sup>u</sup>-** → «mola:»(thú) 'don't run down!' [193]
- c. **do-ibic--i** → «dobi:»(cí) 'raise your hand!' [193]
- d. **cahno-ad-uc--i** → <cah>«nodu:»(cí) 'talk to yourself' [199]
- e. **yehe-ala-me --th<sup>u</sup>-** → <ye>«hela:»(mé) (th<sup>u</sup>) 'don't drag yourself down!' [88]

In an ordered-rule framework, Flipping requires an intermediate step in which the first vowel is long due to Elision, and then the length is flipped (Buckley 1994a, b).

- (79) **Underlying form** moaloqočí cahnoadučí
- Elision and Footing** (mo:lo)(qočí) <cah>(no:du)(cí)
- Foot Extrametricality** «mo:lo»(qočí) <cah>«no:du»(cí)
- Foot Flipping** «molo:»(qočí) <cah>«nodu:»(cí)

This intermediate step is necessary for two reasons: the CvvCv foot is required to trigger Foot Extrametricality, and this foot is what undergoes Foot Flipping in the first place (cf. (49)). Similarly, intermediate superheavy CvvC is required for forms with both Elision and Closed-Syllable Shortening (cf. (50)), though in this case the only purpose is to trigger Foot Extrametricality.

- (80) a. **mo-aq--mela** → «mo:h»(melá) 'I ran through there'
- «moh»(melá)
- b. **píla-ac--me-** → <pí>«la:ć»(mé) 'come here! (pl)' [186]
- <pí>«lać»(mé)

The analysis of variable vowel length as a floating mora extends easily to these cases, and no such intermediate step is necessary (or possible). I assume constraints dominating Mora-IDENT which ensure the deletion of the rightmost of the two adjacent sets of vowel features, notably ONSET (Prince & Smolensky 1993) and NoDIPHTHONG (e.g. Rosenthal 1994), which are unviolated in Kashaya.

- (81) μ μ μ μ μ μ
- | # | | | |
- m o a l o q o c i

Because the second mora is prohibited from remaining linked to its own features, it behaves identically to an underlyingly floating mora, as in (53). The two output possibilities are precisely those outlined in (54), and the rest of the analysis is identical.

(82)

	ALIGNR	ASYN
[moala] <sub>1</sub> {qočí} <sub>2</sub>		
a. (mo:) (laqo:) (cí)	*, **!	
b. (mola:) (qočí)	**	*

As with any mora in Kashaya that has multiple options for its linking, the choice is made on the basis of optimal metrical structure. In a sense, it is a root like *di-č-* which is like *ca-ad-*, rather than vice versa: there is no long vowel in the underlying form of *di-č-*, simply a short vowel and a floating mora, just as in *ca-ad-* there is a short root vowel plus a mora provided by the suffix. Once again the constraint-based analysis makes possible a simpler and more elegant account of the alternations.

3.2.6. True long vowels

While it appears to be a fact about Kashaya that verb roots normally do not have underlying long vowels – i.e. vowel features linked to two moras – there are nevertheless a few cases of apparent underlying long vowels, and these fail to undergo Foot Flipping.

- (83) **ča:hac-id--em** → «ča:»(haci:)(dem) 'when he marries' [T 184]
- ma:ku-c-ibic--?** → «ma:»(kuci:)(bi?) 'start to grow deaf' [127]
- 'aca:č-am-at-ad--u** → <<sup>2</sup>a>«ca:»(čamá:)(tadu) 'embryo start to develop (pl)' [D]

I treat these forms as prespecified in the underlying representation with long vowels, and use the colon [:] in the inputs in (83) as an indication of this analysis.

- (84)  $\mu \mu \mu$   
 $\vee \quad |$   
 č a h a c

This underlying linking is all that is necessary to account for the lack of Flipping.<sup>13</sup> MORA-IDENT – which has been motivated in (69) – prevents movement of the second mora of the long vowel into the following syllable.

