Alignment and Parallelism in Indonesian Phonology*

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§1. Introduction

§1.1 Setting Out the Themes

In Indonesian, morphology influences stress in complex ways. Monomorphemic words have main stress on the penultimate syllable, a secondary stress on the initial syllable, and secondary stress on alternating syllables in between:

(1) Stress in Monomorphemic Words (Cohn 1989:170)

cát	‘print’
cári	‘search for’
bicára	‘speak’
bìjaksána	‘wise’
kòntinuási	‘continuation’
èrodìnamíka	‘aerodynamics’
àmerikànisási	‘Americanization’

But prefixes are outside the domain of stress assignment entirely (2a), and compound or reduplicated roots constitute two separate stress domains (2b). (At the right is shown the expected result if these words were stressed according to the monomorphemic pattern.)

(2) Stress In Prefixed, Compounded, and Reduplicated Words (Cohn 1989:*passim*)

a. Stress in Prefixed Words

di–cát	‘printed’	*dí–cat
di–koréksi	‘corrected’	*dì–koréksi

b. Stress in Compounds

hák–hák	‘rights’	*hák–hak
càp–pós	‘postmark’	*cáp–pos
waníta–waníta	‘women’	*wànità–waníta
bòm–átom	‘atom bomb’	*bom–átom

And suffixes, though part of the same stress domain as the root, cause secondary stresses to be missing (3a) or displaced (3b) from their expected positions:

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*This work developed out of Cohn 1989, 1993 and an initial OT analysis presented by McCarthy in a colloquium at UC Santa Cruz, December 11, 1992. This article (under the title “Foot alignment and apparent cyclity in Indonesian”) was announced in the bibliography to McCarthy & Prince 1993a, and a first draft came into being shortly thereafter, but received only limited circulation. We are indebted to Lisa Selkirk and Alan Prince for comments on this work as it developed and to Junko Itô, Armin Mester, and the other participants in Linguistics 730 (Fall, 1993) for discussion of the material in §2. We are also very grateful to Wilson Manik and Maria Manik for sharing their knowledge of Indonesian with us.

(3) Stress in Suffixed Words (Cohn 1989:176)

a. məm–bicará–kan	'speak about something'	*məm–bìcará–kan
kòntinuasí–ña	'the continuation'	*kòntinùasí–ña
b. məm–bicàra–kán–ña	'speak about it'	*məm–bìcara–kán–ña

Again, the forms at the right show the expected result if suffixed words were stressed according to the monomorphemic pattern.

In the original study of this subject, Cohn (1989) claims that this morphological influence is exerted in different ways in (2) and (3). For prefixed and compound words (2), she proposes that the influence of morphology on prosodic structure is *direct*, via rules mapping the edges of grammatical constituents onto the edges of prosodic ones (Chen 1987, Selkirk 1986). For suffixed words, however, she proposes that the influence of morphology on prosody is *mediated*, via the phonological cycle, the principle according to which stress in complex words is first assigned to their simplex bases (Chomsky, Halle, & Lukoff 1956, Chomsky & Halle 1968, etc.).

In this article we will argue for a uniform treatment of both sorts of effects of morphology on prosody, via the general theory of *Alignment*, which extends the edge-based theory to all levels of grammatical and prosodic structure. The first Alignment constraint was proposed by Prince & Smolensky (1991b, 1993); the general theory of Alignment is developed in McCarthy & Prince 1993b. In particular, McCarthy & Prince argue that constraints demanding alignment of prosodic and morphological constituents (such as foot and root) are responsible for many phenomena attributed to the cycle in previous approaches. In the case of Indonesian, constraints from the Alignment family are responsible both for the apparent cyclicity in suffixed forms and for the metrical opacity of prefixes and compounds. One of our principal goals will be to demonstrate this below.

Crucial to the success of this enterprise is the further claim that Alignment constraints, and indeed all constraints on phonological well-formedness, are embedded within Optimality Theory (Prince & Smolensky 1991ab, 1992, 1993). Optimality Theory is a general approach to constraint interaction, in which constraints are violated under the compulsion of other, higher-rankng constraints. Few of the constraints we consider represent categorical truths; nearly all are violated under particular conditions of domination. Indeed, most of the richness and interest of Indonesian phonology comes from studying just such cases.

Though constraint ranking and violation of dominated constraints are the central principles of Optimality Theory, most research in this framework also assumes *Parallelism* of constraint satisfaction. Parallelism is the idea that the constraint hierarchy evaluates candidates that are fully-formed output representations, with the effects of various phonological and morphological processes all under consideration at once. Like Alignment, Parallelism is a central, recurrent theme in the discussion below, and it will be essential at several critical junctures in the analysis.

The argument proceeds as follows. We begin immediately below (§1.2) with explication of the two main themes, Alignment and Parallelism. In §2, the stress system of simple roots and root+suffix combinations is analyzed — the latter are the "cyclic" cases of earlier treatments. (The earlier accounts are reviewed in Appendix B). The discussion in §3 then turns to the effects of prefixation and root compounding on stress. A closely related matter, taken up §3.2 and §3.3, is the interaction between syllable structure and Alignment constraints, including the effects of syllabification on stress. Parallelism is particularly important in this context, and it continues as a major focus of §4, where a particularly striking consequence of Parallelism for stress in reduplicated forms is investigated. Finally, §5 summarizes the principal results. For ease of reference, we provide an index to constraints and to ranking arguments in Appendix A.

The data discussed here come from a fairly neutral version of Indonesian, as used by educated non-Javanese speakers. Some of the data are drawn from Cohn 1989, but the evidence has been considerably extended and developed in several directions, as will become clear below. We have been greatly aided in this by two native-speaker consultants and by the comprehensive material in Echols and Shadily 1989.

§1.2 Theoretical Background

The family of Alignment constraints is an outgrowth of work on the edge-based theory of the syntax/prosody interface (Chen 1987, Clements 1978:35, Hale and Selkirk 1987, Selkirk 1986, Selkirk and Tateishi 1988, Selkirk and Shen 1990). In this theory, the domains of sentence phonology are specified by rules of the general form "the right/left edge of some syntactic constituent coincides with the corresponding edge of some prosodic constituent". Cohn (1989) and Inkelas (1989) propose that this theory be extended to word-internal grammatical constituents, and McCarthy & Prince (1993ab) extend it still further, to word-internal prosodic constituents and to the alignment of opposite edges. They offer the following general schema for predicates of alignment at all levels of grammatical and prosodic structure:

(4) Generalized Alignment Schema (McCarthy & Prince 1993b)

In ALIGN(GCat, GEdge, PCat, PEdge), the GEdge of any GCat must coincide with PEdge of some PCat, where

GCat (or MCat): Grammatical (Morphological) Category, among which are the morphological categories Root, Stem, Morphological Word, Prefix, Suffix, etc.

PCat: Prosodic Category ≡ μ, σ, Ft, PrWd, PhPhrase, etc.

GEdge, PEdge = Left, Right

As noted, this extends the Chen/Selkirk model in two ways: among the grammatical and prosodic categories subject to alignment are included the *word-internal* morphological constituents root, suffix, etc.

and the *word-internal* prosodic constituents syllable, foot, etc.; and alignment of *different* edges (McCarthy & Prince 1993a: §4.3.3, 1993b) may be demanded.[1]

Alignment constraints have abstract connections with other lines of analysis in the literature. Particularly relevant in the current context are cases where Alignment-like notions are recruited to account for seemingly cyclic phenomena. Perhaps the first is Liberman and Prince's (1977) account of English phrasal and compound stress in terms a kind of alignment of prominence with syntactic constituency, rather than in terms of cyclic stress assignment and demotion. More recently, the cyclic analysis of Diyari stress in Poser 1989 has been given a treatment in terms of rules inserting reified foot-boundaries by Halle & Kenstowicz (1991) (cf. Crowhurst 1994 for an Alignment-based account). This approach is pursued and extended by Idsardi (1992) and Halle & Idsardi (1993) (see Appendix B below for discussion).

Though Alignment constraints have become strongly identified with Optimality Theory, they are not intrinsic to the model — it could in principle exist without them, though arguably it would be much less successful descriptively. Likewise, Parallelism of constraint satisfaction, our other main theme, is logically separate from Optimality Theory, though again it has been strongly identified with it.[2]

The meaning of Parallelism is best elucidated through the overall structure of an Optimality-Based grammar. Schematically, the grammar is like this (Prince & Smolensky 1993):

(5) An Optimality-Based Grammar, Schematically

$\text{Gen}(\ in_i\ ) = \{\ cand_1,\ cand_2,\ \ldots.\ \}$

$\text{Eval}(\ \{cand_1,\ cand_2,\ \ldots.\}\ ) \rightarrow cand_k$ (the output, given in_i)

The function Gen emits a set of candidate analyses consistent with a given input. It consists of very broad principles of linguistic form, defining the representational primitives (e.g., feet and syllables) and their most basic modes of combination (e.g., feet contain syllables, and not the other way around). Eval deals with a system of ranked constraints that rate the members of the candidate set in terms of their *relative harmony*, or degree of success with respect to the language's ranking of the constraints. The maximally harmonic candidate is optimal; the rest are discarded.

Under Parallelism, the effects of Gen on in_i involve many different phonological operations simultaneously. Epenthesis, deletion, assimilation, reduplicative copying, parsing into syllables, feet, prosodic words, and so on — all may apply, individually or together, to in_i to yield the various candidates $cand_1$, $cand_2$, etc. Thus, the ranked constraints of Eval must consider the effects of all of these operations simultaneously. In contrast, a non-parallel Optimality Theory, such as the "Harmonic Serialism" described

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[1]For further developments in the syntactic domain, see Selkirk 1993.

[2]The distinction between that which is intrinsic to Optimality Theory — constraint ranking and violation — and that which is not — Parallelism — is brought home by discussions in the literature where Parallelism is suspended, totally or partially. Full departure from parallelism ("harmonic serialism") is entertained at length in chapter 2 of Prince & Smolensky 1993 and in Black 1993, while limited departure from parallelism, involving serially ordered levels, is argued to be necessary in the Appendix to McCarthy & Prince 1993a. (See also §3.3 below.)

by Prince & Smolensky (1993: Chapt. 2), would limit each candidate to a single phonological operation, and then recursively submits the winning form $cand_k$ to Gen (until there is no change between input and ouput). Other, less radically serialist positions can readily be imagined, such as cyclic or stratal re-entrance to Gen.

Clear empirical differences between Parallelism and Serialism within Optimality Theory are often difficult to come by; many phenomena can be handled equally well under either model. Still, there is a relatively small and rather eclectic list of cases that seem to favor Parallelism, including:

Prosody

- ·Syllabification in Tongan depends on stress, but syllables bear stress (Prince & Smolensky 1993: Chapt. 3).
- ·Extrametricality is "revoked" in words that would otherwise lack a foot (Prince & Smolensky 1993: Chapt. 4)
- ·Stress "shift" from deleted vowels in Bedouin Arabic (McCarthy 1993).

Segmental Phonology

- ·Lardil *kaŋka* (Prince & Smolensky 1993: Chapt. 7).
- ·The "identity paradox" in Yoruba [ATR] harmony (Archangeli & Pulleyblank 1993).
- ·The $a \rightarrow i \rightarrow Ø$ chain shift in Bedouin Arabic (McCarthy 1993).

Reduplication

- ·In Axininca Campa, the reduplicative suffix both triggers and copies augmentation of a short root (McCarthy & Prince 1993a: Chapt. 5), in a type of "overapplication".
- ·In Axininca Campa, the reduplicative suffix both triggers and copies an epenthetic vowel, which itself counts toward disyllabicity of the reduplicative suffix (McCarthy & Prince 1993a: Chapt. 5).
- ·Overapplication of Yoruba $n \rightarrow l$ (McCarthy & Prince 1994b).

Below we will expand greatly on the evidence for Parallelism, finding material of interest and relevance in Indonesian prosody and reduplication.

§2. Alignment Theory and Indonesian Word-Stress

In this section, we will study the accentual properties of single roots, with and without suffixes. The syllabificational properties of these collocations and the accentual properties of other constituents (including prefix+stem collocations, compounds, and reduplications) are topics for §3, where alignment of the left root-edge is the focus of attention.

In simple roots, Indonesian displays a common stress pattern: a right-to-left trochaic alternation, but with a stress (almost) always on the initial syllable.[3] This is analyzed (§2.1) as a consequence of foot/PrWd (prosodic word) alignment constraints, interacting with each other and with constraints on

[3]What is meant by "stress" in this article is lexical word-stress as determined by impressionistic observation of relative prominence in words in isolation and speakers' intuitions. Recent phonetic work on Indonesian prosody (Ode & van Heuven 1994) shows that the phonetic correlates of stress, dialect variation, and the relationship between lexical word-stress and phrasal intonation are all issues of considerable interest warranting further investigation.

exhaustiveness of metrical parsing. The analysis is refined slightly in §2.2 and §2.3, when root/foot alignment, the role of schwa, and word minimality are also taken into account.

In suffixed words, though, Indonesian shows significant and complex departures from the monomorphemic pattern (§2.2). In previous work, starting with Cohn 1989, such facts have been taken as evidence for cyclic application of the stress rules, but there are significant problems with all cyclic accounts, discussed in detail in Appendix B. We argue instead that the apparent cyclic influences on Indonesian stress derive from a constraint requiring alignment of foot and *root*, so that the root within every word has a privileged status metrically.[4] This is an alignment constraint on the prosody/morphology interface, of the same general type first proposed in Prince & Smolensky 1993 and refined and elaborated in McCarthy & Prince 1993b.

The overall picture that emerges, then, is one in which the basic stress pattern is a consequence of satisfying constraints on prosody/prosody alignment (foot/PrWd and PrWd/foot), while the peculiarities of suffixed words — erstwhile "cyclic" stress — follow from satisfying a constraint on morphology/prosody alignment (root/foot). These two constraint-types correspond, in a general way, to the traditional distinction between rhythmic and demarcative stress, respectively. Yet both are expressed under a single rubric, that of Generalized Alignment. Moreover, the two types of constraints interact with each other in the same way that all constraints do: through ranking. The "cyclic" effects are a consequence of granting the morphology/prosody alignment constraint a higher rank than the prosody/prosody alignment constraints. This ranking conforms to the abstract schema $M \gg P$, seen also in Prosodic Morphology (McCarthy & Prince 1993a: §7).

For the analysis presented here, which relies on Parallelism under Optimality Theory, there is no question of actual cyclicity or other derivational complications, as were required in previous accounts. Instead, the grammar selects fully-realized output representations in which the effects of prosodic and morphological structure are felt simultaneously.

§2.1 Monomorphemic Words

The first order of analytic business in Indonesian is to account for the stress pattern of monomorphemic words like those in (6), with the assumed foot-bracketings indicated by parentheses:

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[4] In this respect, our results converge with those independently arrived at by Kenstowicz (1994). Other recent developments along the same lines, in which apparently cyclic stress systems are re-examined within the Generalized Alignment framework, include Crowhurst 1994 (Diyari and other Australian languages), Buckley 1994 (Manam), and Idsardi 1994 (Polish).

(6) Stress in Monomorphemic Words (cf. Cohn 1989:170)

(cári)	‘search for’
bi (cára)	‘speak’
(bìjak) (sána)	‘wise’
(kònti) nu (ási)	‘continuation’
(èro) (dìna) (míka)	‘aerodynamics’
(àme) ri (kàni) (sási)	‘Americanization’

The goal at this stage is to construct a system of constraints that selects the pattern of foot-parsings in (6), derived by Gen from inputs that have no foot structure. Further complications of monomorphemic stress include the role of schwa in the stress system (e.g. *apártəmen* ‘apartment’) and word-minimality effects. We turn to these later, in §2.3.

Lone syllables remain unfooted in odd-parity polysyllabic words like *bi(cára)* or *(kònti)nu(ási)*. This shows that the constraint FT-BIN, which prohibits monosyllabic feet, is visibly active in Indonesian (cf. Cohn 1993):

(7) FT-BIN (Prince 1980, McCarthy & Prince 1986, 1991, 1993ab)
Feet must be binary under syllabic or moraic analysis.

In odd-parity words, FT-BIN is in conflict with another constraint, one that requires exhaustive foot-parsing:

(8) PARSE-SYLL
All syllables are parsed by Ft, else by PrWd.

PARSE-SYLL is a familiar requirement from stress theory (e.g., Liberman & Prince 1977:266, 294; Prince 1980:535; Halle & Vergnaud 1987; Hayes 1987). Syllables are optimally parsed by Ft, but failing that they are parsed by PrWd (Itô & Mester 1992, McCarthy & Prince 1993a: Appendix).

The conflict between FT-BIN and PARSE-SYLL in monomorphemic odd-parity words is resolved by ranking, with exhaustivity of foot-parsing suffering:[5]

(9) FT-BIN ≫ PARSE-SYLL, from /bicara/

Candidates		FT-BIN	PARSE-SYLL
a.	☞ bi (cára)		*
b.	(bì) (cára)	* !	

In the non-optimal candidate (9b), exhaustive foot-parsing is bought at the price of a unary foot, in violation of dominant FT-BIN. In (9a), then, PARSE-SYLL must be violated by the output form.

A third constraint required in Indonesian is trochaic FT-FORM:

(10) FT-FORM(TROCHAIC)
Feet are trochaic (i.e., $(\acute{\sigma}\sigma)_{Ft}$)

[5]For other consequences of FT-BIN and PARSE-SYLL, see Mester to appear.

This is the quantity-insensitive or syllabic trochee of the McCarthy & Prince 1986/Hayes 1987 foot typology. In the present instance, FT-FORM establishes as a formal constraint the *prominential* properties of trochaic feet in universal stress theory. Following Prince & Smolensky (1992, 1993), we assume that FT-FORM is, like all other constraints, violable when dominated. For present purposes, the only type of violation of FT-FORM that will be contemplated is prominential — that is, parsing with an iamb rather than with a trochee.

When only monomorphemic words are considered, FT-FORM cannot be brought into conflict with either FT-BIN or PARSE-SYLL. For example, **(bicá)ra* and *bi(cára)* are equally harmonic with respect to both PARSE-SYLL and FT-BIN. They do differ on FT-FORM, which will correctly select *bi(cára)* regardless of how it is ranked.[6]

The stress-related constraints discussed thus far characterize the basic metrical structure of Indonesian: strictly binary feet, with trochaic stress, and near-exhaustive parsing. Additional constraints are required to specify the parsing of long words into several feet, corresponding to two central observations:

(11) Foot/Word Association, Descriptively

a. R→L Footing

Syllables are paired into feet from right to left.

b. “Initial Dactyl” Effect (Prince 1983:49, Hayes 1985, 1991, Cohn 1993)

But odd-parity words have initial stress (except in trisyllables).

This general pattern of footing is a common one cross-linguistically. McCarthy & Prince (1993b) put forward an Optimality-Theoretic account of it in terms of Generalized Alignment, and we adopt that analysis here.

One visibly active constraint requires a PrWd-initial foot, accounting for the so-called Initial Dactyl Effect:

(12) ALIGN-L (McCarthy & Prince 1993b)

Align(PrWd, Left; Ft, Left).

“The left edge of *every PrWd* coincides with the left edge of *some foot*.”

Similar constraints have been proposed by Itô & Mester (1992) and, in other frameworks, by Burzio (1992) and Idsardi (1992). ALIGN-L is satisfied by any PrWd that is foot-initial. It is relevant to the parsing of long odd-parity words, where it bans the unfooted (and unfootable, by FT-BIN) singleton syllable from initial position:

[6] Additionally, *bi(cára)* is selected over **(bicá)ra* by ALIGN-ROOT-FT (§2.2).

(13) ALIGN-L, Illustrated

	ALIGN-L
[(kònti)nu(ási)	✓
[(àme)ri(kàni)(sási)	✓
[kon(tìnu)(ási)	* !
[a(mèri)(kàni)(sási)	* !

If ALIGN-L is to be obeyed, any left PrWd-edge "[" must coincide with some left foot-edge "(". All even-parity words satisfy this requirement without any ado, but in odd-parity words ALIGN-LEFT selects the parse in which the unfooted syllable is non-initial.

One particular type of odd-parity word, the trisyllable, provides the first argument for ranking ALIGN-L. Exactly the same candidate comparison recruited in (9) can also be called on to rank ALIGN-L with respect to FT-BIN:

(14) FT-BIN ≫ ALIGN-L, from /bicara/

Candidates	FT-BIN	ALIGN-L
a. ☞ bi (cára)		*
b. (bì) (cára)	* !	

Proper left-edge alignment is possible in trisyllables only at the expense of violating FT-BIN, with a predicted secondary stress on the initial syllable. The correct output lacks that secondary stress, and so we have this ranking. This is, however, not a complete account of the optimality of *bicára*; we must also contend with the candidate **(bíca)ra*, and we will do so below (29).

ALIGN-L doesn't account for right-to-left footing (11a), though, and so another constraint is required. It is ALL-FT-R,[7] which demands that *every* foot lie in final position:

(15) ALL-FT-R (Kirchner 1993, McCarthy & Prince 1993b)
Align(Ft, Right; PrWd, Right)
"The right edge of *every foot* coincides with the right edge of *some PrWd*."

By quantifying universally over feet within the PrWd, this constraint requires that all feet be final, and hence that there be a single foot lying at the right edge of the PrWd. But if PARSE-SYLL is to be obeyed maximally, then some feet must be non-final. This is the case in Indonesian, as the following ranking argument shows (Kirchner 1993, McCarthy & Prince 1993b):

[7] The name is due to Alan Prince.

