Cyclic vs. Noncyclic Constraint Evaluation*

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With the advent of constraint-based theories of phonology such as Prince & Smolensky's (1993) Optimality Theory (OT), whether--and if so how many--levels/cycles intervene between the underlying and phonetic representations has emerged as a significant issue. In this paper we raise the question in the context of metrical parsing. After reviewing the basic constraints proposed by Prince & Smolensky (1993), Green (1993), and McCarthy & Prince (1993b) for the analysis of standard trochaic systems in section 1, we turn in section 2 to the stress contours of Indonesian which have been argued by Cohn (1989, 1993) to require a two-stage metrification applying first to the stem and then to the stem plus suffixes. Clashing stresses that arise from metrifying in stages are removed at the surface by a clash deletion rule. We review in some detail the cyclic analysis of Indonesian proposed by Halle & Idsardi (1994) within the bracketed grid framework of metrical parsing. We proceed to show that if alignment constraints between morphological and prosodic structure are permitted, then an equally plausible noncyclic analysis of Indonesian is possible which avoids the intermediate representation. In section 3 we demonstrate that output-oriented constraint evaluation allows us to formalize the mysterious suspension of an otherwise general stress subordination found in Indonesian reduplication structures. In the final sections of the paper we show that unlike in Indonesian, the stress contours of certain constructions in Carib, Shanghai Chinese, and Polish do require an intermediate stage. All these cases involve a monosyllabic clitic/particle that is metrically integrated with the following base by the minimal overwriting of structure computed/evaluated at an earlier stage. While these cases require metrification to proceed in two stages and thus resemble a derivation, we suggest that the motivation for and the actual mechanics of the metrical reparsing are best treated as the product of constraint evaluation.

1. Basic metrical constraints

A major determinant of stress is the odd/even position of the stress bearing syllable with respect to the left or right edge of the relevant domain.

(1)

Pintupi	('σσ)('σσ)	málawàna	'through from behind'
	('σσ)('σσ)σ	púliŋkàlatǰu	'we (sat) on the hill'
Warao	('σσ)('σσ)('σσ)('σσ)	yàpurùkitàneháse	'verily to climb'
	σ('σσ)('σσ)('σσ)('σσ)	enàhoròahàkutái	'the one who caused him

Students of metrical stress are familiar with the paradigms in (1). In the traditional derivational approaches to metrical parsing of generative grammar starting with Halle & Vergnaud (1978) and Hayes (1980) and continuing through Halle & Idsardi (1993) and Hayes (1994) these stress contours are generated by rules that iterate across the representation imposing a binary footing on an abstract grid or at the level of the syllable within the prosodic hierarchy. For example, Pintupi (Hayes 1994 from data in Hansen & Hansen 1969:163) exhibits left-to-right footing and Warao (Hayes 1980 from data in Osborn 1966) right to left.

In Prince & Smolensky's (1993) nonderivational constraints-based framework of Optimality Theory (OT), for any input a general function, GEN(erate), constructs all possible metrifications that could in principle be found in any language. A set of ranked constraints then sorts through the pool of candidate structures to locate the correct output. Languages differ principally in the ranking of the constraints. For the data at hand, the relevant constraints are **Parse-σ** that evaluates structures for whether syllables are grouped into feet and **Ft-Binarity** which monitors feet for binarity (Prince & Smolensky 1993). Additional constraints determine the location of the prominent syllable within the foot--all primarily left-headed trochaic for the cases we consider here. The high ranking Ft-Binarity and Parse-σ constraints are sufficient to force a unique metrification of even-syllabled words, as shown by the tableau in (2). (In accordance with the notation that has become commonplace in the OT literature, we denote negative evaluation by a constraint with an asterisk. The exclamation point indicates when a candidate is eliminated from the competition and the dollar sign signals the most highly valued and hence winning candidate.)

(2)

/σσσσ/	Ft-Binarity	Parse-σ
$ ('σσ)('σσ)		
('σσσσ)	*!	
('σσ)('σ)('σ)	*!*	
('σσ)σσ		*!*

Directionality effects appear in words with an odd number of syllables. Left-to-right binary grouping of syllables into left-headed feet places a metrical lapse at the right edge: ('σσ)...('σσ)σ. Right-to-left parsing locates the stray syllable at the left edge: σ('σσ)...('σσ). In the OT analysis of (3), ranking the Ft-Binarity constraint above Parse-σ (Ft-Binarity >> Parse-σ) freezes out one syllable--but it can be located in the first, the third, the fifth, etc. position in the string.

(3)

/σσσσσ/	Ft-Binarity	Parse-σ
$('σσ)('σσ)σ		*
('σσ)σ('σσ)		*
σ('σσ)('σσ)		*

An additional constraint is thus required to narrow the candidate set to one. For this purpose McCarthy & Prince (1993b) (pursuing an observation of Robert Kirchner concerning Prince & Smolensky's 1993 edgemost constraint) and independently Green (1993) introduce alignment constraints such as (4a) that evaluate feet gradiently for how many syllables intervene between the edge of the word and (for McCarthy & Prince) the edge or (for Green) the head of the foot. In essence, each foot wants to be as far to the left as it can in Pintupi (and as far to the right as it can in Warao). For Pintupi, the net result is to force the unpaired syllable to the right edge. We show this in (4b) where the number of syllables separating each foot from the left edge is indicated.

(4) a. Align(Ft,L,Prwd,L)

b.

/σσσσσ/	Ft-Binarity	Parse-σ	Align-Ft
$('σσ)('σσ)σ		*	#, #σσ
('σσ)σ('σσ)		*	#, #σσσ!
σ('σσ)('σσ)		*	#σ, #σσ!σ

The alignment constraints thus zero in on one candidate; in the case of (4b) on ('σσ)('σσ)σ.

Ranking Align-Ft above Parse-σ sifts the candidate set in one fell swoop. The result is that structures containing a single foot at the left (or right) edge emerge as the winner because additional feet incur alignment violations, as shown in (5). See Kenstowicz (1994) for exemplification of such systems from Aljutor and Chukchee.

(5)

/σσσσσ/	Ft-Bin	Align-Ft	Parse-σ
$('σσ)σσσ		#	***
('σσ)('σσ)σ		#, #σ!σ	*
σ('σσ)σσ		#σ!	***

There are well-known systems which differ minimally from Pintupi in stressing the final syllable of odd-parity words in apparent violation of foot binarity: ('σσ)...('σσ)('σ). Examples include Maranungku (Hayes 1980, based on Tryon 1970) and Banawa (Buller, Buller, & Everett 1993). These follow straightforwardly from ranking Parse-σ above Ft-Binarity (and Align-Ft), as seen in (6a). Derivational analysis couched within the frameworks of Hayes (1980) and Halle & Vergnaud (1987) require another rule after binary parsing that assigns the orphan monosyllable to a foot, completing an exhaustive parsing of the string (6b).

(6) a.

/σσσσσ/	Parse	Ft-Binarity	Align-Ft
$('σσ)('σσ)('σ)		*	σσσ#, σ#, #
('σσ)('σσ)σ	*!		σσσ#, σ#

b. σσσσσ → ('σσ)('σσ)σ → ('σσ)('σσ)('σ)

Within the framework of Halle & Idsardi (1993a) the difference between Pintupi 'σσ'σσσ and Maranungku 'σσ'σσ'σ arises from a single parameter setting of the (left-to-right) iterative parsing rule: whether a left or a right bracket is inserted. Pintupi parses a five-syllable word with right brackets as 'σσ)'σσ)σ while Maranungku parses with left brackets as ('σσ('σσ('σ. In both systems the constituents so constructed are left-headed. A major innovation of the Halle & Idsardi (1993a) system allows metrical constituents to be constructed by a single bracket with the help of an interpretive convention that the constituent extends from one bracket to the next or in the absence of any bracketing then to the word boundary. In particular, a hypothetical #σσσ)σσσ# structure is understood to define a constituent at the left edge while leaving the right edge unmetrified (equivalent to a #(σσσ)σσσ# structure of the earlier theory in which matching brackets delimit the "width" of a constituent). Similarly, #σσσ(σσσ# defines a single constituent at the right edge while the left edge remains unmetrified (translating a #σσσ(σσσ)# structure of the earlier models). In allowing just one edge of the domain to be marked, the metrical constituents in Halle & Idsardi (1993a) formally resemble the prosodic domains derived from the End parameter settings in Selkirk's (1986) theory of prosodic phrasing.[1]

A well known complication to iterative parsing is presented by systems that metrify syllables at the opposite edge of the domain regardless of their odd-even position in the binary count. Garawa is the best known case. In Garawa, the initial syllable always bears the main stress while nonprimary stresses iterate from the right edge of the word with no clash. Polish (Rubach & Booij 1985) constitutes the dual of Garawa in the trochaic parsing languages: main stress falls on the penult

[1]To be completely accurate, foot parsing in Halle & Idsardi (1993) proceeds over line-0 grid marks projected from syllables rather than the syllables themselves.

while secondary stresses iterate from the left edge of the word, again with no clash.

(7) a. Garawa (McCarthy and Prince (1993b) based on Furby (1974)):

'σσ	yámi	'eye'
'σσσ	pu'njala	'white'
'σσ'σσ	wátjimpàŋu	'armpit'
'σσσ'σσ	kámalar̆ànji	'wrist'
'σσ'σσ'σσ	yákalàkalàmpa	'loose'
'σσσ'σσ'σσ	ŋánkir̆ikìrimpàyi	'fought with boomerangs'
'σσ'σσ'σσ'σσ	ŋámpalàŋinmùkunjìna	'at our many'
'σσσ'σσ'σσ'σσ	nár̆iŋinmùkkunjìnamìr̆a	'at your own many'
'σσ'σσ'σσ'σσ'σσ	námpalàŋinmùkunànjimìr̆a	'from your own two'

b. Polish (Rubach and Booij 1985):

'σ	Gdánsk
'σσ	Lúblin
σ'σσ	Warszáwa
'σσ'σσ	pròpagánda
'σσσ'σσ	sàksofonísta
'σσ'σσ'σσ	rèwolùcjonísta
'σσσ'σσ'σσ	rèwolùcjonistámi
'σσ'σσ'σσ'σσ	kònstant`ynopòlitánczyk
'σσ'σσ'σσσ'σσ	kònstant`ynopòlitanczýka
'σσ'σσ'σσ'σσ'σσ	kònstant`ynopòlitànczykámi

To account for these cases researchers beginning with Hayes (1980) allowed the binary footing rule the option to create a unary foot when it runs out of material in order to ensure exhaustive parsing. The result was a ('σ)('σσ) ...('σσ) structure for Garawa. Promotion of the first foot to primary ("σ) ('σσ)...('σσ) was then followed by a rule destressing the second syllable under clash with the stronger primary stress (the unmarked clash resolution according to Hammond 1984).[2] However, extensive study of

[2]To be completely accurate, Hayes (1980) breaks the footing of Garawa into two processes: a binary left-headed foot is assigned at the left edge followed by right-to-left footing of the

many languages from the metrical perspective has in general found little independent evidence for this type of intermediate stage of clashing stresses and subsequent metrical studies have tried to eliminate it by separating the metrification into two processes and preventing one rule from encroaching on the other (for example, by mapping feet to a disyllabic template: McCarthy & Prince 1986, Hayes 1987, Kager 1989). Alternatively, Idsardi (1992) treats Garawa with a rule of edge marking (LLL) that foots the left edge and then prevents rightward binary footing from encroaching on the left edge by an avoidance constraint (x(that blocks unary feet.[3] Due to other assumptions of Idsardi's theory, the Polish case cannot be treated comparably and so he follows Halle & Kenstowicz (1991) in postulating two rounds of metrification: first a binary foot is placed at the right edge (through iterative footing and conflation) followed by the left to right binary parsing for secondary stress.

