Deriving Reduplicants in Prosodic-Morphology Typologies*

Natalie DelBusso
Rutgers University

1 Introduction

Prosodic factors affect morpheme form. Reduplicative morphemes often take the shape of the prosodic units syllable, foot, or prosodic word, regardless of the size of the base to which they attach. Some reduplicants also vary depending on the shape of the base. McCarthy & Prince's (1986, 1993, 1995) work in Prosodic Morphology argues that such effects follow from the interaction of prosodic and morphological constraints without direct reference to reduplicant size.

In this study, I determine the assumptions that are required to produce uniform reduplicative paradigms with the three basic types, syllable (σ), foot (F) and total (T), from the interaction of constraints in a prosodic system. *Uniform* refers to a reduplicant that is the same size across reduplicative bases of different lengths. I systematically analyze three complete factorial typologies of reduplication built on a basic stress system with well-studied properties (Alber & Prince, in prep.). Each subsequent system adds a single constraint to CON. A uniform one-syllable reduplicant is obtainable from pure prosody along with the requirement in GEN that morphemes be overtly realized. Total reduplication requires a single constraint referring to the reduplicant and requiring that it be total (BR.MAX). Uniform bisyllabic foot reduplication only arises when the system includes a constraint relating prosodic and morphological constituents through alignment of their edges.

The interaction of these constraints entails the presence of languages showing a range of structural and size effects that distinguish even- and odd-parity bases, allowing for all reduplicated forms to be exhaustively parsed into all and only binary feet. I refer to such parses as Full Binary Parsing (FBP). The prosodic pressures for FBP gives rise to languages in the typologies having a different sized reduplicant with odd bases than with even; or having a recursive prosodic word structure with even bases and a non-recursive prosodic structure with odd bases. I call such paradigms *nonuniform.* The prosodic shape variation illustrates that constraints referring to the foot and syllable level influence structural choices at higher levels of the prosodic hierarchy, and act as anti-recursion constraints in context specific ways. Both kinds of paradigm variability can co-occur in a predicted language.

FBP can only be achieved in even-parity words, where all syllables are exhaustively parsed into all and only binary feet. Any odd-parity prosodic word fails to have FBP, as one syllable is either left unparsed or parsed as a unary foot, violating syllable parsing or foot binarity constraints (1). FBP effects are known to arise from certain assumptions: the inclusion of syllable parsing and foot binarity constraints in CON and deletion/insertion in GEN (see Hyde 2012a). In reduplicated forms, the size of the reduplicant can be altered depending on the parity of the base to create only even outputs. In the typologies studied here, FBP is achieved in some languages through nonuniform reduplicants or prosodic structures.

(1) Full Binary Parsing[1]

Possible:	Even-parity word:	[-Xu-Xu-]
Not possible:	Odd-parity word:	[-Xu-**o**-] or [-**X**-Xu-]

Empirical support for the centrality of uniform syllable, foot, and total reduplication as basic paradigms comes from a survey of reduplication paradigms in 45 languages. The numbers of the

* Thanks to Bruce Tesar, Jane Grimshaw, Hope McManus, Nick Danis and especially Alan Prince for comments and discussion throughout various stages of this project.

1 For non-reduplicated words, I use the OTWorkplace representations (Prince, Tesar & Merchant 2013): X = foot head; u = non-head of a foot; o = unparsed syllable; dashes indicate foot boundaries.

Proceedings of *AMP 2014*
Completed February 5, 2015

occurrence of each paradigm are given in the table in (2).[2] Sources include works surveying or analyzing reduplication (Downing 2006, Marantz 1982, McCarthy & Prince 1986, 1993, Moravcsik 1978) as well as some primary sources. An additional six reduplication paradigms in the survey varied the reduplicant size depending on the base: Hopi, Southeastern Tepehuan and Pohnpeian (heavy or light syllable reduplicant); Kinande (foot or no reduplicant); Tiene (syllable or no reduplicant) and Northeast Ambae (one or two syllable reduplicant). These are considered nonuniform reduplication paradigms.

(2) Reduplication paradigms

Reduplicant	**Number**
Syllable (σ)	25
Binary Foot (F)	17
Total (T)	6
Nonuniform	6

After defining GEN and CON (section 2), I proceed through the systems showing that the necessary commitments made in GEN and CON in each system derive the three uniform reduplications: 1) a morpheme realization requirement (all systems, section 3.1); 2) a constraint preferring total reduplication (2nd and 3rd systems, section 3.2); and 3) a constraint relating morphology and prosody (3rd system only, section 3.3). Other predicted paradigms involve mixtures of the basic types and arise to satisfy constraints enforcing FBP. Finally, I show how recursive structures arise and are limited through alignment constraints, and how a language can have both structures in a single paradigm to achieve FBP.

2 GEN and CON

The three systems studied here share a single GEN and differ only in adding a single constraint to CON. They are named as follows: 1) *PR* (Prosody + Reduplication); 2) *PBR* (Prosody + Base-Reduplicant correspondence); 3) *PBRM* (Prosody + Base-Reduplicant correspondence + Morphology).

