On Reduplication in Fox[*]

1. Introductory Remarks

Fox (Mesquakie), which is a member of the Algonquian family, is spoken by around 800 speakers in Iowa, on the Kansus-Nebraska border, and in central Oklahoma (Lyovin 1997: 314). This language has two distinct patterns of reduplication[1,2] illustrated in (1): monosyllabic reduplication, which expresses continuative or habitual aspect, and bisyllabic reduplication, which indicates iterative aspect, either an action repeated over a period of time or an action distributed over a group of subjects or objects:

(1)	Base	Monosyllabic Reduplication	Bisyllabic Reduplication
	no.wi:-wa.	na:.-no.wi:.-wa.	no.wi.-no.wi:.-wa.
	'he goes out'		

In the examples above, *-wa* is an inflectional suffix meaning masculine third person singular. The application of monosyllabic reduplication to the base *no.wi:-wa.* yields *na:.-no.wi:.-wa*, which involves continuative or habitual aspect, meaning 'he is (usually) going out.' If bisyllabic reduplication applies to the base, the surface form *no.wi.-no.wi:.-wa.* is derived, which involves iterative aspect, meaning 'he keeps on going out.'

The reduplication system in Fox has been noted in earlier works (Bloomfield 1925, 1927; Voorhis 1971; Dahlstrom 1997; among others). However, they basically focus on the description of the data. This paper and my subsequent works try to account for the data, with respect to Optimality Theory (henthforth, OT), as originally proposed by Prince and Smolensky (1993) and

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1 All data are drawn from Dahlstrom 1997 unless specified.

2 Reduplication applies to verbs, adverbs, numbers, quantifiers, and particles known as prenouns and preverbs (Dahlstrom 1997: 205). The facts described in the following are basically on verb reduplication.

McCarthy and Prince (1993) and developed in various studies mainly in the field of phonology.

Specifically, I would like to focus on the size restriction of each type of reduplication and give an analysis within the OT framework without using templatic constraints. I also would like to discuss the notion of minimal words by reducing it to general OT constraints. In particular, I would like to adopt Ussishkin's (2000) and Itô and Mester's (1992) system, and explore how their system can capture the facts in Fox and the notion of minimal words.

Ussishkin (2000) and Itô and Mester (1992) claim that binarity requirement can be reducible to two general requirements, Hierarchical Alignment and Prosodic Branching defined in the following:

(2) a. Hierarchical Alignment:

$=_{def.}$ PCat1 PCat2 [PCat2 PCat1 & Align (PCat2, PCat1)]

(≡ Every prosodic constituent is aligned with some prosodic constituent containing it.) (Ussishkin 2000: 53)

b. Prosodic Branching:

$=_{def.}$ A prosodic category i must be branched at level i or i-1, where "branch" is defined as follows: A prosodic category branches if and only if it contains more than one daughter. (Ussishkin 2000: 43)

The reason why we adopt their analyses is that they contribute to formalize the minimality and maximality requirements of prosodic structures nicely. Many works have been paying attention to binarity restrictions in prosodic categories. For example, within the OT framework, the binarity requirement for feet has been formalized as FT-BIN. This constraint plays an important role in the OT works. However, it contains several flaws and I believe it should be refined. First, FT-BIN is used with respect to two categories, syllable and mora. Thus, it should be treated as two separate constraints or should be relativized. However, the two types of FT-BIN naturally follow from Ito and Mester's or Ussishkin's mechanism. Next, it seems that FT-BIN is too powerful in that it would ban both unary branching and any structure greater than binary. It means that FT-BIN has a dual function and works for both minimality and maximality effects. Thus, it is worth considering how the dual function of FT-BIN falls on more basic constraints. In what follows, I would like to argue that hierarchical alignment and prosodic branching lead us to one of the possible ways to redefine FT-BIN and other binarity requirement.

The claims that I would like to make in this paper are summarized as follows. First, Bisyllabic reduplication should be regarded as an instance of compounding while monosyllabic reduplication is an affixal reduplication. It follows that bisyllabic reduplicants form prosodic words while monosyllabic reduplicants do not. Second, bisyllabic reduplicants are considered as minimal words in Fox. It leads us to conclude that we need a prosodic category above PrWd. Third, it is hierarchical alignment and prosodic branching as proposed by Ussishkin and Itô and Mester that determine the size of reduplicants and minimal words.