From the OT perspective, the Garawa (ˈσσ)σ(ˈσσ)...(ˈσσ) and Polish (ˈσσ)...(ˈσσ)σ(ˈσσ) structures are the second-best candidates in the eyes of the constraints aligning the feet with an edge. They will emerge as the winners if some higher ranking constraint eliminates the Warao-like σ(ˈσσ)...(ˈσσ) and Pintupi-like (ˈσσ)...(ˈσσ)σ competitors. The constraint McCarthy & Prince (1993b) suggest is one that follows naturally from the general alignment format by simply switching the arguments in the

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remaining portion of the string. In odd-parity forms this creates a stress clash that is resolved by elimination of the nonbranching foot: e.g. #σσσσσσσ# → (ˈσσ)(ˈσ)(ˈσσ)(ˈσσ) → (ˈσσ)σ(ˈσσ)(ˈσσ).

[3] An edge-marking rule is defined by three parameters: insert a left/right bracket to the/right of the leftmost/rightmost position. To illustrate, RRR converts ...*** to ...**)*; RLR converts ...*** to ...*)**; RRL converts ***... to **)*...; and RLL converts ***... to)***..., providing a natural representation for pre-accenting morphemes.

constraint schema--one that requires the edge of the word to coincide with a foot. We state these constraints in (8a). The tableau in (8b) shows how they choose Warao's runner-up candidate as the winner for Garawa. For McCarthy & Prince, Polish and Garawa are thus symmetric.

(8) a. Garawa: Align(Prwd,L,Ft,L) >> Align(Ft,R,Prwd,R)

Polish: Align (Prwd,R,Ft,R) >> Align(Ft,L,Prwd,L)

/σσσσσσσ/	Align-PW	Ft-Binarity	Parse-σ	Align-Ft
(ˈσσ)(ˈσσ)(ˈσσ)σ			*	σσσσσ#σσσ#!, σ#
(ˈσσ)(ˈσσ)σ(ˈσσ)			*	σσσσσ#σσσ#!, #
$(ˈσσ)σ(ˈσσ)(ˈσσ)			*	σσσσσ#σσ#, #
σ(ˈσσ)(ˈσσ)(ˈσσ)	*!		*	σσσσ#σσ#, #

2. Indonesian

2.1 An OT Analysis

With this background, we can now turn to Indonesian (data and basic analysis due to Cohn 1989, 1993). As seen in (9), it has the same distribution of alternating stressed and unstressed syllables as Garawa except in one case--three syllable words: cf. Garawa (ˈσσ)σ vs. Indonesian σ(ˈσσ). In both systems Ft-Binarity dominates Parse-σ and feet are basically left-headed trochees.

(9)	"σσ	cári	'search for'
	σ"σσ	bicára	'speak'
	ˈσσ"σσ	bìjaksána	'wise'
	ˈσσσ"σσ	còntinuási	'continuation'
	ˈσσˈσσ"σσ	èrodìnamíka	'aerodynamics'
	ˈσσσˈσσ"σσ	àmerikànisási	'Americanization'

One possible OT analysis for Indonesian is to postulate two separate constraints each aligning the edges of the prosodic word with a foot, giving priority to rightward alignment. These constraints matching the edge of the prosodic word with a foot supercede the constraint that gradiently aligns each foot with the right edge of the word. We express these three alignment constraints and their ranking in (10).

(10) Align(Prwd,R,Ft,R) >> Align(Prwd,L,Ft,L) >> Align(Ft,R,Prwd,R)

Because of foot binarity, the two constraints aligning the prosodic word with a foot converge on the same structure in disyllables (viz. ('σσ)); and in words of four or greater syllables they do not conflict: ('σσ)...('σσ). It is only in three-syllable cases that a difference emerges with right-edge alignment taking priority.

(11)

/σσσ/	Align-PW-R	Align-PW-L
$ σ('σσ)	#	#σ
('σσ)σ	σ!#	#

If this analysis is correct, it implies that alignment of the Prosodic Word at its left vs. right edge cannot take the form of simple parameter settings for a given grammar. Rather, left vs. right-edge alignment constitute separate constraints, one (or both) of which are typically overshadowed by foot alignment.

An alternative interpretation is possible, however. There is another salient difference between Garawa and Indonesian from which the trisyllabic case would follow: the main stress is always initial in Garawa and penultimate in Indonesian. In explicitly differentiating itself from the "bottom-up" metrification of derivational phonology, the OT framework developed by Prince & Smolensky (building on Mester (1993); cf. also Green 1993 and Hung 1993) postulates constraints on main stress that are independent of the grouping established for the supporting syllables/line-0 grid marks. In particular, main stress is positioned by Edgemost constraints that orient the strongest syllable of the strongest foot towards the right or left edge of the word. An additional complication in many systems is that **Rightmost** is modulated by a constraint of **Nonfinality** that blocks stress from appearing on the final syllable (see especially Hung 1993, 1994). The Edgemost constraint does much of the work of Prince's (1983) End Rule and Halle & Vergnaud's (1987) line-1 metrification. Suppose then that the difference between Garawa and Indonesian is stated at the level of main stress: Leftmost for Garawa and Rightmost plus Nonfinality for Indonesian. The proposed constraints for Indonesian, Polish, and Garawa are displayed in (12).

(12)		Indonesian	Polish	Garawa
main stress:	Nonfinality >>			
	Edgemost	right	right	left
foot level:	Align-Prwd	left	-	-
	Align-Ft	right	left	right

We see that Polish and Garawa remain mirror images of one another while Indonesian is a hybrid of the two displaying the Polish main stress orientation (rightwards) but the Garawa foot alignment (also rightwards). Indonesian is also more complex in that (for the data considered so far) an additional constraint aligning the left edge of the word with a foot is needed to accommodate the trisyllables. For trisyllables, the Indonesian constraints of (12) select the iambically parsed (σ"σ)σ as optimal among the candidates indicated in the tableau of (13a): it bests σ("σσ) in virtue of satisfying Align-PW and is better than ("σσ)σ in locating the main stress closer to the right edge.

(13)

/σσσ/	Ft-Bin	Nonfin	Rtmost	Align-PW	Align-Ft	Trochaic
$(σ"σ)σ			σ#		σ#	*
('σ)("σσ)	*!		σ#		σσ#, #	
σ("σσ)			σ#	*!	#	
σ(σ"σ)		*!	#	*	#	*
("σσ)σ			σσ!#		σ#	

In fact, however, we will see evidence in section 2.3 for another constraint aligning the right edge of the stem with a foot in Indonesian. There is independent evidence that this **Align-Stem** constraint dominates Align-PW (see below). Granted this ranking, (σ"σ)σ will now be rejected allowing the next best σ("σσ) candidate to win. The last three columns in the tableau of (14) show this classic domination effect.

(14)

/σσσ/	Nonfin	Rightmost	Align-Stem	Align-PW	Align-Ft
$ σ("σσ)		σ#		*	#
(σ"σ)σ		σ#	*!		σ!#

We summarize the OT analysis of Indonesian stress with the diagram in (15) indicating the critical rankings among the active constraints we have postulated.

```
(15)       Rightmost          Align-Stem   Ft-Binarity
              |      \         /       |     \ /    /
           Nonfinality \      / Align-PW-L   Parse-σ
                        \   /          \       /
                       Trochaic       Align-Ft-R
```

To briefly review, Rightmost >> Nonfinality keeps the main stress of the final syllable. Ft-Binarity >> Parse-σ >> Align-Ft is the constraint ranking from (4b) that generates binary footing with a lapse in odd-parity words. Align-PW-L >> Align-Ft-R ensures that in the tug of war between leftward and rightward foot orientation, the left edge wins out--except in the case of trisyllables where Ft-Binarity >> Align-PW-L blocks the ('σ)("σσ) candidate and Align-Stem >> Align-PW-L blocks (σ"σ)σ in favor of σ("σσ). Evidence for the remaining rankings of Align-Stem as well as Rightmost >> Trochaic will emerge in 2.3.

2.2 Derivational Alternatives

Let us now consider some derivational alternatives for Indonesian. Cohn (1993) proposes a binary right-to-left footing rule assigning syllabic trochees. According to Cohn, the initial dactyl effect that differentiates Indonesian from Warao arises from a foot rebracketing rule (Kager 1989) that parses the initial syllable to ensure that the words begin with a foot (16).

(16) #σ('σσ)... → #('σσ)σ...

However, this rule must be blocked "if the foot is the only foot in the domain, the main stress, since it would violate the integrity of the main stress" (Cohn 1993: 379). Once again we see the "top-down" effect of the main stress inhibiting an initial dactyl. Although not stated explicitly, the reader is presumably invited to infer that rule (16) applies in Garawa in all odd-parity words including trisyllables since the main stress is initial. Warao differs from Indonesian in simply lacking (16), with the consequence that odd-parity words do not begin with a foot boundary.

Halle & Idsardi (1994) attempt to improve on Cohn's (1993) analysis by taking advantage of special features of their bracketed-grid system in which the foot does not enjoy any privileged status as an analytic primitive but rather is an emergent property of grid marks delimited by metrical brackets and word-boundaries. Proper sequencing of the rules of parenthesis insertion and deletion allows Indonesian stress contours to be computed on the foot level (line-0 of the grid) before main stress is projected. In this way, no complex foot restructuring implied by (16) is required.