(16) PARSE-SYLL ≫ ALL-FT-R

Candidates	PARSE-SYLL	ALL-FT-R
a. ☞ (ame)ri(kani)(sasi)]	*	*******
b. (ame)rikani(sasi)]	** ! *	*****
c. amerikani(sasi)	** ! ***	

Form (b) is better aligned simply by virtue of not positing the medial foot *(kani)*, and form (c) does even better, alignment-wise, by setting up no other feet than the final one. But exhaustiveness of foot-parsing (up to FT-BIN) must be achieved, even at the expense of inferior right-edge alignment.

With PARSE-SYLL dominant, then, ALL-FT-R is in the position of selecting the best-aligned candidate from a field in which all candidates are imperfectly aligned (as proposed by Kirchner 1993), since all minimally violate PARSE-SYLL by displaying near-exhaustive parsing. But this is not a complete account of the optimality of examples like *àmerikànisási*, since one other candidate must be reckoned with. Even better right-edge alignment of Ft-1 than (c) can be achieved (while still violating PARSE-SYLL minimally): **a(meri)(kani)(sasi)*. But this form violates ALIGN-L, fatally, under the ranking ALIGN-L ≫ ALL-FT-R:

(17) ALIGN-L ≫ ALL-FT-R

Candidates	ALIGN-L	ALL-FT-R
a. ☞ [(ame)ri(kani)(sasi)]		*******
b. [a(meri)(kani)(sasi)]	* !	******

Schematically, the ranking ALIGN-L ≫ ALL-FT-R yields the “initial dactyl” pattern.

In sum, the ranking of the constraints proposed is this:

(18) Interim Ranking Summary: Basic Metrical Constraints
FT-BIN ≫ PARSE-SYLL, ALIGN-L ≫ ALL-FT-R

All of these rankings have been justified by arguments given immediately above. As a check on the correctness of the analysis, we provide the following tableaux, including all constraints discussed thus far and all root types (except for trisyllables, covered in (29)):

* * *

There are no interesting candidates other than the optimal one for the disyllabic case.

(19) Exemplificatory Tableau for /cari/

	FT-BIN	PARSE-SYLL	ALIGN-L	ALL-FT-R
a. ☞ [(cári)]				
b. [(cà)(rí)]	** !			

* * *

In quadrisyllables, better left- or right-edge alignment is always conceivable through less-than-exhaustive foot-parsing. But the high rank of PARSE-SYLL bars that possibility.

(20) Exemplificatory Tableau for /bijaksana/

	FT-BIN	PARSE-SYLL	ALIGN-L	ALL-FT-R
a. ☞ [(bìjak)(sána)]				**
b. [bijak(sána)]		* ! *	* !	
c. [(bíjak)sana]		* ! *		**

* * *

As in the quadrisyllabic case, high-ranking PARSE-SYLL elicits exhaustive foot-parsing in six-syllable words:

(21) Exemplificatory Tableau for /erodinamika/

	FT-BIN	PARSE-SYLL	ALIGN-L	ALL-FT-R
a. ☞ [(èro)(dìna)(míka)]				******
b. [(éro)dinamika]		**** !		****
c. [erodina(míka)]		**** !	* !	

* * *

In long odd-parity words, there's a basic choice about where to leave the unfooted syllable. The pair of constraints ALIGN-L and ALL-FT-R ensure that the unfooted syllable is medial, since edge-alignment must prevail.

(22) Exemplificatory Tableau for /kontinuasi/

	FT-BIN	PARSE-SYLL	ALIGN-L	ALL-FT-R
a. ☞ [(kònti)nu(ási)]		*		***
b. [kon(tìnu)(ási)]		*	* !	**
c. [(kòn)(tìnu)(ási)]	* !			*****

* * *

In the final tableau, we see the role of ALL-FT-R in requiring that *every* foot lie at the right edge of the PrWd. Under domination by ALIGN-L, the initial foot *(ame)* must be posited, even though it cannot be right-aligned. Under domination by PARSE-SYLL, a medial foot is required, even though it cannot be aligned either. Nonetheless, the medial foot is *(kani)* rather than *(rika)*, lying as far to the right as possible, minimally violating ALL-FT-R.

(23) Exemplificatory Tableau for /amerikanisasi/

		FT-BIN	PARSE-SYLL	ALIGN-L	ALL-FT-R
a.	☞ [(àme)ri(kàni)(sási)]		*		*******
b.	[a(mèri)(kàni)(sási)]		*	* !	******
c.	[(àme)rikani(sási)]		* ! **		*****
d.	[(àme)(rìka)ni(sási)]		*		******** !

* * *

In summary, the hierarchy of constraints presented to this point chararacterizes a pattern in which the first two syllables are footed and all remaining syllables are gathered into feet from right to left (ALIGN-L ≫ ALL-FT-R). Crucially, ALIGN-L pertains to a single foot, requiring that every PrWd begin at a foot-edge, while ALL-FT-R governs the alignment of all feet. This difference in the two constraints follows from the different treatment of the two constituent arguments in the definition of Generalized Alignment. ALL-FT-R is violated in any candidate where non-final feet are posited — a necessity because ALL-FT-R is dominated by PARSE-SYLL and ALIGN-L. Standing at the top of the hierarchy is FT-BIN, which ensures that unit feet are never found, even (as in odd-parity words) where greater obedience to PARSE-SYLL or ALIGN-L could be achieved.

A couple of matters remain to be settled. As we have already noted, the analysis presented so far does not fully determine the stress pattern of trisyllables; specifically, we must explain why the result is not **(bíca)ra* rather than *bi(cára)*, obeying ALIGN-L in preference to ALL-FT-R. The explanation for the optimality of *bi(cára)* lies with a further alignment constraint, standing at the top of the hierarchy, that is also essential to the analysis of suffixed forms. The other issue involves the locus of main stress, always penultimate. A prominential constraint is required to single out the rightmost stress as most prominent, and this too plays a role in the account of suffixed forms. We therefore turn now to the stress properties of suffixed words, which differ in certain very significant ways from simple roots.

§2.2 Suffixed Words

We turn now from simple roots to roots with suffixes, such as those in (24):

(24) Anomalous Stress in Suffixed Words (prefixes suppressed)

a. Single Suffix

3+1-σ	bicará–kan	‘speak about something’	*bìcará–kan
5+1-σ	kòntinuasí–ña	‘the continuation’	*kòntinùasí–ña
6+1-σ	òtobìografí–ña	‘the autobiography’	*òtobiògrafí–ña
7+1-σ	àmerikànisasí–kan	‘Americanize’	*àmerìkanìsasí–kan

b. Double Suffix

3+2-σ	bicàra–kán–ña	‘speak about it’	*bìcara–kán–ña

Examples like *òtobìografí–ña* and *àmerikànisasí–kan* have not been discussed previously in the literature, though the rest come from Cohn 1989:176. The starred forms on the right show what would be expected if these suffixed forms were treated exactly like monomorphemic ones: in the actual forms, secondary stresses are missing or displaced relative to naive monomorphemic expectation. These effects are only observed with roots of particular sizes, like those in (24) — roots of 3, 5, 6, or 7 syllables with a single suffix, and roots of three syllables with double suffixes. With other root-size/suffix combinations, the observed stress patterns of suffixed forms are not different from monomorphemic words of the same length:

(25) Non-Anomalous Stress in Suffixed Words (Cohn 1989:176) (prefixes suppressed)

a. Single Suffix

2+1-σ	carí–kan	'search for'	(cf. 3-σ bicára)
4+1-σ	màšarakát–ña	'the society'	(cf. 5-σ kòntinuási)

b. Double Suffix

2+2-σ	càri–kán–ña	'search for it'	(cf. 4-σ bìjaksána)
4+2-σ	bìjaksàna–án–ña	'the regulations'	(cf. 6-σ èrodìnamíka)
5+2-σ	àsosiàsi-kán-ña	'associate it'	(cf. 7-σ àmerikànisási)

The goal now is to account for the peculiarities of (24) while still deriving the "normal" pattern in (25).

The missing secondary stresses of some of the examples in (24a) present the most obvious problem: how can morphological complexity, which might be expected to lead to extra stresses or displaced stresses, ever lead to the complete absence of stress in some domain? One tack, taken by Cohn (1989, 1993) and adopted by most subsequent analysts, is to see this as a consequence of destressing rules (see Appendix B below). But destressing requires a step-wise derivation, in which stresses are first assigned by a general process and then removed by a specific one, and such a derivation is impossible under Parallelism. Therefore, alternatives to destressing must be considered.

Within Optimality Theory, where all constraints are in principle and in fact violable, a very different account of the missing stresses is possible: iambic foot-parsing, in which trochaic FT-FORM itself is violated. By this hypothesis, the forms with missing stress in (24a) are parsed as in (26):

(26) Missing Stresses Via Iambic Foot-Parsing

3+1-σ bi*(cará)*–kan
5+1-σ (kònti)nu*(así)*–ña
7+1-σ (àme)ri(kàni)*(sasí)*–kan

If this is correct, then the explanation for the missing secondary stresses is obvious: nowhere is there a string of two unfooted syllables that could have supplied an additional stress. To put it differently, the secondary stresses are not missing or deleted, but rather the optimal parse divides up the available syllables in a way that's different from what's observed in unsuffixed words of the same total size.[8]

---

[8]It should be noted, though, that there is no independent evidence for the iamb in these words. In general, Indonesian does not offer evidence of foot structure other than prominence itself.

The rightmost foot in these forms is an iamb, not a trochee, in violation of FT-FORM. Some dominant constraint must compel violation of FT-FORM (and ALL-FT-R) in these cases, but it must not affect the analysis of unsuffixed words. Another constraint of the ALIGN family is called for:

(27) ALIGN-ROOT-FT

Align(Root, Right; Ft, Right).

"The right edge of every root coincides with the right edge of some foot" — every root ends in a foot.

All unsuffixed words satisfy ALIGN-ROOT-FT easily; since the root and the PrWd are coextensive, the foot that is right-aligned in the *PrWd* (obeying ALL-FT-R) is also right-aligned in the *root* (see §2.1). Thus, ALIGN-ROOT-FT does not affect the analysis of unsuffixed words at all. But in *suffixed* forms the right-alignment of foot with root will lead to a different result, as in (26).

The crucial point of comparison is between (26) and the same forms parsed as if monomorphemic. The tableau (28) shows that ALIGN-ROOT-FT must dominate the principal constraints that control the metrical structure of monomorphemic forms, if it is to have any effect. In this tableau and others below, we observe the convention of marking the relevant edge of the root by "|". As usual, edges of PrWd, when relevant, are shown by "[ ]" and of feet by "( )". So the properly right-aligned configuration demanded by ALIGN-ROOT-FT looks like this "|)".

(28) ALIGN-ROOT-FT ≫ PARSE-SYLL, ALIGN-L, from /bicara–kan/

Candidates	ALIGN-ROOT-FT	PARSE-SYLL	ALIGN-L	ALL-FT-R
a. ☞ [bi(cará|)kan]		*	*	*
b. [(bìca)(rá|kan)]	* !			**

Both candidates have strictly binary feet, so they tie on high-ranking FT-BIN. Form (a) fares worse on both PARSE-SYLL and ALIGN-L, but it crucially obeys dominant ALIGN-ROOT-FT, which form (b) violates. Prince & Smolensky (1993) call attention to situations like this as evidencing "the strictness of strict domination" — no amount of success on low-ranking constraints can offset failure on a high-ranking one.

The role of ALIGN-ROOT-FT in suffixed forms bears directly on one of our main themes. The Generalized Alignment hypothesis says that the morphological structure of the form can directly influence the optimality of the metrical parse, by means of constraints that demand coincidence of the edges of prosodic and morphological constituents. This analysis of Indonesian confirms that, by providing a new and, as we will show in Appendix B, superior treatment of allegedly "cyclic" phenomena.

A short digression. Through domination of ALIGN-L, ALIGN-ROOT-FT is also responsible for the proper analysis of *bi(cára)* and other trisyllables, an issue raised earlier in §2.1. The choice is between left-aligned *(bíca)ra* and right-aligned *bi(cára*). The latter is optimal, since it satisfies the higher-ranking constraint demanding right-alignment:

(29) ALIGN-ROOT-FT ≫ ALIGN-L, from /bicara/

Candidates		ALIGN-ROOT-FT	ALIGN-L
a.	☞ [bi(cára|)		*
b.	[(bíca)ra|	* !	

The choice in (29) is between proper right-edge alignment of foot and root edges (shown by ")|" in (29a)) and proper left-edge alignment of foot and PrWd edges (shown by "[(" in (29b)). The former is more harmonic, given the ranking claimed here. By contrast, in longer odd-parity words, such as *(kònti)nu(ási)* or *(àme)ri(kàni)(sási)*, both constraints can be obeyed perfectly, and so they are. (ALL-FOOT-R would also be decisive, but in fact is not, since it is crucially dominated by ALIGN-L.) End of digression.

Thus far, we have dealt with only the metrical and not the prominential peculiarities of *bi(cará)–kan*; whence the iambic foot, or why not **bi(cára)–kan*? The answer lies with the interaction of three prominential constraints: trochaic FT-FORM (10), NON-FIN(σ́), and RIGHTMOST(σ́):

(30) NON-FIN(σ́) (Prince & Smolensky 1993: Chapt. 4; cf. Hung 1994)
The head syllable of PrWd is not final in PrWd.

(31) RIGHTMOST(σ́)[9]
Align(σ́, Right; PrWd, Right)
"The main-stressed syllable is final in the PrWd."

NON-FIN(σ́) bars stress from the PrWd-final syllable; except in (C*ə*)*CV(C) words (see §2.3), this constraint is unviolated in Indonesian. Its principal competitor is RIGHTMOST(σ́), which demands that the main stress lie as far to the right as possible. Through the ranking NON-FIN(σ́) ≫ RIGHTMOST(σ́), the normal penultimate stress of Indonesian is obtained. (In this, we follow a proposal by Kenstowicz 1994.)

The iambic foot in *bi(cará)–kan* is a consequence of maximal satisfaction of RIGHTMOST(σ́), through crucial domination of trochaic FT-FORM:

(32) RIGHTMOST(σ́) ≫ FT-FORM

Candidates		RIGHTMOST(σ́)	FT-FORM
a.	☞ bi(cará|)kan]	*	*
b.	bi(cára|)kan]	** !	

[9]Cf. the head-alignment constraints in Prince & Smolensky 1993: 39, McCarthy & Prince 1993b: (35), and Pierrehumbert 1993.

When the main-stressed foot is non-final, as in *bi(cara)–kan*, then the competition between the normal trochaic prominence and the exceptional iambic prominence is decided in favor of the iambic, by RIGHTMOST(σ́). But when the main-stressed foot is PrWd-final, as simple roots and doubly-suffixed words, then dominant NON-FIN(σ́) is visibly active, barring stress from the PrWd-final syllable:

(33) NON-FIN(σ́) ≫ RIGHTMOST(σ́), from /cari/

Candidates	NON-FIN(σ́)	RIGHTMOST(σ́)	FT-FORM
a. ☞ (cári)]		*	
b. (carí)]	* !		*

Though *(carí) also violates trochaic FT-FORM, that constraint cannot be decisive here, because it is crucially dominated by RIGHTMOST(σ́) (see (32)).

In summary, we have argued that the following constraint-ranking is responsible for the basic stress pattern of Indonesian and the "cyclic" effects of morphological complexity:

(34) Interim Ranking Summary, Prominential Constraints Added
a. FT-BIN, ALIGN-ROOT-FT ≫ PARSE-SYLL, ALIGN-L ≫ ALL-FT-R
b. NON-FIN(σ́) ≫ RIGHTMOST(σ́) ≫ FT-FORM

The metrical hierarchy (a) and the prominential hierarchy (b) can be joined at one point. Satisfaction of ALIGN-ROOT-FT leads to violation of trochaic FT-FORM in *bi(cará)–kan* and similar examples. That is, the morphological determination of foot position through Alignment leads to positing iambic prominence within a basically trochaic system. Therefore, ALIGN-ROOT-FT must dominate FT-FORM, as the following tableau certifies:

(35) ALIGN-ROOT-FT ≫ FT-FORM, from /bicara-kan/

Candidates	ALIGN-ROOT-FT	FT-FORM
☞ [bi(cará|)kan		*
[(bìca)(rá|kan)	* !	

We now have a full account of the optimality of *bicará–kan*. The explanation for the absence of secondary stress on the initial syllable lies with the constraint ALIGN-ROOT-FT, which demands alignment of a foot at the right root-edge, even at the expense of trochaic prominence and otherwise inferior metrical parsing. In a simple quadrisyllabic root, by contrast, ALIGN-ROOT-FT is satisfied without further ado by trochaic footing and maximal metrical parsing: *(bìjak)(sána)*.

Long even-parity roots display an anomaly that has not been previously discussed in the literature. With a six-syllable root like *òtobìográfi* (24a), a single suffix yields the stress pattern *òtobìografí–ña*, with the secondary stress displaced relative to naive monomorphemic expectation. This case is interesting because it permits us to bring ALIGN-ROOT-FT into direct conflict with ALL-FT-R:

(36) ALIGN-ROOT-FT ≫ ALL-FOOT-R

Candidates	ALIGN-ROOT-FT	ALL-FT-R
a. ☞ [(òto)(bìog)(rafí|)ña]		*********
b. [(òto)bi(ògra)(fí|ña)]	* !	*******

This ranking, argued for independently here, is in any case required by the transitivity of constraint domination. We have already presented arguments that ALIGN-ROOT-FT dominates both PARSE-SYLL and ALIGN-L (28), and we have presented other arguments that, in turn, PARSE-SYLL and ALIGN-L dominate ALL-FT-R (16, 17). What we have here, then, is evidence of internal consistency in the analysis: the rankings required by transitivity of domination are also supported by direct evidence.

The other class of stress anomalies in derived words involves doubly-suffixed forms of 3-σ roots, such as *bicàra–kán–ña*, with the secondary stress displaced from naive monomorphemic expectation (**bìcara–kán–ña*). Once again, the reason for this lies with ALIGN-ROOT-FT, which yields the correct result, as the following tableau shows:

(37) /bicara–kan–ña/ → bicàrakánña

Candidates	ALIGN-ROOT-FT	PARSE-SYLL	ALIGN-L	ALL-FT-R
☞ [bi(càra|)(kánña)]		*	*	**
[(bìca)ra|(kánña)]	* !	*		***

With double suffixation, the main stress falls on one of the suffixes, so the prominential constraint RIGHTMOST(σ́) is irrelevant to the locus of the secondary stress on the root. Therefore, there is no question of violation of FT-FORM, and so only trochaic feet are found.

No stress anomalies are expected or found in doubly-suffixed words whose roots are not trisyllabic (see (25b)). Examples of this include the following:

(38) Stress in Doubly-Suffixed Words with |Root| ≠ σσσ (Prefixes suppressed)

(*càri*)–(kán–ña)	'search for it'
(bìjak)(*sàna*)–(án–ña)	'the regulations'
(àso)si(*àsi*)–(kán-ña)	'associate it'
(èro)(dìna)(*mìka*)–(án–ña)	'the aerodynamicness'
(àme)ri(kàni)(*sàsi*)–(kán–ña)	'americanize something'

In these forms, the foot of interest — the one lying in root-final position, satisfying ALIGN-ROOT-FT — is italicized. Other feet are dispersed around it in the expected way, given the rest of the constraint hierarchy. With double suffixation on a root that is not trisyllabic, the effects of ALIGN-ROOT-FT are indistinguishable from the effects of ALL-FOOT-R, and so the stress pattern is the same as that found in monomorphemic words of the same length.

The following tableaux confirm the correctness of this analysis, by testing it against all of the other anomalous stress patterns in (24) as well as the non-anomalous ones in (25) and others of their ilk:

* * *

In *kòntinuasíña*, the root-final foot satisfies ALIGN-ROOT-FT. It is an iamb, rather than the usual trochee, in minimal violation of the prominential constraint RIGHTMOST(σ́) (see (32, 33)). The actual output form violates all of the lower ranking constraints in this tableau, but no other candidate could do better. For example, **kon(tìnu)(ási)ña* also violates ALIGN-L, while less complete parsings fare worse on PARSE-SYLL.

(39) /kontinuasi–ña/ → kòntinuasíña

Candidates	ALIGN-ROOT-FT	PARSE-SYLL	FT-FORM	ALL-FT-R
☞ [(kònti)nu(así|)ña]		*	*	*****
[(kònti)(nùa)(sí|ña)]	* !			******

* * *

In *àmerikànisasíkan*, a secondary stress is "missing" and another is "displaced" from the position expected if this were a monomorphemic word. As in the previous example, the root-final foot satisfies ALIGN-ROOT-FT by its mere presence, and it minimally violates RIGHTMOST(σ́) by being iambic rather than trochaic. The only other interesting candidate that obeys high-ranking ALIGN-ROOT-FT is **(àme)(rìka)ni(sasí)kan*, which does worse on ALL-FOOT-R than does the actual output form.

