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Diminutive Reduplication in Modern Hebrew*

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In this paper I explore diminutive reduplication in Modern Hebrew (MH) using an Optimality Theoretic (McCarthy & Prince 1995) framework, which has the advantage of allowing interaction of phonological and morphological constraints regulating the reduplication process. I claim that reduplication in MH stems from general principles of reduplication interacting with principles of fixed prosody. A bisyllabic template with pre-specified vocalic material determines the shape of the diminutive form. The bisyllabic template is motivated through constraint interaction on word size. The infixed reduplicant is responsible for reduplicating the last syllable of the input, example: *gezer* 'carrot' → *gzarzar* 'baby carrot'. Trisyllabic output forms: *lavan* 'white' → *levanvan* 'whitish', superficially, do not seem to conform to the bisyllabic template. These arise from phonological constraints on wellformedness of onset clusters. I also account for forms that remain faithful to the input vowel like *xaz***i***r*→ *xazarz***i***r*. Reduplication can be regarded as a case of affixation, specifically infixation, even in non-concatenative languages.

1. Introduction

In Modern Hebrew, reduplication is used for forming diminutive nominal and adjectival forms. This is a productive process, whereby new forms are created using a "template". In this paper, I show how diminutive reduplication in the nominal and adjectival system follows principles of reduplication interacting with principles governing fixed prosodic word structures. I show that in the nominal and adjectival system, a template with pre-specified vocalic material determines the shape of diminutive reduplicated forms.

McCarthy (1981) claims that the process of reduplication involves a specified template composed of consonantal and vocalic slots or moras into which the regular autosegmental material is mapped. "No special rules of reduplication are needed – the phenomenon simply arises when the universal or language particular rules of association yield a one-to-many association between the melody and the template." (p. 410)

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According to the general view (Marantz 1982, McCarthy & Prince 1986, 1995b), reduplication is a simple morphological process of affixation with special phonological properties. The affix comes bare of segmental material and receives its phonological content from the base form.

I claim in this work that diminutive reduplication in Modern Hebrew is a process of affixation. The affix, which I claim is an infix, involves fixed segmentism. However, the process of reduplication does not involve a pre-specified template. Rather, a template-like behavior arises due to the interaction of constraints on word structure and alignement.

(1) gezer → gzarzar
‘carrot’ ‘baby carrot’

The noun *gezer* ‘carrot’ surfaces as the reduplicated form *gzarzar* ‘baby carrot’, where the reduplicant is *zar*. The reduplicated form comes with vocalic material of its own which overwrites the vocalic material of the base, and does not exceed two syllables in size. Complexities arise when impermissible clusters are formed and constraints against impermissible clusters mandate trisyllabic forms. For example:

(2) lavan → levanvan not *lvanvan
‘white’ ‘white-ish’

The data will be accounted for within the framework of Optimality Theory (Prince & Smolensky 1993, McCarthy & Prince 1995b). One of the biggest advantages of an Optimality Theoretic (OT) analysis in the case of reduplication is that it allows interaction of phonological and morphological constraints which regulate the reduplication process. There is simultaneous access to both phonological and morphological representations.

According to McCarthy & Prince (1995), reduplication involves faithfulness relations between all the components of the reduplicated form as follows:

(3)

Input: $/\mathrm{Af}_{\mathrm{RED}} + \mathrm{Stem}/$

I-R Faithfulness $\swarrow\nearrow$ $\downarrow\uparrow$ *I-B Faithfulness*

Output: $R \leftrightarrows B$

B-R Identity

Crucial for this paper is the faithfulness relation between the Reduplicated Form (R) and the Base Form (B) in the output, all other faithfulness relations are secondary (McCarthy & Prince 1995, p. 6):

> The *Reduplicant* is the actual phonological projection of some reduplicative morpheme RED, which has a phonologically – unspecified lexical entry. The *Base* is the phonological material to which the reduplicant is attached... each pair R,B comes equipped with a *correspondence relation* between R and B that expresses the dependency between the elements of R and those of B. The correspondence relation for each candidate is subject to evaluation by the set of reduplicative constraints.

This is captured in the following constraint:

(4) MAX – BR
Every segment of the base has a correspondent in the reduplicant. (Reduplication is total).

The organization of this paper will be as follows: first I will present some relevant background information about Modern Hebrew in Section 2 and discuss constraints on word size as well as permissible syllables. In Sections 3 and 4 I will present the data and the analysis; this will be followed by further motivation in Section 5 for the analysis presented in the paper. In Section 6 I will discuss some other possible analyses in the literature before the conclusion in Section 7.

2. Background

In this section I present the segmental inventory of Modern Hebrew followed by constraints on word size. Then I discuss MH consonantal clusters. All these factors are important because they contribute separate constraints which play a crucial role in the analysis of the data.

2.1 Segmental inventory in Modern Hebrew (MH)

(5)

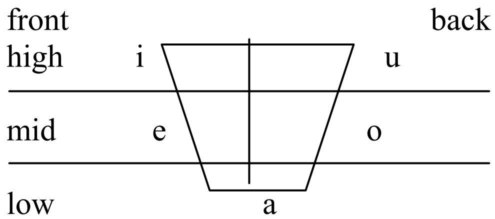
place / manner	labials	coronals [+ant]	coronals	dorsals	glottal
stop	P b	t d		k g	÷
continuant	f v	s z	s‡ z‡	x Ë	(h)
nasal	m	n			
stop + continuant		c=(ts)			
lateral		l			
approximate		j	ts‡ dz‡		

The phones [z‡,ts‡and dz‡] are not native to MH, we find them only in borrowed words. The sound h exists for some speakers but it is frequently realized as its allophone the glottal stop. Labiodental fricatives [f,v] cannot occur as onsets (except for specific borrowed words).

