Edge-in association and OCP 'violations' in Tigrinya

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An important issue in the application of autosegmental principles to Semitic morphology is the way the independent consonantal root is associated to the template provided by the morphology. The three most obvious proposals are from left to right, from right to left, and from the edges in toward the center. I argue that association in the Ethiopian Semitic language Tigrinya is from the edges in, and that the general rule of spreading operates from right to left.

A further issue concerns the possible roots that are available to associate to the templates. The Obligatory Contour Principle (OCP), which for our purposes states that a root cannot contain identical consonants in immediate sequence, has played an important role in explaining certain root patterns in Semitic. As shown below, there are root patterns in Tigrinya which at first appear to contradict the predictions of the OCP, but upon closer examination the OCP actually helps point to a more satisfactory solution.

I begin below in section 1 by giving evidence for edge-in association from the morphology of broken noun plurals in Tigrinya. Section 2 describes the various patterns of spreading found in the verb system and the consequences of these patterns for the mechanisms of association and spreading. Section 3 briefly examines implications for the treatment of association in cross-linguistic context. Section 4 presents a set of roots which seem to violate the OCP and proposes a solution within an edge-in framework which is not only consistent with the OCP but better as a result.[1]

1. Broken Plural Evidence

The most striking evidence for edge-in association in Tigrinya comes from the broken plurals of the nouns. Many nouns in Tigrinya take a simple plural suffix, such as *ʔabbo* 'father', plural *ʔabbo-tat*. These are traditionally called SOUND plurals since the stem is left intact. A large number of nouns, however, have BROKEN plurals; these involve infixation or association to a plural template.[2] The most common pattern consists of a quadriliteral root which associates to a disyllabic template in the singular (*CVCCVC*, where a number of vowels occur) and a trisyllabic template in the plural (always *CʌCaCɨC*).

(1)	*root*	*singular*	*plural*	*gloss*
	{knfr}	kʌnfʌr	kʌnafɨr	'lip'
	{mndl}	mʌndʌl	mʌnadɨl	'chisel'
	{ƙlśm}	ƙɨlśɨm	ƙʌlaśɨm	'arm'

One-to-one association in any order — left-to-right, right-to-left, or edge-in — will generate these forms correctly, since there is an equal number of autosegments and slots. The interesting case is where a triliteral root is associated to the same (quadriliteral) plural template. These forms are somewhat unusual but always behave in the same way: the template is satisfied by spreading the medial consonant:

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[1] Data cited here are taken from Bassano (1918), Leslau (1941), Palmer (1955), and elicitation from Tesfai Haile and Aida Nigussie, both from Eritrea. I would like to thank Larry Hyman for helpful discussions. **[Published 1990. See final page for information about this document.]**

[2] Angoujard and Denais (1989) give an analysis of a number of seemingly templatic broken plural types as infixation. While their treatment is quite interesting and captures certain similarities across plural types, it does not account for all of the data I have seen, so I retain a templatic approach here.

(2)	{tmn}	tʌmʌn	tʌmamɨn	‘snake’
	{grb}	gʌrʌb	gʌrarɨb	‘bush’

The pattern is accounted for in a completely straightforward manner by edge-in association. Yip’s (1988) algorithm consists of ANCHORING (associating the outermost autosegments to the edges of the template) and FILLING (associating the remaining autosegments to the remaining slots in the template). As Yip discusses, the precise nature of filling seems to vary across languages; I assume for Tigrinya that it is governed by Template Satisfaction and so a single remaining autosegment will link to all free slots:

(3)

Anchoring	*Filling*
C V C V C V C	C V C V C V C
| |	| \ / |
t m n	t m n

By contrast, left-to-right association (with a rule of spreading) predicts **tʌmanɨn*, while right-to-left would yield **tʌtamɨn*. A similar problem arises in the left-to-right treatment of such Arabic forms as *kattab*: here the medial consonant must spread, whereas regular association would give **katbab* (McCarthy 1981). Various solutions to this problem have been proposed, but they are unsatisfactory for Tigrinya. For example, McCarthy (1981) gives a rule which delinks /b/ from its first C-slot, allowing the /t/ then to spread rightward. In addition to being ad hoc, the rule must apply to a morphologically defined verb template, so it is inappropriate for Tigrinya where the other instances of the plural template have no need of such a rule. It is also not possible to mark the two middle slots of the template as obligatorily linked to the same autosegment (cf. Yip 1988 in a slightly different context), again because in most cases (i.e. when there is a quadriliteral root) the slots are not so linked. Finally, Hoberman (1988) proposes the Local Spreading Markedness Relationship, which states that multiple linking between adjacent consonant slots (*kattab*) is preferred to linking across a vowel slot (**katbab*); this notion cannot be applied to the plural template since there is no local spreading in either the correct (*tʌmamɨn*) or incorrect (**tʌmanɨn, *tʌtamɨn*) forms.