(40) /amerikanisasi-kan/ → àmerikànisasíkan

Candidates	ALIGN-ROOT-FT	PARSE-SYLL	FT-FORM	ALL-FT-R
☞ [(àme)ri(kàni)(sasí|)kan]		**	*	*********
[(àme)(rìka)(nìsa)(sí|kan)]	* !			***********

* * *

The roots above are of odd parity with a single suffix. In contrast, the stress pattern observed with the singly-suffixed 2-σ and 4-σ *even*-parity roots in (25a) is not distinct from the pattern seen in monomorphemic words of the same size: *carí–kan*, *màšarakát–ña*. The reason for this is that, in words of just this type, the effects of having an *iambic* foot on the last two syllables of the *root* are indistinguishable, prominentially, from having a *trochaic* foot on the last two syllables of the *PrWd*. The following two tableaux show this, comparing the iambic and trochaic parses for these examples:

(41) /cari–kan/ → caríkan

Candidates	ALIGN-ROOT-FT	PARSE-SYLL	FT-FORM	ALL-FT-R
☞ [(carí|)kan]		*	*	*
[ca(rí|kan)]	* !	*		

(42) /mašarakat–ña/ → màšarakátña

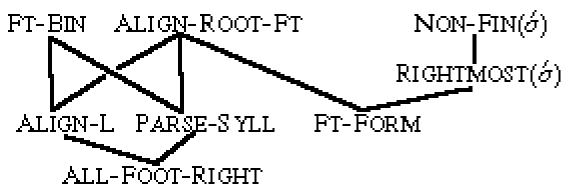
Candidates	ALIGN-ROOT-FT	PARSE-SYLL	FT-FORM	ALL-FT-R
☞ [(màša)(rakát│)ña]		*	*	****
[(màša)ra(kát│ña)]	* !	*		***

The candidates compared in these tableaux are prominentially identical, though metrically distinct. Since we have no way of observing the metrical structure of Indonesian except inferentially, by means of prominence, we cannot say with certainty that these are correct. Nonetheless, it is important to recognize that the analysis, justified by cases where both prominence and metrical structure are different, entails this result: that even-parity roots with a single suffix end with an iambic foot.

* * *

We can now provide a connected partial ordering of all the constraints considered. It is presented here in the form of a graph; superior vertical position in the tree indicates constraint domination:

(43) Summary Constraint Hierarchy: Metrical and Prominential



We have already noted that the ranking ALIGN-ROOT-FT ≫ ALL-FOOT-R is justified on grounds of transitivity of constraint domination (two ways) and through an independent, direct argument. Such circumstances, where a ranking can be proven by both direct argument and transitivity of domination, tend to confirm the correctness of the analysis, by showing its internal consistency and coherence.

The ordering is partial, because not all of the constraints interact in a rankable way, either as a matter of principle or in fact. The purely prominential constraints NON-FIN(σ́) and RIGHTMOST(σ́) do not interact with the metrical constraints; thus, the prominential and metrical hierarchies intersect only at the constraint that stands at the interface between them, FT-FORM. Among the metrical constraints, ALIGN-L can be violated only if PARSE-SYLL also is. Entailed violations like this never produce a rankable configuration. Finally, the conditions never arise in Indonesian that would permit a determination of the ranking of FT-FORM relative to ALIGN-L or PARSE-SYLL, though in principle conflicts among these constraints might be possible.

This covers all of the basic properties of the analysis of suffixed words. We have seen that the influence of morphology on prosodic structure in Indonesian is obtained via the Alignment constraint ALIGN-ROOT-FT, which demands that the root and a foot end together. In concert with ALIGN-L and the root/PrWd alignment constraint ALIGN-WD (developed below in §3), ALIGN-ROOT-FT characterizes what is surely a natural situation of prosody/morphology alignment (cf. Prince 1983:49): the root optimally begins and ends evenly on a foot-edge.

ALIGN-ROOT-FT is a constraint on the *interface* of prosody and morphology; by dominating purely prosodic constraints like ALIGN-L, FT-FORM, and PARSE-SYLL, it is able to influence the output in precisely the way observed in Indoneisan. This ranking, abstractly *M*[orphology] ≫ *P*[rosody], is required for the morphology/prosody interface constraint to influence the outcome, since otherwise the purely prosodic constraints would hold sway. In this general form, the ranking required in Indonesian corresponds to the ranking schema *M* ≫ *P* of Prosodic Morphology (McCarthy & Prince 1993: Chapt. 7). In this way we reveal an abstract connection between the rankings required in Prosodic Morphology — such as reduplication or infixation — and the rankings required in accounting for apparently "cyclic" stress systems, where morphological structure also exerts an effect on prosodic structure. In both cases, constraints of morphology or of the morphology/prosody interface crucially dominate purely prosodic constraints. It is this constraint ranking that is responsible for the combination of rhythmic and root-demarcative properties of stress in Indonesian.

An important feature of this analysis is that the influence of morphology on prosody is *direct*, via Alignment, rather than indirect, via the cycle or its surrogates. Under Parallelism, the prosodic influences on stress (such as ALIGN-L and PARSE-SYLL) are felt simultaneously with the morphological influences on stress (ALIGN-ROOT-FT). The relation between prosody and morphology is expressed by Alignment constraints and ranking (*M* ≫ *P*), rather than by a derivation. (See Appendix B for discussion of various derivational (typically cyclic) treatments of Indonesian.)

§2.3 Word Minimality and the Status of Schwa

We now turn to a body of data that has scarcely been mentioned in previous work on Indonesian stress though, as we will show, it turns out to be of great relevance. This new evidence involves the treatment of schwa within the prosodic system — both stress and word minimality. It turns out to provide completely independent confirmation for two central points of the analysis presented above: violability of FT-FORM under domination by higher-ranking constraints; and obedience to ALIGN-ROOT-FT.

Schwa-headed syllables are never stressed in the variety of Indonesian described here.[10] In the normal course of events, they are unfootable too. These observations are proven by facts like the following, which show the treatment of schwa in various positions in the word:

[10]Impressionistically, schwa is always stressless in the speech described here, though research suggests that schwa may bear stress in other dialects, such as Jakartan Indonesian (Laksman 1994).

(44) Stress Behavior of Schwa (Cohn 1989:174)

Actual	Gloss	Stressable ə	Footable ə
gáməlan	'Indo. orchestra'	*gamə́lan	id.
apártəmen	'apartment'	*àpartə́men	id.
cərítəra	'story'	*cə́ritə́ra	id.
pərəmpuan	'woman'	*pə́rəmpúan	id.
kopərási	'cooperation'	id.	*kòpərási
dìfərensiási	'differentiation'	id.	*dìfərènsiási

The actual stress pattern is no different from what we would expect if the syllables containing schwa were absent entirely. The other columns show the stress patterns that would be derived if, contrary to fact, schwa participated more fully in the stress system, in one of two logically possible ways. If schwa were a full participant — both stressable and footable — then the forms in the column headed "Stressable ə" would be expected. If schwa were a limited participant — footable but unstressable, as in English — then the results in the column headed "Footable ə" would be found.

Cohn (1989) and subsequent analysts have concluded that the extreme inertia of schwa in Indonesian stress requires extreme measures: schwa-headed syllables do not project any structure in metrical representation. But since this is not a logical or empirical necessity — languages can differ on just this point — it must in Optimality-Theoretic terms be seen as a consequence of a rankable constraint. We state it explicitly in (45), but do not digress to consider how this constraint might be expressed formally:

(45) NON-FOOT(ə)

Schwa-headed syllables have no metrical projection.

The constraint NON-FOOT(ə) is in principle violable; we will now show that it is in fact violated in Indonesian, under conditions that are different from those observed in (44).

Indonesian strongly avoids monosyllabic content words, though it has a few (*tik* 'type' (from Dutch), *pak* 'pack'). In a basic word list of 1300 items (Wolff et al. 1986), there are only 16 monosyllabic content words, or about 1% (Cohn 1993).[11] All are borrowings. On the other hand, words that are disyllabic solely by virtue of combining schwa with one non-schwa vowel are abundant, including indigenous words as well as borrowings:

(46) $(Cə)^{+}$CV(C) Polysyllables (cf. Cohn 1989:174)

ərú	'Australian pine'	ənám	'six'
bərí	'give'	kərá	'monkey'
kəcíl	'small'	kərjá	'work'
sətəláh	'after'	əmpəlás	'sandpaper'

[11] In a more extensive vocabulary, which would include many polysyllabic loans, the percentage is presumably even smaller.

Lest these seem a fluke, take note of a further fact. The borrowed monosyllables like *tik* have a tendency to be reanalyzed as disyllabic by the addition of a schwa-headed syllable, seen in prefixed forms: *məŋ+ətik* 'type (active)' *di+kətik* 'typed (passive)'.[12] If disyllabicity is the target, then a schwa-headed syllable must count toward that goal.

It is clear from these observations that schwa-headed syllables *are* reckoned in fulfilling disyllabic word minimality. But word minimality is itself a consequence of foot structure (Prince 1980, Broselow 1982, McCarthy & Prince 1986, 1990, 1991, 1993a). The argument begins with the Prosodic Hierarchy in (47), evolved from that of Selkirk 1980ab:

(47) Prosodic Hierarchy (McCarthy & Prince 1986 *et seq*.)

Prosodic Word	PrWd
	|
Foot	Ft
	|
Syllable	σ
	|
Mora	μ

According to the Prosodic Hierarchy, any instance of the category PrWd must contain at least one foot. By FT-BIN, every foot must be bimoraic or disyllabic. By transitivity, then, a PrWd must contain at least two moras or syllables.

The disyllabic word minimum, then, follows from obedience to FT-BIN. In Indonesian, FT-BIN is undominated and therefore unviolated. In particular, it must dominate some constraint requiring faithful parsing of monosyllabic inputs. We assume that M-PARSE is the operative constraint:

(48) M-PARSE (Prince & Smolensky 1993)

Morphemes are parsed into morphological constituents.

Violation of M-PARSE makes the functional equivalent of no output, the *Null Parse*, a member of the candidate set.

This approach is developed by Prince & Smolensky (1993: Chapter 4.3.4), who observe that the Null Parse, which supplies no analysis to the input, is particularly unsuited to participate in linguistic structure. The idea is that, among the candidate output forms, there is one in which the root receives no morphological analysis at all; the output form remains morphologically unparsed, identical to the input.[13] Such an output is fatally flawed, because it cannot play any role in the syntax or higher morphology: unless an input {A} is analyzed structurally as $[A]_{Cat}$, nothing that refers to *Cat* can deal with it.

---

[12]In reanalysis, the monosyllabic root becomes disyllabic by the addition of initial *kə*. The reason for *k*, rather than some other consonant, presumably has to do with the morphophonemics of *məN*- prefixation, since *məN*- plus root-initial *k* yields *məŋ*. (The combination *məN*+V also yields *məŋ*, but V-initial roots are disfavored by ONSET.) See below, §3.3.

[13]The Null Parse emerges as a candidate if the identity transformation is part of Gen, so the input {A} has, among its output candidates, the Null Parse {A}.

We therefore have the ranking FT-BIN ≫ M-PARSE, meaning that no output at all is better than one containing monosyllabic feet. This entails that *bərí* and other words like those in (46) *satisfy* FT-BIN, since these words exist (they obey M-PARSE) and they are common (they are not simply sporadic lexical exceptions, like *tik*). But words like *bərí* etc. can obey FT-BIN only if they are parsed with disyllabic iambic feet *(bərí)*. If, instead, these forms had monosyllabic feet **bə(rí)*, as complete metrical inertia of schwa predicts, then we would expect them to be very rare, when in fact they are quite common.

This observation means that the unfootability of schwa is a contingent rather than absolute regularity of the language. Schwa is indeed metrically invisible in examples like *kopərási* and *dìfərensiási*, where there is little to be gained by incorporating it into metrical structure. But in words like *bərí*, high-ranking FT-BIN is at stake, and so schwa is metrically visible and therefore footable. Formally, this means that NON-FOOT(ə) is violated under crucial domination by FT-BIN and M-PARSE. The following tableau shows this argument:

(49) FT-BIN ≫ M-PARSE ≫ NON-FOOT(ə), from /bəri/

Candidates		FT-BIN	M-PARSE	NON-FOOT(ə)
a.	☞ (bərí)			*
b.	bə(rí)	* !		
c.	*no output*		* !	

The ranking FT-BIN ≫ M-PARSE accounts for the impossibility of true monosyllabic words (apart from a few lexical exceptions), as we argued above. That independently established ranking shows that (b), with a non-binary foot, cannot be the actual output form. (The shading in (b) is used to indicate a syllable that does not project metrical structure.) Rather, (a) must be the output, and so schwa is footable under domination by these high-ranking constraints. The Null Parse (c) obeys both of the substantive metrical constraints — it posits no feet at all, so it vacuously satisfies FT-BIN and NON-FOOT(ə) — but it is still non-optimal, because M-PARSE, which it violates, crucially dominates NON-FOOT(ə). Syllables with schwa are only contingently unfootable, proving that NON-FOOT(ə) is a violable constraint rather than a categorical truth of phonological representation in Indonesian.

But the most notable feature of this result is that it gives further evidence for the emergence of iambic structure in a basically trochaic language. Under domination by the constraint NON-HEAD(ə), violation of trochaic FT-FORM is compelled. This is, of course, what we also see in suffixed words (§2.2), where the responsible constraints are ALIGN-ROOT-FT and RIGHTMOST(σ́). There are then, two distinct circumstances, defined by the full constraint hierarchy, where trochaic FT-FORM is violated.

Turning back to (44), we see that the forms in the column headed "Footable ə" reveal something about the constraints that NON-FOOT(ə) must itself dominate. If schwa were a full participant in metrical structure, then a word like *kopərasi* would be stressed as **kòpərási*, rather than *kopərási*. This shows that NON-FOOT(ə) crucially dominates ALIGN-L and PARSE-SYLL:

(50) NON-FOOT(ə) ≫ ALIGN-L, PARSE-SYLL

Candidates	NON-FOOT(ə)	ALIGN-L	PARSE-SYLL
a. ☞ [kopə(rási)		*	*
b. [(kòpə)(rási)	* !		

The actual output form incurs a single PARSE-SYLL mark, under the assumption that the syllable *pə* does not project metrical structure in this candidate. (Shading signals a syllable like this.) This non-exhaustive and unaligned metrical parse is preferred to the alternative: participation of schwa in metrical structure, violating NON-FOOT(ə).

This analysis is not a complete account of the optimality of *(bərí)* and the like; we must also explain why stress falls on the final syllable rather than on the penult. Plainly, final stress in *(bərí)* violates NON-FIN(σ́) and trochaic FT-FORM. But what compels this violation? The answer is that un*stress*ability of schwa is a distinct requirement from un*foot*ability, and that the un*stress*ability of schwa is an undominated constraint in Indonesian (as it is in English, where schwas are nonetheless footable):[14]

(51) NON-HEAD(ə)
Stressed ə is prohibited.

As noted, this constraint must dominate NON-FIN(σ́) and FT-FORM, choosing *(bərí)* over *(*bə́ri).*

We have observed that words of the shape *bərí* are plentiful. In contrast, words like **bírə* are categorically prohibited in Indonesian. More broadly, *no* root-final syllable, open or closed, contains ə, so words like **birəm* are impossible too.[15] Examples like **batírəm* or **bátirəm* are equally impossible; this shows that the length of the word is not a factor, and therefore FT-BIN is not the responsible constraint. Parsed as *(*bírə)* or **ba(tírəm)*, these words violate NON-FOOT(ə), but that constraint cannot be decisive either, because *(bərí*) and *sə(təláh)* are allowed. Rather, the impossibility of **bírə*, **batírəm*, and congeners must derive from the interaction of other constraints.

One constraint that is visibly active in such cases is ALIGN-ROOT-FT. If it dominates M-PARSE, then it rules out analyses in which the root-final schwa-bearing syllable is ignored by metrical scansion:

[14]As with NON-FOOT(ə), we do not consider the further formal development of this constraint.

[15]No *suffix* contains schwa either. This is less remarkable, since the set of suffixes is quite small. Still, by comparison, most prefixes have schwa.

(52) ALIGN-ROOT-FT ≫ M-PARSE

Candidates		ALIGN-ROOT-FT	M-PARSE
a.	☞ *no output*		*
b.	(batí)rəm| (báti)rəm|	* !	

According to this ranking, the Null Parse — no output at all — is better than a parse with misalignment of root and foot edges.

A full account of the impossibility of roots with schwa-final syllables requires that we also exclude analyses like **(bírə)* or **ba(tírəm)*, in which obedience to both ALIGN-ROOT-FT and M-PARSE is purchased at the expense of violating NON-FOOT(ə). One possible explanation for why they are not optimal lies with a deeper understanding of the quantitative structure of feet. Consider the various foot-types actually observed in Indonesian:

(53) Indonesian Foot-Types

	(páta)	CVCV Trochee
	(patá)|	CVCV Iamb
	(pətá)	CəCV Iamb
but		
	*(patə)	*CVCə Trochee

Looked at abstractly, this observation recalls the claim of the McCarthy & Prince 1986/Hayes 1987 foot typology that Heavy-Light (HL) is an impossible foot type. This claim is usually made in reference to structural syllable-weight distinctions (long/short, closed/open), but it can be applied to other distinctions of syllable size (cf. Prince 1983: 58, Hayes 1991: Chapt. 7). If we suppose that Indonesian schwa-headed syllables are analogous to light syllables, and other syllables are analogous to heavy ones (Uhrbach 1983), then any constraint that prohibits HL feet will also prohibit CVCə feet.

The analytic burden therefore falls on the constraint that disfavors HL feet. A likely place to look is Prince's (1990) principle of Grouping Harmony:[16]

(54) Grouping Harmony

Let *G* be a Rhythmic unit, at most binary on syllables or moras.
Let X be the first element of G.
Let Y = G – X.
Let |Z| be the size of Z.

The Harmony $\mathcal{H}$ of G is defined as:

$\mathcal{H}(G) = |Y| \,/\, |X|$

[16]See Black 1991 for another application of these ideas.

That is, a rhythmic unit is more harmonic, under Grouping Harmony, to the extent that its final member is weightier than its non-final member. Applied to the standard heavy/light (H/L) moraic syllable-weight distinction,[17] this yields the following harmony scale for disyllabic groups:

(55) Harmony over Disyllabic Groups

	(LH) ≻	(LL), (HH) ≻	(HL)
ℋ(G)	2	1	½

Standing at the bottom of the scale, as the least favored group, is (HL), the group that is categorically prohibited in many languages, Indonesian among them. The relative disharmony of this group is what's responsible for the ill-formedness of words like **birə* or **batirəm*.

To make use of (55) in a grammar, we need to express it as a hierarchy of constraints. General techniques for doing this are provided by Prince & Smolensky (1993: 134f., 181). The idea is to establish a constraint prohibiting each step on the scale and reverse the scale to achieve the proper domination order of the constraints. The constraint hierarchy corresponding to Grouping Harmony is therefore as follows:

(56) Grouping Constraint Hierarchy

NO-(HL) ≫ NO-(XX) ≫ NO-(LH)

If the Grouping Harmony scale (55) is correct, then these constraints are universally ranked in this order.[18] Thus, (HL) is always the most marked grouping, since it violates the highest-ranking constraint.

A universal constraint hierarchy like (56) intersects with a language-particular hierarchy like the one we are proposing for Indonesian by interleaving the rankings in any way that does not contradict the rankings in the universal hierarchy. The highest ranking constraint of the universal hierarchy (56) is NO-(HL). It is unviolated and therefore undominated in Indonesian. In particular, it must dominate M-PARSE, as the following tableau shows:

(57) NO-(HL) ≫ M-PARSE

Candidates		NO-(HL)	M-PARSE
a.	☞ *no output*		*
b.	(birə) ba(tirəm)	* !	

In contrast, the remaining constraints of (56) are crucially dominated by M-PARSE (and PARSE-SYLL), since they prohibit groupings that are actually found in output forms of Indonesian.

[17]For two approaches to syllable weight and moraic structure within Optimality Theory, see Zec in preparation and Sherer 1994.

[18]This does *not* entail that a (LH) foot will be always be more harmonic than a (LL) one. In particular, in a trochaic system, prominential factors (Weight-to-Stress in Prince 1990) will strongly disfavor (LH).

To sum up, we have argued that root-final syllables with schwa are impossible because of two high-ranking constraints of Indonesian. One, NO-(HL), excludes all feet of the form CV(C)Cə(C), through domination of M-PARSE.[19] The other, ALIGN-ROOT-FT, demands that root and foot end together, which is obviously impossible if the root-final syllable is unfooted (whether or not it is projected metrically). Together, these two constraints ensure that all root-final syllables contain a vowel other than schwa, conforming to an exceptionless generalization of the language.

For present purposes, the particular interest of this result lies with the constraint ALIGN-ROOT-FT. Earlier (§2.2), we argued that this constraint is responsible for the "cyclic" stress pattern of suffixed words, and we also demonstrated (§3.3) that violation of this constraint under domination by ONSET leads to a different stress pattern in C|V junctural cases. That the same constraint figures in a prohibition on ə-final roots provides confirmation for it from an unexpected quarter.

Quite apart from its consequences for the grammar of Indonesian, this result also connects with several of our larger themes. For one thing, it rests on the fundamental Optimality-Theoretic assumption that phonological generalizations are expressed by output conditions. The two empirical domains where ALIGN-ROOT-FT is implicated — stress in suffixed words and the $*ə(C)]_{Root}$ regularity — are accounted for by unrelated formal means in standard approaches — cyclic rule application and a morpheme structure constraint, respectively. With output conditions, though, both sorts of observations can be encompassed under the same principle (cf. Prince & Smolensky 1993: Chapt. 9 and references cited there). For another, the result also depends on Parallelism of constraint satisfaction, since Parallelism is a necessity if we are to construct a coherent grammar in which such generalizations are possible. It is well-nigh impossible in a serial derivation to obtain a dynamic effect like stress and a static restriction like $*ə(C)]_{Root}$ from the same principle. But when constraints are called on to select among fully-formed output representations, including no output at all as one of the candidates, it is a straightforward matter, as we have seen, to capture the abstract connection between these two seemingly distinct areas of the phonology

One minor issue remains: the proper treatment of the approximately 1% of a basic vocabulary list that consists of monosyllabic roots. We have argued that these are exceptional, on grounds of very low frequency, status as recognized loans, and other criteria, but nonetheless they must somehow be accommodated within the system. The appropriate analysis is to subject these roots to their own parochial constraint hierarchy, different in certain particulars from the modal hierarchy

[19] Another logical option, a ...Cə(C)Cə(C) foot, is correctly prohibited if NON-HEAD(ə) also crucially dominates M-PARSE.

of the rest of the language.[20] (See Itô & Mester 1993 and Inkelas, Orgun, & Zoll 1994 for discussion of the treatment of exceptions within Optimality Theory.)