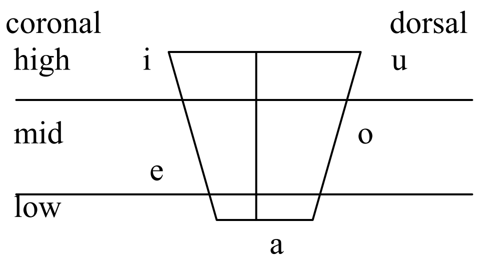
Modern Hebrew has five phonemic vowels. Length is not phonologically distinctive although it occurs phonetically. In (6a) I present a phonetic description of the contrastive vowels. In (6b) I present the same vowels grouped phonologically. The phonological classification is not phonetically transparent and does not fall straightforwardly from the phonetic description. It might be surprising to find a phonetically mid vowel which is phonologically low, but phonetic evidence from Chayen (1972) suggests that /e/ in MH is a mid-low vowel. Additionally, given the contrastive system and the phonological behavior of /e/,[1] I claim it is phonologically low and hence is classified as {[+coronal], [+low]}, which makes it an unmarked vowel. A similar phonological classification can be found for Hungarian where the vowel /e/ is also classified as a low vowel (Nádasdy 1985).

[1] 1) The vowel *e* is a phonological default (according to Bat-El 1989 and Ussishkin 2000), a point which will be addressed later in the paper. 2) It also appears in the environment of gutturals, which usually favours lower vowels. 3) Lastly, there are cases of alternations between *e* and the low dorsal vowel *a*.

(6) a.



(6) b.



2.2 Word size

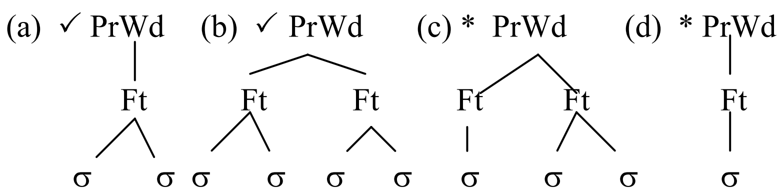
In MH, words are optimally bisyllabic. Ussishkin (2000) argues, on the basis of the verbal system, that bisyllabicity is a dominant prosodic property of MH, a property which he refers to as "fixed Prosody". The constraint on bisyllabic prosody is both minimal and maximal. Words have to be minimally bisyllabic but also maximally so. The constraint that has been used in OT for fixing minimal word size is foot binarity. Ussishkin proposes two separate constraints in order to capture the minimal and maximal requirements on word size, one responsible for minimal binarity and one for maximal binarity.

(7) "Prosodic Branching (PrBranch; generalizing from Ito & Mester's (1992) "Word Binarity")
A prosodic category *i* must branch at level *i* or *i-l*,
where branch is defined as follows:
A Prosodic category branches if and only if it contains more than one daughter.

This corresponds to a family of constraint requiring that prosodic categories branch. Following Ussiahkin, we will instantiate the constraint on prosodic branching at the word level, requiring that all prosodic words branch. Foot Binarity (Price & Smolensky 1993) is insufficient in this case because it does not yield the preference of a trisyllabic word over a monosyllabic word. (This issue will be discussed later.)

(8) PR(OSODIC) W(OR)D BRANCH(ING):
Prosodic words must be binary at the syllabic level (Ussishkin 2000).

Figures 9(a) through 9(c) satisfy the constraint on prosodic word branching. Figures 9(b) and 9(c) branch at the level of the prosodic word, figure 9(a) branches at the syllabic level. Figure 9(d) does not branch at any level and therefore does not satisfy the prosodic branching constraint (adopted from Ussishkin 2000, p. 109):[2]

(9)


There are also effects of maximal binarity. These "upper limit effects", where words exhibit a preference for maximal length, can be achieved through the interaction of constraints on prosodic branching and alignment constraints. Ussishkin (2000, p. 53) claims that:

> The intuitive idea behind this approach is that in prosodic structures that contain only binary branching (as opposed to more), every constituent is aligned to one edge (either the left or right edge) of some larger prosodic constituent... Ito & Mester (1995) thus propose that in a maximally binary structure, constituent prominence is expressed as alignment within a higher constituent. This view is formalized through a particular type of alignment constraint, named *Hierarchical Alignment*...
>
> Hierarchical Alignment (Ito & Mester 1995)
> $\forall$PCat1 $\exists$PCat2 [PCat2 $\supset$ PCat1 & ALIGN (PCat1, PCat2)],
> (Every prosodic constituent is aligned with some prosodic constituent containing it). (Where PCat stands for P(rosodic) Cat(ergory)).

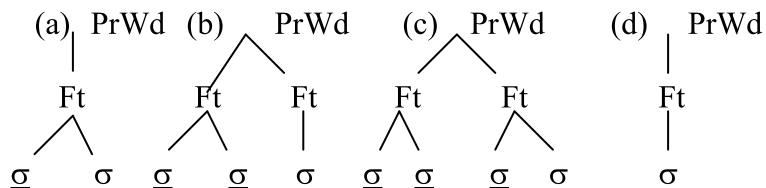
In this paper we will evaluate the alignment of syllables with the right edge of a Prosodic Words. While Ussishkin requires that syllables align with some edge of a prosodic word containing it, in this paper we will require alignment with the right edge only. One of the

[2] Recall that the demand on branching categories is that it branches at level *i* or *i-l*. This means that branching at either foot or syllable level satisfies the constraint for prosodic branching but only binary feet will satisfy the constraint on foot binarity, which is evaluated at the syllabic level.

reasons for this is that alignment with the right edge explains why the reduplicant is an infix. (This issue will be discussed later in the paper).

(10) SYL(LABLE) ALIGN(MENT) (SYL – R; PRWD –R):
Every SYL must be aligned to the right edge of the prosodic word containing it (Ussishkin 2000).

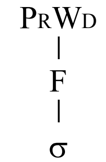
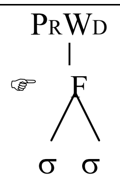
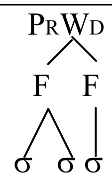
The following are examples of evaluation of the alignment constraint; offending syllables are underlined (adopted from Ussishkin 2000, p. 107):

(11)


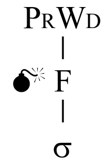
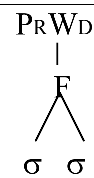
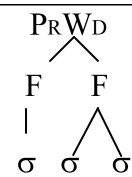
The constraints on word minimality and maximality help establish the fundamental notion that the optimal word in MH is bisyllabic. The constraint SYL(LABLE) ALIGN(MENT) prefers structure (d) but the requirement on word branching means that either (a) or (b) are better. The optimal prosodic word structure is 11(a) but the interaction between SYL(LABLE) ALIGN(MENT) and PR(OSODIC) W(OR)D BRANCH(ING) means that in case the word has to be longer than two syllables, a trisyllabic structure would be preferred to a monosyllabic structure. If we were to use a constraint demanding foot binarity, then monosyllabic words would be preferable to trisyllabic words which is not the situation found in MH.