It is clear that edge-in association is the best suited to deriving forms such as *tʌmamɨn* without recourse to special mechanisms. In addition, edge-in association automatically generates the correct spreading in forms such as the following, where the root is triliteral and the template quadriliteral in both singular and plural:

(4)	{dkʷn}	dɨkʷkʷan	dʌxʷaxʷɨn	‘shop’[3]
	{ƙyt}	ƙɨyyʌt	ƙʌyayɨt	‘brass bracelet’
	{gbl}	gʌbbʌl	gʌbabɨl	‘large snake’

Association takes place as shown in (3), this time in the singular as well. Pairs such as *gʌbbʌl* and *tʌmʌn* both have triliteral roots, but differ in their singular templates; in the plural, since they have the same template, this difference is lost.

A complication arises in a few nouns where it is the final consonant that spreads rather than the medial one. The following are the only such forms in my corpus of more than 450 broken plurals:

(5)	{fyt}	faytot	fʌyatɨt	‘prostitute’
	{ḥnj}	ḥɨnjij	ḥanajɨj	‘type of hornet’
	{mrb}	mʌrbʌb	mʌrabɨb	‘fishing net’

[3] A nongeminate voiceless velar spirantizes post-vocalically (Schein 1981, Kenstowicz 1982).

The first two are fairly unusual in their vocalism as well;[4] the great majority of nouns have only central vowels in the singular template, like *mʌrbʌb*. The latter has the form of an instrumental noun derived from *rʌbʌb* 'put in order', where the template is *mʌCCʌC*. Though the semantic connection is not transparent, the original derivation may have been parallel to the type $C_1C_2C_2$ discussed below; at any rate, it has now been reanalyzed. I propose to treat the nouns in (5) via extraprosodicity of the final C-slot; details will be given below in the discussion of verbs, where similar examples are found in greater number.

2. Verbal Evidence

Having argued that the broken plurals provide strong evidence in favor of edge-in association, I now turn to the more complicated verbal system. There are four basic types of verbs in Tigrinya, most of which can be described according to the number of consonants in the template: triliterals, quadriliterals, quinquiliterals, and type C. In the discussion that follows, I distinguish between the number of consonants in the root and in the template. To take an example from the nouns above, the word for 'snake' has a triliteral root {tmn} and a triliteral singular template *CʌCʌC* which together form *tʌmʌn*; in the plural the template is quadriliteral, so the medial consonant must spread to form *tʌmamɨn*. When I say, for example, 'quadriliteral verb', I refer to a verb whose various templates all have four consonant slots; a root which associates to these templates can, as we will see, have two, three, or four consonants. In citing verb forms I give the stem of the active 'perfect' conjugation.

The triliteral verb is very common, constituting 37.0% of my corpus.[5] This is the type A of Leslau (1941). Type C verbs (borrowing a term from Leslau) are also triliteral, but take a vowel /a/ before the penultimate root consonant, except in the infinitive where there is an [ɨ] in the same place.[6] They are uncommon, only 5.7% of the corpus. Verbs of this type are not predictable from the root consonants and must be lexically marked, since there are minimal contrasts between type C and regular triliterals (type A): e.g. *dʌrʌg* 'unite, agree' versus *darʌg* 'assign lodging to stranger'. Quadriliteral verbs have four consonant slots in the template. They are very common, over half of the corpus (54.2%) under my analysis. Leslau (1941) has a separate type B which I group under the quadriliterals (it accounts for 23.2% of the 54.2% figure given above). I will justify this merger below. Finally, there is a quite rare type, the quinquiliterals; they have templates with five consonants and comprise just 1.0% of all roots. There are great similarities between the quadriliteral and quinquiliteral templates, and it may be possible to derive the latter; I have not worked out the details, so I will assume for the time being that these templates are provided by the morphology.