The monosyllables show the following behavior, without and with suffixes:

(58) Stress with Monosyllabic Roots

cát	‘print’
cát–kan	‘print (something)’
cat–kán–ña	‘print it’

The unsuffixed form is in violation of FT-BIN — a fatal condition in the modal vocabulary, where FT-BIN crucially dominates M-PARSE. The doubly-suffixed form *cat–kán-ña* violates ALIGN-ROOT-FT, as shown by the absence of secondary stress on the root (i.e., it is not parsed as **(càt|)(kánña)*). This too is a fatal condition in the modal vocabulary, where ALIGN-ROOT-FT also dominates M-PARSE.

Putting these observations together, we can conclude that the property shared by monosyllabic roots is a higher ranking of M-PARSE. Specifically, if M-PARSE ≫ FT-BIN, ALIGN-ROOT-FT in a small, lexically specified class of forms, then in just those forms will we find the pattern observed in (58): a stressed monosyllabic root, but no stress on the root under double suffixation. The following tableaux secure the formal details of the argument:

(59) M-PARSE ≫ FT-BIN (lexically limited), from /cat/

Candidates		M-PARSE	FT-BIN
a.	☞ (cát)		*
b.	*no output*	* !	

(60) M-PARSE ≫ ALIGN-ROOT-FT (lexically limited), from /cat–kan–ña/[21]

Candidates		M-PARSE	ALIGN-ROOT-FT
a.	☞ cat|(kán–ña)		*
b.	*no output*	* !	

A further candidate worthy of consideration is **(càt)–(kán–ña)*. Since initial stress would indicate a root-aligned foot, as shown, the absence of secondary stress on *cat* means that ALIGN-ROOT-FT must be violated under domination by FT-BIN:

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[20] An alternative account is to assume that the FT-BIN-violating foot is present lexically, rather than Gen-supplied. If this lexically present foot must be faithfully parsed (by virtue of appropriate constraint ranking), then words like *cát* emerge as a faithfulness effect, despite violating FT-BIN. This is essentially the analysis of Manam in McCarthy & Prince 1986, 1991 or Japanese (Itô 1990, Kiparsky 1993: 304) or Warlpiri (cf. Nash 1980: 103f.). The difference between this analysis and the one in the text is subtle, but note one significant complication: the lexical foot is *not always* faithfully parsed, as shown by *cat-kán-ña*.

[21] The output form (a) is based on the assumption that violations of ALIGN-ROOT-FT are reckoned categorically. If, however, they are determined gradiently, in terms of syllabic distance between the foot-edge and the root-edge, then the prominentially equivalent iambic parse *(cat|kán)–ña* will be optimal, since it achieves better (though not perfect) root-foot alignment at the expense of a FT-FORM violation, and, as we have already established, ALIGN-ROOT-FT dominates FT-FORM. Either way ALIGN-ROOT-FT is construed, the ranking argument just given is valid.

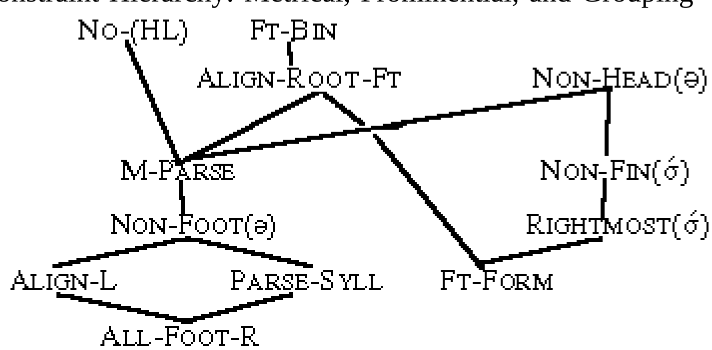
(61) FT-BIN ≫ ALIGN-ROOT-FT, from /cat–kan–ña/

Candidates	FT-BIN	ALIGN-ROOT-FT
a. ☞ cat|(kán–ña)		*
b. (càt|)(kán-ña)	* !	

This ranking needn't be lexically restricted; it's actually consistent with the grammar as a whole, but one that can only be observed with monosyllabic roots. FT-BIN and ALIGN-ROOT-FT aren't rankable on the basis of the modal vocabulary; because both dominate M-PARSE, we will never see a form from the modal vocabulary where either one is violated, so the logical prerequisite for ranking is not met. But FT-BIN ≫ ALIGN-ROOT-FT is perfectly compatible with the analysis of the modal vocabulary, and is required for the analysis of exceptional roots. Thus, the only peculiarity of the lexically restricted, exceptional root class is M-PARSE ≫ FT-BIN; the further ranking M-PARSE ≫ ALIGN-ROOT-FT follows from transitivity of domination.

It is now appropriate to summarize the results of §2. All of the constraints considered thus far are gathered in the following graph, which also encapsulates all known rankings:

(62) Summary Constraint Hierarchy: Metrical, Prominential, and Grouping



Several rankings that can be deduced from this hierarchy on the basis of transitivity of domination have also been argued for independently, by direct ranking arguments presented in previous sections. In §2.1, we showed that FT-BIN dominates both ALIGN-L and PARSE-SYLL, a ranking that is confirmed through transitivity of domination via M-PARSE. And in §2.2, we showed that ALIGN-ROOT-FT must also dominate ALIGN-L and PARSE-SYLL. This ranking is also confirmed transitively, via M-PARSE. Rankings like these, which are supported both by independent arguments and by transitivity of domination, are important for showing the internal consistency and validity of the analysis. They constitute a kind of prediction, following from the transitivity of the domination relation.

This hierarchy is essentially a complete account of the Indonesian stress system. It deals with all of the accentual properties of simple roots and the complications that ensue under suffixation. (Prefixation, a rather different matter, involving a further alignment requirement, is dealt with below (§3).) It also treats matters that have received little attention in previous work: minimality effects — avoidance of monosyllabic roots — and the peculiarities of schwa — its metrical invisibility, its forced participation in the prosody of small words, and its aversion to root-final position.

Throughout, we have related these results to our two main themes, Alignment and Parallelism. Through Alignment, the distribution of feet within PrWds and the location of feet in roots are subsumed under the same general mechanism. In either case, Alignment demands the matching of a foot-edge with the edge of some other constituent, prosodic or morphological. (We will show in §3 that the same formal system is also responsible for the location of PrWd-edges with respect to root-edges, in a more familiar case of the relation between prosodic and grammatical structure.) Under Parallelism, alternatives must be considered to the cycle, a stress/destressing derivation, and the separation of rules and morpheme structure constraints. The alternative presented here, based chiefly on Alignment, turns out to be successful in capturing the familiar generalizations and revealing new ones as well. As we turn now to additional material in §3, we will see that even more direct arguments for Parallelism can also be found.

§3. Consequences of Alignment and Parallelism

In this section, we extend the results of §2 to other word-types, and we explore several further ways in which Alignment and Parallelism contribute to the Optimality-Theoretic analysis of Indonesian prosody. The hierarchy of PrWd, foot, and syllable determines permissible constituency relations among these prosodic units, and constraints on Alignment demand that their edges align with other prosodic or morphological constituent edges. In Optimality Theory with Parallelism, there is no commitment to bottom-up (or top-down) construction (cf. Prince & Smolensky 1993: Chapt. 3) — rather, fully-formed outputs supplied by Gen are evaluated in their entirety by the constraint hierarchy. This means that alignment (or mis-alignment) at one level of the Prosodic Hierarchy may have effects that are echoed at other levels of the Hierarchy, both higher and lower. Thus, alignment of the foot may have consequences for syllable or PrWd structure, while alignment of the PrWd may lead to effects on foot and syllable structure.

Two Alignment constraints will figure particularly prominently in the discussion below. One, ALIGN-ROOT-FT, was already introduced in §2 as the basis of the account of stress in suffixed words. It asserts that every root ends in a foot, but, as we will see below in §3.3, syllabic mis-alignment leads to foot mis-alignment — a possibility predicted by the Prosodic Hierarchy when fully-formed prosodic structures are evaluated in parallel. The other constraint, ALIGN-WD, demands that every root begin together with a PrWd. This constraint is introduced in §3.1, and its syllabificational consequences — mediated through the Prosodic Hierarchy, under Parallelism — are the topic of §3.2.

§3.1 Alignment of Root and PrWd

The analysis developed in §2 provides an account of the stress patterns of monomorphemic and Root + Suffix forms in Indonesian, yet, as seen in (63), it does not fully explain the properties of words containing prefixes, nor, as seen below in (65), words with more than one root, such as reduplications and compounds.

(63) Stress in Prefixed forms (Cohn 1989:182 and additional forms)

a.	di–(cát)	‘printed’	cf. (dídik) ‘educate’
	di–(tík)	‘typed’	
b.	di-(cári)	‘searched for’	
c.	di-ko(réksi)	‘corrected’	cf. (bìjak)(sána) ‘wise’
	di-pi(dána)	‘condemned’	
d.	di-(pròvo)(kási)	‘provoked’	cf. (kònti)nu(ási) ‘continuation’
e.	di-(ànti)si(pási)	‘anticipated’	cf. (òto)(bìo)(gráfi) ‘autobiography’
f.	di-(pèrso)(nìfi)(kási)	‘personified’	cf. (àme)ri(kàni)(sási) ‘Americanization’

Only the passive prefix *di-* is of use to us here, since all other prefixes in Indonesian contain only schwa, which, as we saw above in §2.3, does not usually participate in metrical structure. In point of fact, the observed patterns are no different with the passive prefix *di-* than with the active prefix *məN-*.

Three facts need to be accounted for. First, no matter what the structure of the root, *di-* does not bear stress. The absence of stress on *di-* yields a stress pattern distinct from the monomorphemic patterns in all cases except for the prefixed disyllable (63b). Even though *di-* contains a stressable vowel, it doesn’t bear stress, in violation of ALIGN-L, as shown in (64a). Second, in trisyllabic roots like (63c) PARSE-SYLL is violated twice, as shown in (64b). Stressed as in (64bi), this word should be optimal, with no violations, yet the observed pattern, stressed as in (64bii), violates ALIGN-L and PARSE-SYLL (twice). Third, prefixed monosyllabic roots violate FT-BIN as well as ALIGN-L (63a). In these forms proper alignment is bought at the price of positing unit feet, in violation of FT-BIN, as shown in the display (64c).

(64) Application of Constraints to Prefixed Forms

a. Prefixed forms violate ALIGN-L

	ALIGN-L
[di-(pròvo)(kási)	*
*[(dì-pro)vo(kási)	

b. Prefix + Trisyllabic Root violates PARSE-SYLL twice

		PARSE-SYLL
i.	di–ko(réksi)	* *
ii.	*(dì–ko)(réksi)	

c. Prefix + Monosyllabic Root violates FT-BIN and ALIGN-L

	FT-BIN	ALIGN-L
[di–(cát)	*	*
*[(dí–cat)		

These examples reveal that the system is crucially incomplete, since the constraint hierarchy motivated thus far gives precisely the wrong result in such cases. This situation demands a new constraint (and not just a new ranking) since, whatever the ranking, no candidate can be optimal when it violates a superset of the constraints violated by a competing candidate.

Similar unexpected patterns emerge with reduplications and compounds:

(65) Stress in Reduplicated and Compound Words (Cohn 1989: 185, 188)

Reduplication

a.	(hák)-(hák)	'rights'	cf. (cát-kan) 'print (something)'
b.	(búku)-(búku)	'books'	
c.	wa(níta)-wa(níta)	'women'	cf. (òto)(bìo)(gráfi) 'autobiography'

Compounding

d.	(càp)–(pós)[22]	'postmark'	cf. (cát-kan) 'print (something)'
e.	(bòm)-(átom)	'atom bomb'	cf. a(cára) 'agenda'
f.	(tùkang)-(cát)	'printer'	cf. a(cára) 'agenda'
g.	a(nèka)-(rágam)	'varied'	cf. (kònti)nu(ási) 'continuation'
h.	po(lùsi)-u(dára)	'air pollution'	cf. (òto)(bìo)(gráfi) 'autobiography'

Here again, there are violations of ALIGN-L and PARSE-SYLL in cases with trisyllabic roots (65a, g, h) and FT-BIN with monosyllabic roots (65a, d, e, f). This is shown in the displays (66a & b) respectively:

(66) Application of Constraints to Compounds

a. Trisyllabic roots violate ALIGN-L

	PARSE-SYLL	ALIGN-L
po(lùsi)-u(dára)	* *	*
* (pòlu)(sì-u)(dára)		

[22]There is a variant of this form which has been reanalyzed as simplex, with only a single stress, *cáppos* (Cohn 1989:188-9).

b. FT-BIN Conflicts With ALIGN-ROOT-FT in monosyllabic forms

	FT-BIN	ALIGN-ROOT-FT
(hák|)(hák|)	*	
* (hák|hak|)		*

In (66a), the optimal form violates PARSE-SYLL twice as well as ALIGN-L and in (66b) undominated FT-BIN is violated in compliance with lower ranking ALIGN-ROOT-FT.

These problems all have a common basis: in the incorrect outputs, a foot crosses the left root-edge. A high-ranking constraint, one that dominates even FT-BIN, must exclude this possibility, and such a constraint is provided by Cohn's (1989) analysis of these and similar data. Following a proposal of Booij and Rubach (1984) for Polish and working within the rule-based Chen/Selkirk model of the syntax/phonology interface, Cohn proposes that Indonesian has a grammatical rule projecting the left edge of a PrWd from the left edge of a root.[23] Within the Optimality-Theoretic account developed here, this rule of grammar corresponds to another constraint of the Alignment family:

(67) ALIGN-WD
Align(Root, Left; PrWd, Left)
"The left edge of *each root* coincides with the left edge of *some PrWd*."

Unlike the Alignment constraints proposed earlier, this one is undominated — not at all surprising, since it is the direct counterpart of a rule of grammar in the standard framework, where rules must express true generalizations (true at the surface, or at least at the point in the derivation at which they apply). The essential point about Optimality Theory is that some constraints (including Alignment constraints like ALIGN-L and ALIGN-ROOT-FT) need not be absolutely true.

The configuration demanded by ALIGN-WD is one in which the left edge of the root (indicated by "|") and the left edge of PrWd (indicated by "[") must coincide:

(68) ALIGN-WD, Applied
a. Root, Root|Suffix
[|bicara], [|bicara-kan-ña]
b. Prefix|Root[24]
di[|cat], *[di|cat]
di[|koreksi], *[di|koreksi]

[23]Also see Inkelas 1989 for parallel developments.

[24]There is a further issue about the prosodic structure of prefixes. From stress (immediately above) and segmental phonology (§3.2, §3.3), we know what the prosodic structure is not: the prefix is not part of the PrWd containing the root. Instead, the structure might be [pre $[\text{root}]_{\text{PrWd}}$ $]_{\text{PrWd}}$. Alternatively, the prefix might be parsed only at the next level of prosodic structure, the Clitic Group or Phonological Phrase (depending on details of the Prosodic Hierarchy adopted). Since this level of structure is not directly relevant to the present discussion, we leave this issue aside.

c. Root|Root
[|hak]
[|hak][|hak], *[|hak|hak]

With ALIGN-WD undominated, a prefix cannot be incorporated into the PrWd with the following root, nor can two roots be joined into a single PrWd.

By the Prosodic Hierarchy, PrWd-bracketing has consequences for Ft-bracketing. Because PrWd contains Ft, no foot can be partly inside and partly outside a particular PrWd. Given ALIGN-WD's requirement that the left edge of a root reliably correspond to the left edge of a PrWd, it follows that no root can begin in mid-foot. This is precisely the defect of the ill-formed but otherwise expected outputs in (64, 66):

(69) Improper Bracketing of Ft by PrWd
a. cf. (64b)
* (dì[|ko)(réksi)] vs. di[|ko(réksi)]
b. cf. (64c, 66b)
* (dí[|cat)] vs. di[(|cát)]
* [(|hák][|hak)] vs. [(|hák)][(|hák)]

The representations on the left in (69) are not proper trees, so they are impossible by any construal of the Prosodic Hierarchy, and Gen does not admit them as licit candidates. More broadly, the Prosodic Hierarchy entails that any juncture that is properly aligned with a PrWd edge cannot be "straddled" by any smaller prosodic constituent. Thus, if a left root-edge is also a PrWd edge, as in (68), then it cannot be internal to a foot, a syllable, or a mora.

We will dub this consequence of the Prosodic Hierarchy *Hierarchical Alignment*, as we have occasion to refer to it below in our exploration of footing and syllabification in derived words. Hierarchical Alignment follows from three assumptions we have adopted: the theory of Alignment itself, which permits the formulation of constraints on the edges of prosodic constituents of various levels; the Prosodic Hierarchy, which describes the elementary constituency properties of prosody; and Parallelism in Optimality Theory, which permits evaluation of *all* aspects of well-formedness simultaneously. Under Parallelism, there is no commitment to bottom-up construction of prosodic constituents (Prince & Smolensky 1993: Chapt. 3). Therefore, constraints on PrWd can have consequences for feet and syllables, just as constraints on syllables can have consequences for feet and PrWd's. Interactions of both these types, involving prosody/morphology alignments and misalignments, will emerge in the discussion below.

We can now construct an explicit ranking argument, showing that ALIGN-WD is undominated and that it crucially dominates both NON-FIN(σ́) and FT-BIN, as shown in the following tableau:

(70) ALIGN-WD ≫ NON-FIN(σ́), FT-BIN from /di–cat/

Candidates	ALIGN-WD	NON-FIN(σ́)	FT-BIN
a. ☞ di[|(cát)]		*	*
b. [(dí|cat)]	* !		

This argument establishes that ALIGN-WD is undominated, because FT-BIN and NON-FIN(σ́) were shown to be undominated in the analysis up until this point.[25] The high rank of ALIGN-WD is confirmed by ALIGN-WD ≫ ALIGN-L, which is proven by a candidate-comparison like (64a). We therefore have two independent arguments for this ranking, one direct and one through transitivity of domination, via FT-BIN etc. down the chain of (62).

ALIGN-WD is another member of the family of alignment constraints on the prosody/morphology interface. Like ALIGN-ROOT-FT, it yields stress results that are distinct from the basic monomorphemic pattern we would otherwise expect: prefixes are always stressless, while monosyllabic feet (and final stress) may occur, seemingly unnecessarily, in prefixed, compound, and reduplicated words. At this point, it is useful to explore more systematically the consequences of Hierarchical Alignment. If ALIGN-WD is indeed undominated, then we predict absolute adherence to alignment of the left edges of roots with the left edge of PrWd's, feet, syllables, and so on. That is, if ALIGN-WD is obeyed, then no root can begin in mid-PrWd, mid-foot, or mid-syllable. In the next section we investigate Hierarchical Alignment at the left edge of the root, starting with a more general discussion of syllable structure in Indonesian, and then in §3.3, we study Hierarchical Alignment at the right edge of the root, where different results obtain, due to the lower ranking of the right-edge alignment constraints in Indonesian.

§3.2 Hierarchical Alignment and Left Edges: Consequences for Syllabification

Cohn (1989:192-4) argues that PrWd boundaries are opaque to syllabification (actually, **re**syllabification under her derivational assumptions). The evidence of this comes principally from the realization of syllable-final *k* as *ʔ* and of syllable-final *h* as Ø, as shown in (71).

(71) Diagnostics for Coda Consonants (Cohn 1989:193)

a. Coda *k* = *ʔ*

.má.sak. ‘cook’
ʔ

.á.dik. ‘younger sibling’
ʔ

[25] To be precise, NON-FIN(σ́) is dominated by NON-HEAD(ə), but the latter is relevant only to *ə*-containing words.

b. Coda *h* = Ø
.ín.dah. ‘beautiful’
Ø
.pú.tih. ‘white’
Ø

Applying these tests for coda-hood to reduplicated versions of the words in (71), we find that syllabification does not cross the boundary between the two PrWds making up the complex (two-root) form:

(72) Failure of Syllabification Across PrWd-Edge (Cohn 1989:193) (prefix *kə* suppressed)
a. [.à.di**k**.] [.a.dí.k–an.]
ʔ *k*
b. [.ìn.da**h**.] [.in.dá.h–an.]
Ø *h*

In contrast to the PrWd-final condition at the end of the first conjunct, *k* and *h* in the second conjunct are syllabified as onsets before the suffix *–an*, as shown in (72). This evidence obviously confirms the claim by Cohn (1989), developed here as the constraint ALIGN-WD, that the left edge of every root is also the left edge of a PrWd.

Why are PrWd-edges opaque to syllabification? Cohn (1989:200) stipulates that PrWd is the domain of (re)syllabification, but this is superfluous if we take ALIGN-WD and the Prosodic Hierarchy completely seriously. Because PrWd dominates σ, (re)syllabification across PrWd edges is sufficient to de-align any root, in fatal violation of undominated ALIGN-WD:

(73) De-alignment by Syllabification Across PrWd-Edge (prefix *kə* suppressed)
a. * [.|à.di.] [.**k**|a.dí.k–an.]
k *k*
b. * [.|ìn.da.] [.**h**|in.dá.h–an.]
h *h*

As (73) makes apparent, syllabification of root-final *k* or *h* (of the first conjunct) as an onset would completely de-align the left edge of the second root, contrary to ALIGN-WD. The left root-edge lies in the middle of a syllable, and therefore it lies in the middle of a PrWd, rather than at the left edge of one. The contrast between (72) and (73) shows that when ALIGN-WD and syllabification — really, ONSET[26] — are in conflict; ALIGN-WD wins:

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[26]We assume a formulation of ONSET as $*[_\sigma V$, after Itô 1986, 1989.