Requiring syllable alignment with the right edge of the prosodic word means that the optimal word should be monosyllabic (as can be seen in (12b)). However, the higher ranking of PR(OSODIC) W(OR)D BRANCH(ING) means that words should be at least bisyllabic. Therefore PR(OSODIC) W(OR)D BRANCH(ING) should be ranked higher than SYL(LABLE) ALIGN(MENT). The tableaux in (12) shows the ranking of these two constraints. The correct ranking in (12a) yields the right candidate while the incorrect ranking in tableau (12b) predicts the wrong candidate as the optimal candidate.

(12) a.

	PRWD BRANCH	SYLALIGN
	*!	
		*
		**!

b.

	SYLALIGN	PRWD BRANCH
		*
	*!	
	*!*	

This idea is crucial in the analysis because the template that I use to fix the size and shape of the reduplicated form corresponds to bisyllabic prosodic word. This has an additional benefit; rather than using underlying templates (or using a template that is listed in the lexicon) we derive the notion of template through constraints on word structure.

2.3 Syllable Structure

Modern Hebrew is a quantity insensitive language (Ussishkin 2000, Graf and Ussishkin 2003) and therefore, codas do not contribute to weight nor are there phonologically long vowels. Onset clusters, however, play an important role in capturing the process of reduplication and call for a constraint on onset clusters.

There is a rich array of permissible onset clusters. An exhaustive list followed by a table for convenience are given in (13) and (14).

(13) a. Permissible initial clusters:

pt,pd,pk,pg,ps,pz,ps,‡x,pn,pc,pl,pr,bd,bk,bg,bs,bz,bs,bx,bn,bc,bl,br,tk,tg,tf,tv,ts,tz, ts,tx,tm,tn,tl,tr,dk,dg,df,dv,ds,‡x,dm,dl,dr,kt,kd,kf,kv,ks,kz,ks,‡x,km,kn,kc,kl,kr,gd, gf,gv,gs,gz,gs,‡m,gn,gl,gr,sp,st,sd,sk,sg,sf,sv,sx,sm,sn,sl,sr,zd,zk,zg,zv,zx,zm,zn,zl, zr,sp,sb,st‡sd‡,sk‡,sg‡,sf‡sv‡,sz‡,sx‡,sm‡,sn‡,sl‡sr‡,cd,cf,cv,cx,cm,cn,cl,cr

b. Impermissible initial clusters:

**pb, *pf, *pv, *pm, *bt, *bf, *bv, *bm, *tp, *tb, *tc, *dp, *db, *dt, *ds, *dz, *dn, *dc, *gp, *gb, *gt, *gk, *gc, *f+, *v+, *sb, *sz, *ss‡, *sc, *zp, *zb, *zt, *zs, *zs‡, *zc, *s‡c, *x+, *m+, *n+, *l+, *r+, *cp, *cb, *ck, *cg, *cs, *cz, *cs‡*

(14)

	p	b	t	d	k	g	f	v	s	z	s‡	x	m	n	c	l	r
p	■	■					■	■					■				
b	■	■	■				■	■					■				
t	■	■	■	■											■		
d	■	■	■	■					■	■				■	■		
k	■	■			■	■											
g	■	■	■		■	■									■		
f	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
v	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
s	■	■							■	■	■	■			■		
z	■	■	■						■	■	■	■			■		
s‡											■	■			■		
x	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
m	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
n	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
c	■	■	■		■	■			■	■	■				■		
l	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
r	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

The glottal consonants are problematic and irrelevant for this survey; therefore, I refrain from listing them in the chart and incorporating them into the analysis. The reason they are problematic is that the distinctions between various glottal segments, such as the glottal stop and the glottal fricative, is being lost. These two phones are often viewed as allophonic variants. When it comes to onsets, it is even more problematic because it is not always clear if glottal stops or fricatives are realized phonetically in words where they are present underlyingly. Additionally, they never appear as part of an initial cluster, and therefore there is no need to deal with them at this point.

Generalizations that will subsume all the impermissible clusters are virtually impossible to make. But there are several generalizations which can account for many of the impermissible clusters. Some of these clusters are prohibited due to the Sonority

Sequencing Principle (SSP),[3] which requires that onsets rise in sonority (Clements, 1990; Blevins, 1995; Selkirk, 1984b), as illustrated in 15 below.

(15) (a) vowels > glides > liquids > nasals > obstruents (fricatives > stops)
(b) voiced > voiceless

These two parallel scales can help us classify the clusters. The first segment must be equally or less sonorous than the second segment (either due to voice quality or due to articulatory classification). Most permissible clusters obey the SSP (though there are exceptions). Clusters that do not obey the SSP, yet are still permissible are listed in (16a). In all these cases the first segment is more sonorous than the second (either by articulatory classification or by voicing) which means we have a decline in sonority. Despite the decline, they are well-formed clusters. In (16b) I list all the clusters that are not allowed yet do obey the SSP.

(16) a. Permitted Clusters that do not obey the SSP:
bk,dk,sp,st,sd,sk,sg,sv,zd,zk,zg,zx,sp‡,sl‡,st‡,sd‡,sk‡,sg‡,cd

b. Clusters that do obey the SSP but are not allowed:
**pb*pf,*pv,*pm,*bf,*bv,*bm,*tp,*tb,*tc,*db,*gb,*f+,*v+,*sz,*ss,‡*sc,*sc‡,*cs,*cz,*
**cs‡*

If we add the Obligatory Contour Principle (OCP) (Leben 1973, Goldsmith 1976) as another one of the constraints on initial clusters, we can ban a few more. The OCP bans identical adjacent segments. Clusters that have two segments with the same place of articulation are prohibited. This accounts for the impermissibility of clusters such as: **pb *pf,*pv,*pm,*bf,*bv,*bm,*tc,*sz,*ss,‡*sc,*sc‡,*cs,*cz,*cs*. Taking into account the SSP and OCP, only *tp,tb,db,gb, f+,v+* are left unaccounted for. The two labial fricatives *f* and *v* cannot appear as onsets (except for borrowed words). That leaves us with **tp,*tb,*db,*gb* as the only impermissible clusters that cannot be accounted for, and those

[3] Although Morelli (1998) claims that SSP is not enough to account for consonantal onset clusters, more elaborate and detailed sonority scales (those which differentiate between fricatives and stops within obstruents at the very least), can partially account for the permissible clusters in Hebrew.

clusters that do not obey the SSP and are permissible, such as *bk* and *dk* which are an artefact of historical change.