$C_1C_2C_2$ Verbs. As mentioned in the discussion of nouns, when the number of root consonants is the same as the number of consonant slots in the template to which it is associated, we have no evidence concerning the direction of association; the interesting cases are those where the numbers are different. In many instances a root is associated to a template with more consonant slots than there are consonants in the root. For example, 12.3% of the type A triliterals have the form $C_1C_2C_2$, which, if we accept the OCP, must be explained as spreading (more on this below). Thus *ḵʌnʌn* 'slant, be folded' comes from the root {ḵn}, and *gʌdʌd* 'worsen' from {gd}. The

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[4] In *ḥanajɨj* we see a rule whereby /ʌ/ lowers to [a] when in the same syllable as a guttural (pharyngeal or laryngeal) consonant.

[5] The corpus consists of all verb roots given as entries in Bassano (1918), a total of 2746 roots. The breakdown: triliterals (type A), 1016; type C, 157; quadriliterals, 1489 (of these 637 are Leslau's type B); quinquiliterals, 28; apparent OCP violations, 51; anomalous verbs, 5.

[6] I have argued elsewhere (Buckley 1989) that the [ɨ] is really a dissimilated /a/, which explains both its presence in the same place and the unusual occurrence of [ɨ] in a doubly open syllable.

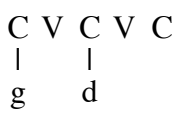
same pattern exists for 10.2% of type C verbs, e.g. *fanʌn* 'be frightened'. These verbs have a triliteral template with biliteral roots. There are no uniliteral roots.

Since these $C_1C_2C_2$ verbs represent a common type in both Semitic generally[7] and Tigrinya specifically, we should be able to account for them without reference to a mechanism such as extraprosodicity (which we will appeal to later for different purposes). This effectively rules out right-to-left association, which would predict spreading of the first radical (**gʌgʌd*) rather than the last (*gʌdʌd*).

(6) *Right-to-Left Association and Leftward Spreading*

In addition, right-to-left association has not generally been advocated as a major association type, so I will not consider it further here. Left-to-right association, on the other hand, can automatically generate rightward spreading. It is 'automatic', however, only if spreading is taken to be a part of the universal rules of association. Though this assumption was made in early work in autosegmental phonology (Goldsmith 1976), since Pulleyblank (1983) it has more often been assumed that initial association is one-to-one and subsequent spreading is by rule. I take the latter position. Consequently, left-to-right association will fill just the first two consonant slots, and the spreading of the final consonant to form *gʌdʌd* must be accomplished by a rule of rightward spreading:

(7) *Left-to-Right Association and Rightward Spreading*



By the same token, edge-in association will accomplish only part of the job, and a rule of *leftward* spreading is necessary (Yip 1988):

(8) *Edge-in Association and Leftward Spreading*

So far there is no basis for preferring left-to-right or edge-in association, since both generate these forms with a single additional rule of spreading.

$C_1C_2C_2C_2$ Verbs. Among the quadriliterals, there are three types of spreading attested. A small number of verbs, 3.6% of the quadriliterals, have a biliteral root that takes the form $C_1C_2C_2C_2$, e.g. *ḵʌnnʌn* 'pour off liquid', *gʌddʌd* 'be important to (someone)'. Assuming the OCP, these verbs must also have the roots {ḵn} and {gd}, like the triliterals above; thus there must be lexical marking which determines what template a root is associated to.[8] The two types of association are once again equally capable of generating the correct forms, e.g. *gʌddʌd*, assuming iterative application of the same spreading rules as above:

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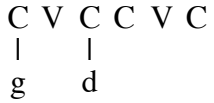
[7] 'There are no Proto-Semitic [triliteral verb] roots with identical consonants in the first and second positions...On the other hand, identical second and third consonants are very common' (Greenberg 1950:178).

[8] To eliminate redundancy in the lexicon, the default template would be the smallest one to which all the root consonants can be associated, e.g. a biliteral or triliteral root to a triliteral template, and a quadriliteral root to a quadriliteral template.

(9) *Left-to-Right Association and Rightward Spreading*



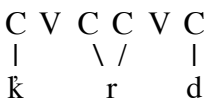
(10) *Edge-in Association and Leftward Spreading*

There is still no reason to prefer one of these two association types over the other.