2. Preliminary Background

Before proceeding, we briefly go over background information on Fox phonology. First of all, according to Dahlstrom (1997), Fox has the following inventory of consonants and vowels:

(3) a. Consonants in Fox

p	t	tʃ	k	k^w	
	s	ʃ			h
m	n				
w		y			

b. Vowels in Fox (vowel length is distinctive)

i		
e		o
	a	

Syllable structure in Fox is relatively simple, as illustrated in (4):

(4) Syllable structure in Fox: (C)(G)V(:)(C)

Although both onset and coda consonants are allowed in Fox, there are some restrictions. First, the second consonant in the onset position must be a glide. Second, only two consonants are allowed in the coda: [ʃ], which appears only before a syllable with a [k] or [k^w] onset consonant, and [h], which appears before stops and [w]. Third, an onsetless syllable is possible but only word-initially.

We have observed the basic Fox phonology in this section. Keeping it in mind, we will consider size restriction in Fox reduplication in the next section.

3. Size Restriction

There are two types of reduplication in Fox, that is, monosyllabic reduplication and bisyllabic reduplication. We need constraints with respect to each type, in order to derive the differences in size and distinct behaviors in these two types. Following Urbanczyk (1995), I assume two different MAX-BR constraints for each reduplication system:

(5) a. Max-BR_{con}: Every segment of the base has a correspondent in the "continuative (=monosyllabic)" reduplicant.
b. Max-BR_{ite}: Every segment of the base has a correspondent in the "iterative (=bisyllabic)" reduplicant. (cf. Urbanczyk 1995)

3.1 Against Templatic Constraints

Before proceeding to the analysis, I would like to note several problems for a templatic approach to size restriction on reduplication. Templatic constraints have been used as a size-restrictor for reduplicants in early studies. Although it seems that templatic constraints successfully describe the facts, they are problematic conceptually. First, we need to assume several types of templates (e.g., RED = σ; RED = σσ, etc.), which seems *ad hoc* under the spirit of OT; constraints are universal across languages. Second, I believe that templates are the 'description', not the 'explanation'. Instead of describing the size restriction by stipulating that the template for the reduplicant in a given language is, say, monosyllabic, we have to go on to the next step. That is, we need to explain why the reduplicant is of this shape. Third, as discussed in various studies, templatic constraints involve a potential problem, known as Kager-Hamilton paradox (McCarthy and Prince 1999). To illustrate the problem, consider the following tableau:

(6) Diyari: RED = MINWD, MAX-IO >> MAX-BR

	/RED-t^jilparku/	RED = MINWD	MAX-IO	MAX-BR
	a. t^jilparku- t^jilparku	*!		
	b. t^jilpa- t^jilpa		*!**	
☞	c. t^jilpa- t^jilparku			***

In the above tableau, the reduplication system in Diyari is analyzed with a templatic constraint, that is, RED =MINWD. With RED=MINWD dominating MAX-BR, we get the desirable candidate, which is (c). However, a problem arises if we adopt templatic constraints. Suppose Diyari', in which the above constraints are permutated:

(7) RED = MINWD, MAX-BR >> MAX-IO

	/RED-t^jilparku/	RED = MINWD	MAX-BR	MAX-IO
	a. t^jilparku- t^jilparku	*!		
☞	b. t^jilpa- t^jilpa			***
	c. t^jilpa- t^jilparku		*!**	

In Diyari' the templatic constraint (i.e., RED=MINWD) dominates MAX-IO. What is the consequence? The existence of templatic constraints leads to predict the existence of languages like Diyari' in which the templatic constraint changes the shape of the base as the winning candidate (b) indicates. Along with the spirit of OT, we are forced to claim that there must be such languages, however, in fact there does not exist such a language.

So far, we have considered potential problems that lie in templatic approaches. In what follows, we will pursue an atemplatic solution for the size restriction in Fox reduplication.

3.2 Monosyllabic Reduplication

First, let us consider the data:

(8) Data

ke.te.mi.na.w-e:.wa.	<u>ke</u>:.-ke.te.mi.na.w-e.wa	'he blesses him'
me:.me.na.t-a.mwa.	<u>me</u>:.-me:.na.t-a.mwa	'he vomits'
tʃi:.ta.pi.-wa.	<u>tʃa</u>:-tʃi:.ta.pi.-wa	'he sits up'
mo:h.ki:h.ta.w-e:.wa	<u>ma</u>:-mo:h.ki:h.ta.w-e:.wa	'he attacks him'
pa.ka.m-e:.wa.	<u>pa</u>:.-pa.ka.m-e:.wa.	'he goes out'
k^wi:.na.ta.wi.	<u>k^wa</u>:.-k^wi:.na.ta.wi.	'at a loss'(preverb)