I will use the following constraint as short hand for a more complete set of constraints ensuring proper onset clusters:

(17) ON(SET) CL(USTER)
Onset consonantal clusters must be well-formed clusters. (No impermissible initial clusters).

Note that although this is not meant to be a universal constraint, a full investigation into the components is beyond the scope of this paper. For more details on permissible clusters in MH see Tene (1962). Further research on the phonetic and phonological nature of onset clusters in Modern Hebrew is underway.

3. Data and analysis

The focus of this Section is diminutive reduplication in nominal and adjectival stems.

3.1 Bisyllabic forms

In (18) we see a bisyllabic input, which results in a bisyllabic output, with an initial consonantal cluster. The consonants of the second syllable of the base are copied into the reduplicant, which is infixed and has the vowel *a*. The reason I claim that the vowel *a* is infixed is because it surfaces in the reduplicated form regardless of what the input vowel is, as can be seen in (18); this will be further motivated in Section 5. Although traditional analyses view the reduplicant as bare phonological material, I assume that it comes with certain fixed segments that are predetermined.

(18) Bisyllabic inputs (all words are in masculine form):

Reduplication template: $C_1V_1\ C_2V_2\ C_3$ -> C_1C_2 a C_3 C_2 a C_3

a. zakan -> zkankan
'beard' 'little beard'
b. gever -> gvarvar
'man' 'young man'

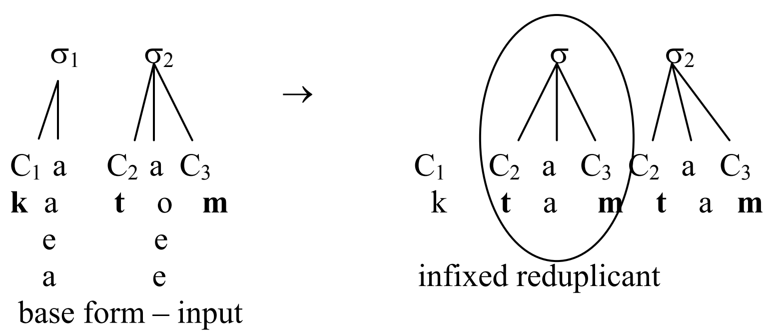
nouns

c. Saxor -> Sxarxar
'black' 'blackish'
d. Samen -> Smanman
'fat' 'chubby'

adjectives

The first vowel of the base is lost in the reduplicated form so that C_1 and C_2 form a cluster. This is schematized in (19) where the infixed reduplicant is circled:

(19)



The reduplicated form corresponds to a bisyllabic template which arises from constraints on word size proposed in Section 2.2. The infixed syllable comes bare of consonantal material but with a pre-specified vocalic content.

Vowels in the reduplicated form differ from vowels in the base in some cases. The vowel *a,* being pre-specified, always surfaces in the reduplicant, but in some cases the vocalic material of the base in the reduplicated form does not change, for example if there is a high vowel in the second syllable, as will be discussed below. According to Bat-El (1994) and Ussishkin (2000) the vowel *a* is a morphological default; therefore, I claim that is the vowel that surfaces in the reduplicant. Some have suggested that the vowel *a* was provided with many *binyanim* or morphological templates thus making it the default vowel.

The faithfulness relations between the base and the reduplicant are responsible for the vocalic overwriting of the vowels of the base; "base/reduplicant negotiation crucially involves information flow from *reduplicant* to the *base*, in a kind of reversal of copying" (McCarthy & Prince 1995). Or in other words, the base has a vowel that gets overwritten by faith to the vowel of the morpheme which is the fixed segment. In this case faithfulness to the reduplicant is ranked higher than faithfulness to the base. This is a case of fixed segmentism, which some people refer to as "morphological default". In this case the morphological default is the vowel *a*. Our ranking in this case is as follows:

(20) B-R FAITHFULNESS, RED. FAITHFULNESS >> BASE FAITHFULNESS.

(21)

RED (a) – *Katom*	PRWD BRANCH	SYL–ALIGN
(a) ka.tom.ka.tom		**!*
☝ (b) ktam.tam		*
(c) ke.tam.tam		**!
☝ (d) ktam.tom		*
(e) kat.ka.tom		**!

Tableau (21) shows that only the bisyllabic reduplicated forms surface as optimal candidates. Candidates (b) and (d) are both optimal in the sense that they satisfy the structural constraints. Both candidates are bisyllabic, as opposed to the trisyllabic (c) and (e) and the quadrosyllabic (a). Since all candidates are more than one syllable long, they all satisfy the constraint on PR(OSODIC) W(OR)D BRANCH(ING). Recall that in (12) we already established that PR(OSODIC) W(OR)D BRANCH(ING) is ranked above SYL(LABLE) ALIGN(MENT). However, there still remains the question of how we can determine which one of the two is optimal. In order to select the real optimal candidate (b), we must turn to additional constraints.

Recall that the reduplicant comes equipped with a pre-specified vowel *a*. Then, the base, which has different vocalic material in the input, copies the vowel of the reduplicant in a process of reverse copying. This can be easily achieved by ranking the faithfulness relation between the base and the reduplicant higher than the faithfulness relations between the base and the input. This allows changes in the base material in the output. Thus we have the following constraints and their ranking (adopted from McCarthy & Prince (1995, p. 16):

(22) MAX – BR
Every segment of the base has a correspondent in the reduplicant.
(Reduplication is total.)

(23) MAX – IO
Every segment in the input has a correspondent in the output.
(No phonological deletion.)

(24)

RED (a) – *Katom*	SYL- ALIGN	MAX BR	MAX IO
(a) ka.tom.ka.tom	**!*		
(b) ☞ ktam.tam	*	*	*
(c) ke.tam.tam	**	**	*
(d) ktam.tom	*	*!*	*
(e) ktom.tom	*	*	**!