$C_1C_2C_2C_3$ Verbs. A much larger number of quadriliterals have triliteral roots (50.1%). Of these, most (78.3%) have medial spreading to create $C_1C_2C_2C_3$, as in *kʌrrʌd* 'persist' and *dʌbbʌn* 'become cloudy'. This is Leslau's type B.[9] At this point it appears that edge-in association is to be preferred over left-to-right, since it automatically produces medial spreading, e.g. in *kʌrrʌd*:[10]

(11) *Anchoring*

Filling



Left-to-right association can be salvaged here if we assume, for example, that the association mechanism incorporates a principle that prefers cases of spreading which involve adjacent consonant slots over those separated by a vowel slot (the Local Spreading Markedness Relationship of Hoberman 1988, who however assumes edge-in association). This solution was shown to be ineffective for the broken plurals, though, and it will also run into problems in the case described next.

$C_1C_2C_3C_3$ Verbs. The other triliteral roots associated to quadriliteral templates (21.7%) have final spreading to create $C_1C_2C_3C_3$, as in *kʌrdʌd* 'cut up vegetables' and *dʌrsʌs* 'heal'.[11] Note that these verbs must be lexically distinguished from type

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[9] Type B and the rest of the quadriliterals have identical templates, with one exception: in the passive imperfect, type B has the same vocalism as type A. That is, a normal quadriliteral in the passive imperfect has the vocalism / ʌ ʌ / and gemination of the initial radical, as in *yɨmn-mʌsgʌn* 'he is thanked'. Type A verbs have gemination of the medial consonant and the vocalism / ɨ ʌ / in all person-number combinations, e.g. *yɨ-sɨbbʌr* 'it is broken'. Note that with this medial gemination, the type A takes on a central characteristic of type B verbs, which assume the same form: *yɨ-bɨddʌl* 'he is offended' from *bʌddʌl* 'offend', rather than **yɨb-bʌddʌl* which would be the normal quadriliteral form. I propose that this quirk in conjugation was made possible by a confusion between the type A and type B roots when the difference between them was seriously reduced by gemination of the medial consonant of type A. This probably took place in Proto-North Ethiopic, since the South Ethiopic languages have gemination in the perfect (Amharic *sʌbbʌr*) rather than the imperfect (*yɨ-sʌbr*). Synchronically I assume that the 'confusion' is morphologized as an exceptional choice of templates (triliteral over quadriliteral), rather than a completely different set of templates for type B, as Leslau's classification implies. My analysis permits the elimination of type B as a separate class of verbs, considerably simplifying the system.

[10] This assumes, as in section 1, that the association mechanism is governed by Template Satisfaction and, when faced with a single consonant and multiple C-slots, will associate the autosegment to all of the slots. Since this smacks of automatic spreading, it may be preferable to have the mechanism associate the autosegment to the rightmost free slot in such a situation, and then let the rule of Leftward Spreading take care of the rest. More on this below.

[11] The following discussion applies also to the two quinquiliteral verbs that have a doubly linked final consonant (*mbʌrkʌx* 'kneel' and *mbʌrɬʌɬ* 'be proud, strut', both of which are passive only)

B (as shown by *ḵʌrdʌd* and *ḵʌrrʌd* 'persist') and the triliterals (*dʌrsʌs* and *dʌrʌs* 'sing praises'). While this type could be easily handled by left-to-right association (with rightward spreading), the modifications that might have been made to accommodate type B would presumably need to be suspended for these verbs, so that, for example, different roots would have different markedness principles connected with them.

At the same time, the edge-in association that works so well for type B cannot by itself derive the quadriliteral with final spreading. One solution is to allow different roots to select different association directions; this kind of power may be unwarranted, and to simplify the grammar I would like to maintain a consistent association type throughout the language — and based on the broken plurals, edge-in seems the best candidate. Another solution, mentioned in section 1, is suggested by Yip (1988): in certain templates in Arabic two given slots must be linked to the same autosegment. This approach is undesirable in Tigrinya, however, since the templates for *ḵʌrdʌd* and *ḵʌrrʌd* are identical with respect to vocalism and syllable structure, so that positing two sets of templates would be ad hoc.

