

In Malayalam (Dravidian: India), as seen in (2), stress falls on the second syllable in this case (cf. Mohanan 1989). A foot cannot be constructed on the first syllable because the two options — degenerate (\sim) and trimoraic ($\sim \bar{\sim}$) — both violate restrictions on the form of a quantity-sensitive trochee. Thus the first foot is simply skipped, which is crosslinguistically the normal outcome in such cases.

In Cahuilla (Uto-Aztecan: southern California), on the other hand, we find a degenerate foot on the first syllable, which takes the main stress. (A $v?$ rime is heavy here.) This result can be analyzed by reversing the standard assumption of bottom-up construction and applying the End Rule first.

(3) Cahuilla: top-down parsing

- | | | |
|--------------------|---------------------------------|------------------|
| <i>i. End Rule</i> | (x) | |
| | \sim - \sim | |
| | su ka? ti | |
| <i>ii. Footing</i> | (x) | |
| | \sim)($\bar{\sim}$) \sim | |
| | sú kâ? ti | ‘the deer (obj)’ |

The need to have a foot underneath the x placed by the End Rule forces creation of a degenerate (\sim) foot so that the initial syllable is stressed.

While the contrast in (2) and (3) can generate the correct forms, it captures only weakly the intuition that what matters in Cahuilla is that the stress fall on the first syllable, and not that prosodic structure be created in a particular order. A constraint-based approach such as Optimality Theory (Prince and Smolensky 1993) makes it possible to capture this idea directly, and that is one of its primary advantages. For example, the contrast between Malayalam and Cahuilla can be analyzed with surface constraints only, such as the following, given in slightly simplified form.

- (4) a. FTBIN A quantitative trochee must contain two moras.
 b. ALIGNL The main stress must be at the left edge of the word.

The two logical rankings of these constraints give us the two languages.

- (5) a. FTBIN » ALIGNL *Do not stress the initial syllable if that would require a degenerate foot. (= Malayalam)*
 b. ALIGNL » FTBIN *Create a degenerate foot in order to achieve initial-syllable stress. (= Cahuilla)*

Thus the basic tool of Optimality Theory — constraint ranking — is all that is necessary to capture the difference between the two stress patterns.

An important example of an intermediate stage is the level of lexical phonology, which captures a relationship between sets of phonological and morphological rules. I illustrate with data from Manam (Oceanic Austronesian: Papua

New Guinea; cf. Lichtenberk 1983), in which stress clash is prohibited within a root but not elsewhere. This leads to the stress pattern $c\acute{v}c.cv.cv$ internal to a root (6) but $c\grave{v}c.c\acute{v}.cv$ elsewhere (7).

- (6) a. $\acute{e}mbe?i$ ‘sacred flute’
 b. $\acute{o}\eta?au$ ‘Onkau’ (*name*)
- (7) a. $ar\grave{o}-n-t\acute{u}?a$ (* $ar\acute{o}ntu?a$) ‘right in front of you’
 b. $s\grave{a}god\grave{e}-n-t\acute{i}na$ (* $s\grave{a}god\acute{e}ntina$) ‘you are really well-mannered’

In a lexical phonology model (e.g. Kiparsky 1982), the root pattern suggests application of footing to the root alone, which avoids clash. Later footing, after suffixation and in a different level, permits clash.

- (8) a. *Root stress* ($\acute{e}mbe)?i$ ($\acute{a}ro$)
 b. *Suffixation* — ($\acute{a}ro$)-n-tu?a
 c. *Refooting* — a(r\grave{o}n)(t\acute{u}?a)

While it is possible to incorporate levels directly into an OT approach (e.g. McCarthy and Prince 1993a), such a move undermines the essential surface orientation of the theory. The lack of levels in a strictly parallel version of OT might then be seen as a disadvantage of this approach, since it cannot reproduce the analysis in (8). Buckley (1995a,b) proposes ‘constraint domains’ which capture the generalizations that motivate levels not with intermediate stages, but by delimiting substrings of the surface representation which are subject to different constraint rankings. In Manam, the crucial domains are the root and the suffixes.