With the additional constraints and their ranking, we are now able to successfully select the correct candidate (b) as the optimal candidate. The other serious competitors, candidates (d) and (e), are ruled out because of lack of faithfulness between the base and the reduplicant and lack of faithfulness to the input vowel of the reduplicant. The ranking of the constraints thus far is as follows:

(25) PRWD BRANCH >> SYL–ALIGN >> MAX BR >> MAX IO

PRWD BRANCH is satisfied in all candidates. Candidates (b), (d) and (e) have at least one syllable which is not aligned with the right edge of the of the prosodic word which means the casting votes are moved downwards to the MAX constraints. The correct candidate (b) is chosen by MAX IO on which candidate (e) fails since the pre-specified vowel *a* of the input reduplicant does not surface anywhere in the output reduplicated form.

3.2 Trisyllabic reduplicated forms

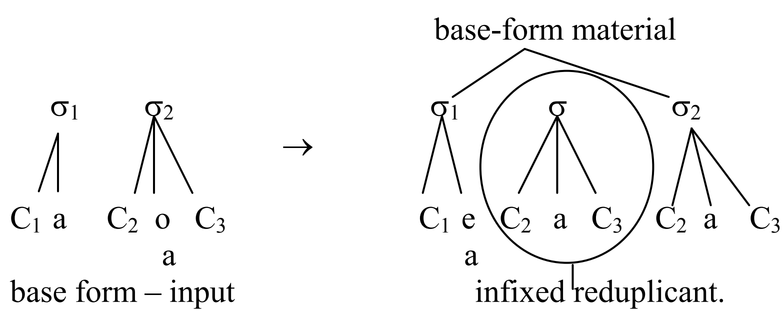
We now turn to cases with trisyllabic reduplicated forms. The case presented thus far (in 18 and schematized in 19) is the general case. Other cases that follow arise from interaction of constraints on prosodic structure with constraints on onset cluster wellformedness. The cases in (26) are an example of this:

(26) Reduplication template: $C_1V\ C_2V\ C_3$ -> C_1 e/a C_2a C_3 C_2a C_3

a. lavan ->	levanvan		adjectives
'white'	'whitish'		
b. yarok ->	yerakrak		
'green'	'greenish'		
c. xamuc ->	xamacmac		
'sour'	'sourish'		

In (26) we see that while the input is bisyllabic, the output is trisyllabic. Also, there is no initial consonantal cluster in these cases. The schematization of this set of data is as follows:

(27)



Recall that in (18) the reduplicated forms correspond to a bisyllabic template, in (26), however, we find that the reduplicated forms have three syllables rather than two. The crucial difference between (18) and (26) is that C_1 and C_2 form a good cluster in the former but not in the latter. In (26) the cluster is broken up by an intervening vowel *e* or *a* (depending on the consonantal context, and will be discussed later), which is not copied from the base. This is a clear case of cluster break up; the consonants C_1 and C_2 in (26) do not form a permissible cluster as shown in Section 2.4, and thus a vowel is inserted in order to break up the cluster, as can be seen in (27).

I claim this vowel is epenthetic and is predictable from the environment. The default vowel that is inserted is *e* unless the first segment of the onset is guttural, as in (28) below. Then the vowel that is inserted is *a.* The vowel *e* is chosen as the epenthetic vowel because it is the phonological default vowel (based on use of *e* as an epenthetic vowel in colloquial speech, Ussishikin 2000 and Bat-El 1994).

(28) Reduplication template: $C_1V\ C_2V\ C_3$ -> C_1 a C_2 a C_3 C_2a C_3

a. xamuc -> xamacmac
'sour' 'sourish'
b. hafux -> hafaxpax
'inverted' 'fickle'

In order to be able to account for these forms within OT, we need to use an additional constraint. The shorthand for the group of constraints that bans impermissible onset clusters was introduced in Section 2.4 as (17) and is repeated here for the reader's convenience as (29):

(29=17) ON(SET) CL(USTER)
Onset consonantal clusters must be well-formed clusters. (No impermissible initial clusters.)

There are two general strategies to solve the problem of impermissible clusters, one is to delete one of the consonants and the other is to insert an epenthetic vowel. Since the language chooses epenthesis as the solution, the constraint against impermissible clusters must be ranked higher than any DEP constraint (McCarthy and Prince 1995 and formulation in this paper taken from Kager 1999).

(30) DEP BR
Every element of the reduplicant has a correspondent in the Base.

(31) ONCL >> DEP BR

These constraints and their ranking, as illustrated in (32), correctly select the trisyllabic forms.

(32)

RED (a) – *yarok*	ONCL	SYL–ALIGN	DEP BR	MAX BR	MAX IO
(a)ya.rok.ya.rok		***!			
(b)☞ ye.rak.rak		**	*		
(c) yrak.rak	*!	*			
(d) ye.rak.rok		**	*	*!	
(e) ye.rok.rok		**	*		*!

Candidate (b) surfaces as the optimal candidate. Candidate (a) violates syllable alignment on three accounts. None of the first three syllables is aligned with the right edge of the prosodic word. Candidate (c), while satisfying SYL -ALIGN, violates the highly ranked ONCL which demands well-formed clusters. Candidate (d) loses because there is no maximal identity between Base and Reduplicant. The reduplicated candidate has an epenthetic vowel *e* because that is the unmarked phonological vowel that is provided by *gen* (more on this topic will be addressed below). The last candidate (e) loses because it is not faithful to the input vowel of the reduplicant (the fixed segment *a*) and thus violates MAX IO. The following ranking hierarchy will correctly choose candidate (b):

(33) ONCL >> SYL–ALIGN >> DEP BR >> MAX BR >> MAX IO

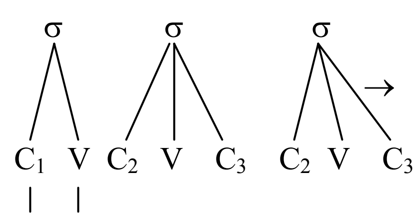
Constraints on permissible onset clusters override even constraints on prosodic word structure because we have forms which surface with three syllables.