Still assuming edge-in association, we could revise our notion of Filling as suggested in footnote 10. In the normal situation the last melodic element would link to the rightmost free slot, and Leftward Spreading would apply to fill the remaining slot. Under this REVISED FILLING the derivation in (11) takes the following form:

(12) *Revised Filling: link to RIGHTMOST empty slot, then spread left*

C	V	C	C	V	C	*ḵʌrrʌd*
|			|		|	
ḵ			r		d	

For lexically marked roots, however, the last melodic element links to the leftmost free slot, so that it is the final consonant that undergoes Leftward Spreading. This derives *ḵʌrdʌd* as shown:

(13) *Marked Filling: link to LEFTMOST empty slot, then spread left*

C	V	C	C	V	C	*ḵʌrdʌd*
|		|			|	
ḵ		r			d	

The disadvantage here is that the root still selects an important aspect of the association algorithm, though not the direction itself. This may be a cross-linguistic parameter, but a simpler solution will keep the entire association mechanism the same throughout the language.

Another possibility comes from McCarthy (1985). As discussed in greater detail in section 3, McCarthy suggests that in the related language Amharic some roots with unusual association patterns have a consonant already associated to their template in the lexicon; the rest of the consonants associate in the normal (left-to-right) manner. Naturally, this solution assumes that for these roots the template is part of the lexical entry. There is motivation for this approach in Amharic, since historical changes have led to the development of numerous new templates which are not predictable from the root consonants. In Tigrinya, however, these changes have not occurred and it is preferable to maintain a simple diacritic approach to templates, analogous to verb classes; otherwise the amount of information in each lexical entry would be greatly increased. Since there is little reason to complicate the lexicon in this way, the lexical association solution does not seem appropriate for Tigrinya.

A more promising lexical property is extraprosodicity. I suggest that a verb such as *ḵʌrdʌd* is derived from a root {ḵrd} which differs from the root for *ḵʌrrʌd* only in the presence of a diacritic [+extraprosodic]; both must select a quadriliteral

template.[12] This diacritic is interpreted to mean that the rightmost C-slot of the template is invisible during initial association. After this association, the rightmost slot is still unfilled, and there is no rule of rightward spreading to fill it. The requirement of Template Satisfaction causes copying of the melody (cf. Bat-El 1984, Broselow and McCarthy 1983, Steriade 1986), and by edge-in association the outermost element links to the free slot (cf. Marantz 1982, Yip 1988); the rest of the melody is deleted by Stray Erasure:

(14)

Association	*Copying*	*Association, Erasure*
C V C C V (C)	C V C C V C	C V C C V C
| | |	| | |	| | | |
ƙ r d	ƙ r d ƙ r d	ƙ r d d

The broken plurals in (5) would be handled in the same manner. There is no evidence, e.g. from Spirantization, as to whether the final two slots are linked to a single melodic consonant to form a true geminate, since the two final slots are never adjacent in a quadriliteral skeleton (see section 4). In other words, we do not need to assume spreading. This is not an OCP violation, however, since that constraint applies only to lexical representations in Tigrinya (cf. Steriade 1989).

More Reduplicated Roots. Another pattern of root consonants which will become important in section 4 involves reduplication of the last two radicals. This can be with a quadriliteral template, resulting in a reduplicated biliteral $C_1C_2C_1C_2$; or with a quinquiliteral template, resulting in $C_1C_2C_3C_2C_3$ (all of which are causative or passive). These verbs fall into several types. First, some exist only in reduplicated form:[13]

(15)	mbʌdbʌd	'fan a fire'	*mʌbʌd, *mʌbbʌd, *mʌbdʌd
	lahlɨh	'pant from fatigue'	*lahɨh

Other roots are found in plain and reduplicated forms, with the same meaning:

(16)	htʌftʌf, hattʌf	'talk in sleep, delirium'
	ḥlʌẋlʌẋ, ḥalʌẋ	'be about to die'
	lʌblʌb, lʌbʌb	'cauterize wound'
	hadhad, hadʌd	'be musty'

A third set of verbs are also found in plain and reduplicated forms, but the meanings are unrelated:

(17)	ẋʷrʌmrʌm	'importune, complain'	ƙʷʌrʌm	'tear off a piece'
	lʌẋlʌẋ	'smear, paint'	lʌẋʌẋ	'move (residence)'
	hazhaz	'be big, sturdy (man)'	hazʌz	'fade (color)'
	lʌflʌf	'chatter uselessly'	lʌfʌf	'finish'

In other cases, there is some relationship in meaning, though it is not exact as in (16):

(18)	ḥzʌnzʌn	'be discontented'	ḥazʌn	'grieve'
	lʌmlʌm	'be soft'	lʌmʌm	'touch lightly'

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[12] If we wish to eliminate every possible redundancy from the lexicon, then a root which is [+extraprosodic] will automatically be associated to a template which has one more C-slot than there are segments in the root.

