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Uniformity in Extended Paradigms*

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A number of researchers have explored recently the advantages of replacing traditional cyclic analyses of phonological patterns with constraints on identity among related words (e.g. Benua 1995, this volume; Burzio 1994; Flemming 1995; Kenstowicz 1995; McCarthy 1995; McCarthy and Prince 1994, 1995; Orgun 1994, this volume). This reformulation of cyclicity, essentially as analogy, is necessary in a parallel model of phonology, and is motivated to the extent that strict parallelism is motivated (e.g. Prince and Smolensky 1993). There are also more specific reasons to prefer correspondence among outputs over cyclicity, since it can account for phenomena which elude a cyclic framework, particularly in the case of paradigm uniformity (e.g. Flemming 1995, Kenstowicz 1995) where the word which exerts influence is not a morphological subset of the target word.

In this paper I show that in Kashaya (a Pomoan language of northern California: Oswalt 1961), paradigm uniformity makes possible a superior account of relations between underlying and surface vowel length, and its effect on the location of stress. In brief, if both phenomena are attributed to stages in a derivation, the rules must be complex and ad hoc; but if stress is influenced by uniformity, vowel length can be accounted for by means of simple and well-motivated surface constraints. However, the fact that vowel length, which interacts with stress, can also be derived from morphological concatenation, leads to the conclusion that the object on which uniformity is defined is not always just the root but some larger complex constituent, which includes at least the root and the first suffix.

Much of this paper is concerned with demonstrating the need to separate the analysis of vowel length from the treatment of stress shift, a necessary background to the basic conclusions which follow. In §1 I give the basic foot structure of the language, contrasting analyses in ordered lexical phonology and surface-oriented Optimality Theory. In §2 I present and account for 'Foot Flipping', whereby the sequence `CvvCv` becomes `CvCvv`. This is accompanied by a shift in stress placement without a triggering environment in the surface form, and so motivates an appeal to paradigm uniformity, as discussed in §3. I then turn in §4 to shortening of long vowels in closed syllables, which also shows stress shift in opaque environments. In §5 we see the important case of Elision, whereby long vowels are derived by morphological concatenation, creating the necessary trigger for stress shift. In §6 I develop a notion of 'extended root' to account for the stress shift in root + suffix combinations that undergo Elision: because a mora of the suffix is incorporated into the root syllable, the suffix itself is incorporated into the root paradigm. In §7 I consider a special case of vowel-length alternation which might also require an extended root. A brief conclusion is given in §8.

1. Metrical Structure

Kashaya builds iambs from left to right. There are no secondary stresses, but the need for iterative footing is shown by Iambic Lengthening (=IL). The main (only) stress is normally on the first foot (the important exception is treated below). In examples here, the root is shown in bold; note the vowel length alternations in the suffixes due to varying foot structure.

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(1) a. **kel**-mul-ad-uced--u
→ (kél)(mula:)(duce:)(du) 'keep peering around'
b. **mo**-mul-ad-uced--u
→ (momú:)(ladu:)(cedu) 'keep running around'

A word-final vowel (1b) never undergoes IL; final long vowels are avoided, but more to the point all verb-final suffixes belong to a class of suffixes which permit no IL of their vowels. Non-lengthening suffixes uniformly occur to the right of those which permit IL, so the domain of IL is a substring at the right side of the word. The double hyphen (--) indicates the beginning of this non-lengthening domain.

(2) a. **mo**-mac-ed--ela
→ (momá:)(ced<u>e</u>)(la) 'I keep running in there'
b. **ṡi**--pʰila
→ (ṡipʰ<u>í</u>)(la) 'if [it] happens'
c. **hoṭʰ**-ala--ṡuw-em
→ (hoṭʰá:)(laṡ<u>u</u>)(wem) 'it would warm [us] up'
d. **mo**-mac-ed--eti
→ (momá:)(ced<u>e</u>)(ti) 'although he kept running in there'

In lexical phonology (e.g. Kiparsky 1982), the derivation of these forms requires several stages: first the lengthening suffixes are added to the root; then IL applies; and then the non-lengthening suffixes are added (Buckley 1994a). After the second round of morphology, IL does not reapply.

(3) a.	*MORPHOLOGY 1*	mo + mac	mo + mac + ed
b.	*Phonology (with IL)*	(moma:) <c>	(moma:) (ce) <d>
c.	*MORPHOLOGY 2*	(moma:) c + eti	(moma:) (ce) d + ela
d.	*Phonology (no IL)*	(momá:) (ceti)	(momá:) (cede) (la)

This analysis crucially refers to an intermediate representation (3b), but research in Optimality Theory has placed that approach in doubt; there is much to be gained if ordered rules are replaced with constraints on surface representations (cf. Prince and Smolensky 1991, 1993, and much subsequent work). An example is the need for provisional final-consonant extrametricality in (3b), to permit IL in intermediate *momac* (see also Buckley 1995a,b).

If we cannot appeal to *momaced* as an intermediate representation, we must refer to it as a substring of the surface representation within which IL occurs. Below, within $\{\ldots\}_1$ IL occurs, within $\{\ldots\}_2$ it does not.

(4) a. *Input* *with domains* $\{$momaced$\}_1\{$ela$\}_2$
b. *Output* *with feet* (mom<u>á:</u>)(ced<u>e</u>)(la)

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, we must generate the foot structure on which IL is based. In a surface analysis, there is no notion of directionality; instead, we must refer to the alignment of feet (McCarthy and Prince 1993). As Crowhurst and 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 feet are permitted. Below in (22) I show that it is right alignment that must be used in Kashaya; this means that degenerate feet must be permitted, as supported by the existence of monomoraic words (e.g. *cá* 'stay!').