3.3 The emergence of the unmarked vocalic material

The epenthetic vowel that breaks up the cluster is *e,* following Bat – El (1994) and Ussishkin (2000), who claim *e* is the phonological default based on epenthetic vowels in colloquial speech. This claim is based on the notion of The Emergence of The Unmarked. According to McCarthy & Prince (1994b, p. 1), "...in the language as a whole, ***C*** may be roundly violated, but in a particular domain it is obeyed exactly. In that particular domain, the structure unmarked with respect to ***C*** is suppressed. This *emergence of the unmarked* is quite conspicuous in the prosodic morphology of reduplication...” and Modern Hebrew is no exception. As has been states previously, in Section 2.1, the vowel *e* is specified as [+cor, +low] and coronal is often considered phonologically least marked, therefore *e* may function as a phonological default vowel.

However, the examples in (28) differ from those in (26) on account of having the vowel *a* epenthesized. I claimed that this is predictable from the environment. In the environment of a guttural consonant the epenthetic vowel is *a*, as in cases like *xamacmac* ‘sour-ish’. Guttural consonants include the dorsal and glottal consonants. There are still three syllables but instead of an epenthetic vowel *e* we have an epenthetic vowel *a*. The explanation for these cases lies in a process of vowel lowering (Bat-El 1989, 1998, Graf and Ussishkin 2003). Vowels are lowered when in proximity to gutturals. In this analysis, gutturals have a dorsal component. The process of vowel lowering can be accounted for by a simple process of spreading where the dorsal spreads its features. This means that the epenthetic vowel is always specified as [+low]. When following a non dorsal segment the epenthetic vowel is [+cor, +low]; when following a dorsal segment the epenthesized vowel is *a* which is a low vowel specified for dorsal (*a* = [+dor, +low]). The place feature is the feature that determines the quality of the epenthetic vowel. We can see the representation in (34) where the epenthetic vowel between C_1C_2 depends on the quality of C_1. When C_1 is not guttural (or not specified for [+dor]) the epenthesized vowel is the low vowel which does not have a dorsal component, the vowel *e*. When C_1 is guttural (or specified for [+dor]), the epenthesized vowel is the low vowel which is specified for [+dor], the vowel *a*.

(34)



[-dor] [+cor, +low] Vowel epenthesis when the first consonant in the cluster is NOT guttural.
[+dor] [+ dor, +low] Vowel epenthesis when the first consonant in the cluster is guttural.

This can be described in OT but requires a new markedness constraint which demands guttural consonants to be followed by low vowels. (This same constraint is responsible for vowel lowering.)

(35) *C $_{[+dor]}$V$_{[+cor]}$
Segments specified for dorsal are not followed by segments specified for coronal.

(36)

RED (a) – *xamuc*	ONCL	* C $_{[+dor]}$V$_{[+cor]}$
(a) [dor] [cor] x e. m a c. m a c		*!
(b) [dor] x . m a c. m a c	*!	
(c) ☞ [dor] [dor] x a. m a c. m a c		

The successful candidate in (36) above is (c), since it has a harmonious epenthetic vowel. Candidate (a) fails because it has a non-dorsal vowel next to a dorsal consonant. The constraints forbidding non-low vowels around gutturals and the constraint forbidding impermissible clusters are not crucially ranked with respect to one another.

3.4 Vowel faithfulness

In (37) the high vowel of the second syllable of the input is not overwritten and remains high in the reduplicated form despite the pre-specified *a*, provided by the template.

(37) Reduplication template: $C_1V\ C_2V_{hi}\ C_3$ -> C_1 e/a C_2 a C_3 C_2 V_{hi} C_3

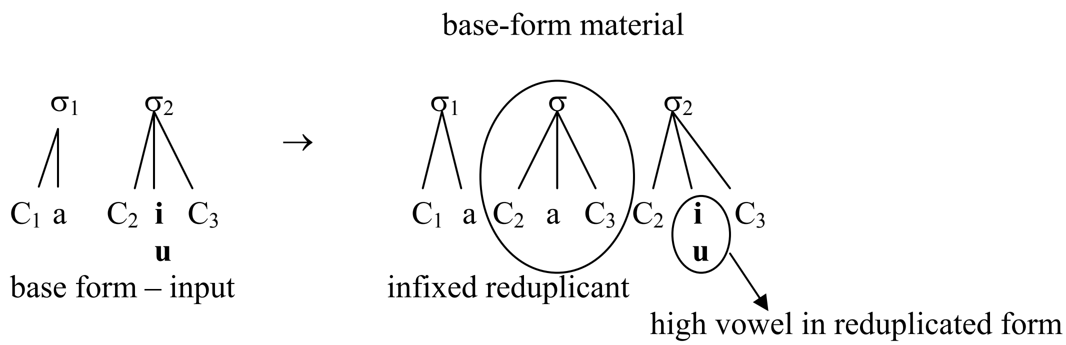
a. xat**u**l -> xatalt**u**l
'cat' 'kitten'

b. xaz**i**r -> xazarz**i**r
'pig' 'piglet'

nouns

The schema for (37) is as follows:

(38)



Note that there is great similarity between the input of the forms in (28) and the input of the forms in (37). However, they differ in that the vowel of the second syllable of the forms in (28) is overwritten while that in the forms in (37) is not, as is illustrated in (39):

(39) a. xam**u**c 'sour' -> xamacm**a**c 'sourish'
hafu**x** 'inverted' -> hafaxp**a**x 'fickle' } adjective

b. xaz**i**r 'pig' -> xazarz**i**r 'piglet'
xat**u**l 'cat' -> xatalt**u**l 'kitten' } nouns

In (39) we see a clear distinction between vowels that are faithful to the base and those that are not. Vowels are faithful to the high base vowel if they appear in nouns. In adjectives, however, the high base vowels are overwritten by the vowel *a* in the reduplicated form. I suggest that there is an appeal to syntactic categories, which are available in the morphology, during the process of reduplication. There is faithfulness to high vowels in nouns but not in adjectives. High vowels in adjectives can be overwritten while high vowels in nouns remain faithful to the base form. This prediction has been tested using a questionnaire given to native speakers. The high vowel was always maintained in nouns while it was overwritten in adjectives.