Let us first see the analytic challenge the Indonesian stress contours pose for the Halle & Idsardi (1993) framework. As mentioned earlier, Garawa's initial dactyl effect arises from LLL edge marking and then binary left-to-right placement of left brackets (Iterative Constituent Construction (ICC)-Left) supplemented with an "avoid" condition blocking the creation of a (*(sequence of brackets, as in (17a). The problem with extending this analysis to Indonesian is that the avoid condition blocks penultimate stress for the trisyllabic case (17b).

```
(17) a.    UR    ******* →

           Edge  (******** →

           ICC    (*****(** →

                 (***(**(** →

                  (*(**(**(**  blocked by "avoid" (*(

     b.    UR    *** →

           Edge  (***  →

           ICC   (*(**    blocked by "avoid" (*(
```

Another possibility is to order iterative footing first and then LLL edge-marking. But then the latter rule creates a clash that must be resolved differently in Garawa vs. Indonesian. In Garawa, clash is eliminated on the right (18a) while Indonesian eliminates clash on the left (18bi) (as well as deleting the one on the right for secondary stresses (18bii)). Once again, the stronger stress appears to overshadow the weaker one.

```
                          *              *
                         (* (*          (*
(18)  a.   Garawa:       (* (* * ...  →  (* * *...

                            *              *
                         (* (*            (*
      b.  Indonesian: i. (* (* * ...  →  * (* *

                     ii. (* (*             *
                         (* (* * ...  →  (* * *
```

Halle & Idsardi (1994) escape this "top-down" effect by proposing the analysis tabulated in (19).

(19) Edge-Marking: RLR, RRL

ICC (R to L): Ø → (/ __ **

Clash:) → Ø / __ *)

It has the advantage of allowing all metrification to take place on line-0 without reference to a higher line in the grid and thus avoids the complexities of the foot rebracketing rule (16). The analysis treats Indonesian feet as right headed (iambic) and invokes two edge-marking rules: RLR ("insert a right bracket to the left of the rightmost element") turns ...* * # to ... *) * # while RRL ("insert a right bracket to the right of the leftmost element") turns # * * ... to # *) * ... These edge-marking rules bear a strong resemblance to the first two alignment constraints of (10). The two analyses differ sharply, however, in the metrical grouping that is imputed: RRL creates an initial monosyllabic foot while RLR in combination with "heads right" produces an iamb one syllable in from the right edge of the word.

Under the analysis in (19), a seven-syllable word receives the derivation schematized in (20).

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(20) UR     ******* →

     Edge   ******)* → *)*****)* →

     ICC    *)***(**)* →  *)*(**(**)* →

              *    *  *
     Heads    *)*(**(**)*
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First, the right and left edges are marked by RLR and RRL, respectively. The iterative constituent construction rule (ICC) then metrifies the gap from right to left: it drops a left bracket after every pair of free asterisks **. Constituents are right headed; a later metrification of line-1 as RRR and "heads right" enhances the final foot as primary.

For the trisyllable case (21), the two edge-marking rules create a clash of stresses and so a rule deleting the first of two right-hand parentheses is postulated. In this connection it should be noted that for Halle & Idsardi (1993, 1994) clash avoidance is a condition placed on the application of individual rules rather than a system-wide constraint on representations.

(21) UR *** →

Edge *)*)* →

ICC inapplicable

Clash **)* →

  *
Heads **)*

This analysis thus avoids reference to main stress in the statement of its grouping rules. It also localizes the intermediate stage of clashing stresses that must later be repaired to just the trisyllables. Furthermore, the repair rule takes the simple form of deleting one of two adjacent brackets. Finally, Halle & Idsardi (1994) find independent motivation for the clash deletion rule in their cyclic analysis of stem-sensitive stress contours.

2.3 Cyclicity versus Stem Alignment

As shown by the paradigms in (22) from Cohn (1989,1993), three, four, and five, and six-syllable words display different stress contours depending on where the morpheme boundaries fall--in particular the juncture between the stem and the suffix.

(22)	σ"σσ	σ"σ+σ	σ+"σ+σ
	bicára	carí+kan	cat+kán+ña
	'speak'	'search for'	'paint it'
	'σσ"σσ	σσ"σ+σ	'σσ+"σ+σ
	bìjaksána	bicará+kan	càri+kán+ña
	'wise'	'speak about (s.t.)'	'search for it'
	'σσσ"σσ	'σσσ"σ+σ	σ'σσ+"σ+σ
	kòntinuási	bìjaksaná+an	bicàra+kán+ña
	'continuation'	'regulations'	'speak about it'
	'σσ'σσ"σσ	'σσσσ"σ+σ	'σσ'σσ+"σ+σ
	èrodìnamíka	kòntinuasí+na	bìjaksàna+án+ña
	'aerodynamics'	'the continuation'	'the regulations'

Following Cohn's (1989, 1993) basic insight, Halle & Idsardi (1994) postulate a cycle for Indonesian in which the rules track in part the word's internal morphological structure. In the model developed in Halle & Vergnaud (1987), rules are organized into two blocks (cyclic and noncyclic) with the option of assigning any given rule to either or both rule blocks. For Indonesian, stems trigger the application of rules in the cyclic block while suffixes do not. After the iteration of rules through the word is completed, the entire word is submitted to the noncyclic rule block for one pass. The rules of edge marking and ICC apply in both the cyclic and noncyclic rule blocks while the clash rule applies in the noncyclic block only. Since the stems are edge-marked RLR in the cyclic rule block, their final syllable is unmetrified in the input to the noncyclic block. With a single suffix, reapplication of the RLR rule in the noncyclic block creates a stress clash and hence an input to destressing. But with two suffixes RLR generates no clash. The noncyclic clash rule applies maximally (simultaneously). As shown by the derivations in (23), the analysis accounts elegantly for the different stress contours on bicára in the three cells of table (22).[4]

(23)	bicara	bicara] kan	bicara] kan + na	
	* * *	* * *	* * *	Cyclic
	* *) *	* *) *	* *) *	RLR
	))*	*)*)*	*)*)*	RRL
	))*	*)*)*+*	*)*)*+* *	Noncyclic
	vac	*)*)*)*	*)*)**)*	RLR
	vac	vac	vac	RRL
	**)*	***)*	**)**)*	Clash

The Indonesian data appear to make a strong case for a cycle and hence for an intermediate representation. In the derivation of bicará+kan two intermediate stresses are assigned that appear in neither the input nor the output. Furthermore, the second one does surface in the derivation of the closely related bicàra+kán+ña.

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4 The assumption that Indonesian feet are delimited by right brackets allows a foot to be assigned in the suffixal rule block without the restructuring mechanism implicitly required in Cohn's (1993) analysis.

The crucial ingredient of the analysis, however, is the stem-suffix juncture that in effect marks the transition from the cyclic to the noncyclic rule block. We are not aware of any other facts of Indonesian phonology that motivate a cycle. The argument thus hinges on the fact that the contrasting 'σσ"σσ vs. σσ"σ+σ stress contours take account of the internal juncture. But instead of seeing the stem metrification as an intermediate step in the derivation, we may alternatively metrify the whole word at one step but take the stem+suffix juncture into account (a point also made by Goldsmith 1992 for Indonesian and more generally by other researchers who (re)interpret blocks of rules with intermediate stages as constraints defining a single level of representation that is divided into domains by the grammatical constituent structure). In OT there is a natural way to do this. Suppose that the stem+suffix juncture is reflected in an alignment constraint requiring the right edge of the stem to coincide with the right edge of a foot (24).

(24) Align(Stem,R,Foot,R)

To produce the proper effect, Stem Alignment must be highly ranked in Indonesian because its satisfaction entails the violation of a number of other constraints that hold sway when no juncture is present--in particular Parse-σ, Trochaic, and the constraint aligning the left edge of the word with a foot. We can appreciate this point by comparing the tableaux for monomorphemic bìjaksána and the internally structured bicará+kan in (25). In order to respect the alignment of the stem, a metrification of the word that is otherwise quite poorly formed must be chosen as the output. To drive this point home, let us total up the cost of aligning the stem. First, the σ(σ"σ)σ structure has two unparsed syllables in comparison to ('σσ)("σσ). Second, it has the otherwise out of place iamb instead of a left-headed trochee. Finally, the left edge of the word does not coincide with a foot and hence violates the constraint Align-PW-L. Our tableaux do not indicate success on the highly ranked Non-Finality and Rightmost constraints as they are irrelevant in choosing among the candidates shown here.

(25)

/bijaksana/	Align-Stem	Parse-σ	Align-PW	Trochaic
$('σσ)("σσ)				
σ("σσ)σ	*!	**	*	*

/bicara+kan/	Align-Stem	Parse-σ	Align-PW	Trochaic
('σσ)("σσ)	*!			
$σ("σσ)σ		**	*	*

As we have just seen, the constraints on main stress being rightmost but nonfinal in combination with alignment of the stem can be met only by shifting the main stress to the right edge of the foot--creating an iamb. But when two syllables follow the stem, they can form a foot by themselves to house the penultimate main stress. The result is that the stem-final foot reverts to a trochee. This is shown by the tableau for <u>bicàra+kán+ña</u> (26a) where the first two candidates tie on stem alignment and the iambic candidate is eliminated further downstream by Trocahic.

(26)

/bicara+kan+ña/	Align-Stem	Parse-σ	Align-PW	Trochaic
$σ('σσ)("σσ)		*	*	
σ(σ'σ)("σσ)		*	*	*!
('σσ)σ("σσ)	*!	*		

Finally, for the sake of completeness, the tableaux in (27) demonstrate how the analysis generates the six-syllable forms *èrodìnamíka*, *kòntinuasí+na*, and *bìjaksàna+án+ña* from (22).

(27)

/erodinamika/	Align-Stem	Parse-σ	Align-PW	Trochaic
$('σσ)('σσ)("σσ)				

/kontinuasi+na/	Align-Stem	Parse-σ	Align-PW	Trochaic
$('σσ)σ(σ"σ)σ		**		*
$('σσ)('σσ)("σσ)	*!			

/bìjaksàna+án+ña/	Align-Stem	Parse	Align-PW	Trochaic
$('ss)('ss)("ss)				
$('ss)(s's)("ss)				*!

In (28) we tabulate the metrical structures imputed to the *bicára* paradigm by the derivational and OT analyses we have reviewed here. Curiously, they converge on an iambic structure in the σσ"σ+σ case but diverge sharply on the grouping for the remaining cases.

(28)	(23)	(25-26)
	bicá)ra	bi(cára)
	bicará)kan	bi(cará)kan
	bicà)rakán)ña	bi(càra)(kánña)

Since metrical grouping often affects segmental phonology as well as prosodic morphology, this difference has potential empirical consequences that in principle allow for a significant test of the two models once we are fortunate enough to either find a language whose structure permits the postulated difference in grouping to be detected or to develop other techniques that assess metrical grouping. (See Kenstowicz 1993 and Flemming 1993 for recent discussion of the role of metrical structure in segmental phonology).