As the above data suggests, monosyllabic reduplicant should be monosyllabic and bimoraic. We would like to derive this fact without templatic constraints. Then, as a size restrictor for monosyllabic reduplication, we adopt two constraints that have been proposed in previous studies:

(9) a. ALIGN-σ-L
=$_{\text{def.}}$ Align (σ, L, PRWD, L))
b. REALIZE-MORPHEME (cf. Walker 2000, among many others):
=$_{\text{def.}}$ A morpheme must have some phonological exponent in the output.

The constraint in (9a) works as a size minimizer in that it prefers minimal phonological structures. However, if we have this constraint only, we could predict that all the words must be monosyllabic irrespective of morphological structure. Therefore, we need another constraint, REALIZE-MORPHEME, which requires a morpheme to have some phonological output. Given the constraints shown above, we would like to suppose the following ranking for Fox monosyllabic reduplication:

(10) REAL-M, MAX-IO >> ALIGN-σ-L >> MAX-BR$_{\text{CON}}$

Since ALIGN-σ-L is ranked between MAX-IO and MAX-BR, the size restriction of the reduplicants can be considered as an instance of TETU effect in the sense of M&P 1995, among others. The following tableau illustrates the consequence of the above ranking:

(11) REAL-M, MAX-IO >> ALIGN-σ-L >> MAX-BR$_{CON}$

	/RED-pakam-e:wa/	REAL-M	MAX-IO	ALIGN-σ-L	MAX-BR$_{CON}$
☞	a. pa:.-pa.ka.m-e:.wa.			****	kame:wa
	b. pa:ka.me:wa.-pa.ka.m-e:.wa.			*****!**	
	c. pa:-pa.		k!ame:wa	*	
	d. ø - pa.ka.m-e:.wa.	*!		***	pakame:wa

Because of REALIZE-MORPHEME, candidate (d), which does not have any phonological output for the reduplicant, is excluded. As the candidate (c) suggests, we cannot delete any element in the base, which incurs the violation of MAX-IO. However, ALIGN-σ-L crucially dominates MAX-BR$_{CON}$, which makes the reduplicant as minimal as possible. As a result, we get candidate (a) as the winner.

However, as we have observed, the monosyllabic reduplicant should be bimoraic. None of the constraints used in (11) works to make a heavy syllable. That is why candidate (a) and (b) in (12) are tied:

(12) Why long?

	/RED-pakam-e:wa/	REAL-M	MAX-IO	ALIGN-σ-L	MAX-BR$_{CON}$
??	a. pa:.-pa.ka.m-e:.wa.			****	kame:wa
??	b. pa.-pa.ka.m-e:.wa.			****	kame:wa

How can we resolve this problem? Here I want to claim is that Branching requirement plays a crucial role. I propose a constraint Foot-Branch, which follows from the definition of prosodic branching requirement:

(13) Branching Requirement:
FOOT-BRANCH =$_{def.}$ Feet must branch.

Notice that FOOT-BRANCH is part of the reinterpretation of FOOT-BIN. Namely, FOOT-BIN follows from the more general requirement; prosodic branching[3].

[3] It should be noted that Foot-Branch does not rule out trimoraic or trisyllabic feet. Constraints such as ALIGN-MORA-FOOT (every mora must be aligned with the edge of foot containing it) and ALIGN-SYLLABLE-FOOT (every syllable must be aligned with the edge of foot containing it) are needed to derive FOOT-BIN effects. Notice that both constraints follow from hierarchical alignment proposed by Ussishkin (2000) and Ito and Mester (1992).

Then, let me analyze prosodic structure in Fox. If we take several alignment constraints into consideration, it can be concluded that the reduplicant forms a bimoraic foot. First of all, assume a monosyllabic reduplicant is an affix. It can be supported by the fact that monosyllabic reduplicants are more phonologically unmarked than bisyllabic reduplicants. For example, consider the vowel quality of the monosyllabic reduplicant. It seems that the vowel is prespefied, and can be analyzed as an instance of TETU. Suppose this morphological information is specified in the lexicon, which can be stated with the following constraint:

(14) RED_{CON} = AFFIX (cf. RED_{ITE} = STEM)