While I give here only single-word examples, Kashaya stress is assigned to the phrase (see Oswalt 1961, Buckley 1995c). The following two constraints generate the basic foot structure.

(5) ALIGNR Align(Ft, R; Phrase, R)
PARSESYL Every syllable must be parsed by a foot.

In order to get the effect of iterative footing it is necessary to rank PARSESYL over ALIGNR (McCarthy and Prince 1993). I assume the undominated constraint FTFORM(Iamb).

(6)

keladucedu	PARSESYL	ALIGNR
a. ☞ (kelá:) (duce:) (du)		*, ***
b. ke (ladú:) (cedu)	*!	**
c. keladu (cedú)	*!**	

As mentioned, using ALIGNR to achieve the effect of left-to-right footing requires that we permit degenerate feet (but see also McCarthy and Prince 1993: 91). In languages that avoid such feet, FTBIN is responsible (Prince and Smolensky 1993). I assume that universally no foot is larger than two syllables.

(7) FTBIN A foot is binary under moraic or syllabic analysis.

Since, however, degenerate feet are necessary for ALIGNR in Kashaya, PARSESYL » FTBIN.

(8)

keladucedu	PARSESYL	FTBIN
a. ☞ (kelá:) (duce:) (du)		*
b. (kelá:) (duce:) du	*!	

The basic effect of IL is to achieve a perfect or canonical iamb, which consists of a light (and unstressed) syllable followed by a heavy (and possibly stressed) syllable (cf. Hayes 1985, 1995).

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

ASYM is ranked lower than ALIGNR; cf. (14b,d). Notice in (10) that the location of feet is determined by PARSESYL and ALIGNR, while ASYM secondarily determines the internal composition of those feet.

(10)

keladucedu	PARSESYL	ALIGNR	ASYM
a. (kelá) (duce) (du)		*, ***	*!*
b. (kelá:) (duce) (du)		*, ***	*!
c. ☞ (kelá:) (duce:) (du)		*, ***	
d. (kelá:) (du) (cedu)		**, ***!	*
e. (kelá:) ducedu	*!**	***	

IL must be prevented in the non-lengthening domain by a constraint of the following type (cf. Urbanczyk 1995: 512, McCarthy 1995: 43).

(11) Q-IDENT The quantity of each input segment must be 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. Since the winner differs across the two domains, there must be a different constraint ranking in those domains.

Following Buckley (1995a,b), I assume the existence of C[onstraint]-domains to which constraints can be particularized.

(12) { root + lengthening suffixes }$_1$ { non-lengthening suffixes }$_2$

Two C-domains, C1 and C2, require two domain-specific constraints. Q-IDENT$^{\{1\}}$, which evaluates only segments in the lengthening C1, is ranked below ASYM; while Q-IDENT$^{\{2\}}$, for the non-lengthening C2, dominates ASYM to prevent IL.

(13) Q-IDENT$^{\{2\}}$ » ASYM » Q-IDENT$^{\{1\}}$

The UR, with domains labeled, is shown in the upper left corner of the tableau.

(14)

{kelala}$_1$ {p^{h}ila}$_2$	Q-IDENT$^{\{2\}}$	ALIGNR	ASYM	Q-IDENT$^{\{1\}}$
a. (kelá) (lap^{h}i) (la)		*, ***	**!	
b. ☞ (kelá:) (lap^{h}i) (la)		*, ***	*	*
c. (kelá:) (lap^{h}i:) (la)	*!			*
d. (kelá:) (la) (p^{h}i) (la)		*, **, **!*		

Although in (14c) iambic structure is perfectly satisfied, it happens at the expense of preservation of underlying vowel length in the suffix *-p^{h}ila*, subject to high-ranking Q-IDENT$^{\{2\}}$. In (b), iambic asymmetry is met only within the domain where low-ranked Q-IDENT$^{\{1\}}$ is violated, making it optimal.[1]

It is a basic fact of Kashaya that the first syllable of the word is extrametrical when the root is at least two syllables in length, or when a root of any length is preceded by a prefix. This can be seen in the displacement of both stress and IL.

(15) a. **libut**-ad--u
→ (butá:)(du) 'keep whistling'

b. **bimucid**-uced--u
→ <bi>(mucí:)(duce:)(du) 'used to eat'

c. du-**ḱil**-iċ--i
→ <du>(ḱilí:)(ċi) 'point at yourself!'

d. do-**hqoṭol**-iċ-ed--a-em
→ <doh>(qoṭó:)(liċe:)(dam) 'couldn't get around'

The examples given earlier all have monosyllabic roots; syllable extrametricality is introduced here because it figures in many examples below, but it is orthogonal to the main discussion. See Buckley (1995c) for discussion and analysis; for present purposes I simply assume satisfaction of

[1] Not only is Q-IDENT$^{\{1\}}$ low-ranked relative to ASYM, it in fact never plays any role in choosing candidates. Any form that Q-IDENT$^{\{1\}}$ might favor is ruled out by ALIGNR, which dominates ASYM and therefore necessarily Q-IDENT$^{\{1\}}$. (Every long vowel leads to a new foot and adds violations of ALIGNR.) As noted by Buckley (1995a), an alternative to the view that a constraint such as Q-IDENT exists in two domain-specific forms is that there is only one constraint, but (in this case) it is ignored in C1. The important point is that violations within C1 never matter, whether this is treated as low ranking of a domain-particularized constraint, or by completely ignoring the violations.

constraints, in particular NONINITIAL, which ensure that the initial syllable is excluded from foot structure in these cases.