(85)

	(ča:haci:)(dem) <sub>2</sub>	MORA-IDENT	ALIGNR	ASYM
a.	☞ (ča:)(haci:)(dem)		* ** *	
b.	(čaha:)(cidém)	*!	**	

Note that MORA-IDENT looks not at whether the content of the features linked to the mora is the same, but whether the same LINKINGS

to the mora are maintained. This means that movement from one /a/ to another is prohibited. The same underlying length holds for the suffix -e: (cf. (56)); it is located in the non-lengthening domain, where linking of a floating mora is prohibited by Q-IDENT. There are no floating moras in any Kashaya suffix: this contrast is restricted to roots. In fact, of the dozens of affixes found in Kashaya, only -e:, which indicates a verb that is non-final in its clause, has underlying vowel length. It occupies the rightmost position in the verb template and is no doubt a recent addition to the morphology, which otherwise reflects the generalization that no affix contains more than one mora per vowel. This gap is a symptom of the widely observed phenomenon whereby affixes permit fewer phonological contrasts than roots.

4. Foot Flipping and Stress

The constraint-based analysis given in section 3.2 successfully unifies the accounts of Iambic Lengthening and Foot Flipping. But we must still deal with the similarity in stress patterns between the flipped and non-flipped words.

4.1. Main Stress.

Recall the general pattern according to which an initial Cvv foot is skipped in choosing the main stress of the word – i.e. it is extrametrical (86). The initial foot dominating the same root is extrametrical even when it is not of the shape Cvv, e.g. when it is flipped or shortened (87).

- (86) a. **di-č-i'**ba → «di:»(čí')(ba) 'could tell'
- b. **di-č--ela** → «di:»(čéla) 'I tell'
- c. **di-č--i** → «di:»(čí) 'tell'
- (87) a. **di-č-aq<sup>w</sup>-ič--i** → «diča:»(qočí) 'take a message out!' [202]
- b. **di-č-id--a-em** → «dičí:»(dám) 'told about' [T 188]
- c. **di-č-wač--a-emu** → «dič:(wačá)(mu) 'what they say (is)' [T 192]
- d. **di-č-maq--o** → «dič:(maqó) 'bring the message in!' [190]

Contrast this with the situation of a root with no (underlying) long vowel in the first syllable, and therefore no skipping of the first foot.



- (88) a. **kel-i'**ba → (kelí')(ba) 'could peer'
- b. **kel--ela** → (kelé)(la) 'I peer'
- c. **kel--i** → (kélí) 'peer'

- (89) a. **kel-adad--u** → (kelá:)(dadu) 'look at while riding' [208]
- b. **kel-ma--w** → (kélí)(maw) 'peer down at' [158]

The forms in (89a) and (87a) have identical syllable structures on the surface, but different stresses. In (87) underlying vowel length has been shifted or eliminated, but the resulting foot is skipped just like Cvv in (86).

A framework tied to surface constraints cannot refer to intermediate levels as was done in the Lexical Phonology analysis illustrated in (49), but as we saw that analysis has numerous problems. First let us account for the case of a simple Cvv foot. Such a foot, when the first one in the domain, is skipped for stress. This can be accomplished by the following constraint.<sup>14</sup>

- (90) **SKIPFT** Align the left edge of a line 2 constituent with the right edge of a Cvv foot.

Exclusion of a foot from line 2 constituency means that it cannot take the main stress. The effect of this constraint can be illustrated by the word in (86b); as we see more explicitly in section 5, the domain of line 2 of the metrical grid is phrasal.

- (91) *line 2: phrase* ( x )
- line 1: foot* (x)(. x)
- di: cé lá

The left bracket on line 2 aligns with the right bracket of the Cvv foot on line 1, excluding that foot from line 2, and from any possibility of bearing the stress. **SKIPFT** must dominate two basic constraints on metrical structure.

- (92) **PARSEFT** Incorporate a line 1 constituent (a foot) into a line 2 constituent.
- ALIGNHD** Align the head of the phrase with the left edge of the phrase.

**ALIGNHD**, the equivalent of End Rule Left in a rule-based approach, has been tacitly assumed throughout this paper; it has the effect of stressing the first foot in the domain. **PARSEFT** prevents feet from being freely ignored by higher prosodic structure.