3. Indonesian Compounds and Reduplication

In this section we examine stress subordination in compounds, which is mysteriously suspended in reduplication structures. We argue that the suspension of stress subordination reflects the language's attempt to maintain identity between the base and the reduplicant--an effect that the output oriented OT model is particularly well-suited to express

.

Indonesian compounds subordinate the stress of the first element to the second.

(29)	bòm#átom	'atom bomb'	['bomb' + 'atom']
	càt#bátik	'batik ink'	['ink' + 'batik']
	tùkaŋ#cát	'printer'	['artisan' + 'print']

anèka#rágam	'varied'	['various + 'way']
polùsi#udára	'air polution'	['polution' + 'air']

The internal juncture obviously disrupts the alternating stress contour resulting for example in two feet instead of three for a six-syllable word such as polùsi#udára (cf. monomorphemic èrodìnamíka). Cohn (1989) does not cite any σσσσ#σσσσ compounds that would show conclusively that such structures are properly analyzed as the compounding of two prosodic words instead of just a single prosodic word in which each stem aligns with the right edge of a foot. Under the former analysis a /σσσσ#σσσσ/ structure will have three degrees of peak prominence ('σσ"σσ#'σσ"σσ) while the latter predicts just two ('σσ'σσ#'σσ"σσ). We assume here the former interpretation, which is also supported by the syllabification of V+C sequences (see below).

Within the OT framework these structures arise from calling on a constraint **Align-X^0** that aligns the left edge of a lexical category (X^0) with the left edge of a prosodic word (cf. Selkirk 1986 et seq.): Align (X^0,L,PW,L). As shown by the paradigm in (30), suffixed material joins with the second conjunct to pull the main stress rightwards and results in a stress contour that mimics the one that is found on the second conjunct considered in isolation (i.e. ragám-an, ràgam-án-ña). The suffixes have no effect on the stress of the first conjunct.

(30)	anèka#rágam	'various'
	anèka#ragám+an	'variety'
	anèka#ràgam+án+ña	'the variety'

If the left edge of X^0 aligns with a prosodic word, then the first conjunct falls in a separate prosodic word and hence (by the logic of the prosodic hierarchy) in a different metrical footing domain. Cohn (1989) justifiably presents these data as a classic case of incongruence between the morphology and the prosody: as indicated in (31), the suffix modifies the compound as a whole but is prosodically integrated with the second conjunct.

```
                    N
                   / \
                  A   \
(31)             / \   \
                A   N   \
                |   |    \
             [aneka] [ragam] an

             [aneka] [ragam] an
                \ /    \ /    /
                 F      F    /
                 |      |   /
               Prwd  Prwd
                  \   /
                  Prwd
```

As Cohn (1989) emphasizes, this mismatch also has ramifications for the segmental phonology. The velar /k/ is realized as glottal stop in the coda of the syllable in Indonesian. Stems ending in [k] syllabify the [k] as onset to a following vowel-initial suffix (cf. /masak/ → masa[?] 'to cook' but masak+an 'food'). However, when terminating the first element of a compound, /k/ appears as [?], demonstrating that syllabification may not cross the internal compound juncture: cf. /adik/ → adi[?] 'younger sibling' but ka[àdi?#adík+an] 'childish'. This shows that the alignment of X^0 with the left edge of the prosodic word (Align-X^0) dominates the Onset constraint which in turn dominates Align-Stem (24). (In the tableau, | denotes the break between one prosodic word and another.)

(32)

/adik#adik+an/	Align-X^0	Onset	Align-Stem
$a.di? | a.di.kan	√ | √	* | *	√ | *
a.di. | ka.di.kan	√ | *!	* | √	* | *
a.di? | a.di?.an	√ | √	* | **!	√ | *

An important question arises at this point with respect to the right edge of the stem. Recall that we postulated an alignment constraint (24) between the right edge of the stem and the right edge of a foot to capture the opaque stress of <u>bicará+kan</u>. The syllabification of stem-terminal consonants as onset with following vowel-initial suffixes indicates that Onset dominates Align-Stem. This raises questions about the metrical parsing of a consonant-final stem with a single vowel-initial suffix that are pursued by Cohn & McCarthy 1994 (on the basis of data not available in Cohn 1989, 1993). For example, Cohn & McCarthy consider a form such as <u>alámat</u> 'address'. If the stem-final consonant [t] forms an onset with the vowel contributed by the suffix in /a.la.ma.t+an/ then alignment of the stem is violated: the final segment of the stem [t] does not coincide with the right edge of the foot--on the critical assumption that feet are built from syllables. If alignment is evaluated in a discrete all-or-nothing fashion, then the lower ranking constraints of Parse-σ and Trochaic will choose ('σσ)("σσ) over σ(σ"σ)σ. Cohn & McCarthy (1993) report data that in general supports this important point (e.g. <u>alámat</u> 'address', <u>maŋ[àlamáti]</u> 'put address on'; <u>wiláyah</u> 'region', <u>pa[wìlayáhan]</u> 'division into territories' (though there are also apparent exceptions (e.g. daérah 'area', par[daeráhan] 'pertaining to a certain region'). If the exceptions can be explained away, and the shift of the stress contour to the "transparent" form displayed by monomorphemic structures before vowel-initial suffixes but retention of the "opaque" stress contour before consonant-initial suffixes (cf. maŋ[alamátkan] 'put address on for', wiliyáhña 'region' def.) represents the general pattern, then we have a surprising and striking confirmation of the hypothesis that metrical feet are built over syllables (rather than simply projected from syllabic nuclei). In this connection it is worth noting that closely related Malay appears to geminate consonants at the stem+suffix juncture in an attempt to provide the suffix with an onset while at the same time maintaining an alignment with the root (see Teoh 1989). Finally, Indonesian cases such as maŋ[àlamáti] contrast with the vowel-final stems such as bicára 'speak' which only show the single ("opaque") stress pattern mam[bicará+kan] that motivates the cycle and/or the stem alignment constraint (24).

Returning to the compounds, we must postulate a constraint that will select candidates in which the strongest foot of the right hand conjunct is enhanced--a type of "nuclear stress" phenomenon found in many languages. If we assume that these enhanced feet define a new level of the metrical grid or prosodic hierarchy, the enhancement can be formulated as a Rightmost constraint on that level. Let us abbreviate it as **Compound Stress** in the following discussion. It becomes of interest because it is sometimes suppressed in reduplication structures.

Reduplicated structures (33) show the prosody of compounds in terms of their internal juncture (recall ka[àdi?#adík+an] 'childish'). They differ from compounds, however, in systematically eschewing stress subordination: búku#búku (not *bùku#búku), minúm-an#minúm-an, etc. But this effect mysteriously disappears under nonequivalent affixation (to the second member): bùku#bukú-ña, minùm-an#minum-án-ña.

(33) búku 'book'

búku#búku 'books'

bùku#bukú-ña 'the books' (*búku#bukú-ña, *bukú#bukú-ña)

mínum 'to drink'

minúm-an 'a drink'

minúm+an#minúm+an 'drinks' noun pl.

minùm-an#minumán-ña 'the drinks' noun pl.[5]

We may understand these different stress contours in terms of constraint conflict. As two separate prosodic words forming a compound, the second (reduplicant) element wants to enhance its rightmost foot. But this enhancement conflicts with the requirement that the two halves of the reduplication mirror one another in segmental as well as prosodic structure. The latter constraint wins out when it can. But if the second reduplicant is supplied with a suffix that is missing from the first, the overriding constraints of Nonfinality and Rightmost enforcing penultimate main stress prevail: they introduce a metrical disparity that cannot be reproduced in the base, yielding stress subordination. This "underapplication" effect is quite prevalent in the phonology of reduplication and has always been a formal mystery for derivational

[5]This form should be [minùm-an#mìnum-án-ña; we assume this to be a transcription error.

phonology (cf. Wilbur 1973); it receives a natural interpretation in OT where phonological analysis proceeds by constraint ranking over fully-formed output structures (McCarthy & Prince 1993a). Since the candidate outputs are fully-formed, it becomes possible to define constraints evaluating how closely the base and the reduplicant match. McCarthy & Prince (1993a) motivate and exemplify an extensive analysis of Axininca reduplication in these terms. Following them, we assume a constraint **Max**(imize) that prefers complete identity between the base and the reduplicant--which we assume to be the second element of the compound in Indonesian. Departing somewhat from their treatment, we assume that alignment constraints governing the edges of the base are carried over to the reduplicant as well. The upshot is that the left edge of the reduplicant must align with a prosodic word while the right edge must align with a foot.

To see how the analysis works, we examine the tableaux in (34-35). The Max constraint evaluating for reduplication identity dominates the Compound Stress constraint that monitors for enhancement of the final member of the compound. Max rejects the weak-strong stress contour of bùku#búku for the echoic búku#búku (34).

(34)

/buku+RED/	Max	Compound Str
$búku | búku		*
bùku | búku	*!	

However, when the reduplicant is affixed by -ña the higher ranking Rightmost constraint draws the stress to the penult of the reduplicant, creating an iamb. Any attempt to echo this stress in the base is rejected by the higher ranking Nonfinality. Thus, [bukú | bukú+ña] is eliminated from the competition. The lower ranking Compound Stress may then select the [bùku | bukú+ña] candidate with stress subordination. Finally, attempting to match the stress by retraction in [búku | búku+ña] will be short circuited by the Rightmost constraint on Main stress which also dominates Max.[6]

(35)

/buku+RED+ña/	Nonfin	Rightmost	Max	Compound Str
$(bùku) | (bukú)ña	|	σ# | σ#	*	
(búku) | (bukú)ña	|	σ# | σ#	*	*!
(bukú) | (bukú)ña	*! |	# | σ#		*
(búku) | (búku)ña	|	σ# | σσ#!		*

The Max constraint is a relatively weak one in Indonesian. It fails to block onsetting of [k] from crossing the right stem boundary to a following syllable [an] in kə[àdi?#adík+an]. This requires ranking Onset above Max. In essence, it is more important for Indonesian to provide an onset to the syllable contributed by [-an] than it is to maintain an equivalence in the prosodic roles onset/coda for the [k] of /adik/ across the two portions of

[6] A reviewer points out that the evaluation of minùm-an#mìnum-án-ña (with two mismatches for stress) must triumph over *(minù)man#(minù)mánña with only a single stress mismatch. Perhaps evaluation must take an all-or-nothing form over the entire base and copy, as the reviewer suggests. Alternatively, a constraint against stress clash may be at work.

the reduplication. This state of affairs contrasts with that in certain Malay dialects (Onn 1976, Kenstowicz 1981) where we find paradigms such as tikam 'to stab', tikam#tikam 'to stab repeatedly', but di-tika#tikami 'to be stabbed repeatedly". Here the final consonant of the base is eliminated in order to make the prosody of the base and reduplicant match at the cost of a Parse violation. Such examples of "overapplication" are particularly puzzling from a derivational perspective. We must delete the final [m] just in case the coindexed segment resulting from the copy transformation has a different syllabic status. Coindexing is needed by the Max constraint is well, of course. The point is not one of computational power but rather that there is a condition of identity between the base and reduplicant that the phonology is striving to achieve.