2. Foot Flipping

Of central interest in this paper is the process that Buckley (1994a,b) calls Foot Flipping. When the leftmost footed sequence of the word is CvvCv, the vowel lengths in the two syllables are 'flipped' or reversed, resulting in the perfect iamb CvCvv.

(16)	a.	**di:ċ**-aq^{w}-iċ--i	→	(diċa:)(qoċí)	'take a message out!'
	b.	**ġa:**-cid--u	→	(ġaci:)(dú)	'keep leaving'
	c.	**miku:ṭ**-ad--e:	→	<mi>(kuṭa:)(dé:)	'keep humming'
	d.	**mu-bo:ḳ**-ibic--ʔ	→	<mo>(boḳi:)(bíʔ)	'start to rise'

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. Below in §3 this stress shift receives an analysis in terms of paradigm uniformity.

Cvv followed by a heavy syllable does not undergo Flipping. The reason: the maximal syllable in Kashaya is CvC, and Flipping would result in *CvvC or *Cvvv (see §2.1).

(17) a. **di:ċ**--iʔba
→ (di:)(ċíʔ)(ba) 'could tell'

b. **ġa:**-muċ--ba
→ (ġa:)(múċ)(ba) 'after leaving each other'

c. **miku:ṭ**--e:
→ <mi>(ku:)(ṭé:) 'hums'

d. **kilu:ca-**:qa--w
→ <ki>(lu:)(cá:)(qaw) 'a lock'

In this case the stress also falls on the second foot in the word. What both cases of stress shift have in common is a long vowel which seems to start out at the beginning of the foot that is skipped; only in (17) does it actually surface there.

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. This requires temporary creation of the ill-formed 'anti-iamb' CvvCv, which persists until Foot Extrametricality applies, after which a literal rule of Foot Flipping simply reverses the vowel lengths to create a true iamb. Henceforth I use « » for an extrametrical foot.

(18)	i.	*Foot Construction*	(dí:) (ċah) (qaw)	(dí: ċa) (qo ċi)
	ii.	*Foot Extrametricality*	«di:» (ċáh) (qaw)	«di: ċa» (qo ċí)
	iii.	*Foot Flipping*	—	«di ċa:» (qo ċí)

In addition to the ad hoc nature of Foot Flipping and the temporary creation of ill-formed structures, Foot Extrametricality also requires the dubious generalization "begins with Cvv", to cover Cvv (17) and CvvCv (16). (This generalization also applies to CvvC in §4.)

A more principled analysis is possible using constraints. The change does not need to be analyzed as 'flipping' per se, whereby the mora moves from one syllable to another. Rather, it can be seen as underlying indeterminacy in the association of the mora, which is resolved by metrical and syllabic well-formedness; that is, the association of the second mora is underspecified (cf. Kiparsky 1993).

(19) a. *root morpheme* b. *with suffixes*

```
  μ μ                    μ μ   μ   μ   μ
  |                      |     |   |   |
d i   ċ                d i   ċ a q o ċ i
```

There are two basic surface realizations possible: leftward or rightward linking to a vowel.[2]

(20) a.

```
  μ μ μ   μ   μ
  |/  |   |   |
d i ċ a q o ċ i
```

b.

```
  μ μ μ   μ   μ
  |  \|   |   |
d i ċ a q o ċ i
```

The choice between these forms is made by ALIGNR, which prefers branching feet at the left edge. (A raised period [·] indicates a floating mora in the UR; a colon [:] is a linked mora.)

(21)

{**di·ċ**aqoċ}$_1${i}$_2$	Q-IDENT$^{\{2\}}$	ALIGNR	ASYM
a. (di:) (ċaqo:) (ċi)		*, **!*	
b. ☞ (diċa:) (qoċi)		**	*
c. (diċa:) (qoċi:)	*!	**	

The next example shows clearly that rightward alignment is necessary in Kashaya, since (22a,b) are identical in all respects except for the location of vowel length and foot boundaries.

(22)

{**miku·ṭ**ad}$_1${e:}$_2$	NONINITIAL	PARSESYL	ALIGNR
a. mi (ku:) (ṭadé:)		*	**!
b. ☞ mi (kuṭa:) (dé:)		*	*
c. (miku:) (ṭadé:)	*!		**

The major success of the constraint-based analysis is that the same constraint needed to determine foot structure in simple cases — namely, ALIGNR — serves as the motivation for Foot Flipping. The fact that the lexical phonology analysis requires the ad hoc rule of Foot Flipping to accomplish the same task constitutes a strong argument in favor of the constraint-based approach.

2.1. Phonologically blocked Flipping

As seen in (17), vowel length surfaces in the root, i.e. there is no Flipping, when the rightward potential docking site of the floating mora is a heavy syllable. Below is a relevant input representation.

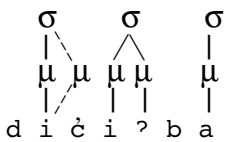
(23)

```
  μ μ   μ     μ
  |     |     |
d i   ċ i ʔ b a
```

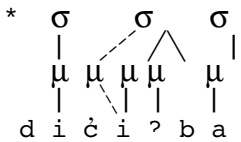
The first consonant in the cluster /ʔb/ syllabifies as a coda, where it must bear a mora itself. That makes a total of two moras in the syllable, with no room for the floating mora (by the constraint BIMORA). This forces leftward linking.