[13] Some of these verbs show the effects of two phonological rules affecting /ʌ/. The first, mentioned in footnote 4, lowers it to [a] when in the same syllable as a guttural. The second raises it to [ɨ] in an open syllable followed by a guttural. Both rules are evident in /lʌhlʌh-ʌ/ -> [lahlɨhe] 'he panted'. Also seen here is a rule which fronts the nonlow central vowels /ɨ,ʌ/ to [i,e] word-finally (Buckley 1989; the suffix is omitted from the verbs in the text here).

The fifth logical possibility — no reduplication at all — is instantiated by the majority of roots. Contrasts such as *gʌddʌd* 'be important' versus *gʌdgʌd* 'make wall of mud-covered wood and branches', both from a root {gd}, show that reduplication is not predictable simply based on there being two root consonants and four template slots. Therefore there must be lexical marking to distinguish them. It is true, however, that whenever three consonants associate to a quinquiliteral template, there is reduplication; these cases can be predicted by rule.

I propose to derive this reduplication in a manner parallel to *ƙʌrdʌd* in (14). That is, the representations for all of these reduplicated verbs are bi- or triliteral roots with the feature [+extraprosodic]. For verbs such as those in (15), the feature (or the quinquiliteral template which predicts it) is obligatory. In (16), the feature is only optionally realized; when it is not realized, there may be other morphological features which come into play (such as association to a quadriliteral template in the case of *hattʌf*). In (17), there are two lexemes, one with [+extraprosodic] and one without it which has a different meaning; this is basically a case of homophony. Ideally, the pairs in (18) should be linked in order to reflect their similarities; for example, the [+extraprosodic] feature could be connected to semantic differences.

Unlike in (14), here the final *syllable* (always CVC) is invisible during association. The feature [+extraprosodic] marks as invisible the largest prosodic constituent which will permit the root melody to be satisfied on the first association. Thus, all elements of a two-consonant melody can link to a four-slot template when the final syllable is invisible, while in (14) there are three consonants in the melody, so only the final slot is invisible. Copying and EI association from the right proceed as above. Quadriliterals are illustrated by *lahlɨh* 'pant':

(19)

Association	*Copying*	*Association*
C V C (C V C)	C V C C V C	C V C C V C
| |	| |	| | | |
l h	l h l h	l h l h

A quinquiliteral verb template is treated the same way, e.g. *mbʌdbʌd* 'fan a fire':

(20)

Association	*Copying*	*Association, Erasure*
C C V C (C V C)	C C V C C V C	C C V C C V C
| | | |	| | | |	| | | | | |
m b d	m b d m b d	m b d b d

As in (14), the excess melodic elements (here just /m/) are deleted by Stray Erasure, since there are no slots left to attach to.

In both cases of extraprosodicity — slot in (14) and syllable in (19-20) — the initial association could be treated as left-to-right without a new rule of rightward spreading. This automatically leaves the proper number of slots unfilled, and since there is no rule of rightward spreading the only way to satisfy the template is through copying as above. This analysis avoids the apparent necessity under edge-in of calculating whether there will be enough slots left over to make a full syllable invisible (or looking ahead at the consequences). On the other hand, it requires an additional association mechanism for the language, and it fails to capture the fact that reduplication only applies to prosodic units (slots and syllables).

Frequentatives. Finally, a type of spreading which is similar to that seen in the broken plurals is found in the frequentative form of the verb. For type A verbs, this template is derived by prefixing *Ca* to the last syllable of the stem: the perfect *CʌCʌC* becomes *CʌCaCʌC*. Just as in the nouns, the medial autosegment spreads: *sʌbʌr* 'broke', *sʌbabʌr* 'broke several times'. Yip (1988) cites this as evidence for edge-in association in Tigrinya, but in fact the situation is more complicated, and I do not

believe that the frequentative provides direct evidence for edge-in association. Briefly, the infixation of *Ca* must occur after initial association of the root; the new slot is filled by leftward spreading, which is an integral part of an edge-in analysis (and unneeded by left-to-right association).