2.2 *GEN* All inputs consist of strings of unparsed syllables, with no quantity distinctions, and a reduplicative morpheme R: R+*n*σ. Bases and reduplicants are specified for their morphological category in the input—bases as *stems* and reduplicants as *affixes.*

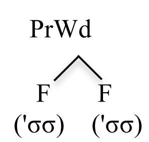
Outputs are any parse of the input meeting the following requirements:

1) The number of syllables in the base is invariant for each input, no deletion or insertion; the number of syllables in the reduplicant varies: a reduplicant is minimally realized as a syllable and maximally as total: $\sigma \leq R \leq |B|$.

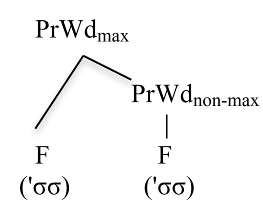
2) In all outputs, the reduplicant precedes the stem as a prefix, R+B.

3) All syllables in the outputs are contained in a PrWd, either a single, non-recursive prosodic word, with the continuous parsing of the base and reduplicant as in (3a) or a recursive structure as in (3b), where the base is parsed as a prosodic word separate from the reduplicant. In the recursive structure, the prosodic word containing another prosodic word is the *maximal prosodic word* ($PrWd_{max}$); the internal prosodic word dominating only feet and syllables is the *non-maximal prosodic word* ($PrWd_{non\text{-}max}$) (Ito & Mester 2012). The maximal/non-maximal distinction is important for the definition of prosodic word alignment in CON (5).

(3) a



b.



[2] There are 54 paradigms in Table 1 because some languages have multiple reduplicative morphemes.

4) All prosodic words are headed, dominating at least one foot.
5) Syllables may be parsed or unparsed, dominated directly by a prosodic word.
6) Feet are maximally bisyllabic.

The outputs were generated using OTWorkplace's (Prince, Tesar & Merchant 2013) automatic generator. For a base of length *n*, outputs are all parses of length *n*+1 (base + σ reduplicant) to 2*n* (total reduplication). Recursive candidates were generated by concatenating all parses for the base of length *n* with all parses for prefixal strings of σ to *n* in length. For example, the candidate set (c-set) for the input with a 3σ base plus a reduplicant was every admitted parse of the strings in (4). In the following, r = reduplicant syllable, b = base syllable, and square brackets [] = prosodic word boundaries.

(4) R+3σ base

Non-recursive strings	*Recursive strings*
[**r**bbb]	[**r**[bbb]]
[**rr**bbb]	[**rr**[bbb]]
[**rrr**bbb]	[**rrr**[bbb]]

2.3 *CON* The hierarchy of CONs is rooted in a basic stress system, CON_{PR}; subsequent constraint sets build on this system through adding a single constraint to the previous system: base-reduplicant correspondence in CON_{PBR} and morpho-prosodic alignment in CON_{PBRM}. The table in (5) defines all the constraints used in the three systems, which are discussed below.

(5) Constraints

<table>
<tr><td colspan="2">Stress system</td><td rowspan="7">PR</td><td rowspan="9">PBR</td><td rowspan="11">PBRM</td></tr>
<tr><td>PS</td><td>*o (unparsed σ)</td></tr>
<tr><td>IAMB</td><td>*-X (left-headed foot, including unary feet)</td></tr>
<tr><td>TROCH</td><td>*X- (right-headed foot, including unary feet)</td></tr>
<tr><td>AFL</td><td>*(σ, F), such that σ precedes F in the maximal ω.</td></tr>
<tr><td colspan="2">Prosodic word alignment</td></tr>
<tr><td>AωL</td><td>*($\omega_{non\text{-}max}$, ω_{max}), such that a σ precedes $\omega_{non\text{-}max}$ in ω_{max}.</td></tr>
<tr><td colspan="2">Base-Reduplicant Correspondence</td></tr>
<tr><td>BR.MAX</td><td>*σ∈Base lacking a corresponding σ∈Reduplicant.</td></tr>
<tr><td colspan="3">Stem and Prosodic Word alignment</td></tr>
<tr><td>ASL</td><td colspan="2">*(σ, Stem), such that σ precedes Stem in the minimal ω containing it.</td></tr>
</table>

The basic stress system (the nGX.L[3] system of Alber & Prince (in prep.)) includes the syllable parsing constraint PARSE-SYLL (PS), the foot type constraints TROCH and IAMB, and foot alignment constraint ALL-FEET-LEFT (AFL).[4] ALL-FEET-RIGHT (AFR) is not included here to reduce the size of the typologies by symmetry. Unary feet violate both TROCH and IAMB. Deciding how to count violations of foot alignment in recursive structures is a non-trivial issue; I propose here that foot alignment is assessed relative to the edges of the maximal prosodic word. Both a non-recursive structure [Xu-Xu-Xu] and a recursive structure [Xu[Xu-Xu]] incur the same number of violations of AFL: 6. Rationale and consideration of some alternatives is given in DelBusso (2014).