- (9) { root } { suffixes }

If stress is assigned only once, the otiose first stage of footing in (8) can be eliminated entirely. The root pattern is expressed as a constraint on stress which holds only within the root domain. A bit schematically (see Buckley 1995b for details):

- (10) *CLASH_{rt} Adjacent stressed syllables are not permitted.
Holds of the root only.

ALIGNR Align the right edge of the word with a foot.

(11)

$\{embe?i\}_{rt}$	*CLASH _{rt}	ALIGNR
a. $\acute{e}mbe)?i$		*
b. $(\grave{e}m)(b\acute{e}?i)$	*!	

(12)

$\{aro\}_{rt} \{n-tu?a\}_{suf}$	*CLASH _{rt}	ALIGNR
a. $a(r\acute{o}ntu)?a$		*!
b. $a(r\grave{o}n)(t\acute{u}?a)$		

- (15) a. MORPHOLOGY, level 3 **kel** + ad + uced
 b. Phonology (with Lengthening) (kela:) (duce:) <d>
 c. MORPHOLOGY, level 5 (kela:) (duce:) d + u
 d. Phonology (no Lengthening) (kela:) (duce:) du

The next derivation illustrates how this analysis captures the difference between level 3 and level 5 suffixes.

- (16) a. MORPHOLOGY, level 3 **mo** + mac + ed
 b. Phonology (with Lengthening) (moma:) ce <d>
 c. MORPHOLOGY, level 5 (moma:) ced + ela
 d. Phonology (no Lengthening) (moma:) (cede) la

Crucially, the suffix *-ela* must not be present at the stage where IL applies.

In a domains analysis, the double hyphen delimits two constraint domains, call them 1 and 2. (A complete account of the phonology may require more subtle division into domains.) Non-lengthening suffixes uniformly occur to the right of those which permit IL, so the domain of IL is a substring at the left side of the word. Schematically, this can be thought of in either of the following two ways: more descriptively (17a) or as a translation of the levels approach (b).

- (17) a. { root + lengthening suffixes }₁ { nonlengthening suffixes }₂
 b. { root + level 2 + level 3 }₁ { level 4 + level 5 }₂

More specifically, if we do not appeal to *momaced* as an intermediate representation, we must refer to it as a substring of the surface representation within which IL occurs (cf. also Inkelas 1989, Inkelas and Orgun 1995). Below, within {...}₁ IL occurs, within {...}₂ it does not.

- (18) a. *Input with domains shown* {momaced}₁{ela}₂
 b. *Output with feet* (momá:)(cede)(la)

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). Using constraints in a domains analysis, I posit the following constraint on Asymmetry within the foot.

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

Here I simply assume that the right foot structure is generated by proper ranking of constraints such as ALIGN, PARSESYL, and FTBIN; see Buckley (1995c) for complete analysis, including motivation for the presence of degenerate feet as shown below. ASYM determines the internal composition of those feet.

(20)	{keladuced} ₁ {u} ₂	ASYM
a.	(kelá) (duce) (du)	*!*
b.	(kelá:) (duce) (du)	*!
c.	(kelá:) (duce:) (du)	

IL must be prevented in the non-lengthening domain, for which purpose I give the following constraint (cf. Urbanczyk 1995: 512, McCarthy 1995: 43).

(21) 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 winning output differs across the two domains, there must be a different constraint ranking in the respective domains. Q-IDENT^{1}, which evaluates only segments in domain 1, is ranked below ASYM, resulting in lengthening; while Q-IDENT^{2}, for domain 2, dominates ASYM and thereby prevents IL.

(22) Q-IDENT^{2} » ASYM » Q-IDENT^{1}

The UR, with domains labeled, is shown in the upper left corner of the tableau. For clarity, domain labels are omitted from the output candidates.²

(23)	{momaced} ₁ {ela} ₂	Q-IDENT ^{2}	ASYM	Q-IDENT ^{1}
a.	(moma) (cede) la		**!	
b.	(moma:) (cede) la		*	*
c.	(moma:) (cede:) la	*!		*

In sum, domains provide a rather straightforward reinterpretation of levels in a surface-oriented framework, avoiding complications of intermediate stages such as otiose footing and ad hoc extrasyllabicity (as in (15); see Buckley 1995a).