To summarize the results of this section, we have seen that the alignment of the left edge of X^0 plays a critical role in shaping the stress contour of Indonesian compounds. We also saw that stress subordination in compounds is sometimes blocked by a compulsion for identity between the base and the reduplicant. However, this identity is outranked by the Rightmost constraint that ensures that main stress consistently appears on the penultimate syllable. Finally, the stress contours in compounds can be generated without appeal to a cycle.

4. Minimal Reparsing

In the previous section we saw that generation of the appropriate stress contours for Indonesian words does not require reference to the intermediate stage implied by the cyclic analysis if alignment constraints between the morphology and the prosody are permitted to control the metrical structure. In this section we look at several cases in which this result does not hold. They all involve a monosyllabic clitic, particle, or affix which must be integrated with the metrical structure of the following base. However, instead of recalculating the entire structure of the base, only a minimal change is made. The rest of the base's metrical structure remains intact. We conclude that certain cases of metrical parsing must invoke an intermediate representation. However, a constraints-based analysis still plays a major role in defining the metrical patterns and in motivating and controlling the reparsing.

4.1 Carib

Our first example is from Carib (Hoff 1968, Inkelas1989 from whom we take the data and much of the basic analysis; see also van der Hulst & Visch 1992 and Kager 1993 for recent interesting discussion). In Carib paradigms such as (36) manifest a left-to-right alternating length phenomenon.

(36)	tonooro	'large bird'
	kuriiyara	'canoe'
	asaaparaapi	'fish sp.'
	wotuuropooro	'cause to ask'

We assume here (with van der Hulst & Visch 1992) that the length reinforces the basic iambic footing to enhance the durational contrast between the initial weak and following strong position in the iamb in the sense of Hayes (1985, McCarthy & Prince 1986). We consider an alternative trochaic analysis (espoused by Inkelas 1989) below; the ultimate conclusion on the need for an intermediate stage remains unaffected by the choice of footing as iambic or trochaic. Before considering the constraints that enforce iambic lengthening, we set the stage by introducing the basic metrical parsing constraints that are active in Carib.

We assume that the alternating length reflects the multiple footing of iambs aligned with the left edge of the word. A five syllable form such as wotuuropooro (s's)(s's)s indicates that Ft-Binarity dominates Parse-σ which in turn dominates Align(Ft-L,PW,L).

(37)

/σσσσσ/	Ft-Binarity	Parse-σ	Align-Ft
$(σ'σ)(σ'σ)σ		*	#, #σσ
(σ'σ)σσσ		**!*	#
(σ'σ)(σ'σ)('σ)	*!		#, #σσ, #σσσσ

Even-parity forms such as kuriiyara suggest that final prominence is blocked--a nonfinality effect quite prevalent in iambic systems (Hung 1993, 1994). The absence of final prominence in kuriiyara (σ'σ)σσ shows that the (σ'σ)(σ'σ) candidate must be blocked by Nonfinality dominating Parse. The fact that the candidate (σ'σ)('σσ) with retracted prominence also loses out shows that Iambic dominates Parse.

(38)

/σσσσ/	Nonfin	Iambic	Parse-σ
$(σ'σ)σσ			**
(σ'σ)(σ'σ)	*!		
(σ'σ)('σσ)		*!	

(39) summarizes the constraint rankings introduced so far.

(39) Nonfinality, Ft-Bin, Iambic >> Parse >> Align-Ft

To allow for iambic lengthening, we postulate the constraint in (40a) that requires the second syllable of an iamb to be bimoraic. IL will dominate a faithfulness constraint Fill-μ (40b) that penalizes the insertion of moras by GEN.

(40) a. Iambic Lengthening (IL): if $[\sigma\ '\sigma]_F$ then $[\sigma\ '\sigma_{\mu\mu}]_F$

b. Fill-μ: penalize any mora not recoverable from the input.

Consider now the candidates for /kuriyara/. We use M to stand for a mora inserted by GEN that cannot be recovered from the input. It appears that Fill-μ must dominate Parse-σ--assuming that a lengthened monosyllable is a legitimate foot. We will see later that another constraint banning unfilled moras from the periphery of the foot is needed. This constraint will also penalize (kurMi)(yMa)ra.[7]

[7] Initial syllables of the stem contrast for vowel length in Carib; stems with an initial long vowel may start an alternating short-long grouping on the second syllable: [taakuwa] 'polishing stone', [paayawaaru] 'cassava beer' (I 258). Disyllabic stems fall into two groups as well: those with an underlying long vowel in their initial syllable preserve the length under suffixation: [waare] 'song', [waare-ta] 'to sing' (I 269); those with underlying short vowels

(41)

/kuriyara/	IL	Fill-μ	Parse-σ
$(kurMi)yara		*	**
(kurMi)yara	*!		**
(kurMi)(yMa)ra		**!	*

We are now ready to examine the data in (42) that motivate a cycle.

(42)

(42)	kuraama	'to look after'
	kïsii-kuraama-ko	'you must look after him'
	kï-kuuraama-ko	'you must look after me'
	poroopï	'to stop'
	ni-pooroopï-i	'actually he stopped'
	a-pooroopï-i	'you must not stop'

Carib has a series of prefixes that show iambic lengthening if disyllabic (e.g. kïsii-kuraamako). When a monosyllable is prefixed, iambic lengthening appears on the initial syllable of the following base; however, the remaining syllables display an alternating length train that starts

show a length alternation: long+short in the bare form but short+long in the suffixed form: [kuupi] 'to bathe', [kïsii-kupii-ya] 'the two of us bathe him' (I 272). The latter shows the expected iambic lengthening. But the initial length of [kuupi] is puzzling. We assume that Nonfinality in Carib takes a more aggressive form in which the final syllable must be unparsed (the equivalent of an RLR edge marking). For a disyllabic stem the result is metrification of just the initial syllable. Foot binarity should reject such a candidate. But given free mora insertion, the initial syllable may lengthen provided that the relevant constraints sanctioning the inserted mora outrank Fill-μ. In this case the relevant constraint is not iambic reinforcement but rather a minimality effect in which the X^{lex} must project to the prosodic word through a bimoraic foot.

from the left edge of the original stem: kï-kuuraama-ko, ni-pooroopï-i. If foot alignment were simply measuring from the edge introduced by the prefix, we would expect *kï-kuu-ramaa-ko and *ni-pooropïï-i as the optimal outputs (43).

(43)

/kï-kuramako/	Iambic	Fill-μ	Parse-σ
$(kïkMu)(ramMa)ko		**	*
(kïkMu)(rMa)mako		**	**!
(kïkMu)(rMama)ko	*!	**	*

One possibile solution to this problem is to say that the initial syllable of the stem in kï+kuuraamako simultaneously belongs to the head of the first foot and the recessive position of the second foot. We can distinguish two versions of this proposal: on the first (44a), the two feet are in the same metrical plane and share the same syllable much the way in which an ambisyllabic consonant simultaneously belongs to the coda of one syllable and the onset of the following syllable. Alternatively, the two feet might belong to two different planes which intersect at the initial syllable of the base (44b).

```
               F  F                          F
              / \/\                         /\
(44)  a.    kï+kurama+ko        b.     kï+kurama+ko
                                         \ /
                                          F
```

Under either story some decision must be made as to how to interpret such intersecting structures. Since the [ku] syllable is both a head and a dependent, one might reason that it will be subject to rules that mark either position (much the way in which an affricate should be subject to rules that mention [+continuant] as well as [-continuant]). Carib lengthens heads and so we might conclude that is sufficient to explain why [ku] is lengthened. But if iambic lengthening reinforces the constrast between the strong and weak positions of the foot, then while lengthening [ku] enhances the durational contrast in the first foot, it simultaneously neutralizes the contrast in the second foot. It thus remains hard to see why lengthening [ku] is optimal. Alternatively, in line with (44b) we might say that the first foot temporally overshadows the second analogous to the way in which one gesture conceals another in the theory of (Browman & Goldstein 1989).

We will review momentarily evidence from Shanghai and Polish that argues against these representational solutions. In anticipation of this result, let us consider a more aggressive interpretation in which the GEN function is allowed to overwrite structure. Specifically, we posit two cycles/levels of GEN and constraint evaluation. For the stem cycle/level, the constraints posited above select the candidate with the appropriate metrification to yield the structure assigned to the base in prefixless words. This metrified structure is then combined with the unmetrified prefix and resubmitted to GEN to obtain a new pool of candidate structures. To force encroachment of one foot on another, we suppose that GEN has the power to cancel or overwrite association lines (metrical bracketing) on the assumption that overlapping structures of the kind represented in (44) are never allowed. The diagram in (45) illustrates our proposal.

(45) first cycle: /kurama+ko/ → GEN + EVAL →

```
          PW
         /
        F
      / \   \ \
    kurMamako
```

second cycle:

```
          PW
         /
        F
      / \   \ \
kï+kuraamako →  GEN + EVAL  →
```

```
          PW
        /  |
       F   F
      /\  X\    \ \
    kïkMuraamako
```

The canceled associations are depicted by writing = over the association line. We assume a corresponding Faithfulness constraint **Overwrite** which militates against such cancellation (analogous to the way in which epenthetic vowels are in general shunned by Fill in Prince & Smolensky 1993). Thus, cancellation will be minimal and only invoked in the service of some higher ranked constraint. For the cases we shall look at here, two such constraints are at play: first an alignment constraint **Align-(PrWd,L,Ft,L)** requiring that the left edge of the word coincide with a foot; and second the Ft-Binarity constraint rejecting a monosyllabic foot for a binary one at the cost of overwriting the foot of the input structure. The incorporation of the particle/proclitic into the prosodic word projected from the base may also be characterized in constraint-based terms; see in particular Selkirk's (1993) analysis of the tone patterns in the Serbo-Croatian dialect dubbed "Neo-Štokavian-1" by Zec (1993).