Under this analysis, the location of stress in a phrase (here, also just a word) beginning with surface Cvv (modulo syllable extrametricality) is due to **SKIPFT** and the floating mora linking leftward (86). But by abandoning the anti-iamb used in the Lexical Phonology analysis in (49), we cannot treat the words in (87) by reference to a foot-initial Cvv: on the surface, the initial foot looks just like another which does take the stress (89). An explanation lies elsewhere, however: every word that undergoes Flipping or Shortening is related to a word where neither occurs, and shift is motivated transparently on the surface by Cvv. This fact is illustrated for the root *di-c'* in (86) and (87). I argue that whereas in many words shift is directly due to **SKIPFT**, in words that lack initial Cvv (thanks to Flipping or Shortening), the shift follows not from the surface form but from, essentially, analogy with words that do have Cvv.

#### 4.2. Uniformity

We have already seen a number of constraints that require a correspondence between the input and the output, such as **Q-IDENT** (35) and **MAX** (61). The formal device to which I now appeal is output-output correspondence, which enforces similarities between different output forms to account for effects traditionally attributed to cyclicity (cf. Benua 1995; Burzio 1994; McCarthy 1995; McCarthy & Prince 1994, 1995; Orgun 1994, 1997). The operation of this principle in paradigms is termed **UNIFORMITY** by Flemming (1995) and Kenstowicz (1995), and that is the term I adopt here.

In the case at hand, it is the location of the metrical head of the word which must remain uniform across instantiations of a root or stem. Thus, because the first foot in (93a) is excluded from the word layer, in all other words whose initial foot also contains this root, that foot is similarly excluded from the word layer (93b-c).

- (93) a. ( x )
- (x)(. x)
- di: cé lá *skipped by SKIPFT*
- b. ( x )
- (. x)(. x)
- di cá: qo cí *skipped by Uniformity*
- c. ( x )
- (x)(. x) (x)
- dié wa cá mu *skipped by Uniformity*

For this purpose I give the following constraint requiring uniformity of main word-stress across output forms.

- (94) STRESS-UNIFORMITY If the first foot is stressed in one instantiation of a root, then it is stressed in all instantiations of that root.

See Buckley (1997) for further discussion of the operation of this constraint in Kashaya.

In the following tableau, related output forms are evaluated together, so that the winning candidate is actually a set of forms, rather than a single form. The candidates assume maximal satisfaction of the constraints already covered, such as ALIGNR and ASYM. A skipped foot is marked with angled brackets for clarity, though strictly speaking the foot is simply excluded from higher (word) structure.

Candidate Sets	STRESS-UNI	SKIPFT	PARSEFT
(95) a. $\text{[kɛ́:lá:]}$ (dadú) (kɛlí') (ba)			
b. $\langle \text{kɛ́:lá:} \rangle$ (dadú) $\langle \text{kɛlí' } \rangle$ (bá)			*! *
c. (kɛ́:lá:) (dadú) $\langle \text{kɛlí' } \rangle$ (bá)	*!		*
(96) a. (dɛ́:á:) (qočí) (dí:) (čí') (ba)		*!	
b. $\langle \text{dɛ́:á:} \rangle$ (qočí) $\langle \text{dí:} \rangle$ (čí') (ba)			* *
c. (dɛ́:á:) (qočí) $\langle \text{dí:} \rangle$ (čí') (ba)	*!		*

In (95), every case of extrametricality is a gratuitous violation of PARSEFT, since nothing requires the foot to be excluded from the word; SKIPFT is relevant only when there is an underlying long vowel, which is absent from the root *kel*. In the set of morphologically related words headed by a root like *kel*, main stress is consistently on the first foot of the word, thereby also respecting STRESS-UNIFORMITY. Gratuitous violation of STRESS-UNIFORMITY, as in (c), cannot be optimal.

In (96b), SKIPFT is obeyed by  $\langle \text{dí:} \rangle$  (čí') (ba) because the first foot is excluded from the word; in the related word  $\langle \text{dɛ́:á:} \rangle$  (qočí), SKIPFT is irrelevant since the first foot is not CVV, but foot exclusion is forced by STRESS-UNIFORMITY. Interestingly, there is no necessary ranking between STRESS-UNIFORMITY and SKIPFT, the property according to which the related words must agree: this is because the winning candidate set in each case satisfies BOTH constraints perfectly, by obeying SKIPFT in the word where it matters, and by patterning the second word after the first (in order to obey STRESS-UNIFORMITY). The two words of each pair illustrate the only types of cases that matter: any other word based on the same root will fall into one of the same categories, i.e. where the underlying length is preserved in the root and where it is not. So the same reasoning applies to the entire derivational and inflectional paradigm: based on a subset of the words that require SKIPFT, all related words will also show the same effect. In this way the requirement for uniformity is computationally tractable.<sup>15</sup>