Foot Flipping

A remarkable indication of the pressure in Kashaya for iambic rhythm is found in Foot Flipping. Putting aside its formulation (which is, in fact, much more principled using constraints: see Buckley 1995c), it has the effect of changing an underlying ‘anti-iamb’ cvvcv, flipping the vowel lengths in the two syllables to create the perfect iamb cvcvv.

(24) a. di:c-aqw-iç--i → (diça:)(qoçí) ‘take a message out!’
 b. qa:-cid--u → (qaci:)(dú) ‘keep leaving’


In addition to the flipping of vowel lengths, in these forms the stress falls on the second foot, rather than on the first one as is normally the case in Kashaya. See Buckley (1995c) for an account of this pattern in Correspondence Theory.

Foot Flipping, like Lengthening, fails to apply if it would result in a long vowel within domain 2, a fact which in OT can be attributed directly to the same constraint Q-IDENT.

- (25) a. **di:ç--eti** → (di:)(çetí) ‘although (he) tells’
 *(diçe:)(tí)
- b. **qa:--mela** → (qa:)(melá) ‘I left’
 *(qame:)(lá)

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 domain 2.

(26)

{qa:}₁{mela}₂	Q-IDENT ^{2}	ASYM
a.  (qa:) (melá)		*
b. (qame:) (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.

With levels the best we might do is to turn off Foot Flipping at the same point, i.e. after level 3 (cf. (16)), though even then the similarity would be a coincidence.

- (27) a. *MORPHOLOGY, level 3* qa: + cid qa:
 b. *Phonology (with Flipping)* (qaci:) <d> (qa:)
 c. *MORPHOLOGY, level 5* (qaci:) d + u (qa:) + mela
 d. *Phonology (no Flipping)* (qaci:) (du) (qa:) (mela)

That is, 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 canonical iamb.³

Final Shortening

The third process is Final Shortening. When a long vowel belonging to a verb root ends up in word-final position, as when a vocalic suffix is elided, the root vowel becomes short.

- (28) a. du-°i:--i → du°i ‘scratch it with your fingernail!’
 b. hi-ša:--i → hiša ‘break!’
 c. qa:--i → qa ‘leave!’

There is a late verbal suffix *-e:*, however, which surfaces with its length intact.

able evidence adduced in favor of a phonology organized around constraints rather than rules. The contrast presented here shows that even though constraints can be fit into a level-ordered framework, a better framework is one which takes seriously the surface orientation of Optimality Theory and replaces levels with constraint domains.

Notes

¹ Cyclic effects like the conversion in (1) are the subject of considerable current work in Correspondence Theory and similar frameworks (e.g. Benua 1995; Burzio 1994; Kenstowicz 1995; McCarthy 1995; McCarthy and Prince 1994, 1995; Orgun 1994, 1996). Essentially, *prótèst_V* has the stress it does because it is morphologically related to *prótèst_N*, not because it is immediately derived from it.

² Not only is Q-IDENT⁽¹⁾ low-ranked relative to ASYM, in fact it never plays any role in choosing candidates. Any form that Q-IDENT⁽¹⁾ might favor is ruled out by an alignment constraint, which dominates ASYM and therefore necessarily Q-IDENT⁽¹⁾. (Every long vowel leads to a new foot and adds violations of ALIGN.) 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 domain 1. The important point is that violations within domain 1 never matter, whether this is treated as low ranking of a domain-particularized constraint, or by completely ignoring the violations. Thus I generally omit Q-IDENT⁽¹⁾ from tableaux, as potential *CLASH^{suf} was omitted for Manam.

³ The similarity is further obscured by the fact that the rule of Foot Flipping cannot turn off after level 3. Rather, it has to be active throughout the lexical phonology, to avoid a true look-ahead device: this is necessary because whether or not Foot Flipping actually occurs depends on the overall syllable structure of the word, and this depends on suffixes added in levels 4 and 5. Therefore it is only the rule of “CV Adjunction”, which feeds Foot Flipping by creating an anti-iamb (CVCV) from nonbranching (CVV), that is inactive after level 3. See Buckley (1994, 1995c) for discussion.

⁴ The prosodic structure in (30) is also intended to account for the fact that a final /a/ in a small set of suffixes is deleted before *-e:* just as in word-final position. It seems likely, however, that this pattern, which is phonologically unnatural, is best treated by appeal to morphological structure.

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