In addition to the lexicalized information as in (14), we tentatively assume that a monosyllabic reduplicant is an external affix in the sense of McCarthy and Prince 1994. Since the base is a stem, it forms a prosodic word, by assuming the alignment constraint, which is ALIGN-L(STEM, PRWD) proposed by McCarthy and Prince, which is defined as follows:

(15) ALIGN-L(STEM, PRWD) $=_{\text{def.}}$ Align(Stem, L, PrWd, L)

We will consider this issue closely in the next section. In addition, we need another constraint, ALIGN-AFF-PRWD whose definition is given in the following:

(16) ALIGN-AFF-PRWD $=_{\text{def.}}$ Align (Red_{con}, R, PrWd, L)

If what we have discussed is on the right track, we have a morpheme which is outside of a prosodic word made by the stem. Here, I would like to claim that the prosodic word formed by the stem and the external affix is embedded in a larger prosodic category, which I call PrWd'. Assuming so, I would like to use another alignment constraint ALIGN-L(PRWD', FT) defined in (17):

(17) ALIGN-L(PRWD', FT) $=_{\text{def.}}$ Align(PrWd', L, Ft, L)

Let us examine the consequences of the constraints in (14)-(17). Consider the following tableaux:

(18) Consequences

ALIGN-L(STEM, PRWD), ALIGN-AFF-PRWD

		ALIGN-L (STEM, PRWD)	ALIGN-AFF-PRWD
☞	a. $(_{Ft}$ Red$_{con}$)- [$_{PrWd}$ {$_{Stem}$($_{Ft}$ Base….}]		
☞	b. Red$_{con}$-[$_{PrWd}$ {$_{Stem}$ ($_{Ft}$ Base….}]		
	c. [$_{PrWd}$ ($_{Ft}$ Red$_{con}$-{$_{Stem}$ Base) ….}]	*!	
	d. [$_{PrWd}$ ($_{Ft}$ Red$_{con}$)-{$_{Stem}$ ($_{Ft}$ Base ….}]		*!

In (18), ALIGN-L(STEM, PRWD) eliminates candidate (c) in which a foot is formed across the stem boundary, because this foot formation forces the discrepancy between PrWd and Stem. In addition, candidate (d) in which the reduplicant is embedded in a PrWd is excluded because of the misalignment of the left edge of the PrWd and the right edge of the reduplicant. As a result, we have two candidates, that is, (18a), in which the reduplicant is footed, and (18b), in which the reduplicant is not footed. Then, ALIGN-L(PRWD', FT) comes into play to rule out (18b), as follows:

(19) ALIGN-L(PRWD', FT)

		ALIGN-L(PRWD', FT)
☞	a. [$_{PrWd'}$ ($_{Ft}$ Red$_{con}$)- [$_{PrWd}$ ($_{Ft}$ Base….]	
	b. [$_{PrWd'}$ Red$_{con}$-[$_{PrWd}$ ($_{Ft}$ Base….]	*!

As a consequence, we have candidate (a) as the winning candidate. The prosodic structure of candidate (a) can be schematized as follows:

(20) Prosodic Structure: [$_{PrWd'}$ ($_{Ft}$ RED$_{con}$) –[$_{PrWd}$ ($_{Ft}$ BASE ….)]]

I am fully aware that this is a very theoretically internal conjecture that is speculative. I need to justify the conjecture empirically. However, suppose that we are on the right track and that (20) is the prosodic structure for monosyllabic reduplicants, let us consider the following tableau:

(21) ALIGN-σ-L, FT-BRANCH>> MAX-BR$_{CON}$

		/RED-pakam-e:wa/	ALIGN-σ-L	FT-BRANCH	MAX-BR$_{CON}$
☺	a.	(pa:).-pa.ka.m-e:.wa.			kame:wa
	b.	(pa).-pa.ka.m-e:.wa.		*!	kame:wa
	c.	(pa.ka).-pa.ka.m-e:.wa.	*!		mewa

Given the assumption that a monosyllabic reduplicant forms a foot, the desirable result can be drawn. Candidate (b), which contains a degenerate foot, violates FT-BRANCH since it does not contain prosodic branching. Although Candidate (c) satisfies FT-BRANCH, it contains more violations of ALIGN-σ-L than candidate (a) does, therefore it is excluded. As a result, we get candidate (a) as the winner, which we desire.

To sum up the discussion so far, we have considered the size restriction on monosyllabic reduplication. We have claimed that two constraints play a crucial role in determining the size: the size minimizer (i.e., ALIGN-σ-L) and the size maximizer (i.e., FT-BRANCH), which outrank MAX-BR$_{CON}$. In the next subsection, we will consider the size restriction on bisyllabic reduplicaton.