(74) ALIGN-WD ≫ ONSET, from /adik–adik–an/

Candidates		ALIGN-WD	ONSET
a. ☞	[| .à.dik.] [| .a.dí.kan.]		*
b.	[| .à.di.] [.k | a.di.kan.]	* !	

Thus Indonesian selects properly aligned (72) over ill-aligned (73). (In contrast, we find [|.a.dí.kan.] not *[|.a.díʔ.an.], since ONSET ≫ ALIGN-ROOT-FT, as we show in §3.3.) This seeming top-down effect of ALIGN-WD on syllabification makes perfect sense if fully-formed representations are assessed in parallel, though it would be awkward or impossible to account for in derivational terms.

At this point, let us look more systematically at the syllable configurations resulting from morpheme concatenation, to see if the above result is borne out consistently. In morphologically complex forms, there are four logically possible patterns of C's and V's — V|C, V|V, C|V, C|C. All occur in Indonesian and will be discussed below. But first a brief conspectus of Indonesian syllable structure.

The basic syllable structure in Indonesian is (C)V(C), with some restrictions on the coda consonant. Some examples are presented in (75):

(75) Canonical syllables in Indonesian

a.	bi.ca.ra	'speak'
	ca.ri	'look for'
b.	a.yam	'chicken'
	a.kan	'will'
	a.dat	'custom'
	ki.pas	'fan'
c.	ban.tu	'help'
	aŋ.kat	'lift'
	kər.tas	'paper'
d.	du.wa	'two'
	di.ya	'3per. sing.'
	su.ʔun	'vermicelli noodle'

Any consonant can appear in syllable-initial position, and most consonants can appear in coda position word-finally (75a & b). Restrictions hold on codas in non-final syllables; canonical clusters include homorganic nasal-stop clusters and *r*-stop clusters (75c). Word-initially, vowel-initial syllables are allowed, while medially, there is epenthesis of a glide or glottal stop (75d).

In (76), we summarize the shape of Indonesian formatives; these may occur as morphemes or as parts of morphemes (see Lapoliwa 1981: 45 and Ramlan 1984: 50 & 55).

(76) Shape of Indonesian morphemes[27]

a. Roots are generally of the shape (C)V(C)(C)V(C)
   ca.ri, ban.tu, kər.tas

b. Prefixes are of the shape of CV(C)-
   di-, pə-, sə-, kə-
   məN-, pəN-
   bər-, tər-, pər-

c. Suffixes are of the shape -(C)V(C)
   -i
   -an
   -ña, -mu, -ku
   -kan

d. Circumfixes consist of independently occurring prefix and suffix formatives
   kə-an, sə-ña

By combining morphemes of these various shapes, it is possible to construct all types of C and V combinations at prefix-root, root-root, and root-suffix juncture.

With this brief summary of syllable and morphological structure, consider what happens at left edges, pre|root and root|root. Based on the observed strict adherence to ALIGN-WD, we would predict complete alignment of PrWd's, feet, and syllables at left edges, and this is indeed the observed result.

As shown in (77a), when a V-final prefix or root is concatenated with a C-initial root, the edges of the morphemes are in distinct syllables. These cases are uninformative; there are no interesting misaliged candidates in these cases, since the most harmonic alignment and the most harmonic syllabification are the same. The only possible prefix-final C's are *N* and *r*, and a full range of consonants may occur as root-final. Putting these together with a following root, V-initial or C-initial, we obtain (77b) and (77c), respectively. Finally, a wide range of VV cases may arise as a result of a prefix ending in a vowel (*i* or *ə*) or a root ending in a vowel (anything but ə) combining with a following vowel-initial root (77d).

(77) Root-Initial Junctural Types

a.	V|C		
	pre|root:	di|.ca.ri.	'looked for'
	root|root:	bu.ku.|bu.ku	'books'
b.	C|C		
	pre|root:	bər.|ba.ju	'wear a shirt'
		məm.|ban.tu	'help, act.'
	root|root:	a.yam|kam.puŋ	'free range chicken'
c.	C|V		
	pre|root:	bər.|a.nak	'have children'
	root|root:	a.nak|a.nak	'children'
		ʔ ʔ	

[27] We exclude a few other affixes described by Lapoliwa and Ramlan, such as *-wan, maha-, para-*, due to their marginal status in the language. (Additionally, the latter two function as the first half of a compound).

d. V|V[28]
pre|root: di.|i.si 'filled up'
root|root: po.lu.si.|u.da.ra 'air pollution'

The strict alignment of left edges in the root|root cases is clear; as discussed above, the C|V case does not result in the root-final consonant appearing as the onset of the following syllable. This is predicted by ALIGN-WD ≫ ONSET. In the C|C root|root cases, many clusters not allowed morpheme-internally are tolerated. The only restriction that we observe in these cases is degemination of a sequence of two identical consonants: /cappos/ → *capos* 'postmark', /labil-labil/ → *labilabil* 'labels'. But degemination is systematically adhered to across-the-board in Indonesian (a constraint clearly motivated by the OCP violation of a fake geminate) and shows no sensitivity to morphological structure. Finally, in the V|V cases, hiatus is tolerated.

Basically the same result obtains for the pre|root case. Nothing more needs to be said about the V|V and V|C pre|root cases. Let us consider in greater detail the C|C and C|V cases, exemplified with the prefix *bər*.

(78) Prefix–Root C|C and C|V Juncture

a. bər|C
bər.|ta.mu 'have guests'
bər.|main 'play'
bər.|rasa 'feel'
r
bər.|rənaŋ 'swim'
r

b. bər|V
bər.|anak 'have children'
bər.|atur 'be arranged'
bər.|isi 'be filled'
cf. monomorphemic bə.ri.ta

c. syllab.
bər...a...nak where ... indicates careful-speech syllabification
bər...a...tur
vs. bə...ra...sa or bər...ra...sa

In the C|C pre|root cases, only sequences that are allowed morpheme-internally are found, since only *N* and *r* may occur as the coda of a prefix. Here, as in the root|root cases, there is degemination (and in this case the degemination is reflected in the orthography).

Of particular interest is the C|V case, where the consonant is not in the onset, in clear violation of ONSET. Evidence for this violation comes first from the possible presence of root-initial glottal stop (as described by Kridalaksana 1989 and Aminoedin et al. 1984), e.g. *tərʔakhir* 'final, last', *bərʔarah* 'have

[28] Actually in the surface form, an epenthetic glottal stop obtains (no matter what the quality of the two vowels), e.g. *diʔisi*, *polusiʔudara*. We argue below (§3.3) that these glottal stops arise in the postlexical phonology; within the lexical phonology, the level relevant to stress, hiatus is tolerated.

a purpose'.[29] Further evidence for the integrity of the left root-edge comes from speakers' patterns of syllabification, illustrated in (78c). Speakers syllabify the consonant-initial root cases as *bə...r* or *bər...r*, while they systematically syllabify the vowel-initial root cases as *bər*...V. Thus the results are completely consistent with the root|root pattern discussed above — the left edge of a root is opaque to syllabification, as required by high-ranking ALIGN-WD through the Prosodic Hierarchy.

The situation in the C|V and C|C cases is complicated somewhat by the behavior of the prefixes *məN-* and *pəN-*, which, at first glance, appear to involve a particularly intimate relationship between prefix and root, with consequent violation of ALIGN-WD. We argue that these effects are specific to the place-less nasal present in these affixes (after Uhrbach 1987), and that ALIGN-WD is in fact crucially obeyed in such cases.

The prefixes *məN-* and *pəN-* display the patterns of nasal assimilation and voiceless-stop deletion familiar to many students of introductory phonology, as exemplified in (79). (We do not offer an explicit analysis of these facts, as it would sidetrack us from the issues at hand; see Uhrbach 1987 for comprehensive discussion and Pater 1994 for an Optimality-Theoretic account.)

(79) Alternations of *məN-* and *pəN-*

		root	prefix-root	syllabification	gloss
a.	b, d, g, c, j	bantu	mə**mb**antu	məm...ban...tu	'help'
b.	m, n, ŋ	masak	mə**m**asak	mə...ma...sak	'cook'
		nomor	mə**n**omori	mə...no...mo...ri	'number'
		ŋəri	məŋərikan	mə...ŋə...ri...kan	'horrified/ing'
c.	l, r, w, y	latih	mə**l**atih	mə...la...tih	'practice'
d.	p, t, s, k	potoŋ	mə**m**otoŋ	mə...mo...toŋ	'cut'
		tulis	mə**n**ulis	nə...nu...lis	'write'
		kata	məŋatakan	mə...ŋa...ta...kan	'word/say'
e.	vowels, h	isi	məŋisi	məŋ...i...si	'fill'
		atur	məŋatur	məŋ...a...tur	'arrange'
		hargai	məŋ**h**argai	məŋ...har...ga...i	'value'

In (79a), we see the basic pattern of nasal assimilation with voiced stop- (and affricate-) initial roots. Nasal assimilation is required *only* with these prefixes, because they end in a place-less nasal; heterorganic nasal-stop clusters occur at root+suffix juncture (Uhrbach 1987: 75): *məmalam–kan* 'to stay overnight', *məŋheran–kan* 'to surprise someone'. The nasal-initial and approximant-initial cases (79b & c) result in the deletion of the place-less nasal (possibly combining assimilation and degemination). In the case of voiceless stops and fricatives, there is merger of the place-less nasal with the following consonant, yielding

[29]Root-initial glottal stop was not observed in the speech of speakers studied here, but both of these sources are very explicit about the presence of these glottal stops. Aminoedin et al. (1984) also report epenthetic glottal stops word-initially in vowel-initial words, not observed in the present study.

a nasal with the place of the original root-initial consonant (79d). Finally, with vowel- or *h*-initial roots, the place-less nasal surfaces as velar.

The examples of greatest interest involve the apparently homophonous results with *k*-, *ŋ*-, and V-initial roots; these forms seem most clearly to run afoul of ALIGN-WD. Significantly, though, while these words appear to be segmentally homophonous, there is an important difference between them. As argued by Uhrbach (1987) and confirmed by speakers in the present study, the syllabification in the V-initial and *k*-initial or *ŋ*-initial cases is different: as illustrated in the third column in (79), the consonant-initial cases are syllabified *mə...ŋ*V, while the vowel-initial cases are syllabified as *məŋ...*V, parallel to the patterns of syllabification in the *bər-* forms. This difference in syllabification is seen most clearly in reduplicated forms, where it has consequences for what is copied (see Uhrbach 1987 and Ramlan 1984):

(80) *məN*+Reduplication

a.	p, t, s, k	potoŋ	məmotoŋ	mə**m**otoŋ-**m**otoŋ	'cut'
		tulis	mənulis	mə**n**ulis-**n**ulis	'write'
		kata	məŋatakan	məŋata-ŋatakan	'word/say'
		kira	məŋira	məŋira-ŋira	'guess'
b.	m, n, ŋ	masak	mə**m**asak	məmasak-masak	'cook'
		nomor	mənomori	mənomor-nomori	'number'
		ŋəri	məŋərikan	məŋəri-ŋərikan	'horrified/ing'
c.	vowels	isi	məŋisi	məŋ**i**si-**i**si	'fill'
		atur	məŋatur	məŋ**a**tur-**a**tur	'arrange'

Thus the facts of syllabification in pre|root and root|root are completely consistent with the stress facts presented above in (63). ALIGN-WD is obeyed in /məN+isi/ → *məŋ.i.si* — that is, there is strict alignment of left edges of root and PrWd, which by Hierarchical Alignment entails the strict alignment of foot and syllable too, despite the violation of ONSET.[30]

The Optimality Theoretic analysis not only accounts for both the stress facts and syllabic consequences of the left edge boundary effects observed here, but it does so in a unified way, since both the "cyclicity" effects and "boundary" effects result from adherence to constraints in the Alignment family, within a framework that assesses complete output representations in parallel. This is in contrast to a standard account such as Cohn 1989, which appeals to rule ordering and the cycle in the former case and prosodic domains in the latter.

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[30]The copying of *ŋ* seen in /kira/ → *məŋira-ŋira* shows that *ŋ* is the original root-initial /k/ with nasality added, by a kind of merger or coalescence, so ALIGN-WD is in fact obeyed. On "over" and "under-application", as seen in the reduplicated forms, see §4 below.

§3.3 Hierarchical Alignment and Right Edges: The Consequences of Low Rank

As seen above in (72), the effect of syllabification on alignment at the right edge is quite different from the left edge. Let us review the possible C/V combinations at the right root-edge, indicated here by "|":

(81) Root–Suffix Junctural Types

	root|suffix		
a.	V|C	məm–bicara|kan	'discuss, act.'
		acara|ña	'agenda, def.'
b.	C|C	ayam|ku	'my chicken'
		mə–makan|kan	'feed someone'
		ayam|mu *m*	'your chicken'
c.	V|V	bantu|wan	'help, nom.'
		jadi|yan	'case'
d.	C|V	masak|an *k*	'food'
		indah|an *h*	'beauty'

As seen above for pre|root and root|root cases, the V|C root|suffix case (81a) is uninformative, since morpheme and syllable boundaries match up in the ONSET-satisfying candidate. Likewise, in the C|C case (81b), not much more needs to be said; clusters which do not occur morpheme-internally are possible, including non-homorganic nasal-stop sequences. As in all other C|C cases, there is degemination of identical consonant sequences. It is the V|V and C|V cases which are of particular interest. In the V|V cases, (81c), an epenthetic glide or glottal stop surfaces. This is different from the pre|root and root|root cases, where hiatus is tolerated lexically (and postlexically a glottal stop surfaces). We return to this matter below.

Finally, in the C|V case (81d), the final consonant of the root syllabifies as the onset of the next syllable, as seen by the diagnostics of *k* → *ʔ* and *h*-deletion (which would tell us if it were a coda). Therefore, the right root-edge | must fall in the middle of a syllable in the optimal forms, and the right edge of the syllable does not align with the right edge of the root:

(82) Root-Final Consonants Surface as Onsets Before –V

a.	ma.sa.k|an	*ma.saʔ.|an
b.	inda.h|an	*indaØ.|an

These data argue that ONSET ≫ ALIGN-ROOT-FT; under Hierarchical Alignment, this ranking predicts dramatic consequences for foot structure. Since Ft contains σ in the Prosodic Hierarchy, the right root-edge cannot be properly aligned with the right foot-edge. Thus, ONSET is obeyed at the expense of ALIGN-ROOT-FT. The following tableau certifies the validity of the ranking argument:

(83) ONSET ≫ ALIGN-ROOT-FT, from /masak–an/

Candidates	ONSET	ALIGN-ROOT-FT
a. ☞ [.ma(.sá.k|an.)]		*
b. [(.ma.sák|.) an]	* !	

This in turn has potential consequences for stress placement. In (83a), violation of ALIGN-ROOT-FT has no observable effect on prominence, since it only affects the (non-observable) foot-parse of the output and not the actual placement of stress. Nonetheless, this is a predicted result of the theory of Alignment, as applied in the analysis presented here.

Under appropriate conditions, this prediction does have observable actual effects on prominence. ONSET-induced violations of ALIGN-ROOT-FT are predicted to affect stress placement in cases of C|V juncture when a polysyllabic, odd-parity root is combined with a single suffix (cf. (24a)). In such cases, the violation of ALIGN-ROOT-FT should result in no “cyclic” effect on stress, as shown schematically in the following tableau:

(84) Conflict between ONSET & ALIGN-ROOT-FT

Candidates	ONSET	ALIGN-ROOT-FT
a. (CV̀.CV)(CV́.C|V)		*
b. CV(CVCV́C.|)V	*	

The expected “cyclic” result, where the root edge and foot edge line up, is not optimal because of the violation of ONSET (84b); rather, ALIGN-ROOT-FT is violated, and in that case the best foot parse is one that best satisfies the PARSE-SYLL, yielding the “non-cyclic” pattern of (84a).

This prediction is correct. Examples meeting these criteria are not reported in Cohn 1989, 1993 but are presented here:

(85) C|V Juncture With Odd-Parity Roots

Root	C|V	
alámat	məŋ**à**lamát|i	cf. (24a) b**i**cará|kan
‘address’	‘put address on’	
nasíhat	mən**à**sihát|i	
‘advice’	‘advise someone’	
wiláyah	pəw**ì**layáh|an	
‘region’	‘division into territories’	

From (85), we observe that odd-parity roots followed by a vowel-initial suffix *do* have a root-initial secondary stress (marked in bold).[31] This difference is predicted by Hierarchical Alignment, as justified in (81d) and (83). That is, they have the stress pattern of monomorphemic quadrisyllables like *bìjaksána* (6), rather than suffixed trisyllables like *bicará–kan* (24a), showing that ALIGN-ROOT-FT is violated in the optimal form. The following tableau makes the comparison explicit:

(86) ONSET ≫ ALIGN-ROOT-FT, from /wilayah–an/ (prefix suppressed)

Candidates	ONSET	ALIGN-ROOT-FT
a. ☞ (.wì.la)(.yá.h|an.)		*
b. .wi(.la.yáh|).an.	* !	

The two candidates differ not only in foot-parsing, like (83), but also prominentially, in the presence versus absence of an initial secondary stress. The "missing" secondary stress of (86b) is characteristic of morphologically complex forms, as (24a) and the analysis above show. That the secondary stress is actually present shows that these forms with C|V juncture do not conform to the usual expectation. But this follows from Hierarchical Alignment, specifically from the ranking ONSET ≫ ALIGN-ROOT-FT, which makes right-hand alignment of the root impossible at C|V juncture.

To show that this stress pattern is indeed due to the de-aligning syllabification of the root-final consonant as onset, we compare the data in (85) with the same roots followed by consonant-initial suffixes, as shown in (87):

(87) Odd-Parity Roots, C|V vs. C|C

Root	C|V	C|C
alámat	məŋ**à**lamát|i	məŋ**a**lamát|kan
'address'	'put address on'	'put address on for'
nasíhat	mən**à**sihát|i	mən**a**sihát|kan
'advice'	'advise someone'	'give as advice'
wiláyah	pəw**ì**layáh|an	w**i**layáh|ña
'region'	'division into territories'	'region, def.'

In the case of a consonant-initial suffix, the "cyclic pattern", that seen above in (24a) is observed, since in these cases the right edge of the root and the edge of a syllable are properly aligned.

This result provides unexpected confirmation for the approach taken here. Because of Hierarchical Alignment, ONSET and ALIGN-ROOT-FT will inevitably conflict over C|V juncture. The segmental

[31] These observations are not as robust as those reported elsewhere in this article and in Cohn 1989, 1993. There are also cases where no "extra" secondary stress is observed; for example, *pərdaeráh/an* 'pertaining to a certain region', cf. *daérah* 'area' was observed and both *kəùniversitás/an* and *kəùnivèrsitás/an* 'matters pert. to the university' (cf. *ùniversítas* 'university') were observed for one speaker.

phonology (81c) shows that this conflict is resolved in favor of ONSET, so ONSET ≫ ALIGN-ROOT-FT. But this ranking has entirely independent consequences for the stress patterning of the language, and the evidence in (85) confirms that these consequences are correct.

This result shows that an apparently fine detail of alignment at the syllable level can have significant consequences for the global stress patterning of the whole word. An analogous case is found in Axininca Campa (McCarthy & Prince 1993a: Chapt. 4.3), which must contend with the effects of C|V juncture on the enforcement of a word-minimality requirement. This type of behavior, which now has significant cross-linguistic justification, strongly supports the theory of Alignment and Paralellism. The independent, global consequences of misalignment in such cases are brought about through evaluation in parallel, since all aspects of the system — alignment, stress, and syllabification — must be considered simultaneously. Such results are impossible and inexplicable within a derivational approach, especially one (like those considered in §2.4) that relies on cyclic rule application.

We now return to the V|V case. According to Cohn (1989:192-3), hiatus in PrWd-medial position is resolved by an epenthetic glide or glottal stop, depending on the quality of the adjoining vowels (see also Lapoliwa 1981, Ramlan 1984):

(88) Resolution of PrWd-Medial Hiatus (Cohn 1989:192, 203)

a. Between unlike vowels: glide homorganic with preceding vowel

/diam/	*diyam*	'quiet'
/hari–an/	*hariyan*	'daily'
/uji–an/	*ujiyan*	'exam'
/beo/	*beyo*	'myna bird'
/tua/	*tuwa*	'old'
/bantu-an/	*bantuwan*	'help'
/soal/	*sowal*	'problem'

b. Between identical vowels: ʔ

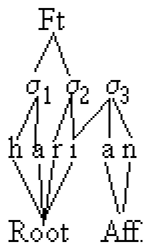
/baca-an/	*bacaʔan*	'reading'
/məmandi-i/	*məmandiʔi*	'give a bath repeatedly'

A glide agreeing in backness with the first vowel surfaces after a [–low] vowel (85a), except when the two vowels are identical, in which case a glottal stop surfaces (85b).[32]

We will not contend with the details here (see McCarthy & Prince 1993b and especially Rosenthall 1994), but it seems clear that an epenthetic glide emerges in hiatus when the first vowel can spread to fill the onset of the second syllable:

[32]In the pattern after a [+low]V, something of a glide (smooth transition rather than hiatus) occurs, though the quality is less clear than in the [–low] cases. Some sources describe an optional glottal stop for the /ai/ case. We focus here on the more clearcut (V_1 = [–low]) and more common (V_1 = [+high]) cases.

(89) The Epenthetic Glide in Root|Suffix



When the first vowel cannot spread (perhaps because of the OCP) FILL-violating *ʔ* is found instead. In either case, ONSET is obeyed.