[2] While it appears to be a fact about Kashaya that verb roots normally do not have true underlying long vowels, a few are non-alternating and fail to undergo Foot Flipping (e.g. *ċa:hac-* 'get married'). Such roots simply have two underlyingly linked moras (Buckley 1995c).

(24) a.



b.



In (24b), to avoid a bimoraic syllable, but maintain the long vowel, the coda would have to be eliminated from the syllable, either by deleting the consonant (**diċi:ba*) in violation of MAX; or by inserting a vowel so the consonant can syllabify as an onset (**diċi:ʔiba*), violating DEP (see McCarthy and Prince 1995).

(25)

{**di·ċ**iʔ}$_1${ba}$_2$	BIMORA	MAX	DEP	ALIGNR
a. ☞ (di:) (ċiʔ) (ba)				*, **
b. (diċi:ʔ) (ba)	*!			*
c. (diċi:) (ba)		*!		*
d. (diċi:) (ʔiba)			*!	**

See Buckley (1995c) for discussion of constraints which prevent other rearrangements of the moraic structure, e.g. MORA-IDENT, MAX(μ), and LINEARITY.

2.2. Morphologically blocked Flipping

In addition to its ad hoc nature, the serial lexical phonology analysis in (18) treats IL and Foot Flipping as independent rules, yet the domains of the two rules are identical. For example, notice that the suffix *-mela* resists IL (26a) as well as Foot Flipping (b).

(26) a. **baṭi**--mela → <ba>(ṭimé)(la) '[we] camped'
*<ba>(ṭimé:)(la)

b. **ġa·**--mela → «ġa:»(melá) 'I left'
*«ġame:»(lá)

Formally, this shared restriction on IL 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. This prediction is dubious, since both processes result in the same perfect iamb.

In the OT analysis, the high-ranking status of Q-IDENT$^{\{2\}}$ accounts for both facts: IL and Foot Flipping both introduce a long vowel, and Q-IDENT$^{\{2\}}$ ensures that this not occur in C2.

(27)

{**ġa·**}$_1${mela}$_2$	Q-IDENT$^{\{2\}}$	ALIGNR	ASYM
a. ☞ (ġa:) (melá)		**	*
b. (ġame:) (lá)	*!	*	

The special status of C2 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 is a powerful argument against such a derivation. See also Buckley (1996).

3. Stress Uniformity

The constraint-based analysis elegantly unifies the accounts of IL and Foot Flipping. Now we must deal with the similarity in stress patterns between the flipped and non-flipped words. 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 (28). The initial foot dominating the same root is extrametrical even when it is not of the shape `Cvv`, i.e. when it is flipped or shortened (29).

(28)	a.	**di·ċ--**iʔba	→	«di:»(ċíʔ)(ba)	'could tell'
	b.	**di·ċ--**ela	→	«di:»(ċelá)	'I tell'
	c.	**di·ċ--**i	→	«di:»(ċí)	'tell!'
(29)	a.	**di·ċ-**aqʷ-**iċ--**i	→	«diċa:»(qoċí)	'take a message out!'
	b.	**di·ċ-**id--a-em	→	«diċi:»(dám)	'told about'

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.

(30)	a.	**kel--**iʔba	→	(kelíʔ)(ba)	'could peer'
	b.	**kel--**ela	→	(kelé)(la)	'I peer'
	c.	**kel--**i	→	(kelí)	'peer!'
(31)	a.	**kel-**adad--u	→	(kelá:)(dadu)	'look at while riding'
	b.	**kel-**ma--w	→	(kél)(maw)	'peer down at'

The forms in (31a) and (29a) have identical syllable structures, but different stresses. In (29) underlying vowel length has been shifted, but the resulting foot is skipped just like `Cvv` in (28).

A framework tied to surface constraints cannot refer to intermediate levels as was done in the lexical phonology analysis illustrated in (18), but as we saw that analysis has numerous problems anyway. 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. For present purposes, this can be accomplished by the following constraint.

(32) SKIPFT Do not stress an initial CVV foot.

The formal consequence is exclusion of the foot from line 2 constituency in the metrical grid. It is not possible to have a constraint which says not to stress **any** `Cvv` foot, since the effect is not iterative; cf. *<ki>lu:cá:qaw* in (17d).

SKIPFT must dominate two basic constraints on metrical structure.

(33)	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.

Under this analysis, the location of stress in a phrase (here, just one word) beginning with surface `Cvv` (modulo syllable extrametricality) is due to SKIPFT and the floating mora linking leftward (28). Every word that undergoes Flipping is related to a word where none occurs, and where shift is motivated transparently on the surface by `Cvv`. This fact is illustrated for the root *di·ċ* in (28) and (29). Whereas in many words shift is directly due to SKIPFT, in words that lack initial `Cvv` (thanks to Flipping), the shift follows not from the surface form but from uniformity with words that do have `Cvv`.

(34) a.

```
     (   x)
(x) (.   x)
di: ċe lá
```

by SKIPFT

b.

```
     (   x)
(.   x)(.   x)
di ċa: qo ċí
```

by uniformity with (a)

Specifically, the location of the metrical head of the word must remain consistent across instantiations of a root or stem.

(35) UNIFORMITY If the first foot is stressed in one instantiation of a root, then it must be stressed in all instantiations of that root.

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.