ALL-ω-LEFT (AωL) is violated by any pair of non-maximal and maximal prosodic words whose left edges do not coincide: one violation is assessed if a syllable intervenes between the left edge of a non-maximal prosodic word and that of the maximal prosodic word dominating it. This constraint acts as an

[3] The name of the system, nGX, comes from Alber and Prince (in prep.) where the typologies of this and related stress systems are analyzed. "L" indicates that only AFL is used in this system.
[4] The definition of AFL is based on the formulation in Hyde (2012b).

anti-recursion constraint: all recursive forms[5] violate AωL while no non-recursive form does, as these do not contain a non-maximal prosodic word.

The base-reduplicant correspondence constraint BR.MAX (McCarthy & Prince 1995), is violated by all non-total reduplication. As syllables are treated here as unanalyzed units, violations of this constraint are counted by syllable rather than segment, taking the difference between the number of syllables in the base and that in the reduplicant.

ALL-STEM-LEFT (ASL), based on McCarthy & Prince's (1993) ALIGN-L, is violated by each syllable standing between the left edge of a morphological stem—here, the base—and the left edge of the minimal prosodic word containing them. This constraint favors recursion with reduplicated forms, where the base is aligned with the internal, non-maximal prosodic word. The violation tableau in (6) shows the violations of ASL: recursive forms have 0 violations (6d-e) while non-recursive forms incur a minimum of one violation and more depending on the number of syllables in the reduplicative prefix (6a-c). The right-aligning variant of this constraint is not used here, but is necessary for deriving compound prosodic word structures. Recursion is tied to morphological complexity: no mono-morphemic word with a recursive structure is optimal in this system, as no prefix misaligns the left edge of the stem from that of a prosodic word.

(6) Recursive structures and stem alignment

Input	Output	ASL	Reduplicant and shape
R+3σ	a. [**r**bbb]	1	1σ, non-recursive
	b. [**rr**bbb]	2	2σ, non-recursive
	c. [**rrr**bbb]	3	3σ, non-recursive
	d. [**r**[bbb]]	0	1σ, recursive
	e. [**rrr**[bbb]]	0	3σ, recursive

The languages of the nGX.L stress system for non-reduplicated candidates are classified by foot type, alignment, and density type. A *dense* language has multiple binary feet per prosodic word in words containing four or more syllables; a *sparse* language has a single foot per prosodic word in all lengths. The *dense* languages further divide into *weakly dense* and *strongly dense* depending on whether the odd syllable in odd-parity words are unparsed or unary feet, respectively (Alber & Prince in prep.). To generalize over iambic/trochaic symmetries, I adopt Alber & Prince's terminology of *Fdom* for the dominant foot type constraint: TROCH in a trochaic language, IAMB in an iambic language; and *Fsub* for the subordinated foot type constraint. The optima for the non-reduplicated 5σ input and the rankings for each density type are shown in (7) using trochaic exampes; in all, Fdom≫Fsub.

(7) Languages of nGX.L by density type (trochaic language)

Density	***5s form***	***Ranking***	
Sparse	[-Xu-o-o-o]	AFL|Fsub≫PS	
Weakly Dense	[-Xu-Xu-o-]	Fdom≫PS≫AFL, Fsub	
Strongly Dense	[-X-Xu-Xu-]	PS≫	Fdom≫Fsub AFL

3 The Reduplication Typologies

Uniform σ, F and T reduplication paradigms arise in the typologies through the inclusion of certain constraints in CON. Uniform single σ reduplication results from prosody alone and the morpheme realization requirement in GEN. It occurs in all three systems. Total reduplication requires that CON include BR.MAX (PBR and PBRM); recursive structures and foot reduplication only occur when CON includes ASL (PBRM). Without ASL, the prosodic word alignment constraint AωL prevents any recursive structure from being optimal. The table in (8) summarizes the main features of the three systems. Each is considered below in turn. The typologies of all three systems are fully symmetric with regard to trochaic

[5] With the exception of vacuous recursion, which cannot be controlled by this constraint. The GEN used in the current systems does not produce such outputs.

and iambic foot type. All of the languages in each system are retained in subsequent systems—the additional constraints only add possible optima and combinations of these optima that were not possible in the previous system. The ranking structure for the factorial typologies of each of the three systems was analyzed in OTWorkplace (Prince, Tesar & Merchant 2013) using the tools of modern rigorous OT.

(8) Overview of the typologies

System	*Number of lgs*	*σ*	*F*	*T*	*Recursive structures*
PR	8	Y	*N*	*N*	*N*
PBR	14	Y	*N*	Y	*N*
PBRM	52	Y	Y	Y	Y

3.1 *PR* There are two reduplication paradigms in PR: uniform σ across all bases and a non-uniform paradigm where the reduplicant is σ with odd bases and a foot (2σ) with even. The uniform σ reduplicant arises in sparse and strongly dense languages without any reference to morphology beyond the morpheme realization requirement in GEN. It cannot occur in weakly dense languages. Foot reduplication occurs, but only with even bases in dense languages. Uniform foot and total reduplication are impossible in this system.

The languages of the typology are shown in (9). The following representations are used throughout: as above, R/r = syllables of the reduplicant; B/b = syllables of the base; prosodic word boundaries are square brackets [; capitals are foot heads, lowercase letters are non-heads or unparsed syllables; dashes - are foot boundaries and separate unparsed syllables.