3.3 Bisyllabic reduplication

This subsection deals with bisyllabic reduplication in Fox. Before proceeding, let us review the relevant data again:

(22) Data

a.	ka.na.wi-wa.	ka.na.-ka.na.wi-wa	'he speaks'
	me.na.h-e:.-wa.	me.na.-me.na.h-e:wa.	'he makes him drink'
	mya:.ʃi.na.we:.h-e:.-wa.	mya:.ʃi.-mya:.ʃi.na.we:.h-e:.wa.	'he makes him feel bad'
	mah.ka.te:.wi:.-wa.	mah.ka-mah.ka.te:.wi:.-wa.	'he fasts'
	wa:.pa.ʃim-e:.wa.	wa:.pa.-wa:.pa.ʃim-e:.wa.	'he ridicules him'
	ko.k^{w}a:ʃ.ke:.-wa.	ko.k^{w}a-ko.k^{w}a:ʃ.ke:.-wa.	'he is jerked'
b.	vowel shortening in the last syllable		
	a:.mi:.-wa.	a:mi- ha:mi:-wa.	'he moves camp'
	tʃi:.pi:.kwe:.-wa.	tʃi:.pi .-tʃi:.pi:.kwe:.-wa.	'he winks'
	ma.yo:.-wa.	ma.yo .-ma.yo:.-wa.	'he cries'
c.	No coda is allowed		

ne.neh.ke:.ne.m-e:.-wa. ne.ne .-ne.neh.ke:.ne.m-e:.-wa.'he thinks about him'
na.kiʃ.kaw-e:.na. na.ki .-na.kiʃ.kaw-e:.na. 'he meets him'

Basically, the first two syllables are reduplicated, but if the second syllable contains a long vowel, it is shortened in the reduplicant. Also, no coda is allowed in the second syllable of the reduplicant. From the above data, we can observe the following things. First, reduplicants are strictly bisyllabic. Second, the restrictions on the second syllable in the reduplicant are similar to the ones on the word-final position (i.e., all words in Fox must end with a short vowel). Note that all words in Fox except one are at least bisyllabic[4].

Given these facts, it is natural to conclude that the bisyllabic reduplicant forms a prosodic word by itself. I would like to propose the prosodic structure as in (23), in which prosodic words are formed by the reduplicant and by the base, respectively. The prosodic words are embedded in a bigger prosodic word, which I call PrWd', as we suppose in considering prosodic structure for monosyllabic reduplication. The structure we propose is the following:

(23) Prosodic Strucure: $[_{PrWd'}\ [_{PrWd}$ RED $]$-$[_{PrWd}$ BASE $]]$ (RED= STEM)

This structure is represented as RED=STEM. It seems that this constraint is templatic, but it is not quite. Following McCarthy and Prince 1994, we claim that the iterative reduplicant is specified as a stem in the lexicon, while the continuative reduplicant is specified as an affix. Then, most harmonic state is that a stem equals to a prosodic word, which can be analyzed via alignment constraints given in (24):

(24)a. ALIGN-LEFT (STEM, PRWD) $=_{def.}$ Align (Stem, L, PrWd,, L) (= (15))
b. ALIGN-RIGHT (STEM, PRWD) $=_{def.}$ Align(Stem, R, PrWd, R)

Being a stem, the iterative reduplicant is a prosodic word. Therefore, RED_{ITE} = STEM bans the bisyllabic reduplicant which is embedded within a single prosodic word:

[4] There is one exception, the verb *i* ‘say’. However, it occurs with combination of affixes and never occurs alone.

(25) RED$_{ITE}$ = STEM

	/RED$_{ite}$-kanawi-wa/	RED$_{ITE}$=STEM	ALIGN-σ-L
☞	a. [$_{PrWd}$ ka.na.]-[$_{PrWd}$ ka.na.wi-wa]		*
	b. [$_{PrWd}$ ka..-ka.na.wi-wa]	*!	

In (25), candidate (b) is ruled out because the bisyllabic reduplicant do not form a prosodic word by itself.

In addition, I would like to use the cover term 'FINAL-CV' to regulate the well-formedness of the prosodic word-final position. It describes the facts that prosodic words in Fox must end with CV. FINAL-CV is a bundle of constraints that need refinement, however, I tentatively treat it as a single constraint for the sake of exposition in this paper:

(26) PrWd Effect: FINAL-CV = PrWd must end with CV.