5. Phrasal stress

Stress in Kashaya is, as mentioned above, assigned to a phrasal constituent. This constituent can be referred to simply as the phonological phrase, although there is insufficient knowledge of Kashaya phrasal phonology to make substantive claims about how this phrase fits into proposed universal prosodic hierarchies (e.g. Selkirk 1986, Nespor & Vogel 1986). The following sets of examples illustrate the stressing of two words in isolation, plus the stress when the two words occur together in a single phrase. Note that the combined stress generally does not correspond to either of the isolation stresses, demonstrating that it is truly phrasal, but that the property of extrametricality is the same for a domain-initial word whether it is in isolation or not. (The root is again shown in bold).

- (97) a.  $\langle \text{p}^{\text{h}}\text{a} \rangle$  (lá) 'again'  
 b. (momú:)(lí:ce:)(duce:)(du) 'keep back running around'  
 c.  $\langle \text{p}^{\text{h}}\text{a} \rangle$  (lamó)(mu:)(lí:ce:)(du) 'keep back running around again' [B 177]
- (98) a.  $\langle \text{q}^{\text{h}} \rangle$  (dí) 'good'  
 b. ('icé:)(du) 'be!'  
 c.  $\langle \text{q}^{\text{h}} \rangle$  (dí'í)(ce:)(du) 'be good!' [311]

- (99) a. <cah>(nó) 'language'  
 b. (lowá):(cál) 'be speaking'  
 c. <cah>(noló)(wa):(cál) 'the language (we're) speaking' [30]
- (100) a. <ha>( 'á) 'horn'  
 b. <ba>(nemá):(cáy) 'let me put (them) on'  
 c. <ha>( 'abá)(nema):(cáy) 'let me put the horns on' [257]
- (101) a. <cu>(ní) 'bread'  
 b. <mo>«bok'i»:(bí) 'start to rise'  
 c. <cu>«ni»:(mó)(kí):(bí) 'the bread started to rise' [D]

These data exemplify various possible relationships among words in isolation and in phrasal context. For example, in (100) and (101) the phrasal stress falls on a syllable that is extrametrical when the word is in isolation; (101b) involves Foot Flipping, as can be seen more easily in (47e). Also, in (101a) the foot (*ni*;) cannot be skipped because then there would be no stress at all, but in the larger phrase (101c) it can be skipped, and is.<sup>16</sup>

In a Lexical Phonology analysis (e.g. Buckley 1994a), the fact that lexical and postlexical foot structure need not correspond is attributed to the difference between components of the grammar. First, foot construction applies in the lexicon, to the word alone, and lexical rules such as Iambic Lengthening apply based on this metrical structure (102a). Later, when the word is placed in phrasal context, new foot structure is created, but here – by stipulation – Iambic Lengthening does not reapply, and the new metrical representation is used solely for the calculation of stress (102c).

- (102) a. *Lexical Foot Construction*  
 Iambic Lengthening  
 <p<sup>h</sup>a>(la) (momu)(lice)(duce)du  
 <p<sup>h</sup>a>(la) (momu):(lice):(duce):du  
 b. *Syntax*  
 <p<sup>h</sup>a>(la) (momu):(lice):(duce):du  
 c. *Removal of old feet*  
 New Foot Construction  
 Stress (word layer)  
 <p<sup>h</sup>a>lamomu:lice:duce:du  
 <p<sup>h</sup>a>(lamo)(mu):(lice):(duce):du  
 <p<sup>h</sup>a>(lamó)(mu):(lice):(duce):du

For step (c), note that the extrametricality of the first syllable must persist during the removal of the old feet (Buckley 1994b), and Iambic Lengthening must not be permitted to reapply to the new

feet. While the focus of this paper is not phrasal phonology, I will present a sketch of an approach to the derivation of both words and phrases without recourse to the intermediate stage of a lexical output. This shows that the surface-oriented analysis that works so well for the word-internal metrical phonology of Kashaya can also account for the interaction of the word-internal and phrasal foot structures.