	Candidate Sets	UNIFORMITY	SKIPFT	PARSEFT
(36)	a. ☞ (kelá:) (dadu) (kelíʔ) (ba)			
	b. «kela:» (dadú) «keliʔ» (bá)			*! *
	c. (kelá:) (dadu) «keliʔ» (bá)	*!		 *
(37)	a. (diċá:) (qoċi) (dí:) (ċiʔ) (ba)		 *!	
	b. ☞ «diċa:» (qoċí) «di:» (ċíʔ) (ba)			* *
	c. (diċá:) (qoċi) «di:» (ċíʔ) (ba)	*!		 *

In (36), perfect satisfaction of all three constraints is possible. In (37), the two highest ranked (UNIFORMITY and SKIPFT) can be satisfied, so there is no necessary ranking between them, only that both dominate PARSEFT. The winning candidate set obeys SKIPFT in the word where that constraint matters, and patterns the second word after the first (in order to obey UNIFORMITY).

4. Closed-Syllable Shortening

Foot Flipping is not the only source of surface-opaque stress shift, and therefore not the only motivation for paradigm uniformity. Notice in (38) that the first foot is again skipped for stress, even though on the surface it does not contain a long vowel.

(38)	a.	**di·ċ**-waċ--a-emu	→	«diċ»(waċá)(mu)	‘what they say (is)’
	b.	**di·ċ**-maq--o	→	«diċ»(maqó)	‘bring the message in!’
	c.	**di·ċ**-mul-iċ--i	→	«diċ»(mulí:)(ċi)	‘bring the message around!’
	d.	**miku·ṭ**--qa-e:	→	<mi>«kuṭ^{h}»(qá:)	‘must have hummed’
	e.	ca-**hwe·n**-muċ--ʔli	→	<cah>«wen»(múʔ)(li)	‘a seesaw’
	f.	da-**li·t**-qa--w	→	<da>«lit^{h}»(qáw)	‘let wave with the hand’

As with Foot Flipping, in a serial analysis an ill-formed structure — in this case superheavy `CvvC` — must be temporarily permitted until Foot Extrametricality applies, after which it undergoes Shortening (cf. Buckley 1991).

(39)	i. *Foot Construction*	`(di:ċ) (waċa) (mu)`	`<da> (li:tʰ) (qaw)`
	ii. *Foot Extrametricality*	`«di:ċ» (waċa) (mu`	`<da> «li:tʰ» (qaw)`
	iii. *Shortening*	`«diċ» (waċá) (mu)`	`<da> «litʰ» (qáw)`

The OT analysis developed so far actually accounts quite easily for Closed-Syllable Shortening. The following input has a cluster of two consonants, /ċw/, following the root vowel.

(40)
```
   μ μ   μ   μ   μ
   |     |   |   |
d i ċ w a ċ a m u
```

In this context, the floating mora has not just two places to link, in the ways seen above, but it can also, as shown in (41c), serve as the mora for the coda consonant /ċ/.

(41) a.
```
   μ μ   μ   μ   μ
   |/    |   |   |
d i ċ w a ċ a m u        =    *(di:ċ)(waċa)(mu)
```

b.
```
   μ   μ μ   μ   μ
   |    \|   |   |
d i ċ w a ċ a m u        =    *(diċ)(wa:)(ċamu)
```

c.
```
   μ μ   μ   μ   μ
   | ¦   |   |   |
d i ċ w a ċ a m u        =     (diċ)(waċa)(mu)
```

The form in (41a) is ruled out by BIMORA, as in (25). The linking to the following vowel in (41b), by contrast, is well-formed syllabically. But it is not as well aligned as (41c), where the floating mora links to the coda consonant and pre-empts Weight-by-Position (e.g. Hayes 1989).

(42)

{**di·ċ**waċ}$_1$ {amu}$_2$	BIMORA	ALIGNR	ASYM
a. (di:ċ) (waċa) (mu)	*!	*, ***	*
b. (diċ) (wa:) (ċamu)		**, ***!	*
c. ☞ (diċ) (waċa) (mu)		*, ***	*

This 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. (Stress shift with Shortening is treated below in §6.)

5. Elision

Within C1, adjacent vowels /V_iV_j/ become long [V_i:] by Elision.[3] This occurs where Flipping is blocked, whether phonologically (43) or morphologically (44).

[3] In C2 the result is short [V_i], by Q-IDENT, which prevents compensatory lengthening; cf. (38a), where /ae/ surfaces as short /a/.

(43)	a.	**mo**-ibic--ʔ	→	«mo:»(bíʔ)	‘run away’
	b.	**ca**-ad--uʔba	→	«ca:»(dúʔ)(ba)	‘could fly’
	c.	**puhṭi**-aqac--ʔ	→	<puh>«ṭi:»(qáʔ)	‘go up alone’
(44)	a.	**mo**-aq--ela	→	«mo:»(qalá)	‘I’m running’
	b.	**mo**-ad--eti	→	«mo:»(detí)	‘even though [it] was running’
	c.	cʰi-**de**-ad--u	→	<cʰi>«de:»(dú)	‘carry along’

The two adjacent vowels are also a common source of Foot Flipping when the next syllable would otherwise be light Cv.

(45) a. **mo**-aloqʷ-iċ--i
→ «molo:»(qoċí) ‘run up out here!’

b. **do**-ibic--i
→ «dobi:»(cí) ‘raise your hand!’

c. **yehe**-ala-meċ--tʰu-ʔ
→ <ye>«hela:»(méʔ)(tʰuʔ) ‘don’t drag yourself down!’