(9) Languages of PR

Density	*Reduplicants*	*R+3σ*	*R+4σ*
Sparse	σ	[**R**b-b-b]	[**R**b-b-b-b]
Weakly dense	σ, F	[**R**b-Bb]	[**R**r-Bb-Bb]
Strongly dense	σ	[**R**b-Bb]	[**R**-Bb-Bb]
	σ, F	[**R**b-Bb]	[**R**r-Bb-Bb]

The rankings of the prosodic constraints in (7) for sparse and weakly dense languages are sufficient in themselves to determine the form of the reduplicant. For languages with strongly dense parsing, the two reduplication paradigms occur with two distinct refinements of the rankings in (7). When outputs are invariant in length, Fdom and AFL are not crucially ranked. They come into conflict in reduplicated forms with even bases, as shown in the comparative tableau in (10). The selected winner, the σ reduplication candidate, achieves better alignment by having a unary foot. The loser, the F reduplication candidate has an additional alignment violation and only binary feet. AFL assigns fewer violations to the winner. Fdom prefers the loser; the winning form incurs a violation of Fdom due to the unary foot, while the loser contains only binary trochaic feet. The two constraints do not conflict with odd bases, shown in ERC 2 (Entailed Ranking Condition, Prince 2002): a σ reduplicant has the minimal number of violations of AFL and none of Fdom; the F reduplicant is never optimal with an odd base (see below).

(10) σ reduplication, Strongly dense languages

ERC	Input	Winner	Loser	PS	AFL	TROCH	IAMB	AωL
1	R+2σ	[**R**-Bb]	[**Rr**-Bb]		W	L		
2	R+3σ	[**R**b-Bb]	[**R-R**b-Bb]		W	W	W	

The reduplication paradigm having both σ and F sizes allows for FBP in all reduplicated forms by having a nonuniform reduplicant: σ with odd bases, F with even. This allows for full satisfaction of both PS and Fdom, which necessarily conflict only in odd-parity forms where one syllable cannot be parsed into a binary foot ((1) above). This conflict is avoided when all optima are even-parity. For weakly dense languages, where both PS and Fdom both dominate AFL and Fsub, the σ, F paradigm is the only possible reduplication paradigm. Uniform σ paradigm contains forms with unparsed syllables. The tableau in (11) shows that there is no possible ranking under which the selected winners—σ reduplication—are optimal in a weakly dense language. ERCs 1 and 2 are ranking conditions for a weakly dense language (WD); ERCs 3 and 4 for a σ reduplicant. A subset of these ERCs fuse to L: their ranking requirements are inconsistent.

(11) Weakly dense language, σ reduplication

ERC	Input	Winner	Loser	TROCH	PS	AFL	IAMB	AωL
1	5σ	WD	SD	W	L	W	W	
2	5σ	WD	Sp		W	L	L	
3	R+2σ	[**R**b-b]	[**Rr**-Bb]		L	W	W	
4	R+3σ	[**R**b-Bb]	[**Rr-**Bb-b]		W			
5	Fusion 2◦4				L	L	L	

Two of the target paradigms do not occur: uniform foot and total reduplication. Total reduplication is not possible because no constraint in the system prefers a longer word length: all prosodic structures added by the reduplicant violate at least one prosodic constraint (12). The more syllables the reduplicant adds, whether parsed or unparsed, the greater the number of violations of some constraint in the system.

(12) Reduplicant structure violations

Reduplicant	***Violates***
Binary foot: **Rr, rR**	TROCH or IAMB, AFL (when multiple feet/ω)
Unary foot: **R**	TROCH and IAMB, AFL (when multiple feet/ω)
Unparsed syllable: **r**	PS

With bases of more than 2 syllables, the total reduplication candidate is harmonically bounded by non-total candidates. For a dense language (13a), foot alignment (AFL) and the subordinated foot type constraint Fsub (in the tableau shown, IAMB) assign fewer violations to the candidate with fewer feet, the non-total reduplication candidate (the selected Loser). The other constraints do not distinguish these candidates. No constraint prefers the selected winner, the total reduplication candidate, and the ERC consists of only L's. It cannot be satisfied with any ranking of the constraints. In a sparse language (13b) with only a single foot per prosodic word, the total reduplication candidate has more unparsed syllables than the non-total candidates do. The only constraint distinguishing the candidates is PS, which assigns fewer violations to the candidate with the smallest reduplicant (σ). In both cases, the constraints assigning L's to the total reduplication candidate are those that are subordinated in the basic rankings in the languages (see the rankings in (7) above).

(13) a. No total reduplication: Dense languages

Input	Winner	Loser	TROCH	IAMB	PS	AωL	AFL
R+3σ	[**Rr-R**b-Bb]	[**R**b-Bb]		L			L

b. No total reduplication: Sparse languages

Input	Winner	Loser	TROCH	IAMB	PS	AωL	AFL
R+3σ	[**Rr-r-**b-b-b]	[**R**b-b-b]			L		

The lack of foot reduplication is due to the impossibility of an even reduplicant with an odd base in PR. The resulting form is odd parity, containing either an unparsed syllable or a unary foot, and thus violating PS or both foot type constraints, respectively. In strongly dense languages, the additional foot also incurs a violation of AFL. Tableau (14) shows that candidates of the form $rr+b^{2n+1}$ (odd base, even reduplicant) are harmonically bounded by candidates of the form $rr+b^{2n}$ (odd base, odd reduplicant), which can have FBP. Any constraint that distinguishes between the candidates assigns the selected winner an L.