If the lexical component does not exist as a separate stage in the derivation, as a truly parallel derivation in OT requires, we cannot appeal to the intermediate lexical representation to account for the lack of perfect isomorphism between the feet for Iambic Lengthening and the feet for stress. The answer I give is that Iambic Lengthening does, in fact, respond to phrasal footing, but that it is the phrasal footing of a word in ISOLATION that matters. Recall from (97) to (100) that there do exist words whose stress and lengthening feet are entirely consonant: each example (b), where the verb occurs initially in a phrase (more particularly but noncrucially, it occurs here in isolation). I propose that the contradictory demands on foot structure evinced by the examples (c) are once again due to an output-output correspondence, in this case on the location of vowel length, or quantity. I propose the following constraint.

- (103) Q-UNIFORMITY For a given word, quantity within the word is identical across occurrences.

This constraint is distinct from the Q-IDENT already given (22), which is an input-output constraint. Also, Q-UNIFORMITY is not particularized to constraint domains.

In this approach, the significance of the category 'word' arises not from its status as the output of the lexicon, but rather its status as a morphosyntactic category of which identity requirements can be predicated. The question then arises as to why it is the isolation form of the word, rather than the form predicted in some other phrasal context, that exerts its influence over all other forms. The following comment by McCarthy (1995: 52) is relevant.

Descriptively, the effect of cyclicity is something like this: the word [[X]+Afx] shows the phonology of [X] alone, without [+Afx]. Under Correspondence Theory, this can be interpreted to mean that there is a correspondence relation between the output forms of the word X and the word X+Afx...

Further research is necessary to determine whether correspondence

should be possible in the opposite direction, such that [X] alone can also show the phonology of [X]<sub>1</sub>+Afx], a kind of reverse cyclicity (cf. Burzio 1994). In the phrasal cases under consideration here the answer is definitely no. This perhaps follows from the fact that, in the examples above, each (b), the word in isolation is a morphological subset of the corresponding (c), the word in phrasal context. The subset is treated as the more fundamental form, and there is a relationship of priority: the isolation candidate is evaluated without reference to Q-UNIFORMITY (nor to how its satisfaction of other constraints might compare to that of a particular phrasally situated example); rather, every phrasal example is required to satisfy Q-UNIFORMITY relative to the (established) isolation form.<sup>17</sup>

There are at least two motivations which support this interpretation, whereby the phrase is based on the word. First, in the case of metrical phonology, the foot structure of the smaller word cannot consistently be the same as that of the larger phrase, simply because in some cases a foot will span a word, and that is quite impossible to duplicate when the word exists in isolation. But a word-internal foot can always be duplicated in a larger phrase that includes that word. Second, and more generally, note the incoherence of establishing 'in phrasal context' as the basic form to be imitated by the isolation word as well as by other phrasally occurring examples: there is in principle an infinite set of phrasal contexts which might serve as the basic form, while the isolation form is unique. Thus it is natural that the isolation word should be taken as the basic form with which all phrasally occurring examples are compared.

The following example illustrates the operation of this principle. The essential point is that Q-UNIFORMITY must dominate basic foot well-formedness constraints, so that for example a nonbranching foot is permitted even when a branching foot is possible given the syllable structure. Recall the following words and phrase, repeated from (98), and shown with explicit underlying forms.

- (104) a.  $\dot{q}o' \dot{d}i$  →  $<\dot{q}o' > (d\acute{i})$  'good'  
 b.  $'i\text{-}ced\text{-}u$  →  $('ic\acute{e}:)du$  'bel'  
 c.  $\dot{q}o' \dot{d}i 'i\text{-}ced\text{-}u$  →  $<\dot{q}o' > (d\acute{i}'i)(ce:)du$  'be good!'

The tableau below gives the derivation of (104b), as pronounced in isolation.

(105)

$'icedju$	Q-UNI	ALIGNR	ASYM
a. $('ic\acute{e})(du)$		*	*!
b. $'i\text{-}ced\text{-}u$		**	
c. $('i:)(ced\acute{u})$		**!	*

For this word, Q-UNIFORMITY is vacuously satisfied by any candidate, since this is the isolation form with which the constraint demands identity of vowel length. (Alternatively, the constraint is not satisfied per se, but rather uninterpretable and thus ignored.)