Does the configuration (89) have consequences for Alignment? The general form of this question has been raised recently by Itô & Mester (1994). According to McCarthy & Prince (1993b), the configuration (89) *violates* ALIGN-R — they argue that, in effect, σ_2 has no right edge, so root and syllable are not aligned, and therefore root and foot are not aligned. This failure of alignment would be expected to have consequences for stress, leading to the same result observed with consonant-final roots in (85). Yet the following examples show that this is incorrect:

(90) ALIGN-ROOT-FT Not Violated in V|V Root-Suffix Juncture

suámi	'husband'	pər*su*amíyan	'matters pert. to husbands'
àsosiási	'association'	pənàso*si*asíyan	'act of associating'
dòkumentási	'documentation'	pəndòku*men*tasíyan	'system of documentation'

The italicized syllables lack secondary stress, showing that the presence of the epenthetic glide does not dealign the foot structure. Therefore, the C-final cases (85) are crucially different from the V-final cases (90), and the configuration (89) exhibits proper alignment of root with syllable (and hence with foot).

In Itô & Mester's terms, (89) is a case of "non-crisp" alignment, and it offers evidence regarding their conclusion that "non-crispness" does not affect obedience to constraints like ALIGN-WD. (It is a separate matter whether there are constraints, independent of Alignment proper, against non-crispness.) To account for this formally, they propose that the definition of Alignment be changed to refer to the segmental content of the aligned categories (a notion essentially the same as the "substantive fringe" of Pierrehumbert & Beckman 1988). Because the rightmost element of the segmental content of Root is the same as the rightmost element of the segmental content of σ_2 in (89), these two categories are properly (though non-crisply) aligned.

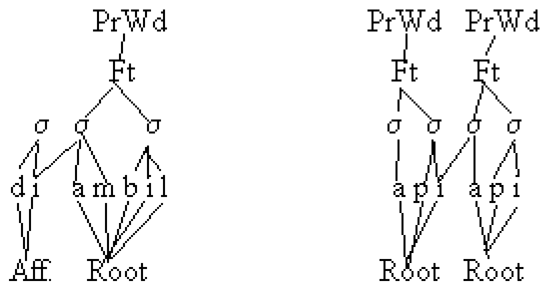
As we noted earlier (fn. 28), spreading of a vowel into a following onset is not an option in the case of a V|V prefix|root or root|root juncture; instead, only glottal stop is observed:

(91) PrWd-Initial Hiatus (Cohn 1989:192)

di[|ámbil]	*diʔambil*	**diyambil*	'taken'
di[|ajári]	*diʔajari*	**diyajari*	'taught'
[|ápi] [|ápi]	*apiʔapi*	**apiyapi*	'fires'

Significantly, this result is distinct from the root-internal and root|suffix cases (88), where *i+a* is realized as *iya*. As Cohn (1989) argues, these various realizations of the epenthetic consonant support the difference between prefixal, compound, or reduplicative juncture on the one hand, and internal suffixal juncture on the other. If a prefix-final or root-final vowel were to spread, ALIGN-WD would be violated, as the following non-optimal structures show:

(92) Impossibility of Epenthetic Glide in Prefix|Root or Root|Root



In these structures, ALIGN-WD is fatally violated (under the Itô-Mester 1994 definition), because the leftmost element in the segmental content of Root (root-initial *a* in both cases) is not the same as the leftmost element in the segmental content of PrWd (final *i* in both cases). Thus, onset-filling spreading of a preceding vowel is prohibited root-initially by the undominated status of ALIGN-WD.

Yet ONSET is ultimately satisfied, since epenthetic ʔ does appear in (91). The explanation for this lies with the level-structure of Indonesian phonology. Within the lexicon, there is no good phonological evidence for distinct levels, and what morphological evidence there is (coming from ordering relations among various formatives) is better treated with subcategorizational constraints (cf. Uhrbach 1987). But the distinction between lexical and post-lexical phonology plays a role, with *k* → ʔ, *h*-deletion and degemination all holding post-lexically. The processes of *k* → ʔ and *h*-deletion are sensitive to prosodic but not morphological structure and degemination applies across the board. We propose that ALIGN-WD is undominated lexically, while the de-aligning PrWd-initial glottal stops of *diʔambil*, *apiʔapi*, etc. arise post-lexically. This distinction is obviously supported by the fact that different epenthetic segments are seen PrWd-initially and PrWd-medially, since a difference in choice of epenthetic segment is diagnostic of levels.

This result, motivated by evidence from the segmental phonology, converges with the behavior of stress. As seen above, ALIGN-WD is undominated within the lexical phonology (the level at which stress is assigned in Indonesian). This accounts for the observed stress effects, notably the absence of stress on a prefix, since by Hierarchical Alignment the left edge of the foot must align with the left edge of a PrWd. There is a further entailment predicted by Hierarchical Alignment: there can be no epenthesis in PrWd-initial position at this level in the grammar, since the syllable edge must also align with the PrWd edge.

Epenthesis, in compliance with ONSET (and in violation of FILL), would dealign the syllable edge; this in turn would also affect the observed stress pattern, as illustrated in the tableau in (93).

(93) De-Alignment by Epenthetic Parse

Candidates		ALIGN-WD	ONSET	FILL
a.	.di[.a.(já.ri.)]		*	
b.	* [.dì.ʔ|a.)(.já.ri.)]	* !		*

Violation of ALIGN-WD would be expected to lead to other consequences, including the incorporation of the prefix *di*– into a binary foot-parse yielding the incorrectly stressed pattern seen in (93b). The candidate comparison in (93) shows that a single constraint system can never yield the actual output form *di[ʔa(jári)]*. The conflict is irredeemable, and either ALIGN-WD or ONSET must yield; (93) shows that ONSET loses. The fact that ʔ-epenthesis still occurs, but without any effect on stress through de-alignment, shows that stress and PrWd-initial epenthesis cannot be derived in parallel. Because root-initial epenthesis irrevocably de-aligns the root, assignment of stress must occur before initial epenthesis, if ALIGN-WD is to have any visible effect on vowel-initial roots. This aspect of the system must be conceived of serially; it cannot be analyzed by totally parallel satisfaction of constraints and evaluation of candidates. In contrast, stress and PrWd-**medial** epenthesis can be derived in parallel, because there is no problematic conflict between ONSET and ALIGN-ROOT-FT or any other stress-constraint in situations of hiatus.

This conclusion concurs with the observations about the interaction of medial and initial epenthesis with stress. Lexically, medial epenthesis (glide insertion) and stress are derived in parallel, but initial epenthesis is not. The output of this level includes ONSET-compliant forms like *haríyan*, but also non-epenthetic forms like *di.a(jári)* (93a), where epenthesis is impossible because ALIGN-WD ≫ ONSET. These outputs of the lexical phonology are then submitted to the postlexical phonology, which crucially differs in its ranking of ALIGN-WD/ONSET and therefore in its treatment of *di.a(jári)*. Postlexically, root-initial epenthesis is possible, showing that ONSET ≫ ALIGN-WD. The output of the postlexical phonology, then, is *diʔajári*.

The difference in ranking between the lexical and post-lexical levels posited for Indonesian — really, demotion of ALIGN-WD post-lexically — is in accordance with McCarthy & Prince's 1993a: Appendix observations about a potential similarity between the Optimality-Theoretic analysis and one of the fundamental observations underlying the theory of Lexical Phonology (e.g., Kiparsky 1982, Mohanan 1982, Borowsky 1986). Among the syndrome of properties said to characterize rules of the lexical phonology is **cyclicity** and morphological dependence; in contrast, rules of the postlexical phonology are non-cyclic, and independent of morphological structure. In the present framework, Alignment constraints do the work of the cycle and they encode the morphological dependence in the phonology. Therefore, demotion of an alignment constraint like ALIGN-WD between the lexical and the post-lexical phonology echoes the claim, intrinsic to Lexical Phonology, that the postlexical phonology is non-cyclic and independent of the morphology. Obviously, the analogy is inexact,[33] but the point is clear that there is significant precedent for this difference between the grammars of the lexical and postlexical levels.

We now summarize the results of §3, focusing on the main themes of Alignment and Parallelism. The evidence presented in §3.1 shows that the left root-edge in prefixed, reduplicated, and compound forms is opaque to metrical footing — prefixes are always unstressed, and conjoint words are separate stress domains. The evidence laid out in §3.2 shows that the left root-edge is also a barrier to syllabification — spreading of a final vowel or assignment of a final consonant to a root-initial syllable are impossible. These two observations follow from a single stipulation: the undominated status of ALIGN-WD. This constraint, standing at the top of the ranking, demands that each root begin with a new PrWd. Through the Prosodic Hierarchy, alignment with PrWd means that this juncture cannot be straddled by a foot or a syllable either, yielding the observed opacity conditions. Under Parallelism, this sort of top-down effect, where alignment with one constituent of the Prosodic Hierarchy has consequences for constituents subordinate to it, is entirely normal and expected.

The situation with *right* root-edges is more complex and therefore more interesting. The relevant constraint in this context is ALIGN-ROOT-FT, introduced in §2, which requires that every root end together with a foot. The evidence for this constraint, also presented in §2, is the pattern of missing or displaced secondary stresses seen in suffixed words. Because of the Prosodic Hierarchy, ALIGN-ROOT-FT also interacts with syllabification — if ALIGN-ROOT-FT is obeyed, then no syllable can straddle a right root-edge. Yet it is clear from the evidence of §3.3 that syllables do in fact straddle right root-edges in C|V junctural cases, when high-ranking ONSET is relevant. In just such cases, root/foot alignment must fail, with a cascade of consequences for stress in the rest of the word. This analysis rests, of course, on Parallelism, since Parallelism ensures that syllabificational requirements can affect foot structure in this way (an impossibility in a bottom-up sequential derivation).

Both ALIGN-WD and ALIGN-ROOT-FT are important constraints in the grammar of Indonesian, and both pertain to alignment of root-edges with prosodic constituents. Is there more to be said about the relation between them? This issue is raised by McCarthy & Prince (1993b), who suggest that there may

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[33] It should not be at all troubling that the analogy *is* inexact. Lexical Phonology has no claim to a kind of epistemological priority, according to which all subsequent theories must seek to reconstruct its principles exactly. Rather, the goal here is to show that a possible germ of truth discovered in Lexical Phonology has a natural interpretation in the terms of a very different framework.

be a perfect symmetry, except for ranking, between left-edge and right-edge alignment. The idea is that both constraints will be formulated to refer to PrWd as the aligned-with prosodic constituent:

(94) Root/PrWd Alignment

a. ALIGN-WD-L (replaces ALIGN-WD)
Align(Root, L, PrWd, L)
"Every Root starts together with a PrWd."

b. ALIGN-WD-R (replaces ALIGN-ROOT-FT)
Align(Root, R, PrWd, R)
"Every Root ends together with a PrWd."

ALIGN-WD-L is no different from before. It is ALIGN-WD-R that has changed, by demanding right-edge alignment with PrWd rather than foot.

The two constraints are formally symmetric, but as they are actually applied in the grammar of Indonesian, they lead to different results. This difference can be captured through ranking. This ranking disrupts the symmetry, since ALIGN-WD-L dominates ONSET, while ONSET itself dominates ALIGN-ROOT-FT.[34] Through transitivity of domination, we have ALIGN-WD-L ≫ ALIGN-WD-R. This is a common situation cross-linguistically, in which left-edge alignment is more robust than right-edge alignment (McCarthy & Prince 1993b). In fact, direct conflict between the two alignment constraints is sometimes possible, as when there is a choice between initial and final augmentation of a sub-minimal word (e.g., Choctaw vs. Lardil). It seems quite plausible that the favored left-edge alignment has an explanation in the processing domain, perhaps because the coincidence of a root edge and a conspicuous PrWd edge favors lexical retrieval. Similar considerations would also favor right-edge alignment but not nearly as strongly, because linguistic processing is fated to proceed in the left-to-right direction only.

§4. Parallelism in Reduplicative Stress

In this section we return to the question of stress in compounds and reduplications. As seen above in (65), two important issues present themselves. As argued in §3.1, the first issue — the stress of unit feet, generally disallowed in Indonesian — results through strict compliance with ALIGN-WD. But additionally,

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[34]Thus, ALIGN-WD-R is violated in C|V junctural cases. In the other junctural conditions, adopting ALIGN-WD-R introduces some structural complications:

(i) [[bi(cará|)]$_X$ kan]$_Y$
[[bi(càra|)]$_X$ (kán–ña)]$_Y$

We have here what looks like a recursive structure, in which the root is a PrWd and the entire form, root plus suffixes, is another, superordinate PrWd. The difficulty is that these two constituents cannot in fact both be PrWd. The lower one, X, must permit final stress, while the upper one, Y, must ban it (by NON-FIN(σ́)). Perhaps the domain of non-finality is actually phrasal. Apart from this matter, structures like these are completely consistent with all of the data considered, segmental and prosodic.

there is a systematic contrast whereby compounds show a subordinated stress pattern, while (unaffixed) reduplications show equal stress. It is this issue to which we now turn.

Compounds contain two roots. Since ALIGN-WD is undominated, they must also contain two PrWds, and indeed they act as two separate stress domains, as shown in (65d-h) and the following:

(95) Stress in Compound Forms (cf. Cohn 1989:188)

a. [(|tùkaŋ)] [(|cát)]	'printer'
b. [|a(nèka)] [(|rágam)][35]	'varied'
kə[|a(nèka)] [(|ragám)–an]	'variety'
kə[|a(nèka)] [(|ràgam)–(án–ña)]	'the variety'
c. [|po(lùsi)] [|u(dára)]	'air pollution'
d. [(|bòm)] [(|átom)]	'atom bomb'
pəm[(|bòm)] [(|atóm)–an]	'bombing'
pəm[(|bòm)] [(|àtom)–(án–ña)]	'the bombing'

Each left root-edge coincides with a left PrWd-edge, as required by ALIGN-WD. This accounts for the possibility of stress clash in compounds, seen in (95d), for example. In accordance with PARSE-SYLL, all non-prefixal syllables, including suffixal syllables, are parsed by one of the PrWds that is aligned with a root-edge.

These examples reveal a further detail of prominence in Indonesian: main stress in a compound falls on the right conjunct. This is also the basic phrasal stress pattern of Indonesian, so we adopt the following constraint, dubbed NUC-STR (after Chomsky and Halle 1968):

(96) NUC-STR

In $PrWd_1$ $PrWd_2$, $PrWd_2$ is more prominent.

This constraint evidently holds regardless of the syntactic relation between the two words, since it applies equally to phrases and compounds of various types. It can be fully formalized within any version of metrical theory, grid, tree, or mixed — the details are not important in the current context. It simply asserts what we have observed about (95), and it conflicts with no other constraint discussed thus far, since it characterizes the relation between two PrWds, whereas other constraints operate at the level of the syllable or foot.

Indonesian exhibits a number of patterns of reduplication. Of interest here are those which are most productive: *Root-Reduplication*, the copying of a root, often in conjunction with affixation; and *Doubling*, the complete copying of a whole word. In both of these cases, reduplication copies at least the root, so reduplicated words are always two-rooted (v. McCarthy & Prince 1993a: Chapt. 5.4). The left edge of each root must coincide with the left edge of a PrWd, under ALIGN-WD. This means that the left root-edge is also an absolute barrier to foot-parsing and syllabification, for reasons discussed previously.

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[35] Cohn (1989:187-8) reports that two consultants sporadically produced *anéka rágam*, with equal stress on both conjuncts.

The effects of ALIGN-WD on stress in reduplicated compounds are shown in in (65a-c, 68c) and the following examples:

(97) Stress In Reduplicated Forms (cf. Cohn 1989:185)

a.	[(|búku)] [(|búku)]	‘books’
	[(|bùku)] [(|bukú)–ña]	‘the books’
b.	[|wa(níta)] [|wa(níta)]	‘women’
	kə[|wa(nìta)][|wa(nitá)–an)]	‘womanly’ adj.
c.	[(|màsa)(rákat)] [(|màsa)(rákat)]	‘societies’
	[(|màsa)(ràkat)] [(|màsa)(rakát)–ña]	‘the societies’
d.	[(|minúm)–an] [(|minúm)–an]	‘drinks’ n.
	[(|minùm)–an] [(|mìnum)–(án–ña)][36]	‘the drinks’
e.	di[(|pàs)] [(|pás–kan)]	‘tried on, repeatedly’

Each left root-edge is a left PrWd-edge, an impermeable barrier to foot-parsing even when a better foot-parse could be achieved. The reduplicated forms, then, have exactly the character of compounds with respect to the foot-level analysis.

However, reduplications differ from compounds in one important respect. Compare the first and second example of each pair in (97a-d). Cohn (1989:184-5) emphasizes that the stresses on each conjunct are equal in unsuffixed reduplications (first example in 97a-c) or when the suffix is reduplicated too (first example in 97d). But the stress of the first conjunct is subordinated to the second conjunct, following the usual compound pattern (*v. supra*), when a non-reduplicated suffix is present (second example in 97a-d).

This is a complex-seeming dependency among suffixation, reduplication, and stress subordination. But Optimality Theory, with its commitment to evaluating fully-formed candidate output forms in parallel (rather than a succession of derivational steps), offers a solution to this problem. From the parallelist perspective, the fundamental observation about (97) concerns the stress-pattern of the output alone:

(98) Stress Subordination/Reduplication Relation, Descriptively

In reduplicated forms, there is no stress subordination between conjuncts if the original and the copy otherwise have the same stress pattern. If they otherwise have different stress patterns, normal compound stress subordination is observed.

To put it differently, if the stress of base and copy are identical in all other ways, they will also be equally prominent. Failing that, NUC-STR is obeyed, as usual in compounds. In the familiar terms of operational theories, (98) characterizes a species of reduplicative “underapplication” — operationally, a phonological rule fails to apply when it would disrupt the identity between the original and the copy. (We retain the traditional terminology, though obviously there is no question of rule “application” in the Optimality Theory framework.)

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[36]The secondary stress in the right conjunct is not reported in Cohn 1989:185; this form is recorded without a secondary stress in her notes, but does appear to be present on re-checking. Its existence is predicted by the Cohn 1989, 1993 analysis and by the one presented here.

Underapplication is type of interaction between phonology and reduplication; the other is overapplication, in which (operationally) a rule applies to both original and copy, though its structural description is met in only one.[37] Addressing a case of overapplication in Axininca Campa phonology, McCarthy & Prince (1993a: Chapt. 5.2) propose that this phenomenon follows from Parallelism of constraint satisfaction within Optimality Theory. Constraints demanding identity between base and reduplicative copy — the "copying constraints" — operate in parallel with constraints on phonological structure. (Also see McCarthy & Prince 1994b for further developments along these lines.) This means that the constraints on reduplicative identity evaluate completely formed output candidates, just as the phonological constraints do. So-called over- and under-application simply show the force of these identity constraints in evaluating output forms. In particular, in under-application, a phonological constraint and an identity constraint stand in conflict; the higher-ranking identity constraint compels violation of the lower-ranking phonological constraint.

McCarthy & Prince (1993a, 1994ab) present a full theory of the reduplicative identity constraints, but for present purposes just one will do. That constraint is MAX, and it requires complete identity between the base (B) and the copy, called the reduplicant (R):

(99) MAX
R = B

When MAX is violated, as of course it must be whenever it is crucially dominated, then the perfection of reduplicant/base identity will be violated **minimally**, as always in Optimality Theory. For example, in Ilokano heavy syllable reduplication, MAX is dominated by the templatic constraint PREFIX=$\sigma_{\mu\mu}$, which compels less than total copying. But violation of MAX is minimal, so *trabaho* 'work' reduplicates as *trab–trabaho* and not **tra:–trabaho,* since the reduplicant *trab* more similar to the base *trabaho* than **tra:* is.[38]

Returning to Indonesian, let us recall the fundamental observation above in (98): when the stress is otherwise identical, there is no subordination. What we have is a conflict between an identity constraint, MAX, and a phonological constraint, NUC-STR. The conflict is resolved in favor of identity:

[37]On over- and under-application, see among others Wilbur 1974, Marantz 1982, Carrier 1979, Carrier-Duncan 1984, Odden and Odden 1985, Kiparsky 1986, Mester 1986, and Uhrbach 1987.

[38]In contrast, *roʔot* reduplicates as *ro:–roʔot*, though **roʔ–roʔot* would better obey MAX. In this case, greater MAX-violation is compelled by a constraint, undominated in Ilokano, that prohibits coda glottal stop. See Hayes & Abad 1989, McCarthy & Prince 1993a.

(100) MAX ≫ NUC-STR, from /buku–buku/

Candidates	MAX	NUC-STR
a. ☞ [(búku)] [(búku)]		*
b. [(bùku)] [(búku)]	* !	

Non-optimal (100b) forsakes perfect identity between base and reduplicant for proper compound stress subordination. But perfect identity is possible (100a) at the price of giving up only the subordination of stress. The evidence shows that perfect identity is preferred to proper subordination, so MAX ≫ NUC-STR. Moreover, the evidence shows that MAX must be capable of comparing details of metrical and prominential structure, as well as more obvious quantitative and segmental properties.[39] (From its very different perspective, this proposal recalls one of the properties of Cohn's analysis: metrical structure is copied together with segmentism in Indonesian reduplication (cf. Steriade 1988).)

Now we turn to a case like *bùku–bukú–ña*, which respects the second clause of (98): if the base and reduplicant have different stress patterns, then they have normal stress subordination. The key observation here is that, if the base and reduplicant have different stress patterns, MAX is violated in any case, and it is violated equally whether stress is subordinated or not. Compare the candidates in the following tableau:

(101) MAX Violated in /buku–buku–ña/

Candidates	MAX	NUC-STR
a. [(búku)] [(bukú)–ña]	*	* !
b. ☞ [(bùku)] [(bukú)–ña]	*	

For ease of reference, let's call the first conjunct the base and the second the reduplicant. In (101a), the base *búku* and the reduplicant *bukú* differ prominentially — one is trochaic, the other iambic. In (101b), the base *bùku* and the reduplicant *bukú* also differ prominentially, in precisely the same way. Clearly, the base-reduplicant pair *búku–bukú* (101a) does not achieve greater identity than *bùku–bukú* (101b). Thus, the two candidates tie on MAX, and the choice falls to the next constraint in the hierarchy, NUC-STR. We have therefore accounted for the final aspect of (98): normal compound stress subordination is observed as a default, when complete reduplicative identity cannot be achieved.