Since I advocated that the difference between syntactic categories may well be responsible for the peculiar behavior between adjectives and nouns, I propose that faithfulness to input in nouns is ranked higher than BR identity. The constraints would then be as follows:

(40) MAX $IO_{[nouns]}$ >> MAX BR >> MAX $IO_{[adjectives]}$

However, this is not the case in all nouns. The example: *gever* 'man' -> *gvarvar* 'young man' seems like a counterexample to the faithfulness constraint in nouns. In this case the input vowel *e* turns up as *a* in the reduplicated form. The explanation for this is that the faithfulness is to high vowels only. This means that we need to replace the constraint MAX $IO_{[nouns]}$ to MAX $V_{[high]}$ $IO_{[nouns].}$ This kind of constraint will protect the high feature of the vowel in nouns but not in adjectives, while allowing vocalic overwriting in cases where the vowel in the input noun is not high. The ranking is then as follows:

(41) MAX $V_{[high]}$ $IO_{[nouns]}$ >> MAX BR >> MAX $IO_{[adjectives]}$

Let us see how this last constraint affects the system.

(42)

RED (a) –*xatul* (noun)	ONCL	SYL–ALIGN	MAX $V_{[high]}IO_{[nouns]}$	MAX BR	MAX $IO_{(adj)}$
(a) xa.tul.xa.tul		***!			
(b) xtul.tul	*!	*			
(c) ☞ xa.tal.tul		**		*	
(d) xa.tal.tal		**	*!		

Candidate (a) is ruled out on account of having three syllables not aligned with the right edge of the prosodic word. Candidate (b) has an impermissible onset cluster. The candidate that is chosen is the one that fares best on all the constraints, i.e. candidate (c). The reduplicated form is the one that is faithful to the input rather than the one with BR identity (candidate d) since the input is a noun with a high vowel. As I claim in this paper, faithfulness to high vowels in nouns is higher ranked than BR identity in nouns. Note that MAX $IO_{(adj)}$ does not get any marks because we are evaluating a noun and MAX $IO_{(adj)}$ evaluates only adjectives and therefore does not evaluate this particular input. This is not the case for adjectives as can be seen in (43):

(43)

RED (a)– *xamuc* (adj)	ONCL	SYL–ALIGN	MAX BR	MAX $IO_{(adj)}$
(a) xa.muc.xa.muc		***!		
(b) xmuc.muc	*!	*		**
(c) xa.mac.muc		**	*!	*
(d) ☞xa.mac.mac		**		*

In the case of adjectives, identity relations between the base and the reduplicant are more important as the constraint MAX BR is ranked higher than faithfulness relations between input and output (regardless of the input vowel). In this case the winner is (d). Candidate (a) violates SYL–ALIGN because three syllables are not aligned with the right edge of the prosodic word. Candidate (b) has an impermissible cluster. Candidate (c) loses because the input is an adjective, which requires identity between base and reduplicant. The vowels in the base and the reduplicant are different and therefore it does not have identity between the base and the reduplicant leaving candidate (d) as the winner. Candidate (d) has an identical vowel in the base and in the reduplicant. The constraint MAX $V_{[high]}IO_{[nouns]}$ does not even play a role in this case because it evaluates nouns and we are evaluating an adjective.

4. Bisyllabic template

As mentioned above, I rely on the notion of bisyllabic templates in my analysis. I claim that there is a certain “templatic motivation” for the shape of the reduplicant. The preference of a bisyllabic template which is derived from the above constraints is what constrains the output of the reduplicated form. I use reduplication of the monosyllabic forms to further motivate the bisyllabic template. These forms surface as bisyllabic when reduplicated, as can be seen in (44):

(44) Monosyllabic inputs: Reduplication template $C_1\ V_x\ C_2$ -> $C_1\ V_x\ C_2$ i C_2

a. d̲ag̲ -> d̲agig̲
‘fish’ ‘small fish’

b. k̲of̲ -> k̲of̲if̲
‘monkey’ ‘small monkey’

Monosyllabic words are mapped onto a bisyllabic template. There is no motivation for this aside from the preference for a bisyllabic template. The reason we do not see **kfif* in (44b) as the surface form is because of the set of constraints on the prosodic form.

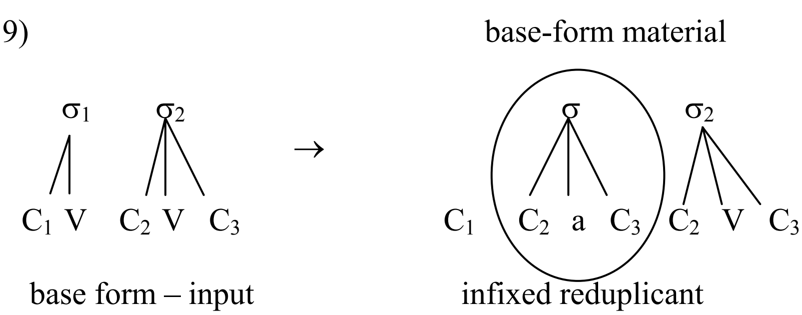
There are only two cases of the monosyllabic examples, as far as I am aware. In both cases there is a high vowel in the second syllable, which conforms with predictions since both examples are nouns and not adjectives. Even though the vowel is not provided with the input it surfaces in the output. This could be a case of conforming with other cases in the paradigm or simply a case of lexically stored items.

5. Further motivation for infixed reduplicant

Throughout the paper I have claimed that the reduplicant is an infix in the reduplicated form, to which the reduplicated material is mapped. In this section, I would like to argue for this view and further motivate it.

The structure of the reduplicated form I have assumed is in (19) (repeated in (45) for the reader's convenience):

(45=19)



There are two main reasons that lead me to conclude that (45) is the correct template for reduplicated forms. First, the vowel between C_2 and C_3 in what I claim is the infixed material (the first syllable in the reduplicated form), is invariantly *a*. Secondly, in those cases where there is faithfulness to the base vowel, it is always in the last syllable of the reduplicated form (*xatul* 'cat' -> *xataltul* 'kitten').

The question is why the reduplicant should be an infix rather than another form of suffixation such as a suffix or prefix. The reason for this is the alignment. In addition to syllables which need to align with the right edge, the base should also align with the right edge and this causes the affixes to be pushed to the middle of the word. Generally, right edge seems to be important for a variety of morpho-phonological processes in MH and plays a major role in other cases as well. For example, stress assignment depends on the right edge; word stress is aligned with the right edge of the prosodic word (Graf and Ussishkin 2003).