(14) Harmonic bounding of 2σ reduplication with an even base (dense language)

Input	Winner	Loser	TROCH	IAMB	PS	AωL	AFL
R+3σ	[**R**-**R**b-Bb]	[**R**b-Bb]	L	L			L
R+3σ	[**Rr**-Bb-b]	[**R**b-Bb]			L		

The typology of PR shows that the interaction of the prosodic constraints alone constrains the range of possible and impossible reduplication paradigms. No constraint refers to morphology; the only reference to the reduplicant is the requirement in GEN that the reduplicant be realized. In such a system, uniform σ reduplication is possible but foot and total reduplication paradigms are impossible.

3.2 *PBR* PBR is obtained from PR by the addition of the base-reduplicant correspondence constraint BR.MAX in CON. This constraint makes explicit reference to the reduplicative morpheme and is violated whenever it is less-than-total. The inclusion of BR.MAX results in the possible optimality of total reduplication candidates with all density types. No other changes to the typology of PR occur: a uniform foot reduplicant is still not possible. The languages of PBR are schematized in (15).

(15) Languages of PBR

Density	***Reduplicants***	***R+3σ***	***R+4σ***
Sparse	σ	[**R**b-b-b]	[**R**b-b-b-b]
	Total	[**Rr-r**-b-b-b]	[**Rr-r-r**-b-b-b-b]
Weakly dense	σ, F	[**R**b-Bb]	[**Rr**-Bb-Bb]
	Total	[**Rr-R**b-Bb]	[**Rr-Rr**-Bb-Bb]
Strongly dense	σ	[**R**b-Bb]	[**R**-Bb-Bb]
	σ, F	[**R**b-Bb]	[**R**r-Bb-Bb]
	Total	[**Rr-R**b-Bb]	[**Rr-Rr**-Bb-Bb]

There is no single ranking condition shared by all the total or non-total reduplicating languages: which constraints must be dominated by BR.MAX in a given language depends on their ranking relative to the other prosodic constraints in the system. In both sparse and dense languages, the constraints that conflict with BR.MAX are dominated in the language: AFL and Fsub in dense languages (16a) and PS in sparse languages (16b). It is these constraints that are violated by the additional structure in forms with total reduplication. The first rows of the tableaux in (16) show the ERCs for dense and sparse languages with non-reduplicated forms. The same constraints dominated here must be dominated by BR.MAX for total reduplication. The non-total paradigms require the reverse rankings.

(16) Total reduplication

a. Dense trochaic language

Input	Winner	Loser	BR.MAX	TROCH	IAMB	PS	AωL	AFL
5σ	Dense	Sparse			L	W		L
R+3σ	[**Rr-R**b-Bb]	[**R**b-Bb]	W		L			L

b. Sparse trochaic language

Input	Winner	Loser	BR.MAX	TROCH	IAMB	PS	AωL	AFL
5σ	Sparse	Dense			W	L		W
R+3σ	[**Rr-r**-b-b-b]	[**R**b-b-b]	W			L		

The typology of PBR differs from PR only in the inclusion of total reduplication; CON_{PBR} differs from CON_{PR} only in the inclusion of BR.MAX. As in PR, uniform foot reduplication does not occur. For that to be possible, the reduplicant cannot be parsed with the base as a continuous prosodic unit, requiring a recursive prosodic word structure and reference to morphological structure.

3.3 *PBRM* PBRM builds on PBR with the addition of the morpho-prosodic alignment constraint ASL in CON_{PBRM} and includes all three of the uniform target paradigms. In this system, recursive structures occur as optimal, and recursion is controlled through the interaction of ASL with the prosodic word alignment constraint AωL and the prosodic constraints. Recursive optima also bring into conflict constraints that were not crucially ranked with regard to one another in the previous systems, thus further refining the rankings. The languages in this typology are shown in (17). Two new nonuniform paradigms occur that show interesting variations on the basic types: σ, T: σ with an odd bases, total with even; and Fn: the maximal number of binary feet, no additional syllables. Prosodic shapes are abbreviated as "N", non-recursive; "R", recursive; and "RN" for languages having both.