For a phrase containing this word, Q-UNIFORMITY is very much relevant. For example, form (106b) maximally satisfies the basic constraints on foot structure, but because it has long vowels different from those in the isolation form (105b), it fails.

(106)

$\dot{q}o' \dot{d}i$ $'icedju$	Q-UNI	NONINITIAL	PARSESYL	ALIGNR
a. $(\dot{q}o') (d\acute{i}'i)(cedu)$	*!	*		** , ***
b. $\dot{q}o' (d\acute{i}'i)(cedu)$	*!		*	**
c. $\dot{q}o' (d\acute{i}'i)(cedu)$	*!		*	**
d. $'i\text{-}ced\text{-}u$ $\dot{q}o' (d\acute{i}'i)(ce:)du$			*	*, **
e. $\dot{q}o' (d\acute{i})('ice:)(du)$			*	*, ***!

The last pair, (106d,e) illustrates that although undominated Q-UNIFORMITY eliminates many candidates from consideration (a-c), lower-ranked constraints still play an important role in choosing the winning form: we see again that ALIGNR forces branching feet to be as far to the left as possible.

6. Conclusion

I have presented data from the metrical phonology of Kashaya and argued that a constraint-based analysis in Optimality Theory is able to capture the shared motivations and formal similarities between phenomena such as Iambic Lengthening and Foot Flipping in ways not available to an ordered-rule analysis – namely, the inter-

action of surface constraints such as ALIGNR, ASYM, and Q-IDENT. In order to provide a full accounting of the facts, two enrichments to the original version of OT are necessary: constraint domains, which permit substrings to be subject to different constraint rankings; and uniformity (or output-output correspondence), which permits the optimal form of one word or phrase to be determined in part by reference to the output form of another word.

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#### Notes

<sup>1</sup> The double hyphen marks suffixal classes described below. The symbol 'c' indicates palato-alveolar [tʃ]. The underlying forms given in this paper are somewhat simplified, incorporating the effect of several segmental alternations. Most notably: every [d] is derived from /h/ in the onset; many tokens of [u] after [d] are derived from /i/; and 'incremental' /, h/ are omitted from the input when they do not surface; see Buckley (1994a) for details. References to sources of data are given as follows: a simple number refers to a page in Oswalt (1961); 'T' refers to the texts in Oswalt (1964); 'V' and 'D' refer to the vocabulary and dictionary of Oswalt (1975, 1990) respectively; 'B' refers to Buckley (1994a); and unmarked examples are from the author's unpublished notes.

<sup>2</sup> This is not to say that the very real avoidance of final long vowels in Kashaya never plays a role in IL, simply that in verbs – my focus here due to their much greater morphological and phonological complexity – it is pre-empted by a more specific property. In non-verbs such as (*stó*) 'three' or (*comá*) 'feast', however, this avoidance accounts for the lack of lengthening, since there are no suffixes present which might be analyzed as 'non-lengthening'. See also (14c) where final shortening occurs.

<sup>3</sup> I assume here basic familiarity with the notations and assumptions of Optimality Theory; see Prince & Smolensky (1993).

<sup>4</sup> This constraint is the same in effect as the TRANSFER of Urbanczyk (1995: 512) and Wt-IDENT of McCarthy (1995: 43); see those sources for more formal statements. I reject the use of Wt ('weight') because the constraint is not mediated by syllable structure.

<sup>5</sup> A thorough accounting of Kashaya suffixal phonology requires more than two domains (Buckley 1995a), but only this bifurcation is relevant to the phenomena discussed in this paper.

<sup>6</sup> ALIGNR is ranked below Q-IDENT<sup>(2)</sup>; this ranking is not crucial here, but is motivated below in (72).

<sup>7</sup> Two earlier examples from (6) require comment. The root *du.cié* 'know' has exceptional stress on the first syllable, which prevents extrametricality (including the type discussed below in section 4). The verb *dabane* 'throw away' belongs to a small set of apparent compound roots containing the element ( )*da*, all of which

resist extrametricality, probably because the requirement that the root be footed extends to this element ( )*da*; see also Buckley (1994a:229-32).