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[39]It is an open matter what aspects of the reduplicant and base are compared in determining identity and measuring minimal violation — as McCarthy & Prince (1993a: Chapt. 5) note, this is inextricably linked to the vexed question of transfer of quantity and other properties in reduplication (Levin 1983, Clements 1985, Hammond 1988, McCarthy & Prince 1988, Steriade 1988, Dell & Elmedlaoui 1992). Nonetheless, the stress properties of Indonesian reduplications clearly show that metrical structure can figure into the determination of identity under MAX.

This analysis of course presupposes that MAX is violated in suffixed reduplications like *bùku–bukú–ña*. Violation of MAX is compelled by constraints on the morphological composition of the reduplicant that are not relevant here. But MAX is also crucially dominated by many of the constraints of the stress system other than NUC-STR. Abstractly, this is apparent from the fact that the two conjuncts of suffixed reduplicants like *bùku–bukú–ña* are always parsed metrically like two unconnected words, with no deference to maintaining identity between them. Concretely, one obvious conflict is with the prominential constraints NON-FIN(σ́) and RIGHTMOST(σ́):

(102) NON-FIN(σ́), RIGHTMOST(σ́) ≫ MAX, from /buku–buku–ña/

Candidates		NON-FIN(σ́) RIGHTMOST(σ́)	MAX
a. ☞	[(bùku)] [(bukú)–ña]		*
b.	[(búku)] [(búku)–ña]	* !	
c.	[(bukú)] [(bukú)–ña]	* !	

Failed candidates (102b & c) achieve complete identity between base and reduplicant only by violating NON-FIN(σ́) or RIGHTMOST(σ́) in one conjunct or the other. This is not possible, as the NON-FIN(σ́), RIGHTMOST(σ́) ≫ MAX ranking ensures.

Another conflict, slightly more tricky to see, arises between MAX and FT-FORM. A form such as [*bantù-an*][*bàntu-án-ña*] 'help, n. pl. def.' (cf. *bántu* 'help', *bantúan* 'help, n.'), with suffixation both inside and outside reduplication, supplies a direct comparison of these constraints:

(103) FT-FORM ≫ MAX, from /bantu–an–bantu–an–ña/

Candidates		FT-FORM	MAX
a. ☞	[(bantù|)an] [(bàntu|)(án–ña)		*
b.	[(bantù|)an] [*(bantù)*(án–ña)	* !	

The italicized foot in (101b) is an iamb, a violation of FT-FORM but an exact match to the corresponding foot in the other conjunct. Parsing with an iamb here achieves greater similarity between base and reduplicant, as required by MAX. Yet this candidate is not optimal — rather, prosodic harmony is achieved at the cost of reduplicative identity, and so the ranking is FT-FORM ≫ MAX. Since FT-FORM is the lowest ranking of the stress constraints in (62), this establishes that MAX is dominated by all the constraints of the stress and alignment systems, except of course for NUC-STR, which pertains to inter-PrWd and not intra-PrWd stress. This recalls the situation in Axininca Campa (McCarthy & Prince 1993a) and

Makassarese (McCarthy & Prince 1994a); as in Indonesian, MAX is a low-ranking constraint, crucially dominated by all of the major prosodic constraints active in the language.

Returning briefly to an earlier issue, this analysis provides independent confirmation for the claim (see (61) above) that FT-BIN dominates ALIGN-ROOT-FT. Reduplicated monosyllables, when suffixed, have the subordination typical of compounds: *di–pàs–pás–kan* 'tried on, repeatedly'. This shows that the metrical analysis of this form must be as in (104a) — different foot structure in the two conjuncts, so MAX is violated anyway, and therefore NUC-STR can be obeyed. If the proper metrical analysis were the one in (104b), then MAX would be obeyed perfectly, so NUC-STR would be violated, and there would be no stress subordination:

(104) Confirmation of FT-BIN ≫ ALIGN-ROOT-FT, from *pas–pas–kan* (prefix suppressed)

Candidates		FT-BIN	ALIGN-ROOT-FT
a. ☞	[(pàs|)] [(pás|kan)]		*
b.	[(pás|)] [(pás|)kan]	* !	

In (104b), the foot in the second conjunct is right-aligned but unary. Yet (104a) is optimal, showing that a binary foot is preferred to a right-aligned one, with the further consequence that low-ranking MAX is violated too, so stress subordination is in effect.

We have seen the importance of suffixes in characterizing stress in reduplicated forms. But what about prefixes — do they have any consequences for MAX? Consider the following patterns of reduplicated words with prefixes:

(105) Prefixed Reduplications

				Pattern A	Pattern B
a.	pre-XX reduplication, indicating intensification or repetition				
	síap	'be ready'	bərsíap	bərsíap-síap	bərsìap-síap
	tári	'dance'	mənári	mənári-nári	mənàri-nári
b.	X-məN-X reduplication, indicating reciprocity				
	púkul	'hit'	məmúkul	púkul-məmúkul	pùkul-məmúkul
	tári	'dance'	mənári	tári-mənári	tàri-mənári
c.	pre-XX-suff reduplication, indicating intensification or repetition				
	lári	'run'	bərlàri-larían		
	káta	'word'	məŋàta-ŋatákan		
d.	X-pre-X-suff reduplication, indicating reciprocity				
	súrat	'letter"	sùrat-məñuráti		

The pattern in (105a), pre-XX, has the effect of repetition or intensification. This is highly productive; most verbs, including recent borrowings, can be reduplicated in this way. As discussed above, with voiceless-stop-initial roots, there is "overapplication" of nasal assimilation, induced by MAX. A second, very productive pattern is the X-*məN*-X pattern (105b), indicating reciprocity, formed from both verbal and nominal bases. In this case, no overapplication of nasal assimilation is observed.[40] Both of these patterns can be suffixed as well (105c & d). Under suffixation, stress subordination is observed, as expected from the discussion above.

In the unsuffixed forms (105a & b), though, speakers exhibit two different patterns of stress. Some speakers show no stress subordination (pattern A); this is straightforwardly accounted for by the analysis laid out above. Prefixes, being outside of the PrWd, do not affect the metrical analysis within the PrWd; following (98), no stress difference exists in the two halves, so complete identity is maintained. For other speakers, though, there is stress subordination (pattern B) in both reduplication types.[41] The reasons for this variation are not entirely clear, but perhaps non-copying of the prefix is seen as sufficient MAX-violating non-identity to lead to compliance with NUC-STR.

In summary, apart from the variation just noted, reduplicated forms show a consistent lack of stress subordination when unsuffixed, but regular stress subordination when suffixed. This observation stands in contrast to the general situation with compounds in the language, and so reduplicative identity constraints are implicated. The difference in behavior of unsuffixed vs. suffixed forms concurs with this: it is just in the case of suffixation that the two halves of a reduplicated form have different metrical structure and different stress patterns in any case, so that lack of stress subordination would not contribute to greater identity.

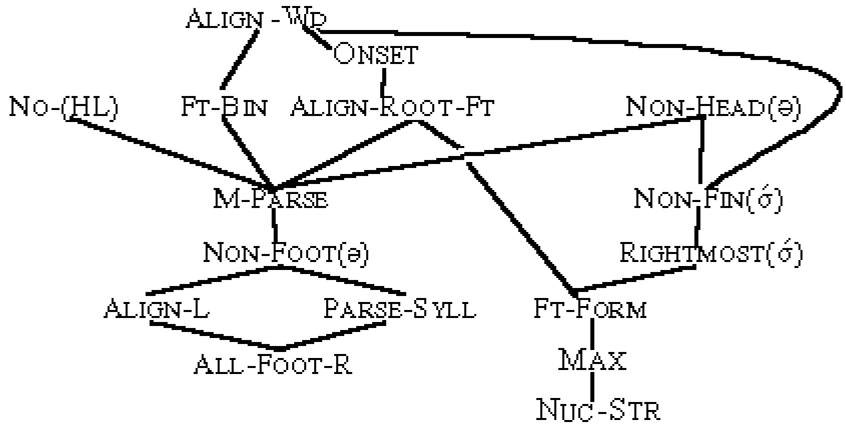
This type of identity-preserving interaction between reduplication and other phonology is well known; the analysis we propose rests on McCarthy & Prince's (1993a, 1994b) interpretation of this interaction within Optimality Theory. Under Parallelism, fully-formed candidates that include both the reduplicative copy and the derived prosodic structure are submitted to the constraint hierarchy. The hierarchy includes constraints relevant to prosodic structure (such as NUC-STR, FT-FORM, NON-FIN(σ́), and RIGHTMOST(σ́)) and constraints relevant to reduplicative identity (such as MAX). Through appropriate ranking of MAX relative to the prosodic constraints, the pattern of identity-preserving and identity-disrupting interactions is derived, as the following diagram summarizes:

---

[40]The difference between *məN*–X–X and X–*məN*–X in the treatment of nasal assimilation can be accounted for within the model of reduplicant/base identity in McCarthy & Prince 1994b. To present the analysis here would involve a lengthy digression, however, and so we defer discussion.

[41]Sanchez and Stevens (1991) observe subordination in the pre-XX forms and equal stress in the X-pre-X forms.

(106) Final Constraint Hierarchy



In Indonesian, most aspects of prosodic structure take precedence over reduplicative identity, so constraints like Ft-Form, Non-Fin(σ́), and Rightmost(σ́) all dominate Max, as (106) shows. But when these constraints are irrelevant to reduplicative identity, so that the original and the copy will in any case agree in their metrical structure, then reduplicative identity takes precedence over stress subordination — formally, Max ≫ Nuc-Str. As noted, the whole account rests on the assumption that reduplicative identity and prosody are assessed in parallel, over a set of phonologically complete candidate output forms.

§5. Conclusion

In this article, we have presented a complete account of word stress in Indonesian and the ways in which it interacts with affixation, limitations on root structure, PrWd juncture, syllabification, and reduplication. The analysis is set within Optimality Theory, and its properties are particularly relevant to our two main themes, Alignment and Parallelism. Throughout, we have found evidence that Alignment constraints successfully express familiar generalizations and lead to new ones as well, through their ability to demand coincidence of the edges of prosodic and/or morphological constituents. Phenomena that have formerly been analyzed in terms of the phonology/morphology mapping, the cycle, (non-)iterative foot assignment, and morpheme-structure constraints are all subsumed under this single rubric, leading to greater generality and greater explanation. Furthermore, Parallelism has emerged as playing a central role in the system. In §2, it leads to examination of Alignment-based alternatives to the cycle, in which the influence of morphology on prosodic structure is direct, rather than mediated by a derivation. More importantly, in §3 and §4, we pointed to several conditions where *only* a parallel analysis will work, because the top-down, bottom-up, or identity effects observed are simply inconsistent with a step-wise derivation.

What we have here, then, are three hypotheses that find confirmation in the grammar of Indonesian: Optimality Theory, Alignment, and Parallelism. Are they connected to one another, or are they distinct and severable? As a matter of logic, these three hypotheses are not intrinsically bound up with one another. As we emphasized in §1, the fundamental principle of Optimality Theory is the claim that a grammar consists of a hierarchy of violable constraints, with no mention of Alignment or Parallelism. Alignment is nothing more than the claim that there exist phonological constraints requiring coincidence of constituent edges and that these constraints have a certain extension in the world. Parallelism too is separate from the other principles, since it simply says that grammars (whatever they consist of) evaluate complete output representations, rather than successive steps of a derivation.

Though there is no inherent logical connection among these three, there are very powerful requirements of descriptive adequacy that link them to one another. In particular, without Optimality Theory, the other two principles would have little to recommend them. If constraints were not violable, then only ALIGN-WD would survive, since it alone stands at the top of the hierarchy. This would mean a loss of generality, as other means of dealing with foot/PrWd alignment (ALIGN-L and ALL-FOOT-R) and prosody/morphology interaction (ALIGN-ROOT-FT) would need to be sought. It would also mean a loss of empirical coverage, since violation of ALIGN-ROOT-FT is essential to the analysis of C|V junctural anomalies presented in §3.3. Likewise, without Optimality Theory, Parallelism is virtually doomed to failure. Most phonological generalizations are not surface truths, as the phonology of Indonesian amply illustrates. In serial theories, phonological generalizations are true at one stage of the derivation, but their truth may be obscured by later developments. Parallel theories must either accept constraint violation or else give up most of phonology. The coherence and internal consistency of a system like Indonesian, as well as breadth of empirical coverage, strongly support the position taken here.

Appendix A: Index of Constraints and Ranking Arguments

Index of Constraint Formulations (alphabetical)

ALIGN-L	(12)
ALIGN-ROOT-FT	(27)
ALIGN-WD	(67)
ALL-FT-R	(15)
FT-BIN	(7)
FT-FORM	(10)
M-PARSE	(48)
MAX	(99)
NON-FIN(σ́)	(30)
NON-FOOT(ə)	(45)
NON-HEAD(ə)	(51)
NUC-STR	(96)
PARSE-SYLL	(8)
RIGHTMOST(σ́)	(31)

Index of Ranking Arguments (alphabetical by higher-ranking constraint)

ALIGN-L ≫ ALL-FT-R	(17)	
ALIGN-ROOT-FT ≫ ALIGN-L	(28), (29)	
ALIGN-ROOT-FT ≫ ALL-FOOT-R	(36)	
ALIGN-ROOT-FT ≫ FT-FORM	(35)	
ALIGN-ROOT-FT ≫ M-PARSE	(52)	
ALIGN-ROOT-FT ≫ PARSE-SYLL	(28)	
ALIGN-WD ≫ FT-BIN	(70)	
ALIGN-WD ≫ NON-FIN(σ́)	(70)	
ALIGN-WD ≫ ONSET	(74)	
ALIGN-WD ≫ PARSE-SYLL	cf. (66)	
FT-BIN ≫ ALIGN-L	(14)	
FT-BIN ≫ ALIGN-ROOT-FT	(61), (104)	
FT-BIN ≫ PARSE-SYLL	(9)	
FT-BIN ≫ M-PARSE	(49)	
M-PARSE ≫ NON-FOOT(ə)	(49)	
FT-FORM ≫ MAX	(103)	
M-PARSE ≫ FT-BIN	(59)	(lexically restricted ranking)
M-PARSE ≫ ALIGN-ROOT-FT	(60)	(lexically restricted ranking)
MAX ≫ NUC-STR	(100)	
NO-(HL) ≫ M-PARSE	(57)	
NON-FIN(σ́) ≫ MAX	(102)	
NON-FIN(σ́) ≫ RIGHTMOST(σ́)	(33)	
NON-FOOT(ə) ≫ ALIGN-L	(50)	
NON-FOOT(ə) ≫ PARSE-SYLL	(50)	
ONSET ≫ ALIGN-ROOT-FT	(83), (86)	
PARSE-SYLL ≫ ALL-FT-R	(16)	
RIGHTMOST(σ́) ≫ FT-FORM	(32)	
RIGHTMOST(σ́) ≫ MAX	(102)	

Appendix B: Discussion of Other Analyses of Indonesian Stress

The account of Indonesian stress in Cohn 1989, 1993 served as an initial impetus for the results obtained in §2. Furthermore, as we saw in §3, the basic analysis of the external relations of PrWd carries over directly from Cohn's analysis, and it plays a central role in the system of constraints.

There are, however, some important differences between Cohn's analysis and the one presented in §2, and at least some can be traced to differences in theoretical perspective: the contrast between a derivational approach, founded on rule application, and Optimality Theory, founded on constraint satisfaction; and the contrast between cyclic rule application and alignment, particularly the constraint ALIGN-ROOT-FT. We sketch Cohn's analysis below, and then highlight some of these differences. We then turn to consideration of several other reanalyses of Indonesian that have appeared in recent work.

The Cohn 1989 analysis of Indonesian stress is embedded within the grid theory of Prince 1983. The following set of rules, ordered as listed, derives the monomorphemic stress pattern:

(1) Cohn 1989 Rule Set

a. Extrametricality
    Final σ is extrametrical.

b. Final Stress
    End Rule (Right)

c. Initial Stress[1]
    End Rule (Left)

d. Alternating Stress
    Perfect Grid (R→L)

e. Main Stress
    End Rule (Right)

In brief, stresses are placed on the penultimate and initial syllables, and then intervening syllables receive a right-to-left alternating pattern. The stress on the penultimate syllable is promoted to the strongest stress in the word. The only significant complication arises in trisyllables like *bicára*. Application of Final Stress, Initial Stress, and Main Stress would wrongly predict **bìcára*. Therefore, the constraint Avoid-Clash is invoked; it blocks application of Initial Stress to the output of Final Stress *bicára* when clash would result.

In suffixed forms, the rule set (1) applies cyclically. With a singly-suffixed form like *bicará–kan*, main stress is assigned to the penult on each cycle (2a, b), so the output of the cyclic phonology has clashing stresses (2c). A post-cyclic rule of Destressing deletes the weaker stress, thereby resolving the clash (hence satisfying Avoid-Clash):

(2) Cyclic Derivation of *bicará–kan*

a. *bicara* Cycle
```
   x
   x
bicara
```
b. *bicara–kan* Cycle
```
     x
   x x
   x x
bicarakan
```
c. Output of Cyclic Phonology
```
     x
   x x
   x x
bicarakan
```
d. Post-Cyclic Destressing-in-Clash
```
     x
     x
     x
bicarakan
```

---

[1]The principal difference in the Cohn 1993 analysis is the use of binary feet, leading to a different characterization of the "initial dactyl" effect.

Crucially, the *cyclic* rules of Initial Stress and Alternating Stress are not permitted to apply to the *post-cyclically* derived unstressed initial sequence *bica*. If either did, the result would be **bìcarákan*, stressed just like a monomorphemic quadrisyllable, and the whole rationale for cyclic application would evaporate.

In doubly-suffixed forms like *bicàra–kán–ña*, the output of the cyclic phonology has three clashing stresses (3d). Post-cyclic Destressing applies to the middle one, in accordance with Hammond's (1984) Trigger Prominence principle:

(3) Cyclic Derivation of *bicàra–kán–ña*

a. *bicara* Cycle

```
   x
   x
bicara
```

b. *bicara–kan* Cycle

```
     x
   x x
   x x
bicarakan
```

c. *bicara–kan–ña* Cycle

```
       x
     x x
   x x x
   x x x
bicarakanña
```

d. Output of Cyclic Phonology

```
       x
     x x
   x x x
   x x x
bicarakanña
```

e. Post-Cyclic Destressing-in-Clash

```
       x
   x   x
   x   x
bicarakanña
```

Crucially, Destressing cannot apply cyclically, since then it would apply at step (3b), permitting Initial Stress to apply at step (3c), yielding **bìcarakánña* (which also wrongly follows the monomorphemic pattern).

Leaving aside differences in representational assumptions, which are in any case even less dramatic when the Cohn 1993 analysis is considered, the rule-based analysis (1) and the constraint-based analysis developed here are similar in many respects. Both give special treatment to the penultimate and initial syllables, and both see the alternating pattern (via the Perfect Grid and Avoid-Clash, or their counterparts FT-FORM and FT-BIN) as fundamental to the system. Discrepancies between the two accounts lie not so much in the rules or constraints themselves, but in how they interact.

Three interactional moves underlie the rule-based analysis of Cohn 1989:

[i] Destressing is a post-cyclic rule. If it were cyclic or it were a persistent rule (Myers 1991), it would wrongly apply to (3b), as was noted above.

[ii] Perfect Grid assignment is a cyclic rule but not a post-cyclic one, so it is not permitted to apply again after post-cyclic Destressing. Otherwise it would wrongly apply to (2d), as was also noted above.

[iii] Avoid-Clash blocks Initial Stress from applying to trisyllables like *bicára*, but it does not block the creation of clash by the application of Penult Stress on successive cycles. If Avoid-Clash did not block Initial Stress, then **bìcarákan* would result. If Avoid-Clash blocked Penult Stress, then **bicárakan* would be the output.

All of these interactional requirements are crucial to the analysis, since without them wrong outputs are obtained. Yet they have no external justification or relation to universals of rule interaction.

Point [iii] is a characteristic complication of approaches that attempt to combine well-formedness constraints like Avoid-Clash with rules like Initial Stress and Penult Stress. There is no principled way to stipulate why one rule might be blocked by a constraint but another might apply anyway, leading only much later to invocation of a repair rule. Furthermore, it is difficult or impossible to express the connection between the constraint Avoid-Clash and the related repair rule. Optimality Theory provides a general answer to this local instance of the blocking/repair conundrum (Prince & Smolensky 1993: Chapts. 3, 4, 10): there is no blocking or repair, because there are no rules.

Points [i] and [ii] are closely related, since their role is essentially to "make the system cyclic" — that is, to force the prosodic structure to be controlled, at least in part, by the morphological structure. Without these specifications, suffixed words would have the same stress as plain ones. Obviously, some sort of stipulation is required, since morphological control of prosody is not a matter of linguistic or logical necessity, but [i] and [ii] have a specificity and complexity that seem unwarranted for what they do. In contrast, the equivalent of [i] and [ii] in the Optimality-Theoretic analysis of §2 is nothing more than the relatively high ranking of ALIGN-ROOT-FT, which, as we have noted, can be understood in terms of a more general ranking schema, $M \gg P$.