6. Other solutions

Bat – El (1989) claims that reduplication in MH is not a case of affixation and that copying is often unpredictable except for purely lexical cases where forms are obviously listed in the lexicon as reduplicated forms. Often the portion which surfaces as the reduplicant in the reduplicated form is also unpredictable. Additionally, she claims that: “there is no particular morphological function associated with reduplication” (Bat-El 1989, p. 77). In this paper I have argued against this view. There are several different types of reduplication in MH. There is reduplication which is morphologically motivated, and there is phonologically motivated reduplication. The morphologically motivated reduplication, discussed in this paper is, I claim, a case of affixation. Due to its morphological nature and the fact that it is a case of affixation, both the copying process and the copied material are predictable. In this work I discussed only the diminutive reduplication in the nominal and adjectival system. (I did not address reduplication in the verbal system or cases of reduplication which are not diminutive and which are a different process.)

In later work, Bat-El (2002) claims that reduplication is one of the language’s strategies of word formation. While this is true for certain types of reduplication (which are motivated by phonological restrictions on word size), it is not the case in diminutive reduplication. She claims that all forms of reduplication can and should be accounted for in one analysis. While a single analysis would be optimal, it is my opinion that in the case of MH it cannot be done. Reduplication, as mentioned above, has various functions and may appear in different places in the language, as a semantic strategy or as a means to satisfy “templatic” requirements. Since these are different functions, the reduplication process in each one of these cases should be treated differently. Bat-El (2002) claims that

"The problem arises with forms like *vradrad* [pinkish]… whose template would probably be [$\sigma_{\mu\mu}\sigma$]. However, there is no way to distinguish between *vradrad* and *xamcic*, since onsets are not moraic". While I agree that onsets are not moraic, it is not the case that the two forms Bat-El suggests cannot be distinguished. At the very least, they can be distinguished semantically, one of them, *vradrad*, is a diminutive form, while the other one is not.

Bat-El (2002) claims that reduplication is triggered by a morphological constraint which she calls COPY. This constraint, unlike RED, is not affixational. Unlike other languages' reduplication systems, in MH, she claims, the process is different. It is not affixational, but rather more dependent on phonology. COPY is a morphological constraint triggered by the requirement to form bisyllabic stems since prosodic restrictions and semantic properties are insufficient to induce reduplication. "There is no exclusive correlation between patterns of reduplication and semantic properties, and therefore the selection of reduplicative patters is lexical". While this may be the case for certain types of reduplication, it is not the case for diminutive reduplication, which is sematically motivated. Additionally, while the bisyllabic template is maintained in diminutive reduplication, it is not the trigger of the process of reduplication; rather, it is the result or the emergent template which surfaces due to constraints on word size in MH. There are cases of reduplication, triggered by insufficient phonological material and constraints on minimal word size, but those are beyond the scope of this paper and pertain to a different type of reduplication (the phonologically motivated reduplication mentioned above).

7. Conclusion

In this paper I provided an account of Modern Hebrew diminutive reduplication. I claim that there is a bisyllabic template, which emerges from constraints on word size and which contains an infixed reduplicant. The infixed reduplicant reduplicates the last syllable in the input. I provided an account of forms which have three syllables and superficially do not seem to conform to the bisyllabic template. Those arise from phonological constraints on wellformedness of onset clusters which mandate the epenthesis of a vowel which results in an additional syllable in the output. I also provided an explanation for the forms that remain faithful to the input vowel. The paper was framed within the framework of Optimality Theory. I motivated the bisyllabic template through constraint interaction on word size. Additionally, I showed how Modern Hebrew conforms to other cases of affixational reduplication and argued against accounts which claim that MH reduplication is different from the reduplication in other languages. I also accounted for the epenthetic vowels, both *e* and *a*, which are used to break up impermissible consonantal clusters. I accounted for the high vowels, which surface in the reduplicated form in nouns but not in adjectives. Those are claimed to surface due to faithfulness to high vowels in nouns and not in adjectives.

The paper shows that reduplication can be a case of affixation even in non-concatenative languages. The morphological nature of these languages motivates a different kind of affixation. As I have shown in this paper, the reduplicative affix is an infix.

Reduplication in MH also conforms with general prosodic constraints on word structure, which only supports the idea of fixed prosody in MH. The rigid constraints on prosodic word structures are obeyed in the output of the reduplicated form. However, constraints on syllable internal structure, namely those on permissible onset clusters, override constraints on prosodic word structures. Constraints on onset wellformedness are undominated. Even DEP constraints, which forbid epenthesis, are ranked lower than constraints on onset wellformedness. In those cases where impermissible clusters may arise from a phonological or morphological process, the language epenthesizes a vowel to break up those clusters.

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Appendix

base	meaning	reduplicant	meaning
kelev	dog	klavlav	puppy
xatul	cat	xataltul	kitten
s‡afan	hare	s‡fanfan	little hare
xazir	pig	xazarzir	piglet
gever	man	gvarvar	young man
zanav	tail	znavnav	tiny tail
zakan	beard	zkankan	little beard
bacal	onion	bcalcal	tiny onion
gezer	carrot	gzarzar	tiny carrot
kof	monkey	kofif	small monkey
dag	fish	dagig	little fish

Figure A: Base and Reduplicated noun forms

color	meaning	reduplication	meaning
cahov	yellow	cehavhav	yellowish
÷adom	red	÷adamdam	reddish
s‡axor	black	s‡xarxar	blackish
lavan	white	levanvan	whitish
varod	pink	vradrad	pinkish
kaxol	blue	kxalxal	bluish
txelet (taxol)	light blue	txalxal (not for all)	light bluish
sagol	purple	sgalgal	light purple
÷afor	grey	÷afarpar ~ ÷afarfar	light grey
yarok	green	yerakrak	light green
katom	orange	ktamtam	light orange
zahav	gold	zehavhav	goldish
s‡axum	browned	s‡xamxam	brown-ish

Figure B: Base and Reduplicated adjectival forms (colors)

base	meaning	reduplication	meaning
s‡amen	fat	s‡manman	full (plump)
kacar	short	kcarcar	shortish
katan	small (little)	ktantan	tiny (very small)
hafux	upside down	hafaxpax	fickle
xamuc	sour	xamacmac	sourish
matok	sweet	metaktak	sweetish
agol	round	agalgal	roudish (also plump)
s‡akuf	transparent	s‡kafkaf	a type of trasparant sandals

Figure C: Base and Reduplicated adjectival forms