In an ordered-rule framework, Buckley (1994a,b) has to assume that even in cases of Flipping, the intermediate step exists in which the two vowels are syllabified together, and then the length is flipped.

(46)	*Underlying form*	moaloqoċi	cahnoaduċi
i.	*Elision and Footing*	(mo:lo)(qoċi)	<cah>(no:du)(ċi)
ii.	*Foot Extrametricality*	«mo:lo»(qoċi)	<cah>«no:du»(ċi)
iii.	*Foot Flipping*	«molo:»(qoċí)	<cah>«nodu:»(ċí)

This intermediate CvvCv foot is necessary to trigger both Foot Extrametricality and Foot Flipping. Similarly, intermediate superheavy CvvC is required for forms with Closed-Syllable Shortening (cf. (38)), though in this case the only need is to trigger Foot Extrametricality.

(47) a. **mo**-aq--mela
→ «mo:h»(melá)
→ «moh»(melá) ‘I ran through there’

b. **pʰila**-aċ--me-ʔ
→ <pʰi>«la:ċ»(méʔ)
→ <pʰi>«laċ»(méʔ) ‘come here! (pl)’

The floating-mora analysis extends easily to these cases, and obviates the intermediate steps. Assume that loss of the second set of vowel features is accomplished by constraints such as ONSET (e.g. Prince and Smolensky 1993) and NODIPHTHONG (e.g. Rosenthall 1994).

(48)
```
  μ μ   μ   μ   μ
  | ǂ   |   |   |
m o a l o q o ċ i
```

The second mora, prohibited from remaining linked to its own features, behaves identically to an underlyingly floating mora, as in (19b). The two output possibilities are precisely those outlined in (20).

(49)

{moala}$_1$ {qoċi}$_2$	ALIGNR	ASYM
a. (mo:) (laqo:) (ċi)	*, **!*	
b. ☞ (mola:) (qoċi)	**	*

In a sense, a root like *di·ċ-* resembles *mo-aq-*, rather than vice versa: there is no long vowel in the underlying form of *di·ċ-*, 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.

6. Extended Roots

For consonant-final roots, the property of skipping the first foot is shared for all instantiations of that root. For any root ending in a long vowel, this is also true. For example, in the case of Closed-Syllable Shortening (a), the root is skipped under the influence of forms with the same root but which do not have shortening (b-c).

(50) a. **di·ċ**-waċ--a-emu → «diċ»(waċá)(mu) 'what they say (is)'
b. **di·ċ**--iʔba → «di:»(ċíʔ)(ba) 'could tell'
c. **di·ċ**--ela → «di:»(ċelá) 'I tell'

(51) a. hi-**ṡa·**-hqa--w → <hi>«ṡah»(qáw) 'cause to break'
b. hi-**ṡa·**--ti → <hi>«ṡa:»(tí) 'in order to break'
c. hi-**ṡa·**--mela → <hi>«ṡa:»(melá) 'I broke'

In fact, with Closed Syllable Shortening, it is crucial that paradigm uniformity apply only to the root itself. The reason for this is that the consonant cluster following the root vowel ensures that it will shorten in every case of that suffix. For example, when *-hqa* follows *hi-ṡa:-*, the root vowel is always short. Only by looking at the root in cases where another suffix follows, e.g. *hi-ṡa:-tí*, is it possible to detect a surface-motivated example of stress shift. So far, then, the paradigm which must be uniform is defined by the root morpheme alone.[4]

The situation is more complicated when it comes to a root ending in a short vowel, however. Because of Elision, such roots may or may not have a long vowel to undergo Flipping, depending on which suffix immediately follows. Take, for example, *mo-* 'run'. If a consonant follows, it patterns like *kel-* in (36), with no foot skipping.

(52) a. **mo**-mul--i → (momú:)(li) 'run around!'
b. **mo**-ht-mul--ʔ → (móh)(timuḷ) 'ran around (pl)'

If a vowel follows, however, Elision yields an extra mora, and the complex stem patterns like *di·ċ-* (37), i.e. the first foot is uniformly skipped, with or without Flipping.

(53) a. **mo**-ibic--ʔ → «mo:»(bíʔ) 'to run away'
b. **mo**-ibic--ba → «mo:»(bíċ)(ba) 'after running away'
c. **mo**-ibic--i → «mobi:»(cí) 'run away!'
d. **mo**-ibic-ed--u → «mobi:»(cedú) 'to run away'
e. **mo**-ibic-ed-uced--u → «mobi:»(cedú:)(cedu) 'to keep running away'

[4] Prefixes such as *hi-* in (51) are not relevant since they are always extrametrical.

In determining the uniform paradigm, then, more than just ‘root’ is relevant: we must be able to take account of the first suffix as well. It is this morphologically complex constituent for which paradigm uniformity is enforced.

This exception to the ‘root only’ generalization is motivated prosodically by the fact that, in cases such as (53a-b), a suffixal mora joins with the mora of the root to create the long vowel in the root syllable. The apparent consequence of this fact is that the combined root + suffix constituent is what serves as the basis of paradigm uniformity. In other words, when a suffixal mora is incorporated into the same syllable as the root, then the suffix itself joins into an ‘extended’ root constituent.