<sup>8</sup> In Buckley (1994a,b) this generalization is made in terms of the 'base', a morphological constituent which includes the root, any prefix which may be present, and any of a small set of (mostly nonsyllabic) suffixes. In the Lexical Phonology framework assumed there, the base is merely a heuristic term, formalizable as the output of level 2. (Syllable Extrametricality applies only in level 2, where it is subject to blocking by the Non-Exhaustiveness Condition.) In the present approach, of course, no reference to an intermediate stage is possible, and the substance of any sub-word constituent takes on far greater importance. A direct translation into the analysis in this paper would require the constraint FT-BASE rather than FT-ROOT. These two formulations are identical in empirical effect, except for three words containing the possible suffix *-hci*. The 'bases' *ca-hci*, *di-hci*, and *ho-hci*, which are the Semelfactive forms of the roots *ca* 'sit (sg)', *di* 'pick up', and *ho* 'get hot', do undergo extrametricality (cf. Oswalt 1961: 165, Buckley 1994a: 228). If this *-hci* is treated as a separate morpheme (a rare allomorph of normal Semelfactive *-c*), we must refer to the base in the constraint, since the root – the first syllable – of *ca-hci* etc. is excluded from foot structure. If *ca-hci* etc. are treated as suppletive roots, then the constraint can refer simply to the root, and footing the syllable /ci/ in each case will satisfy the constraint; that is the assumption I make here. This makes the constraint-based approach considerably more restrictive. Note that the constraint-based approach makes different predictions from the Lexical Phonology model. In the latter, the Non-Exhaustiveness Condition might have an effect at any lexical level, so that it might be any number of potential substrings of the word which are necessarily footed. Using a constraint like FT-ROOT, however, we expect that the morphological constituent being referred to should have some special status that makes it possible to refer to it in the first place, such as being the head of the word. Thus we might expect that FT-BASE is an impossible constraint, actually FORCING the suppletive analysis of *ca-hci* etc.

<sup>9</sup> See Buckley (1994b) for a hierarchical analysis which permits both a syllable and a foot to be cumulatively extrametrical without violating the Peripherality Condition.

<sup>10</sup> This approach to underspecification is similar to that advocated by Kiparsky (1993), and is predicted by the principle of Lexicon Optimization in OT (Prince & Smolensky 1993, Inkelas 1995).

<sup>11</sup> In particular morphological contexts, a final syllable of the shape CvCC or CvVC is possible; in addition, certain borrowed words have word-internal CvVC syllables. See Buckley (1994a) for discussion and analysis.

<sup>12</sup> This constraint is distinct from Q-IDENT because the latter refers to the material which is linked to a particular mora, while Max(μ) refers only to the mora itself and is unviolated by a mora which changes its associations.

<sup>13</sup> This analysis sheds new light on borrowed words in Kashaya that contain unexpected CvVC syllables. Buckley (1994a) and Inkelas & Cho (1993) account for the lack of Shortening here by pre-linking the coda consonant to the same mora as the second half of the long vowel. Under the present view, however, simply linking the vowel to both moras will accomplish the same task, and the irregularity of CvVC (no Shortening) receives the same formal account as the irregularity of the roots in (83) which resist Flipping.

<sup>14</sup> The constraint cannot prohibit stress on ANY CvV foot, since the phenomenon is not iterative. For instance, in the word <*hi*> *!u.á:qaw* 'a lock', the first CvV is skipped, but not the second. See Buckley (1994a, b) for additional examples and discussion.

<sup>15</sup> The issue of computability here is similar to that which arises in constraints

which are subject to potentially infinite violations, e.g. DEF being violated by rampant insertion of epenthetic syllables.  
 16 Obviously there must be a constraint such as Culminativity which requires the word to have a metrical head, and this dominates SKIP<sub>FT</sub> (cf. Selkirk 1995, Hayes 1995).  
 17 Notice that the relationship of identity enforced by STRESS-UNIFORMITY in section 4.2 is not of the type McCarthy describes: rather than cyclic [X] and [[X]+Afx], the forms compared are paradigmatic [[X]+Afx1] and [[X]+Afx2] (Or, with Elision, [[X+Afx1]+Afx2] and [[X+Afx1]+Afx3]). This case is more akin to Burzio's (1994) principle of Metrical Consistency, and the Uniformity of Flemming (1995) and Kenstowicz (1995).

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