FINAL-CV is undominated in Fox. In particular, it dominates FAITH-IO constraints as the following tableaux illustrate:

(27) FINAL-CV: ex. /-ige: / 'dwell' (Bloomfield 1925, 1927, Voorhis 1971)

(i)

	/pi:t-ige:/ 'inside, indoors'	FINAL-CV	MAX-IO(μ)
☞	a. [$_{PrWd}$ pi:tige]		*
	b. [$_{PrWd}$ pi:tige**:**]	*!	

(ii)[5]

	/keht-ige:-ni/ 'farm'	FINAL-CV	MAX-IO(μ)
	a. [$_{PrWd}$ kehtigani]		*!
☞	b. [$_{PrWd}$ kehtiga**:**ni]		

So far we claimed that bisyllabic reduplicants are prosodic words in Fox. It can be regarded as a minimal prosodic word since no word in Fox is monosyllabic. Then, what is counted as minimal prosodic words?

5 The vowel /e:/ in the input is changed to [a:] in the output. I will not consider this vowel change, because it is not relevant to the discussion here, which concerns with the length of the vowel in question.

(28) What is counted as a minimal prosodic word in Fox?

a. ka.na.-ka.na.wi-wa $[_{PrWd}\ (_{Ft}\ \sigma\ \sigma)]$

b. wa:.pa.-wa:.pa.ʃim-e:.wa $[_{PrWd}\ (_{Ft}\ \sigma <\mu\mu>)\sigma\ ]$[6, 7.]

but NOT wa:.-wa:.pa.ʃim-e:.wa $*[_{PrWd}\ (_{Ft}\ \sigma <\mu\mu>)\ ]$

As shown in (28), two types of minimal words should be allowed in Fox. Both are bisyllabic, although, as (28b) suggests, the first syllable may be heavy. It means that the right edge of the foot made by the heavy syllable is not aligned with the right edge of the prosodic word. Then, in order to capture the 'minimal wordness', I would like to propose another constraint which follows from Branching Requirement:

(29) PRWD-BRANCH: PrWd must branch.
(cf. Itô and Mester 1992, Ussishkin 2000)

Given the above definition, we have three potential minimal prosodic words, schematized as follows:

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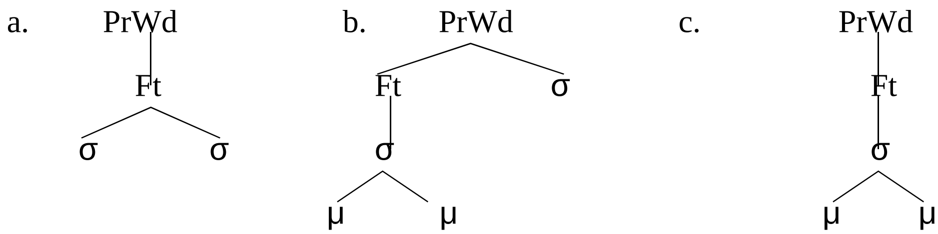
[6] Note that we do not assume the foot of the shape CV:CV (i.e.,$(_{Ft}\ \sigma <\mu\mu>\ \sigma\ )$) since it looks like a weird trochaic foot. In some languages whose stress assignment is based on trochee, vowel shortening takes place to avoid the foot which is of the form CV:CV. See Hayes 1995 (especially, 6.1.5.2). regarding trochaic shortening in Fijian. Therefore, it is natural to conclude that the first heavy syllable forms a foot by itself.

[7] See Spaelti 1997 regarding the relationship between feet and minimal words. It is usually the case that a minimal word coincides with a foot.

(30)[8,9]



The above structures in (30) all satisfy PRWD-BRANCH in that the PrWd contains branching. Here, in order to show that our approach is on the right track, I would like to mention some of the typological facts. First, it should be noted that Japanese truncation shows similar distribution of minimal words to Fox. As shown in (31), Japanese truncation allows at least two types of prosodic words:

(31) Japanese truncation: (30a) and (30b) (but not (30c)) observed[10]
(Itô and Mester 1992).

a. $[_{PrWd}\ (_{Ft}\ \sigma\ \sigma)]$

demo(nsutoreesyon)	'demonstration'
roke(esyon)	'location'

b. $[_{PrWd}\ (_{Ft}\ \sigma <\mu\mu>) \sigma\ ]$

daiya(mondo)	*dai	'diamond'
paama(nento)	*paa	'permanent'

Also, I would like to present an example, suggesting that the (30c) type of minimal words should be allowed. According to Takeda (1998), minimal words in Kammu are at least bimoraic and it is supported by the fact that there is no word which is of the shape of V or CV in that language:

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[8] Note that Ussishkin's formalization of branching requirement (originally, proposed by Selkirk 1984) defined in (2b) would rule out (30c). However, I intentionally make (30c) ruled in by modifying the definition (i.e., the restriction of the level i and i-1), since there are many languages which allow (30c) as a minimal word.