(54)

```
        σ       σ
        ¦ ╲     ¦
        μ   μ   μ
        |  ╱ ╪   |
[[[ m o ] i b i c ] ʔ ]    →    mo:bíʔ
  ─────────────
  extended root
```

In (54), the morphological affiliation of the second mora is with the suffix *-ibic*. But its phonological fate becomes tied to that of the first mora, which belongs to the root. Because the root nucleus extends into the suffix, the root paradigm does as well. The result is an extended root which is the new basis for paradigm uniformity. An alternative way to think of it is that the root, for the purposes of defining the paradigm, cannot end in the middle of a nucleus — the latter constituent is simply too coherent an entity.[5] In this regard, the operative notion is related to the idea of alignment (McCarthy and Prince 1993): just as some morphological constituents are prohibited from spanning a syllable, so in Kashaya the root paradigm cannot span a nucleus.

This principle defines combinations like *[[mo]ibic]* as complex paradigms. While prosodically motivated, the paradigm that results is fundamentally morphological in nature (i.e. it consists of the root and suffix, not the root syllable alone). Therefore this extended root serves as a complex paradigm in all instantiations of *[[mo]ibic]*, including those where the root syllable does not in fact include a mora from the suffix — as is the case, of course, in all examples with Foot Flipping, such as *[[[mo]ibic]i]* → *mobi:cí*.

An interesting parallel for the Kashaya extended root comes from the well-known operation of analogy in certain roots taking a nasal infix in Latin (e.g. Ernout 1953). This infix functioned originally to mark the present stem and preserves this function in many cases.

(55)

	‘break’	‘split’	‘conquer’
pres. act. indic. 1sg.	rump-ō	find-ō	vinc-ō
pres. infinitive	rump-ere	find-ere	vinc-ere
perf. pass. part. m.sg.	rup-tus	fis-sus	vic-tus
perf. act. indic. 1sg.	rūp-ī	fid-ī	vīc-ī

However, in a number of other roots the infix has been generalized to some or all other forms of the verb, not just the present.

[5] It is necessary to speak of the nucleus, and not just the syllable, since a coda consonant from a suffix is not sufficient to induce a similar extension of the root paradigm (as in *hi-ṡa-h.qá-w*).

(56)	'fashion'	'join'	'lick'
pres. act. indic. 1sg.	fi<u>n</u>g-ō	ju<u>n</u>g-ō	li<u>n</u>g-ō
pres. infinitive	fi<u>n</u>g-ere	ju<u>n</u>g-ere	li<u>n</u>g-ere
perf. pass. part. m.sg.	fic-tus	jū<u>n</u>c-tus	lī<u>n</u>c-tus
perf. act. indic. 1sg.	fī<u>n</u>x-ī	jū<u>n</u>x-ī	lī<u>n</u>x-ī

These verbs historically had no nasal in the root (cf. the English cognates *yoke*, *lick* with Latin *jung-*, *ling-*), but synchronically the nasal is fully incorporated into the root, just like in those cases where the nasal is an original part of the root (e.g. *tingō* 'moisten'). This analogical change is an entirely natural development, given the fact that the nasal morpheme intrudes phonologically into the root. In Kashaya the incorporation of a suffixal mora into the root syllable creates a similar intrusion that motivates a parallel extension of the root paradigm.

Another, quite distinct phenomenon which supports the notion of extended paradigm proposed here comes from Bantu reduplication. As shown by Sibanda (1997), in Ndebele material from an inflectional suffix (such as final vowel *-e*) is not normally included in reduplication; instead a default /a/ is inserted where necessary to satisfy the disyllabic template.

(57)	a.	-bon-e	-bon-<u>a</u> + bon-e	'see'
			*-bone + bone	
	b.	-bon-il-e	-bon-<u>a</u> + bon-il-e	'saw'
			*-boni + bonil-e	

The relevant data arise when the perfective *-il-e* undergoes **imbrication**, i.e. fusion with a root ending in /l/ (and sometimes other consonants), as illustrated in (58). When such a form is reduplicated, not only is default /a/ possible (59a), but optionally the suffix material can be included instead (59b).

(58)	a.	-libal-			'forget'
	b.	-libal-il-e	→	-libel-e	'forgot'

(59) a. -lib-<u>a</u> + lib-el-e
b. -lib<u>e</u> + libel-e

In the case where default /a/ is used, it is likely that the overwhelming Bantu pattern in favor of CVC roots and VC suffixes leads to the reanalysis of the output of imbrication — [el] in (59a) — as suffixal rather than root material, in which case it follows the pattern in (57b). The alternative, in (59b), is an extended root that incorporates the suffixal material.[6]

Significantly, if we look at imbrication with a shorter root we see that the final suffix *-e* cannot be included here, just as it cannot be included in (57b).

(60)	a.	-thath-			'take'
	b.	-thath-il-e	→	-theth-e	'took'

(61) a. -theth-<u>a</u> + theth-e
b. *-thethe + thethe

The generalization is that only a suffix which has been fused with the root can be included in reduplication; a concatenatively distinct suffix such as *-e* cannot, even when an adjacent suffix has undergone imbrication. Similar data exist elsewhere in Bantu, such as Kinande (Hyman and

[6] It is worth noting that the reanalysis of a CVC root plus a VC suffix as a simple root of the shape CVCVC is the diachronic origin of most of the longer roots in modern Bantu languages.

Mutaka 1990) and Kikerewe (Odden 1996). Just as in Kashaya and Latin, a phonological fusion of the root and suffix creates a single 'extended' constituent to which other processes are sensitive.