(17) Languages of S_2

Density	***Reduplicants***	***Prosodic Shape***	***R+3σ***	***R+4σ***
Sparse	σ	N	[**R**b-b-b]	[**R**b-b-b-b]
	Total	N	[**Rr-r**-b-b-b]	[**Rr-r-r-**b-b-b-b]
	σ	R	[**r**[Bb-b]]	[**r**[Bb-b-b]]
	Total	R	[**r-r-r**[Bb-b]]	[**r-r-r-r**[Bb-b-b]]
Weakly dense	σ	N	[**R**b-Bb]	[**R**b-Bb-b]
	σ, F	N	[**R**b-Bb]	[**Rr**-Bb-Bb]
	σ, F	RN	[**R**b-Bb]	[**Rr**[Bb-Bb]]
	σ, T	RN	[**R**b-Bb]	[**Rr-Rr**[Bb-Bb]]
	F	R	[**Rr**[Bb-Bb]]	[**Rr**[Bb-Bb]]
	Fn	R	[**Rr**[Bb-Bb]]	[**Rr-Rr**[Bb-Bb]]
	Total	N	[**Rr-R**b-Bb]	[**Rr-Rr**-Bb-Bb]
	Total	RN	[**Rr-R**b-Bb]	[**Rr-Rr**[Bb-Bb]]
	Total	R	[**Rr-r**[Bb-b]]	[**Rr-Rr**[Bb-Bb]]
Strongly dense	σ	N	[**R**b-Bb]	[**R**-Bb-Bb]
	σ	RN	[**R**b-Bb]	[**R**[Bb-Bb]]
	σ	R	[**R**[B-Bb]]	[**R**[Bb-Bb]]
	σ, F	N	[**R**b-Bb]	[**R**r-Bb-Bb]
	σ, F	RN	[**R**b-Bb]	[**Rr**[Bb-Bb]]
	σ, T	RN	[**R**b-Bb]	[**Rr-Rr**[Bb-Bb]]
	F	R	[**Rr**[Bb-Bb]]	[**Rr**[Bb-Bb]]
	Fn	R	[**Rr**[Bb-Bb]]	[**Rr-Rr**[Bb-Bb]]
	Total	N	[**Rr-R**b-Bb]	[**Rr-Rr**-Bb-Bb]
	Total	RN	[**Rr-R**b-Bb]	[**Rr-Rr**[Bb-Bb]]
	Total	R	[**R-Rr**[B-Bb]]	[**Rr-Rr**[Bb-Bb]]

Prosodic and morphological constituents are related through alignment of their edges. The constraint enforcing such alignment, ASL, has two main effects: 1) it prefers a recursive structure; and 2) in non-recursive structures it prefers smaller reduplicants, minimizing the number of syllables intervening between a stem and a prosodic word edge. In recursive prosodic words, ASL does not distinguish candidates with different size reduplicants, as shown in (6) above. The following subsections explain how uniform and non-uniform recursion arises and how a recursive structure allows for uniform foot reduplication.

3.3.1 *Deriving recursion and non-recursion* In PBRM, no constraint refers directly to recursion: it arises from alignment of morphological and prosodic categories and is inhibited by the prosodic word alignment constraint AωL. Additionally, the prosodic constraints, specifically those favoring FBP, PS and Fdom, interact with ASL and are anti-recursion in contextually-specific ways, allowing for a recursive structure to be optimal with even bases but not odd. The ranking of ASL relative to AωL and to the prosodic constraints determines the distribution of recursive prosodic words in a language in the typology: in all forms, in no form, or in even forms only.

All recursion is driven by morphology and occurs to match the edges of prosodic and morphological constituents. When there is no reduplicant or other affix, the stem is aligned within the single prosodic word, and ASL is fully satisfied by the non-recursive structure (18a). It only distinguishes between recursive and non-recursive candidates with morphologically complex words (18b,c). AωL exerts the opposite pressure: a recursive structure always violates AωL, which aligns non-maximal prosodic words within maximal prosodic words (18b). AωL is purely prosodic, making no reference to morphological categories. It assigns the same number of violations regardless of the morphological complexity of the candidate. In a uniformly non-recursive language, AωL dominates ASL; for any recursive forms to occur in a language, ASL must dominate AωL.

(18) ASL and AωL violations

Output	ASL	AωL	Comment
a. [stem]ω_{max}	0	0	No affixes: stem and PrWd aligned
b. [prefix-[stem]ω_{nonmax}]ω_{max}	0	1	Internal PrWd is misaligned
c. [prefix-stem]ω_{max}	1	0	Stem is misaligned

ASL≫ AωL is a necessary but not sufficient condition for a language to have recursive structures. Full recursion with all bases only occurs when ASL dominates one of Fdom and Ps in addition to AωL. In strongly dense languages, ASL must also dominate AFL. Because prosodic word boundaries determine the kinds of footing structures possible, the constraints operating at the foot and syllable level have an effect on structure at the prosodic word level, specifically those enforcing FBP. A recursive structure prevents exhaustive binary footing with odd length bases. When both Fdom and Ps dominate ASL, a non-recursive structure is optimal with odd bases.

The table in (19) shows how a recursive structure prevents FBP for total reduplication candidates. The base and reduplicant cannot be footed together; one syllable in each is unparsed, violating with Ps (19a); or parsed as a unary foot, violating foot-type constraints (19b). A non-recursive form achieves FBP by footing the base and reduplicant together, fully satisfying both Ps and Fdom (19c). The table in (19) further shows that Ps and Fdom are only anti-recursive with odd bases. They cannot distinguish between non-recursion and recursive candidates with even bases, as both base and reduplicant satisfy FBP (19d,e). With even bases, the only constraints distinguishing the candidates are ASL and AωL.