We turn now to consideration of several other treatments of Indonesian stress, including Halle & Idsardi 1993, Kager 1993, and Goldsmith 1992. Without exception, these works limit their attention exclusively to the root and root+suffix patterns, analyzed above in §2.1 and §2.2. We discuss them here in that light only. From the sketches below, however, it should be clear that these analyses would face major (perhaps insuperable) difficulties if confronted with the much broader range of evidence considered in §2.3 (schwa and word-minimality), §3 (alignment, and violation of alignment), and §4 (stress in reduplication).

Many of the basic ideas in Cohn 1989 are applied in Halle & Idsardi's (1993) analysis to the metrical bracketing theory of Idsardi (1992), which is itself a development of ideas in Halle & Vergnaud 1987 and Halle & Kenstowicz 1991. A basic tenet of this theory is that the constituent bracket symbol is reified, and stress rules will deploy left or right constituent brackets (e.g., foot brackets) individually. With addition of the complementary bracket and identification of heads, the overall stress pattern of the word is derived.

Three rules of bracket insertion are employed in their analysis of Indonesian (paraphrased here):

(4) Bracket Insertion in Halle & Idsardi 1993

- a. Right Edge Marking
  - Insert a right foot-bracket ")" before the last syllable.
- b. Left Edge Marking
  - Insert a right foot-bracket ")" after the initial syllable.
- c. Iterative Footing
  - Insert a left foot-bracket "(" before each pair of *strictly adjacent* syllables, from right to left. (We introduce the notion *strictly adjacent* to characterize elements that have no "(" or ")" between them, following Idsardi 1992.)[2]

Vacuous parentheses (those that bracket nothing) are eliminated by a general convention. Iterative Footing follows the edge-marking rules, so it applies only in words of at least four syllables, which can have two unbracketed syllables in a row.

Applying these rules to monomorphemic words of various types yields the following results:

(5) Results of Bracket Insertion (after Halle & Idsardi 1993)

a. cat)	b. ca)ri	c. bi)ca)ra	d. bi)(jaksa)na
e. kon)ti(nua)si	f. e)(rodi(nami)ka	g. a)me(rika(nisa)si	

When feet are closed by matching parentheses and if the heads of feet are projected from their *rightmost* syllables, then the observed stress pattern is obtained in all cases but one. For the trisyllable *bicara*, it is necessary to invoke an additional rule of destressing-in-clash to avoid deriving *(bì)(cá)ra*. This rule is formulated as follows:

(6) Destressing in Clash (after Halle & Idsardi 1993)

$) \rightarrow \emptyset \;/\; \underline{\quad}\; \sigma\;)$

The rule of Destressing in Clash plays a key role in the Halle-Idsardi analysis of cyclic stress effects in Indonesian. The output of Bracket Insertion on the root cycle, (that is, (5)) undergoes affixation and another pass through Bracket Insertion. For examples with anomalous stress like those in (24), this leads to the following results:

[2] In Halle & Idsardi 1993, the rule of Iterative Footing refers to "free elements", but presumably "free" is undefined prior to matching of constituent brackets, which follows Iterative Footing.

(7) Cyclic Stressing in Halle & Idsardi 1993

	First Pass	Affixation	Second Pass	Destressing
a.	bi)ca)ra	bi)ca)ra–kan	bi)ca)ra)kan	bicara)kan
				bicarákan
b.	bi)ca)ra	bi)ca)ra–kan–ña	bi)ca)(rakan)ña	bica)(rakan)ña
				bicàrakánña
c.	kon)ti(nua)si	kon)ti(nua)si–ña	kon)ti(nua)si)ña	kon)ti(nuasi)ña
				kòntinuasíña
d.	a)me(rika(nisa)si	a)me(rika(nisa)si–kan	a)me(rika(nisa)si)kan	a)me(rika(nisasi)kan
				àmerikànisasíkan

In these derivations, it is assumed that Destressing in Clash is a post-cyclic rule, applying from left to right or simultaneously to the output of the second pass through Bracket Insertion. Alternatively, Destressing could itself be cyclic, applying after Bracket Insertion on each cycle. Either way, the same results are derived.

As an analysis of word stress, this account is successful descriptively, largely equivalent in both breadth of empirical coverage and depth of explanation to Cohn 1989, 1993. On the more theoretical side, a notable feature of Halle & Idsardi's analysis is the structural incoherence of the foot in output forms, a consequence of building feet by the ordered (sometimes opaque) interaction of four fairly diverse rules, ungoverned by output constraints. Though disyllabic feet are found, they are by no means the norm, and both monosyllabic and trisyllabic feet can be observed: ***(à****me(rikà)kan*. In contrast, other foot-based accounts assume strictly disyllabic feet.[3]

The principal evidence of foot-structure is indirect — the location of prominence — and with such indirect evidence, it is not possible to compare prominentially-equivalent analyses that posit different foot-types. There is, however, one source of direct evidence for foot structure in Indonesian: word minimality, as described in §2.3. Monosyllabic words are exceedingly rare in Indonesian, and they tend toward nativization by adding a syllable, rendering them disyllabic. We have argued, following Prince (1980) and others, that word minimality effects are a consequence of obedience to FT-BIN, which requires that any foot must branch. The smallest word is disyllabic because every word must contain a foot and the smallest foot is disyllabic, under FT-BIN. Monosyllabic words are rare exceptions to this regularity.

In contrast, Halle & Idsardi (1993) must and do claim that monosyllabic words reflect a regular pattern of Indonesian. The rules of bracket insertion encounter no difficulty in parsing monosyllabic words, and monosyllabic feet are derived freely in longer words as well. Yet free derivation of monosyllabic words runs counter to the evidence of scarcity and regularization.

Another issue in the Halle-Idsardi analysis concerns the formulation and mode of application of Destressing-in-Clash. Crucially, it must apply across the board, changing *bi)ca)ra)kan* to *bicara)kan* and not to **bi)cara)kan* (which would correspond to the incorrect stress pattern **bìcarákan*). This means that Destressing cannot simply effect the *minimal* repair of this Clash-Filter[4] violation — rather, it must delete several stresses, though deleting just one would do as well. To our knowledge, other rhythmic or prosodic processes do not apply in this across-the-board way — they always favor some sort of alternation, consistent with the minimal repair, as of course fundamental principles of Optimality Theory would predict.[5]

Furthermore, the rationale for Destressing-in-Clash in the Halle-Idsardi formulation is difficult to see. As it stands, it is no more or less likely than any of dozens of other conceivable transformations on brackets interspersed in a syllabic string. Its rationale may perhaps lie with the Clash Filter or Foot Binarity or some other general prominential or metrical principle, but the formulation of the rule itself bears no relation to these possible motivations for its application. This problem — the separation between rules and the well-formedness principles they enforce — is a characteristic difficulty of rule-based approaches, and one that Optimality Theory addresses directly.

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[3]Structural incoherence or non-uniformity is not necessarily a liability. Indeed, the analysis proposed here allows a different sort of structural incoherence, in the location of foot-heads rather than the size of feet.

[4]On the role of clash, see Liberman 1975, Liberman & Prince 1977, Prince 1983, Hammond 1984, Selkirk 1984, and much subsequent work.

[5]One possible exception to this observation, the "Slovak Rhythmic Law", is convincingly reanalyzed by Kenstowicz & Rubach (1987).

A very different view of cyclicity in Indonesian, based on cyclic vowel reduction, is proposed by Kager (1993), in the context of a general study of the effects of the cycle on stress. His goal is to accommodate the facts of Indonesian to a theory in which truly cyclic (as opposed to stratal) stress interactions are always mediated by *lexically distinctive* metrical or quantitative structure, for reasons related to Structure Preservation. That is, the only way that stress information can be passed along from one cycle to another is if stress or quantity is distinctive in the language as a whole. For instance, cyclic lengthening of stressed vowels is a way for the locus of stress to be passed along from one cycle to the other. Since Indonesian has cyclic stress effects, but does not have lexically distinctive stress or quantity, it is a potential counter-example to this proposal.

In response, Kager puts forward the idea that Indonesian has cyclic vowel reduction, so that *unfooted* vowels on each cycle become prosodically (though not qualititatively) like schwa, which is a lexical vowel of the language. In this way, unfootedness on one cycle becomes unfootability (and consequent unstressability) on the next, and at least some information about stress is successfully transmitted from one cycle to the next.

A couple of examples will illustrate this proposal. We do not summarize Kager's proposals about the stress system itself, which are in any case similar to Cohn 1993. We will notate "reduced" vowels, which are unstressable and unfootable like schwa, with shading:

(8) *kòntinuasí–ña* in Kager 1993

First Cycle:		/kontinuasi/
	Stress	(kònti)nu(ási)
	Reduction	(kònti)nu(ási)
Second Cycle:		/kontinuasi–ña/
	Stress	(kònti)nua(síña)
	Reduction	(kònti)nua(síña)
		kòntinuasíña

In this example, unfooted *nu* is reduced to schwa-like unfootable status on the first cycle. At that end of that cycle, all stress information other than this lexical distinction is erased, and the result is transmitted to the next cycle. On the second cycle, the syllable *nu* is metrically invisible, like schwa, and so it is impossible to create a proper binary foot **(nua)*. The "missing" secondary stress follows from this.

(9) *bicàra–kán–ña* in Kager 1993

First Cycle:		/bicara/
	Stress	bi(cára)
	Reduction	bi(cára)
Second Cycle:		/bicara–kan–ña/
	Stress	bi(càra)(kánña)
	Reduction	"
		bicàrakánña

In this form, unfooted *bi* becomes unfootable via Reduction on the first cycle, and so it is not visible to stress on the second cycle. (The system does not cycle on each suffix.) Therefore, no "initial dactyl" effect is expected or observed.

One potential criticism of this account is that it does not seem to conform to its own premises. Though Indonesian has a lexical distinction between schwa and non-schwa vowels, it does not have a lexical distinction between full and reduced versions of the non-schwa vowels. That is, there are no vowels, other than schwa, which are invisible to metrical structure in underived lexical items. The analogy to schwa does not provide evidence of this non-existent lexical distinction.

Another, more serious matter is that this analysis does not derive correct results. Though it works for all of the examples cited in Cohn 1989, it does not succeed with the broader range of data examined in §2.2. Consider the following derivation:

(10) *àmerikànisasí–kan* after Kager 1993

First Cycle:		/amerikanisasi/
	Stress	(àme)ri(kàni)(sási)
	Reduction	(àme)ri(kàni)(sási)
Second Cycle:		/amerikanisasi–kan/
	Stress	(àme)rika(nìsa)(síkan)
	Reduction	(àme)rika(nìsa)(síkan)
		**àmerikanìsasíkan*

The output is wrong; descriptively, the first-cycle stress on *ka* is respected on the second cycle, but this analysis provides no way of transmitting information about the location of stress itself (as opposed to unfootedness) from one cycle to the next. Similar problems are presented by examples like the following:

(11) *òtobìografí–ña* after Kager 1993

First Cycle:		/otobiografi/
	Stress	(òto)(bìog)(ráfi)
	Reduction	"
Second Cycle:		/otobiografi–ña/
	Stress	(òto)bi(ògra)(fíña)
	Reduction	(òto)bi(ògra)(fíña)
		**òtobiògrafíña*

In this example, no syllables are unfooted on the first cycle, and so there is no reduction whatsoever. Therefore, nothing about the locus of stress or metrical structure is transmitted from one cycle to the next, and cyclic effects with even-parity roots are impossible.

Narrowly, then, the Kager 1993 analysis of Indonesian encounters empirical difficulties, but more broadly his overall conclusion about the nature of cyclic stress interactions may very well be supported by our results. We have argued that Indonesian stress is not cyclic at all, and therefore any efforts to accommodate it to a theory of cyclic stress systems are misplaced. If indeed there are cyclic stress systems (see also Cole 1992, Cole and Coleman 1992, Kenstowicz 1994, Buckley 1994, and Crowhurst 1994 for recent discussion), then they could certainly conform to the principles Kager adduces. But Indonesian can play no role in settling that issue.

There is one remaining account of Indonesian in the literature, this one very different from all the others. Goldsmith 1992 proposes a theory of Indonesian stress and cyclicity based on the Goldsmith/Larson dynamic linear model for iterative stress processes.[6] This theory computes the activation of each syllable based on its own inherent (positional) properties and its relation to the activation of the syllables around it, and then interprets activation peaks as stress. Cyclic effects are obtained by combining the results for the various "words" making up a derived form.

The specific dynamic linear model for Indonesian is as follows:

(12) Dynamic Linear Model for Indonesian (Goldsmith 1992)

$$x_i^{(t+1)} = K(i) + \alpha \cdot x_{i+1}^{(t)}$$

$\alpha = -.5$
K(1) = .7 (for initial syllable)
K(n-1) = 1 (for penultimate syllable)
else K(i) = 0 (all other syllables)

All x_i are activations of the *i*th syllable. All K(i) are constants added to the *i*th syllable based on its position in the word. This equation computes the activation of the *i*th syllable by subtracting from its inherent positional bias K(i) a fraction of the activation of the following syllable. The computation is iterative, meaning that it uses the activations derived at step *t* to compute the activations at step *t+1*, repeating until all x_i assume stable values.

Positive values for the constants K(i) select particular positions *i* for stress tropism — they correspond to specific local stress rules in symbolic models. Stress is always observed on the penultimate syllable; this is stipulated by specifying

[6] Also see Goldsmith 1991, 1993 and Goldsmith & Larson 1993. We are very grateful to Alan Prince for detailed discussion of the Goldsmith analysis and the Goldsmith/Larson model. See Prince 1993 for extensive analysis of the properties of this class of theories.

an inherent bias of 1 on the first syllable. Stress is nearly always observed on the initial syllable — among monomorphemic words, only trisyllables lack initial stress. This too is stipulated via an inherent bias, in this case .7 (a value which will be explained later).

The coefficient α describes the effect that one syllable has on the syllable that precedes it. Through chaining from a syllable back to the preceding one, α can have effects quite far back in the word (see Prince 1993: 8–14, 93–96 for discussion of the linguistic implications of this). Because $|\alpha| < 1$, the effect that a syllable can exert on preceding ones becomes weaker with distance. Because $\alpha < 0$, a strongly activated syllable will tend to be immediately preceded by a weakly activated one, and vice-versa. This characterizes a type of alternating stress pattern.

The activations derived in this way are *not* stresses. Rather, they are *interpreted* as stresses. The interpretation assumed by Goldsmith (1992) is that any local maximum of activation constitutes a stress. The size of the peak has no relation to the degree of stress — only stress/non-stress can be read off of the activations, so some separate principle (as in the symbolic models) is required to specify that the penultimate syllable is the one that bears main stress.

The following table shows the activations derived by this model for monomorphemic words of various lengths. It also shows the expected stress pattern, given the proposed interpretation of the activations.

(13) Results for Monomorphemic Words

		Stress Pattern
3-σ	0.20 1.00 0.00	[xXx]
4-σ	0.95 –0.50 1.00 0.00	[XxXx]
5-σ	0.57 0.25 –0.50 1.00 0.00	[XxxXx]
6-σ	0.76 –0.12 0.25 –0.50 1.00 0.00	[XxXxXx]
7-σ	0.67 0.06 –0.12 0.25 –0.50 1.00 0.00	[XxxXxXx]

These results are consistent with actual observations. The alternating pattern of even-parity words comes from the right-to-left effect of this particular instantiation of the dynamic linear model. The "initial dactyl" effect in long odd-parity words also emerges, chiefly because of the bias of .7 on the initial syllable, which ensures a peak there except when the penultimate syllable immediately follows (in trisyllabic words).

The extension of this system to suffixed forms is by far the more remarkable result. According to Goldsmith 1992, "[the cyclic] difference is the sum total of the effects on that syllable." The idea is that cyclic effects are obtained by adding together the effects of the various morphological domains to which each word belongs. This basic idea is obviously quite attractive, but direct application of it leads to wrong results. For instance, the first syllable of *[[[cat]kan]ña]* is initial in three domains and penultimate in one, so it might be expected to receive the total bias for all of these (3*.7+ 1 = 3.1), guaranteeing it a stress. Yet in fact this syllable is unstressed. To obtain correct results in cases like this, the actual analytic practice followed in Goldsmith 1992 appears to be rather loosely connected with the underlying idea: each syllable receives only a single bias, 1 if it is penultimate in any domain and .7 if it is initial (and not penultimate) in any domain. This means that the core of the analysis rests on evidently implicit principles of bias exclusion and bias prioritization, for which the numerical analogy of addition does not seem appropriate.

With this much in hand, we can go on to compute the expected stress patterns of suffixed words:

(14) Results for Singly-Suffixed Words

		Stress Pattern
2+1-σ	0.50 1.00 0.00	[[xX]x]
3+1-σ	0.45 0.50 1.00 0.00	[[xxX]x]
4+1-σ	0.82 –0.25 0.50 1.00 0.00	[[XxxX]x]
5+1-σ	0.63 0.12 –0.25 0.50 1.00 0.00	[[XxxxX]x]
6+1-σ	0.73 –0.06 0.12 –0.25 0.50 1.00 0.00	[[XxXxxX]x]
7+1-σ	0.68 0.03 –0.06 0.12 –0.25 0.50 1.00 0.00	[[XxxXxxX]x]

(15) Results for Doubly-Suffixed Words

		Stress Pattern
1+2-σ	0.50 1.00 0.00	[[[x]X]x]
2+2-σ	0.75 0.50 1.00 0.00	[[[Xx]X]x]
3+2-σ	0.32 0.75 0.50 1.00 0.00	[[[xXx]X]x]
4+2-σ	0.89 –0.37 0.75 0.50 1.00 0.00	[[[XxXx]X]x]
5+2-σ	0.61 0.19 –0.37 0.75 0.50 1.00 0.00	[[[XxxXx]X]x]
6+2-σ	0.75 –0.09 0.19 –0.37 0.75 0.50 1.00 0.00	[[[XxXxXx]X]x]
7+2-σ	0.68 0.05 –0.09 0.19 –0.37 0.75 0.50 1.00 0.00	[[[XxxXxXx]X]x]

There is an impressive correspondence between these results and actual observation, even for patterns (such as 7+1-σ or 6+2-σ) that were not reported in Cohn 1989 but that are introduced in §2.

Obviously, we cannot study the properties of this numerical model in the same way we have examined the various symbolic accounts of Indonesian stress. Nonetheless, we can take it on its own terms, and try to understand its why it is set up the way it is. One observation has already been discussed: the value of α, which is set at –.5 in this model. As was noted, because $\alpha < 0$, any syllable with high activation will tend to be adjoined by syllables with low activation, so an alternating pattern results. And because $|\alpha| < 1$, the "stress-canceling" (Prince 1993: 8-9, 97) properties of a stress peak are attenuated with distance. This ensures that long odd-parity words will have an initial stress, even though trisyllables don't.

The bias of the penultimate syllable, K(n-1), is simply 1, obviously a very natural value. This is just the equivalent of a penultimate stress rule. But the bias of the initial syllable, K(1), is .7, an oddly specific fraction. In fact, any value of K(1) from a certain fairly broad range would do just as well — the limits of the range are set by examining words of different sizes. (For general analysis of dependence on string length in the Dynamic Linear Model, see Prince 1993: 17, 31–41, 97.)

The lower bound on K(1) is set by the 5-σ case [XxxXx]. To see what it is, consider what the activations would be without the contribution of K(1):

(16) Activations of 5-σ Word without K(1)
5-σ –0.125 0.250 –0.500 1.000 0.000

But in fact there is a peak on the initial syllable, so its activation must be greater than 0.25. Since the difference between 0.250 and –0.125 is 0.375, K(1) > 0.375.

The upper bound on K(1) is set by the 3+1–σ case [[xxX]x]. Again, consider what the activations would be without the contribution of K(1):

(17) Activations of 3+1–σ Word without K(1)
3+1-σ –0.250 0.500 1.000 0.000

As a matter of fact, there is no peak on the initial syllable in this case, so its activation cannot be greater than 0.500. This sets an upper bound on K(1) at 0.750.

In summary, then K(1) must lie between 0.375 and 0.750, and any value in this range would do as well as .7, the figure given in Goldsmith (1992). Outside this range, though, various odd effects are observed. For smaller values of K(1) (i.e., –.188 < K(1) < .375), the stress pattern of the lower-bounding 5-σ case changes from [XxxXx] to [xXxXx]. That is, the "initial dactyl" effect disappears, but only in 5-σ monomorphemic words; initial [Xxx...] is still found in 7-σ monomorphemic words and appropriate suffixed forms.

For larger values of K(1) (i.e., .75 < K(1) < 1.125), the stress pattern of the 3+1-σ case changes from [[xxX]x] to [[XxX]x]. This has a sensible linguistic interpretation: it is a shift from a "cyclic" or morphologically-influenced stress pattern to one that is indistinguishable from the stress pattern of a monomorphemic word of the same size. But the oddity is that setting the value of K(1) in this range produces "non-cyclic" behavior *only* in 3+1–σ words; the other word-types in (24) still show the effects of the morphology on their stress patterns.

This analysis of some possible values of K(1) shows that, for natural, quantized settings of this constant (cf. Prince 1993: 90), we obtain a range of behavior that includes an actual linguistic system and other systems that seem unlikely. With K(1) = .5, Indonesian stress is derived exactly. But with K(1) = 0, the stress pattern of just one word-type, the 5-σ case, is different. And with K(1) = 1, the stress pattern of another unique word-type, the 3+1-σ case, is different. This behavior of the model under differing values for K(1) is potentially problematic; linguistic parameters do not usually show this degree of delicacy and specificity, where natural changes in the value lead to differences in just one form, with no repercussions elsewhere in the system. The source of this difficulty lies with the continuous numerical character of the overall model. Linguistic typology through parametrization of the constants and coefficients is an important area for continued study of systems of this type. (For some initial results along these lines, see Prince 1993: 90f.)

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