In his discussion of paradigmatic analogy, Kenstowicz (1995) states that uniformity functions to 'minimize the differences in the realization of a lexical item (morpheme, stem, affix, word).' For example, uniformity in the realization of /s/ applies specifically to the Spanish prefix *des-* but not to other morphemes; while uniformity in correspondence of /r/ applies to Latin noun roots such as *hono:s*, which is subject to the influence of *hono:r-em* etc. In Kashaya, the basic lexical item in question is the root; but with the special case of the extended root in the case outlined above. A clear and important point that we can draw from the Kashaya data is that paradigm uniformity cannot in all cases be restricted to single morphemes. If we could refer only to, say, the root *mo-* 'run', we would be trapped in the contradiction between the forms with this root in (52), stressed on the first foot; and those in (53), stressed on the second foot. The extended root resolves this conflict.

7. A Special Case

A phenomenon distinct from Elision which, however, also leads to the same sort of dual behavior for a root is termed Morphological Shortening by Buckley (1994a). Rather than lengthening an underlying short vowel, this process — triggered by certain null or contentful suffixes such as the 'Plural Act' (Oswalt 1961) — eliminates an underlying floating mora from the root.

(62)	a.	di-**cʰi·ṭ-**	→	dicʰi·ṭ-	'fall out (sg)'
	b.	di-**cʰi·ṭ-Ø-**	→	dicʰiṭ-	'fall out (pl)'
(63)	a.	**duqa·c-**	→	duqa·c-	'get lost (sg)'
	b.	**duqa·c**-ta-	→	duqatac-	'get lost (pl)'

In (63b), the *-ta* allomorph is infixed; cf. (66d) below.

As expected, only the singular form with the floating mora shows stress shift, but it does so uniformly.

(64)	a.	di-**cʰi·ṭ**--eti	→	<di>«cʰi:»(ṭetí)	'despite falling out (sg)'
	b.	di-**cʰi·ṭ**-ad-uced--u	→	<di>«cʰiṭa:»(ducé:)du	'habitually fall out (sg)'

The plural, with a shortened vowel, uniformly shows **no** stress shift.

(65)	a.	di-**cʰiṭ**--eti	→	<di>(cʰiṭé)ti	'despite falling out (pl)'
	b.	di-**cʰiṭ**-ad-uced--u	→	<di>(cʰiṭá:)(duce:)du	'habitually fall out (pl)'

These facts demonstrate that whether or not the Plural Act suffix is present must be taken into account in determining paradigm uniformity — that is, this suffix must also be included in an extended root. But unlike in the case of Elision, there is not the same prosodic motivation; the suffix results in the loss of a mora in the root syllable, not the addition of one. If we generalize the notion illustrated in (54) so that it appeals not only to the inclusion of a suffixal mora in the root syllable, but rather to any suffix which results in the addition **or** loss of a root-syllable mora, the desired effect follows. The intuitive appeal of the explanation is perhaps then weakened, but since the nature of pseudo-phonological rules which serve as the exponence of a morphological category is not well understood, it is difficult to say to what degree the extended root in this case is well motivated.

An alternative analysis is to say that Morphological Shortening is not actually a productive process; that is, pairs like *cʰi·ṭ-* and *cʰiṭ-* are not derived but are listed lexically. There is good

evidence for this position, since Plural Act morphology in general is highly idiosyncratic. For example, there are a number of suffixes and infixes attested, many of which appear in similar environments (Oswalt 1961).

(66)

	SINGULAR	PLURAL	
a.	di ʔ k̓ol-	di ʔ k̓ol-**aq**-	'prune (branch)'
b.	ba ʔ t̓il-	ba ʔ t̓il-**m**-	'be too noisy'
c.	dahqoṭol-	dahqoṭol-**ta**-	'fail (to do)'
d.	bilaqʰam-	bilaqʰa-**ta**-m-	'feed'
e.	pʰanem-	pʰane-**t**-m-	'hit with the fist'
f.	kel-	ke-**h**-l-	'peer'

The choice of affix here must be lexically listed. Further, some patterns are unique, and must be listed as suppletive roots.

(67)

	SINGULAR	PLURAL	
a.	-qʰo·**c**-	-qʰo**ṭ**-	'take out by the roots'
b.	moʔo**n**-	moʔo**ʔta**-	'strike'
c.	ṡoʔo·m-	ṡoʔo**hwi**m-	'excrete'
d.	ʔa**š**-	ʔa**cʰulaq**-	'miss (a target)'

Notice that some of these verbs involve shortening as well as segmental changes (67a,c). One might treat the pure shortening examples such as (62) as similarly listed forms, which happen not to have any segmental changes. If this is the case, then the plural is morphologically a simple root, without any internal structure, and it is hardly surprising that each constitutes a distinct paradigm from the independently listed singular root. But since other forms with shortening, illustrated by (61), do occur with a relatively productive suffix, the lexicalization analysis seems to miss an important generalization. At any rate, the available data regarding Morphological Shortening are rather limited, and I leave the resolution of this question open.

8. Conclusion

I have argued that an analysis with surface constraints captures the formal similarities between phenomena in Kashaya such as Iambic Lengthening and Foot Flipping in ways not available to an analysis reliant on intermediate steps — namely, the interaction of constraints such as ALIGN, ASYM, and Q-IDENT. To provide a full accounting of the facts, two enrichments to the theory are necessary: constraint domains, which permit substrings to be subject to different constraint rankings; and paradigm uniformity, which permits the optimal form of one word to be determined in part by reference to the output form of another word. Further, uniformity must be able to refer to paradigms defined by a root plus a suffix in particular circumstances where the phonological bond between the two morphemes is sufficiently strong.

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