(19) Recursive structure prevents FBP with odd bases

Input	Output	FBP
R+3σ	a. [**Rr**-**r**[Bb-b]]	No: unparsed syllables
	b. [**R**-**Rr**[B-Bb]]	No: unary feet
	c. [**Rr**-**R**b-Bb]	Yes
R+2σ	d. [**Rr**-Bb]	Yes
	e. [**Rr**[Bb]]	Yes

The odd-/even-parity sensitivity of Ps and Fdom to recursion results in languages of the typology with both structures in a single language. The ranking support in (20) illustrates such a recursive/non-recursive paradigm for a dense language with total reduplication in a trochaic language. Both Ps and TROCH (Fdom) dominate ASL (ERCs 1 & 2), resulting in the optimality of non-recursive outputs with odd bases. With even bases, the choice of a recursive structure is made by the ranking ASL≫AωL (ERC 4). For these bases, both recursive and non-recursive candidates pass through the filtration of TROCH and Ps, allowing the choice to be made by ASL, which prefers the recursive candidate. Finally, the ranking of BR.MAX ≫ ASL selects the total reduplication candidate as optimal, though this candidate has greater misalignment of the stem from the left edge of a prosodic word boundary than in the non-total candidate (ERC 3).

(20) Recursion and non-recursion: Dense languages

ERC	Input	Winner	Loser	TROCH	Ps	BR. MAX	ASL	AωL	IAMB	AFL
1	R+3σ	[**Rr**-**R**b-Bb]	[**R**-**Rr**[B-Bb]]	W			L	W	W	W
2	R+3σ	[**Rr**-**Rr**-Bb]	[**Rr**-**r**[Bb-b]]		W		L	W	L	L
3	R+3σ	[**Rr**-**R**b-Bb]	[**R**b-Bb]			W	L		L	L
4	R+2σ	[**Rr**[Bb]]	[**Rr**-Bb]				W	L		

Full recursion with all bases is only possible when ASL dominates either one of PS or TROCH. In this case, uniformity of prosodic structure is driven by morphological alignment, at the expense of FBP with all outputs. Full recursion is also necessary for foot reduplication, as shown in the next subsection.

3.3.2 *Foot reduplication* Uniform foot reduplication is only possible in a system that contains a constraint preventing the base and reduplicant from being footed together, here ASL. In PR or PBR, an F reduplicant with an odd base was never optimal over a σ reduplicant, which allows for FBP. With a recursive structure, the reduplicant cannot be footed with the base regardless of its size. Altering reduplicant size cannot alleviate violations of PS or the foot type constraints incurred by an odd base. The two morphemes are treated as independent units for parsing. A single binary foot reduplicant is the minimal binary unit satisfying PS and Fdom. The ranking support for a foot-reduplicant language is given in (21). A smaller, σ, reduplicant violates either Fdom, as a unary foot, or PS (ERC 3). A larger reduplicant has additional violations of Fsub and AFL (ERC 4). As shown above in section 3.3.1, ASL must dominate both AωL and one of PS or Fdom, here PS (ERC 2) for recursion to occur with all bases.

(21) Foot reduplication in a weakly dense language

ERC	Input	Winner	Loser	TROCH	ASL	PS	AωL	IAMB	AFL	BR.MAX
1	R+3σ	[**Rr**[Bb-b]]	[**Rr**[B-Bb]]	W		L		W	W	
2	R+3σ	[**Rr**[Bb-b]]	[**R**b-Bb]		W	L	L			W
3	R+3σ	[**Rr**[Bb-b]]	[**r**[Bb-b]]			W		L	L	W
4	R+4σ	[**Rr**[Bb-Bb]]	[**Rr**-**Rr**[Bb-Bb]]					W	W	L

The presence of ASL is crucial: in ERC 3 in (21), PS favors the σ, non-recursive candidate. Reversing the ranking of ASL and PS results in a paradigm with nonuniformity of both size and shape: odd bases have σ reduplicants and non-recursive forms; even bases have F reduplicants and recursive forms (22). All reduplicated forms have FBP in this paradigm.

(22) σ, F reduplication, R and N shapes

ERC	Input	Winner	Loser	TROCH	PS	ASL	AωL	IAMB	AFL	BR.MAX
1	R+3σ	[**R**b-Bb]	[**Rr**[Bb-b]]	W		L	W		L	L
2	R+3σ	[**R**b-Bb]	[**r**[Bb-b]]		W	L	W	L	L	
3	R+2σ	[**Rr**[Bb]]	[**Rr**-Bb]			W	L			
4	R+4σ	[**Rr**[Bb-Bb]]	[**Rr**-**Rr**[Bb-Bb]]					W	W	L

ASL allows for the optimality of uniform F reduplication. The interaction of the constraints of the system leads to other nonuniform combinations of sizes and shapes being possible in a language, including the language shown in (22). Such paradigms are driven by FBP. They are entailed by any constraint system with constraints violated by unparsed syllables and unary feet and a GEN that allows for variation in the length of outputs, whether the length variation is due to added morphemes, as in the case here, or deletion and epenthesis, as studied in Hyde (2012a) and McManus (in prep.). The preference for FBP also has effects at higher levels of prosodic structure, thus influencing the distribution of recursive prosodic words. The nonuniform paradigms are driven by the prosodic constraints; uniform recursion and foot reduplication are only possible when morpho-prosodic alignment dominates ate least one of the FBP constraints, PS and Fdom.