The cancellation operator "=" employed in (45) can be understood in two senses. It could be an informal notation for the deletion of an association line, deparsing the syllable from membership in the relevant foot. On this view the Overwrite constraint must compare candidate outputs with the input in order to properly evaluate competing derivations. Alternatively, "=" can be seen as a marker added to an association line. The advantage of this interpretation is that Overwrite can operate exlusively on candidate outputs--the output does not have to be compared against the input because the input is still contained in the output. This, of course, requires sharpening the Parse-σ constraint so that lines marked with "=" are counted as violations.

The tableau in (46) illustrates how the constraints sort among the candidate structures. The input contains the metrical parse of the base with a reinforced iamb over the first two syllables assigned at the stem cycle/level.

(46)

<table>
<tr><th>F
/\
/kï+kuraamako/</th><th>Align-PW</th><th>Ft-Binarity</th><th>Fill-μ</th><th>Overwrite</th></tr>
<tr><td>F F
/\..X\
i. kï+kMuraamako</td><td></td><td></td><td>*</td><td>*</td></tr>
<tr><td>F
/\
ii. kï+kuraamako</td><td>*!</td><td></td><td></td><td></td></tr>
<tr><td>F F
| /\
iii. kï+kuraamako</td><td></td><td>*!</td><td></td><td></td></tr>
<tr><td>F F
| /\
iv. kMï+kuraamako</td><td></td><td></td><td></td><td></td></tr>
</table>

Candidate (46i) aligns the left edge of the prosodic word with a lengthened iamb at the cost of one Fill-mora and Overwrite violation. It bests (46ii) on alignment and (46iii) on Ft-Binarity. As pointed out to us by an anonymous reviewer, there is one additional competitor (46iv) that must be excluded. First, let us clarify that we have marked (46i) with only one Fill-μ violation. We assume that the mora added by GEN on the stem level/cycle to satisfy iambic lengthening becomes "filled" (linked to a vowel) in the course of interpreting the output of the stem level as the input to the prefix level. It is now representationally equivalent to an underlying long vowel and will be appropriately distinguished from a mora added by GEN on the prefix level. Secondly, we must still exclude (46iv). The the appropriate generalization clearly is that a mora is added only under iambic reinforcement, not otherwise: in particular, not to a monosyllabic foot. We may ensure this result by invoking a constraint that forces the inserted mora to the middle of a foot by requiring that the peripheral moras in the foot be "filled" or underlying moras. In a monosyllabic bimoraic foot, each mora is necessarily peripheral and hence (46iv) violates the proposed **Peripherality** constraint. Only a disyllabic foot offers a medial position to shield the inserted mora from Peripherality. This constraint (appropriately ranked before Overwrite and below Lx≈Pr to permit (kuu)pi--see note 7) will now eliminate (46iv).

4.2 Excursis

We briefly discuss here an alternative trochaic analysis of Carib that also requires a two-stage analysis but avoids the appeal to Overwrite. On this account stressed open syllables are lengthened, reflecting a requirement that a stressed syllable be bimoraic (a "Stress-to-Weight" requirement; cf. Prince & Smolensky's (1993) "Weight-to-Stress" constraint). Our analysis crucially relies on the **Lapse** constraint of Green (1995) (itself a development of Kager's (1994) Parse-2) that penalizes successive unstressed syllables not separated by a foot boundary.

(47) Lapse: adjacent unstressed (metrically weak) syllables must be separated by a foot boundary.

As Green shows, the Lapse constraint subsumes the core case of Hayes' (1994) weak local parsing: ...σ)σ(σ... passes the constraint while ...σ)σσ(σ... does not. The Lapse constraint also helps to define three-syllable window effects. For example, if feet are aligned to the right, #σ(σσ)... satisfies Lapse while #σσ(σσ)...does not. It is this effect that we need to capture alternating length in Carib. In (48) we repeat the core cases.

(48) kuupi 'bathe'
tonooro 'large bird'
kuriiyara 'canoe'
asaaparaapi 'fish sp.'

More formally, we assume the constraint ranking in (49).

(49) Lapse, Trochaic >> Align-Ft Right >> Parse-σ

The key tension is between Lapse and Align-Ft. The latter constraint is violated with every additional foot that appears in the representation. But superordinate Lapse forces a foot to be inserted in order to avoid successive unstressed syllables. High ranking Lapse also requires feet to be no larger than a disyllable because ('σσσ) violates Lapse as well.

To see how the analysis works, we consider three, four, and five-syllable forms. A trisyllabic input requires one foot to be inserted in order to avoid a Lapse violation. The foot must be no greater than disyllabic to avoid a lapse as well. σ('σσ) is better aligned with the right edge than ('σσ)σ and so it is the winner. The tableau in (50) demonstrates the optimality of σ('σσ).

(50)

/σσσ/	Lapse	Align-Ft	Parse-σ
$ σ('σσ)		σ#	*
('σσ)σ		σσ!#	*
('σσσ)	*!	σσ#	

In four syllable cases (51), one foot is more economical than two as far as alignment is concerned. And in order to avoid a Lapse violation, the foot must encompass the two medial syllables.

(51)

/σσσσ/	Lapse	Align-Ft	Parse-σ
$ σ('σσ)σ		σσ#	**
('σσ)('σσ)		σσσ!#, σ#	
σσ('σσ)	*!	σ#	**

Finally, in a five syllable case (52), given that the feet are left-headed, two feet must be inserted to avoid a Lapse violation. Rightward alignment chooses σ('σσ)('σσ) as the optimal candidate.

(52)

/σσσσσ/	Lapse	Align-Ft	Parse-σ
$σ('σσ)('σσ)		σσσ#, σ#	*
σ('σσ)σσ	*!	σσσ#	***
('σσ)σ('σσ)		σσσσ#, σ!#	*

We thus see that with rightward foot alignment dominating Parse-σ, each stem begins with an unparsed syllable. The result is to derive Inkelas' (1989) left-edge invisibility that is the key to producing the cyclic effects in Carib without the need for overwriting existing structure. To see this, we turn to the paradigms that motivate cyclicity (repeated below).

(53)	kuraama	'to look after'	poroopï	'to stop'
	kïsii-kuraama-ko	'you must look after him'	ni-pooroopï-i	'actually he stopped'
	kï-kuuraama-ko	'you must look after me'	a-pooroopï-i	'you must not stop'

As before, we assume that the metrified stem ku(r'ama)ko is the basis for the metrification of the prefixes so that the inputs to the prefixal level/cycle are thus [kïsi-ku(r'ama)ko] and [kï-ku(rama)ko]. Clearly, adding no metrical structure leaves a Lapse violation. A new foot must be inserted. For [kïsi-ku(rama)ko], the optimal output is kï(s'i-ku)(r'ama)ko (kïsiikuraamako).

(55)

/σσ+σ('σσ)σ/	Lapse	Align-Ft	Parse-σ
$ σ('σσ)('σσ)σ		σσσσ#, σσ#	**
σσσ('σσ)σ	*!*	σσ#	****
('σσ)σ('σσ)σ		σσσσσ#, σσ!#	**

For [kï-ku(rama)ko], the optimal output is kï-(k'u)(r'ama)ko (kïkuuraamako).

(56)

/σ+σ('σσ)σ/	Lapse	Align-Ft	Parse-σ
$ σ('σ)('σσ)σ		σσσ#, σσ#	**
σσ('σσ)σ	*!	σσ#	***
('σσ)('σσ)σ		σσσσ#, σσ!#	*

It is better aligned than [(k'ï-ku)('rama)ko] on Green's (1993) assumption that alignment is measured from the head of the foot. This is crucial since otherwise the two candidates would tie on alignment and Parse-σ would incorrectly choose [(k'ï-ku)(r'ama)ko]. For all of the cases considered so far, measuring alignment violations from the peak or the edge has made no difference.

The ultimate decision between left versus right-headed accounts of Carib awaits a more detailed study of the language. But under either analysis, metrification of the stem prior to metrification of the prefix+stem is required.

4.3 Shanghai Chinese

Some evidence bearing on the overlapping proposal considered in (44b) comes from Shanghai Chinese. Duanmu (1992, 1995) shows that the tone sandhi domains of Shanghai are actually left-headed metrical feet in which the tone (LH rising or HL falling) of the leftmost syllable is preserved and reparsed over the rest of the foot while the tones of nonprominent syllables are suppressed. The appropriate metrical structure is most clearly evident in the adaptation of multisyllabic loanwords (58). Each syllable is assigned an underlying tone as a function of the character used to represent it. In general, these tones do not surface in normal speech. Instead, an alternating pattern is imposed allowing for the realization of the tones characterizing the first, the third, etc. syllables in odd-parity forms. The tones of the final syllable are always suppressed. Examples (from Duanmu 1993) are shown in (58). The underlying tone of each syllable is indicated in the top row.

(58)

HL LH	LH LH	HL HL HL	HL LH HL LH
H L	L H	H L L	H L H L
(pa-li)	(zã-ne)	(tsz-ka)-ku	(ya-lu)(sa-lã)
'Paris'	'Shanghai'	'Chicago'	'Jerusalem'

HL LH LH LH LH	LH LH LH HL LH	LH LH HL LH LH LH
H L L H L	L H L H L	L H H L L H
(ka-li)-(fo'-ñi)-ya	(yĩ-du)-(ni-çi)-ya	(je'-ka')-(sz-lu)-(va'-ka')
'California'	'Indonesia'	'Czechoslovakia'

After alternating ('σσ)...('σσ)σ and ('σσ)...('σσ) metrical structures are imposed for odd and even-parity forms, the tones of weak syllables are suppressed while the remaining rising and falling contours of the strong syllables are distributed over both syllables of the foot in the phonetic output. Unparsed syllables receive a default low tone.