[9] It should be noted that (30a) and (30c) form a natural class with respect to possible minimal words in some languages. We could say that STRICTLAYERING (PrWd must be strictly layered with respect to prosodic hierarchy, cf. Selkirk 1984, Ito and Mester 1996 and Ussishkin 2000) is dominant in these languages. In Fox, however, STRICTLAYERING is supposed to be lower ranked, since it allows (30b) to be a possible minimal word.

[10] Itô and Mester (1992) also note that Japanese truncation allows a structure with two feet (ex. $[_{Wd}(_{Ft}$ seku$)(_{Ft}$ hara$)]$ 'sexual harrasument'). This structure must be banned as Fox minimal words (cf. 36c). We can say that the alignment condition (i.e., σ-ALIGN, defined later in (34)) is low ranked in Japanese truncation while it is highly ranked in Fox.

(32) Kammu: (30c) is regarded as a minimal word. (Takeda 1998)

$[_{PrWd}\ (_{Ft}\ \sigma <\mu\mu>)\ ]$: CVC or CVV

l´h	‘to rise’	luh	‘to have a hole’
cˆa	‘seed’	ka:	‘to climb’

Let us go back to Fox reduplication. Fox does not allow (30c) type of minimal words. However, we already find a solution to ban (30c). Consider the tableaux in (33):

(33) Fox potential ‘minimal words’

(i)

	/RED$_{ite}$-kanawi-wa/	FINAL-CV	PRWD-B	MAX-BR$_{ITE}$
	a. [(ka.)]-[ka.na.wi-wa]		*!	nawiwa
	b. [(ka:.)]-[ka.na.wi-wa]	*!		nawiwa
☺	c. [(ka.na.)]-[ka.na.wi-wa]			wiwa

(ii)

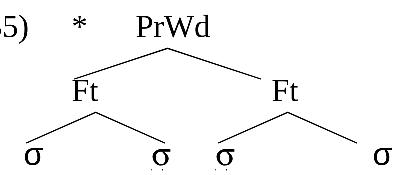
	/RED$_{ite}$-wa:paʃim-e:wa/	FINAL-CV	PRWD-B	MAX-BR$_{ITE}$
	a. [(wa.)]-[wa:paʃim-e:wa]		*!	paʃime:wa
	b. [(wa:.)]-[wa:paʃim-e:wa]	*!		paʃime:wa
☺	c. [(wa:)pa.]-[wa:paʃim-e:wa]			ʃime:wa

In both tableaux, candidate (a)’s are eliminated since they violate PRWD-BRANCH. Candidate (b)’s indeed satisfy PRWD-BRANCH, however, we have FINAL-CV which excludes them since they end with a long vowel.

It seems that minimal wordness in Fox is regulated by the Branching Requirement. However, given the paradigm illustrated in (30), one may wonder how we can block a minimal word that consists of two feet, such as $[_{PrWd}\{_{Ft}\sigma\ \sigma\}\{_{Ft}\ \sigma\ \sigma\}]$ (i.e., *[ka.na.wi.wa].-ka.na.wi-wa). Here, I would like to argue that hierarchical alignment works as a size restrictor. The relevant constraint is σ-ALIGN, defined as follows:

(34) σ-ALIGN: every syllable must be aligned to the edge of a prosodic word containing it. (Ussishkin 2000)

(30a-c) all satisfy σ-ALIGN in that each syllable coincides with either edge of the prosodic word. However, the following structure for $[_{PrWd}\ \{_{Ft}\,\sigma\ \sigma\}\{_{Ft}\,\sigma\ \sigma\}]$ does not satisfy σ-ALIGN:

(35)


The diagram in (35) involves two violations of σ-ALIGN because the second syllable and the third syllable are not aligned to the edge of PrWd.