4 Conclusions

A basic prosodic system restricts the possible forms of a reduplicative morpheme. Total reduplication paradigms only occur with the addition of a base-reduplicant correspondence constraint (BR.MAX) to CON. Single binary foot reduplication only occurs with the addition of a constraint referring to morphology (ASL), which, when undominated, prevents the base and reduplicant from being footed continuously in the same prosodic word. The systems resulting from these alterations to CON built on and refine one another, producing systems with increasing complexity that retain all languages from the previous systems.

The interaction of the prosodic constraints in CON and the variation of size and shape permitted by GEN entail the presence of languages showing FBP effects. FBP can influence the choice of both reduplicant size and prosodic structure, having anti-recursive properties in specific contexts. Foot and syllable parsing constraints interact with higher levels of the prosodic hierarchy to derive the prosodic shape of morphologically complex words.

Empirical attestation of FBP effects is most visible in non-reduplicative affixation. In Shipibo (Faust 1973, González 2005) and Yidiɲ (Dixon 1977), affixation is conditioned by the parity of the stem. Such effects are less apparent in documented reduplication paradigms. One potential case is Pohnpeian quantity-sensitive reduplication (Rehg & Sohl 1981), where the reduplicant varies between a heavy and light syllable depending on the weights of the first two syllables of the base. Another example is Northeast Ambae reduplication (Hyslop 2001), where in some reduplicative paradigms the reduplicant varies between one and two syllables. However, it is not clear here whether the relevant distinction is between even and odd bases or 2σ bases and bases greater than 2σ. Other cases could exist that were originally analyzed as separate reduplication paradigms, one of syllable reduplication and one foot, though further research is needed here. An additional reason for the lack of attestations of the σT and Fn paradigms could be due to the fact that these can only be disambiguated from σF and F reduplication, respectively, when the bases contains four or more syllables, which are relatively rare in many languages. Identification or learning of these patterns could be hindered by lack of relevant data.

References

Alber, Birgit & Prince, Alan. In prep. *Typologies.*

DelBusso, Natalie. 2014. Paradigmatic nonuniformity: Prosodic effects on reduplicative form. Ms. Rutgers University.

Dixon, R.M.W. 1977. *A Grammar of Yidiɲ*. Cambridge University Press.

Downing, Laura. 2006. *Canonical forms in prosodic morphology.* Oxford: Oxford University Press.

Faust, Norma. 1973. *Lecciones para el aprendizaje del idioma Shipibo-Conibo*. Instituto Linguistico de Verano.

González, Carolina. 2005. Phonologically-conditioned allomorphy in Panoan: Towards and analysis. *UCLA Working Papers in Linguistics 11: Papers in Phonology* 6: 39-56.

Hall, Nancy 2000. Max-position drives iterative footing. In Karine Megerdoomian and Leora Anne Barel (eds.), *WCCFL 20 Proceedings*, 101-114. Somerville, MA: Cascadilla Press.

Hyde, Brett 2012a. The odd-parity input problem in metrical stress theory. *Phonology* 29: 383-431.

Hyde, Brett. 2012b. Alignment constraints. *Natural Language and Linguistic Theory* 30: 789-836.

Hyslop, Catriona. 2001. *The Lolovoli dialect of the North-East Ambae languages, Vanuatu.* Canberra, Australia: Pacific Linguistics.

Ito, Junko & Mester, Armin. 2012. Recursive prosodic phrasing in Japanese. In Toni Borowsky, Shigeto Kawahara, Takahito Shinya, & Mariko Sugahara (eds.) *Prosody matters: Essays in honor of Elisabeth Selkirk*, 280-303. Advances in Optimality Theory, London: Equinox.

Marantz, Alec. 1982. Re: Reduplication. *Linguistic Inquiry* 11(3): 435-482.

McCarthy, John J. & Prince, Alan. 1986. *Prosodic Morphology*. Ms., University of Massachusetts, Amherst, and Brandeis University, Waltham, Mass.

McCarthy, John J. & Prince, Alan. 1993. *Prosodic Morphology: Constraint interaction and satisfaction*. RuCCS-TR-3. New Brunswick, NJ: Rutgers University Center for Cognitive Science. ROA-482, http://roa.rutgers.edu.

McCarthy, John J. & Prince, Alan. 1994. The emergence of the unmarked: Optimality in prosodic morphology. In Mercè Gonzàlez (ed.), *Proceedings of NELS 24:* 333-379. Amherst, MA: GLSA. ROA-13, http://roa.rutgers.edu.

McManus, Hope. in prep. Interactions of stress and deletion in M, F-OT. PhD dissertation, Rutgers University.

Moravcsik, Edith A. 1978. Reduplicative constructions. In Joseph H. Greenberg (ed.), *Universals of human languages. Volume 3: Word structure,* 297-334. Stanford University Press.

Prince, Alan. 2002. Entailed Ranking Arguments. ROA-500, http://roa.rutgers.edu.

Prince, Alan, Tesar, Bruce, & Merchant, Nazarré. 2013. OTWorkplace. Available at: http://ruccs.rutgers.edu/~prince/.

Rehg, Kenneth .L. & Sohl, Damian G. 1981. *Ponapean Reference Grammar.* Honolulu: University of Hawaii Press.