(59)

yĩ-du-ni-çi-ya	→	(yĩ-du)-(ni-çi)-ya	→	(yĩ-du)-(ni-çi)-ya
LH LH LH HL LH		LH LH		L H L H (L)

je'-ka'-sz-lu-va'-ka'	→	(je'-ka')-(sz-lu)-(va'-ka')	→
LH LH HL LH LH LH		LH HL LH	

(je'-ka')-(sz-lu)-(va'-ka')
L H H L L H

This is of course the familiar left to right binary footing we have seen in Pintupi. The interesting cases are in (60) where a monosyllable has been added.

```
(60)  LH # HL LH  LH  LH  LH       HL # HL  LH  LH  LH LH
       L    H    L   L   H   L       H      L     L    L    H   L
      (nø # ka)-li-(fo'-ni)-ya      (çi # ka)-li-(fo'-ni)-ya
      'South California'            'West California'

      LH # LH   LH  LH  HL LH       HL # LH   LH LH  HL  LH
      L      H    L    L    H   L       H      L     L   L    H    L
      (nø # yĩ)-du-(ni-çi)-ya       (çi # yĩ)-du-(ni-çi)-ya
      'South Indonesia'             'West Indonesia'


        nø # (yĩ-du)-(ni-çi)-ya → (nø yĩ)-du-(ni-çi)-ya
        LH     LH       LH              L  H   (L)  L   H  (L)

        'South'  'Indonesia'

        çi # (yĩ-du)-(ni-çi)-ya → (xi yĩ)-du-(ni-çi)-ya
        HL    LH        LH            H   L   (L)  L   H  (L)

        'West' 'Indonesia'
```

Here the tones of the monosyllabic conjuncts <u>nø</u> (LH) 'South' and <u>çi</u> (HL) 'West' predominate over the tones associated with the initial syllables [ka] (HL) and [yĩ] (LH) of the following base. But just as in Carib, the remaining feet are measured from the left-edge of the second conjunct. If they were aligned with respect to the left edge of the prefix without regard to the internal juncture, then the triple-footing pattern of monomorphemic (je'-ka')(-sz-lu)(-va'-ka') 'Czechoslovakia' should be imposed.

Now if the (yĩ-du) foot was simply hiding behind the (nø-yĩ) one in the manner of (44b), then we would expect the second tone of the base's initial syllable to appear on the [du] syllable (61).

(61)

Duanmu (p.c.) reports that such pronunciations are impossible. The tones of the base's initial syllable must be completely suppressed when the monosyllable precedes the base; and the second syllable of the base must be realized with a default low tone.

This range of data follows automatically if the clitics are integrated into the prosody of the following base by minimal overwriting under a cycle. Since Shanghai has the Pintupi-like ('σσ)*σ footing pattern, we know that Ft-Binarity dominates Parse-σ and that feet are gradiently aligned with the left edge of the word. To force the metrical reparsing, we assume that, like Carib, Shanghai has an undominated alignment constraint requiring the left edge of the word to coincide with a foot. The action of the constraints in sorting among the various candidates is depicted in (62). The alignment constraint rejects the σ('σσ)('σσ)σ candidate (62ii) that preserves the structure of the base. As in Carib, the Ft-Binarity constraint dominates Overwrite. This ranking rejects the ('σ)('σσ)('σσ)σ candidate (62iv). It will also reject the (62iii) candidate that overwrites just a single association line (in effect reparsing the head syllable of the base's initial foot, which in turn shrinks to a monosyllable). Finally, Overwriting must be ranked above Parse-σ. The base's remaining metrical structure is preserved at the expense of an additional unparsed syllable (62v).

(62)

F F /\ /\ /σ#σσσσσ/	Ft-Binarity	Align-PW	Overwrite	Parse-σ
F F F /\X X /\ i. $ σ#σσσσσ			**	**
F F /\ /\ ii. σ#σσσσσ		*!		*
F F F /\ X\ /\ iii. σ#σ σσσσ	*!		*	*
F F F | /\ /\ iv. σ#σσσσσ	*!			*
F F XX XX v. σ#σσσσσ \/ \/ \/ F F F			***!*	

4.4 Polish

We now return to Polish where the range of data bearing on the reparsing problem is somewhat more abundant (Rubach & Booij 1985, Rubach p.c., Idsardi 1994). We recall from section 1 that main falls on the penult and that secondary stresses are oriented leftward in the Pintupi pattern: $('\sigma\sigma)^*\sigma(''\sigma\sigma)$. Polish has a large number of clitics that can appear before or after the verb depending on the syntax. The clitics also metrify as trochees. Enclitics exhibit rightward orientation and never disrupt the stress of the base; the proclitic string disturbs the stress contour of the base under very restricted circumstances. We therefore focus on the proclitics. The facts are summarized in three generalizations. First, if the proclitic string contains an even number of syllables, then they metrify as a series of trochees and do not disturb the stress pattern of the base (63a). But if the proclitic string contains an odd-number of syllables greater than one, then the final proclitic syllable is stressed only when the following base is a trisyllable (63b).

(63) a. ˈσσ # "σσ   b`y to zróbil
        '(he) would do this' (R&B 298)
   ˈσσˈσσ # "σσ   òn by wàm to zróbil
        'he would do this to you' (R&B 297)

b. ˈσσˈσ # σ"σσ   jàk on b`y # Jankówi (powiedzial)
        'if he had told John' (I 2)
   ˈσσσ # ˈσσσ"σσ   jàk by on # òprotestówal
        'how he would have protested' (R p.c.)
   ˈσσσ # ˈσσ"σσ   jàk on by # pròtestówal
        'how would he protest' (R&B 302)

Second, a proclitic string composed of a single syllable appears with secondary stress when the base is three syllables or longer. The initial syllable of the base loses its secondary stress but other secondary stresses remain undisturbed.

(64) σ # "σσ   do dómu
        'to the house' (I 2)
   ˈσ # σ"σσ   dò Warszáwy
        'to Warsaw' (R p.c.)
   ˈσ # σσˈσσ"σσ   tèn rewolùcjonísta (cf. rèwolùcjonísta)
        'that revolutionary' (R&B 302)

'σ # σσ'σσ'σσσ"σσ òd konstant`ynopòlitanczýka
'from the Constantinopleite' (R&B 302)

Finally, when the base is five syllables, the secondary stress of the base also shifts to a monosyllabic proclitic string; but an additional secondary stress appears on the second syllable of the base. In other words, /σ#σσσσσ/ emerges with three stresses: 'σ#σ'σσ"σσ.

(65) 'σ#σ'σσ"σσ tèn saksòfonísta (cf. sàksofonísta R&B 296)
(R p.c., Idsardi '94)

These data are puzzling from a purely derivational point of view in which metrical structure results from the mechanical operation of parsing rules with no eye to the final product. To account for the apparent shift of stress from the base to the clitic, we might propose an analysis in which the initial foot at the left edge of the base is deformed under procliticization so long as it does not house the major stress. The freed syllables then join the proclitics in metrifying from left to right.

(66) /σσσ # ('σσ)σ("σσ)/ → σσσ # σσσ("σσ) → ('σσ)('σ#σ)('σσ)("σσ).

The problem with this approach is that the foot at the left edge of the base is preserved when the clitic string is of odd-parity greater than one:cf. 'σσσ#'σσσ"σσ <u>Jàk on by òprotestówal</u> (63b). To deal with this problem we might retain the footing on the base, metrify the proclitics exhaustively from left to right, and then delete a constituent under stress clash. This correctly generates the odd-parity case, as shown in (67a). But it fails to account for the cases with a single clitic (67b). Here it is the initial foot of the base that must give way under clash.

(67) a. /σσσ#('σσ)σ("σσ)/ → ('σσ)('σ)#('σσ)σ("σσ) → ('σσ)σ#('σσ)σ("σσ)

b. /σ#('σσ)σ("σσ) → ('σ)#('σσ)σ("σσ) → ('σ#σ)σσ("σσ)

c. /σ#('σσ)σ("σσ)/ → ('σ)#('σσ)σ("σσ) → ('σ)#σσσ("σσ) →

('σ#σ)('σσ)("σσ)

The Polish data also argue against the overlapping representation of (44a). Since heads are marked by stress, we should expect two stresses in such cases as <u>tèn # rewolùcjonísta</u>; but <u>tèn # rèwolùcjonísta</u> with a clash of stresses is impossible.

It seems clear that what is driving the metrification is a target configuration in which the left edge of the proclitic string starts with a binary foot (the same constraint operating in Carib and Shanghai). This constraint is only violated in one case--when the base is disyllabic and hence houses the main stress. Finally, the additional stress appearing in <u>tèn</u> <u>saksòfonísta</u> argues that the reparsing effect cannot be described simply as a shift of the secondary stress from the initial syllable of the base to the preceding monosyllabic clitic (as in Rubach & Booij's 1985:302 rule). There must be a more aggressive approach in which the metrification of the proclitic is allowed to invade the base--but only in order to ensure that the clitic string begin with a foot--i.e. in the monosyllabic case. This complex hierarchy of options is ideally expressed in OT terms--on the assumption that the constraints evaluate structures cyclically and that GEN has the power to (minimally) overwrite structure inherited from an earlier cycle/level.

First, consider the monosyllabic proclitic with a base containing two or more secondary feet--e.g. an input of the structure /σ#σσσσσσσ/. The relevant tableau is shown in (68). The dominant Ft-Binarity and

Alignment constraints force a binary foot at the left edge of the clitic, rejecting the σ#('σσ)('σσ)σ("σσ) (68ii) and ('σ)#('σσ)('σσ)σ("σσ) (68iv) candidates that incur no overwriting violations. Note that both legs of the initial foot must be overwritten; canceling just the first gives a ('σ#σ)('σ)('σσ)σ("σσ) (68iii) structure that also violates Ft-Binarity. Finally, the fully parsed ('σ#σ)('σσ)('σσ)("σσ) (68v) is rejected for ('σ#)('σσ)σ('σσ)σ("σσ) (68i) with two unparsed syllables demonstrating that Overwrite dominates Parse-σ.

(68)

F F F /\ /\ /\ /σ#σσσσσσσ/	Ft-Binarity	Align-PW	Overwrite	Parse-σ
F F F F /\XX /\ /\ i. $ σ#σσσσσσσ			**	**
F F F /\ /\ /\ ii. σ#σσσσσσσ		*!		*
F F F F /\ X\ /\ /\ iii. σ#σσσσσσσ	*!		*	*
F F F F | /\ /\ /\ iv. σ#σσσσσσσ	*!			*
F F F XX XX /\ v. σ#σσσσσσσ \/ \/ \/ F F F			***!*	

Let us now turn to <u>tèn</u> <u>saksòfonísta</u> which shows that when the initial foot has been overwritten, the preferred candidate is one which is fully parsed. This result follows automatically if Parse-σ is allowed to sort among the candidates. We consider only candidates in which the initial two syllables have been parsed to satisfy Ft-Binarity and Align-PW. In the winning candidate (69i), the first foot has been overwritten twice incurring two violations. The result is that all syllables are parsed: ('σ#σ)('σσ)("σσ). This form is better by Parse-σ than the candidate which overwrites to satisfy Ft-Binarity and Align-PW but fails to parse the medial syllable ('σ#σ)σσ("σσ) (69iii).

(69)

F F /\ /\ /σ#σσσσσ/	Ft-Binarity	Align-PW	Overwrite	Parse-σ
F F /\ /\ i. $ σ#σσσσσ \/ \/ F F			**	
F F F /\/\ /\ ii. σ#σσσσσ	*!		*	*
F F F /\/\ /\ iii. σ#σσσσσ			**	**!