Given the constraints we have proposed, consider the tableau (36):

(36) CVCV (ALIGN-σ-L: only reduplicants concerned)

	$/RED_{ite}$-kanawi-wa/	PRWD-B	σ-ALIGN	MAX-BR_{ITE}	ALIGN-σ-L
	a. [(ka.)]-[ka.na.wi-wa]	*!		nawiwa	
☺	b. [(ka.na.)]-[ka.na.wi-wa]			wiwa	*
	c. [(ka.na.)wi.]-[ka.na.wi-wa]		*!	wa	**
	d. [(ka.na.)(wi.wa.)]-[ka.na.wi-wa]		*!*		***

In (36), candidate (a), namely, the reduplicant which is monosyllabic, is ruled out by PRWD-BRANCH. Candidate (c) and (d), both of which contain more than two syllables are excluded because of σ-ALIGN. The same things hold to the case of (37):

(37) CV:CV (ALIGN-σ-L: only reduplicants concerned)

	/RED-wa:paʃim-e:wa/	FINAL-CV	PRWD-B	σ-ALIGN	MAX-BR_{ITE}	ALIGN-σ-L
	a. [(wa.)]-[wa:paʃim-e:wa]		*!		paʃime:wa	
	b. [(wa:.)]-[wa:paʃim-e:wa]	*!			paʃime:wa	
☺	c. [(wa:)pa.]-[wa:paʃim-e:wa]				ʃime:wa	*
	d. [(wa:)(pa.ʃi)]-[wa:paʃim-e:wa]			*!	me:wa	**

In the above tableau, Candidate (d) violates σ-Align since the second syllable of the reduplicant is not aligned to any edge of the foot. Candidate (a) with a degenerate foot is ruled out PrWd-Branch. Candidate (b), which contains a bimoraic foot is eliminated by Final-CV. Notice that the size-restrictor for monosyllabic reduplication, which is Align-σ-L, should be crucially dominated by Final-CV and PrWd-Branch, therefore, it is inactive as a size restrictor for bisyllabic reduplication.

So far, we have examined the size restriction on bisyllabic reduplication. We claimed that the branching requirement and the hierarchical alignment determine the possible shape(s) of minimal words, which correctly captures Fox facts. The discussion on the size restriction will be summarized in the next subsection.

3.4 Summary

In the preceding subsections, we have considered two types of reduplication and claimed that branching requirement and hierarchical alignment are important to determine the size for both types. To sum up, the overall constraint ranking is summarized in (38):

(38) Ranking (cf. Stratified ranking by Tesar and Smolensky 1998)

Stratum 1	Final-CV Align-Aff-PrWd	Align-L(Stem,PrWd), Red_{ITE}=Stem	Align-L(PrWd',Ft), Red_{CON}=Affix
Stratum 1 (possibly)	Ft-Branch	Real-Morph	PrWd-Branch
Stratum 2		Max-IO	
Stratum 3	Align-σ-L		σ-Align
Stratum 4	$\text{Max-BR}_{\text{CON}}$		$\text{Max-BR}_{\text{ITE}}$

I would like to note some of the remaining issues in size restriction in Fox reduplication. First of all, I need to refine Final-CV with more general constraints. Next, the ranking between PrWd-Branch and $\text{Max-BR}_{\text{ITE}}$ is not justified empirically in this paper. It seems that the candidates like (36a) and (37a), which crucially violate PrWd-Branch also involve more violations of

MAX-BR$_{ITE}$, comparing with the winning candidates. Nevertheless I assume PRWD-BRANCH dominates MAX-BR$_{ITE}$ for the following reason. Considering language acquisition, it is supposed that MARKEDNESS Constraints dominate FAITHFULNESS constraints in the initial state, according to Tesar and Smolensky 1998, Smolensky 1996 and other works. In the course of acquisition, MARKEDNESS constraints should be demoted by Constraint Demotion Algorithm. Then, in Fox, we do not have any data that make PRWD-BRANCH, which is a MARKEDNESS Constraint, demoted. In other words, PRWD-BRANCH can stay in a stratum that is higher than the one for FAITHFULNESS constraints. Then, it is reasonable to claim that PRWD-BRANCH dominates MAX-BR$_{ITE}$. I will leave these issues open in this paper.

4. Concluding Remarks

In this paper, we examined the patterns of Fox reduplication In particular, we focused on the size restriction of two types of reduplication in Fox and claimed that the hierarchical alignment constraints and branching requirement are crucial in size restriction of the reduplicants. We have considered what minimal words are, with respect to the prosodic hierarchical structure and branching requirement within the OT framework.

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