Finally, we consider cases such as <u>jàk</u> <u>on</u> <u>by</u> <u>òprotestówal</u> where the base is not overwritten at all. These cases follow automatically from ranking Overwrite above Parse-σ. Since Ft-Binarity and Align-PW are satisfied by the foot erected over the initial two syllables of the clitic string, any overwriting of the base is penalized (70ii), even at the cost of two unparsed syllables (70i).

(70)

F F /\ /\ /σσσ#σσσσσ/	Ft-Binarity	Align-PW	Overwrite	Parse-σ
F F F /\ /\ /\ i. $ σσσ#σσσσσ				**
F F F F /\ /\ XX /\ ii. σσσ#σσσσσ			**!	

5. Conclusions

To briefly sum up, we have shown that if alignment constraints are permitted to play a role in constraint evaluation then it is possible to analyze the stress contours of Indonesian without appeal to an intermediate representation. In section 4 we examined cases from Carib, Shanghai Chinese, and Polish where this result does not hold--reference to an intermediate stage is required to generate the correct stress contours for structures containing a monosyllabic proclitic or particle. The latter is integrated with the prosody of the following base through a minimal overwriting of the base's initial foot. In each case the reparsing is motivated jointly by an alignment constraint requiring the left edge of the prosodic word to start with a foot and the requirement that the foot be binary.

An important question these cases raise for future research is whether the intermediate stage constitutes a separate level in the sense of Lexical Phonology or simply one cycle among (possibly many) others in the derivation of the word. On this point the evidence is not clear. The base over which the opaque stress contour is computed is equivalent to a free standing word in each of the three cases we have studied here and thus is arguably a word-level representation. This looks like evidence for a difference of levels. On the other hand, the constraint rankings involved in the metrification of the base and the clitic+base structures are apparently identical. This is precisely what cyclic derivation predicts. Demonstrating a different constraint ranking would bolster the claim that two distinct levels are involved; see Goldsmith 1993 for discussion of this point. In this respect a crucial difference between Polish and Indonesian should be noted. Since the Carib, Shanghai Chinese, and Polish facts appear to require overwriting an intermediate stage, we must ask whether this analysis can be extended to Indonesian. It can, but only if distinct levels are recognized with a crucial difference in constraint ranking. The critical case is once again bicará+kan. As in Carib, et al. the relevant constraints are Ft-Binarity and (for Indonesian, a right edge) alignment of the prosodic word with a foot dominating Overwrite. The problem, as shown by the tableau in (71), is that the lower ranking Parse constraint selects the bìcará+kan candidate.[8]

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[8] Cohn (1989, 1993) gives no examples of five-syllable bases with a single suffix. However, several are cited by Cohn & McCarthy (1993:37) such as dòkumentási 'documentation' but pan[dòkumentasí+an] 'system of documentation' with explicit recognition of the lack of secondary stress on [men]. This example is a virtual minimal pair with Polish [tèn#saksòfonísta] where parsing from the clitic reaches beyond the initial foot of the base sàksofonísta.

(71)

F /\\ /bicara+kan/	Ft-Binarity	Align-PW	Overwrite	Parse-σ	Align-Ft
F F XX/\\ σσσ+σ			**	**!	#
F XX $ σσσ+σ \\/ \\/ F F			**		σσ#, #

In order to extend the overwriting analysis to Indonesian, just a single foot must introduced at the right edge on the second round of metrification. This result can be achieved if the (gradient) constraint aligning the foot with the right edge of the word is ranked above Parse-σ, penalizing candidates with internal footing. This reranking has the effect of switching the final two columns of the tableau in (71) and awards <u>bicará+kan</u> with the $. Also, unlike the two analyses discussed in section 2 and summarized in (28), this alternative analysis predicts an internal lapse in case four suffixes are added to the base (e.g. σ'σσ#σ+σ+'σ+σ) since it builds just a single foot at the right edge. It is unclear whether such structures lie beyond the reach of the language's morphology. Finally, on this alternative analysis, <u>bicará+kan</u> ends in a trochee σσ('σ+σ) like all other words of Indonesian. It thus crucially distinguishes itself from the monolevel analysis that simply shifts the main stress rightwards within a foot that is fixed at the right edge of the stem: bi(cará)+kan. Once again, we see that finding independent evidence for metrical grouping becomes a high-priority objective as the constraint-based and rule-based models compete for empirical advantage.

References

Browman, Catherine & Louis Goldstein (1989). Articulatory gestures as phonological units. Phonology **6**. 201-52.

Buller, Barbara, Ernest Buller & Daniel Everett (1993). Stress placement, syllable structure, and minimality in Banawá. International Journal of American Linguistics **59**. 280-93.

Cohn, Abigail (1989). Stress in Indonesian and bracketing paradoxes. Natural Language & Linguistic Theory **7**. 167-216.

Cohn, Abigail (1993). The initial dactyl effect in Indonesian. Linguistic Inquiry **24**. 372-81.

Cohn, Abigail & John McCarthy (1993). Foot alignment and apparent cyclicity in Indonesian. Amherst: University of Massachusetts ms.

Duanmu, San (1992). End-based theory, cyclic stress, and tonal domains. Chicago Linguistics Society **28**.2 65-76.

Duanmu, San (1993). Metrical and tonal phonology of compounds in two Chinese dialects. University of Michigan ms. To appear in Language 1995.

Flemming, Edward (1993). The role of metrical structures in segmental rules. UCLA ms.

Furby, Christine (1974). Garawa phonology. Pacific Linguistics, Series A. Canberra: Australian National University.

Goldsmith, John (1992). Local modelling in phonology. S. Davis, ed. Connectionism: theory and practice. Oxford University Press.

Goldsmith, John (1993). Harmonic phonology. J. Goldsmith, ed. The last phonological rule. Chicago: University of Chicago Press, pp. 21-60.

Green, Thomas (1993). Configurational constraints in a generalized theory of phonological representation. MIT Ph.D. dissertation. (to appear)

Green, Thomas (1995). The stress window in Pirahã: a reanalysis of rhythm in Optimality Theory. Ms., MIT.

Halle, Morris & William Idsardi (1993a). General properties of stress and metrical structure. To appear in J. Goldsmith, ed. Handbook of phonological theory. Blackwell.

Halle, Morris & William Idsardi (1994). A reanalysis of Indonesian stress. MIT Working Papers in Linguistics **21**. 1-9

Halle, Morris & Michael Kenstowicz (1991). The free element condition and cyclic and noncyclic stress. Linguistic Inquiry **22**. 457-502.

Halle, Morris & Jean-Roger Vergnaud (1978). Metrical structures in phonology.Cambridge: MIT ms.

Halle, Morris & Jean-Roger Vergnaud (1987). An essay on stress. Cambridge: MIT Press.

Hammond, Michael (1984). Constraining metrical theory: a modular theory of rhythm and destressing. UCLA Ph.D. dissertation.

Hansen, Kenneth C. & L.E. Hansen (1969). Pintupi phonology. Oceanic Linguistics **8**. 153-70.

Hayes, Bruce (1980). A metrical theory of stress rules. MIT Ph.D. dissertation.

Hayes, Bruce (1985). Iambic and trochaic rhythm in stress rules. Berkeley Linguistics Society **13**. 429-46.

Hayes, Bruce (1987). A revised parametric metrical theory. NELS **17**. 274-89.

Hayes, Bruce (1994). Metrical stress theory: principles and case studies. University of Chicago Press.

Hoff, B. (1968). The Carib language. The Hague: Martinus Nijhoff.

Hung, Henrietta (1993). Iambicity, rhythm, and non-parsing. University of Ottawa ms.

Hung, Henrietta (1994). Rhythmic and prosodic organization of edge constituents. Brandeis University Ph.D. dissertation.

Idsardi, William (1992). The computation of prosody. MIT Ph.D. dissertation.

Idsardi, William (1994). Optimality, alignment and Polish stress. Linguistics Society of America Annual Meeting, Boston.

Inkelas, Sharon (1989). Prosodic constituency in the lexicon. Stanford University Ph.D. dissertation.

Kager, René (1989). A metrical theory of stress and destressing in English and Dutch. Dordrecht: Foris.

Kager, René (1993). Blocking effects in lexical stress rules. Utrecht University ms.

Kager, René (1994). Ternary rhythm in alignment theory. Utrecht University ms.

Kenstowicz, Michael (1981). Functional explanations in generative phonology. D. Goyvaerts, ed. Phonology in the 1980's. Ghent: E. Storia-Scientia. 431-443.

Kenstowicz, Michael (1993). Evidence for metrical constituency. K. Hale & S.J.Keyser, eds. The view from building 20: essays in honor of Sylvain Bromberger. Cambridge: MIT Press 257-73.

Kenstowicz, Michael (1994). Sonority-based stress. Cambridge, MA. MIT ms.

McCarthy, John & Alan Prince (1986). Prosodic morphology. Brandeis University ms.

McCarthy, John & Alan Prince (1993a). Prosodic morphology I: constraint interaction and satisfaction. Rutgers University and University of Massachusetts, Amherst. To appear, MIT Press.

McCarthy, John & Alan Prince (1993b). Generalized alignment. Yearbook of Morphology **1993**. 79-153.

Mester, Armin (1994). The quantitative trochee in Latin. Natural Language & Linguistic Theory **12**. 1-62.

Onn, Farid (1976). Aspects of the phonology and morphology of Malay. University of Illinois Ph.D. dissertation.

Osborn, Henry (1966). Warao I: phonology and morphophonemics. International Journal of American Linguistics **32**. 108-23.

Prince, Alan (1983). Relating to the grid. Linguistic Inquiry **14**. 19-100.

Prince, Alan & Paul Smolensky (1993). Optimality theory: constraint interaction in generative grammar. Rutgers University and University of Colorado, Boulder. To appear, MIT Press.

Rubach, Jerzy & Geert Booij (1985). A grid theory of stress in Polish. Lingua **66**. 281-319.

Selkirk, Elizabeth (1986). On derived domains in sentence phonology. Phonology Yearbook **3**. 371-405.

Selkirk, Elizabeth (1993). The prosodic structure of function words. University of Massachusetts, Amherst ms.

Teoh, Boon Seong (1987). Geminates and inalterability in Malay. Studies in the Linguistic Sciences **17,2**. 125-36.

Tryon, Darrell. (1970) An introduction to Maranungku. Pacific Linguistics, B 15. Canberra: Australian National University.

Wilbur, Ronnie (1973). The phonology of reduplication. Bloomington: Indiana University Linguistics Club.