3. Implications

In the preceding sections a range of evidence has been presented to show that association in Tigrinya is edge-in. Yip (1988) argues that an edge-in analysis, which is already a necessary part of phonological theory to account for reduplication, is also preferable for Arabic templates, and points out supporting data from Tigrinya, Tigre, Cupeño, and Yokuts, while Hoberman (1988) assumes edge-in association in his analysis of Syriac. This evidence raises the question of whether left-to-right is necessary at all for segmental association, and can be replaced by edge-in, thereby simplifying the theory. Of course, this depends on whether all previous analyses of templatic morphology in a left-to-right framework can be adapted to the edge-in framework. Here I will just briefly discuss two other languages. The first, also mentioned by Yip (1988), is Amharic, a fairly close relative of Tigrinya.

Amharic has a number of verbs which are historically triliteral but which have become biliteral due to the loss of many gutturals. This leads to contrasts such as the following:

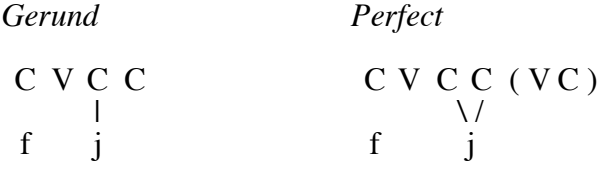
(21)

	'wear'	'love'	'consume'
perfect	läbbäs	wäddäd	fäjj
gerund	läbs	wädd	fäjt

The regular pattern is represented by *läbbäs*; *wäddäd* shows what seems to be a biliteral root that spreads. This is complicated by *fäjj*, which is one syllable shorter in the perfect and has a /t/ in the gerund. Broselow (1984) analyzes the difference between *wäddäd* and *fäjj* by assuming that the OCP does not hold in Amharic, and that the roots are {wdd} and {fj}. The templates are perfect *CäCC(äC)* (with the medial slots underlyingly linked to the same autosegment) and gerund *CäCC*. The elements in parentheses are optional and filled only when necessary to satisfy the root melody; there is no long-distance spreading. Since {wdd} has three consonants, it fills the entire template, just like {lbs}, whereas {fj} only has two consonants so in the perfect the last slot is unfilled and does not surface. In the gerund, the last slot is also unfilled, but since it is not optional it is realized as default /t/. Clearly, this assumes left-to-right association.

Under Broselow's treatment, it does not seem possible to maintain edge-in association, since the unfilled slot must be on the right edge. McCarthy (1985) gives evidence that the OCP is in force in Amharic, and suggests a reanalysis of the data which is consistent with the OCP. He proposes underlying association of certain root consonants to the template, similar to a tonal analysis of Mende by Leben (1978); although McCarthy assumes left-to-right association, this can also be adapted to an edge-in framework. Basically, *wäddäd* has the root {wd}, similar to {fj}, but in the latter case /j/ is associated underlyingly to the penultimate slot of the template:

(22)



The only thing left to associate is the first consonant which links to the leftmost slot (recall that in the perfect the two medial slots are underlyingly linked to the same melodic element, though in an elaborated edge-in analysis this fact may be derivable). Since there is no rule of rightward spreading (just leftward, as in Tigrinya, to give

wäddäd), the optional slots in the perfect are deleted. Thus Amharic does not necessarily require left-to-right association.

Other cases are more difficult to reconcile to an edge-in framework. As analyzed by Smith (1985), Sierra Miwok has left-to-right association with spreading only between vowel slots in the same syllable; unfilled vowels surface as /i̵/, unfilled consonants as /ʔ/. For example:

(23)	*base form*	polaat	tappu	halh	tiil	katt
	CVCVC	polat	tapuʔ	hali̵h	tili̵ʔ	kati̵ʔ
	CVCCVV	poltaa	tapʔuu	halhi̵i̵	tilʔi̵i̵	katʔi̵i̵

In *polaat* there are enough root elements to fill the derived templates; in the others, however, there are insufficient consonants and/or vowels to fill all slots, so those remaining unfilled surface as the defaults. These are always on the right. It is hard to see how this insight could be captured in any straightforward way using edge-in association. Similarly, Yip (1988) points out cases of tonal association — Tiv and Kikuyu — which do not seem amenable to an edge-in treatment. For such languages it appears that left-to-right association must remain an option, and we must conclude that two types of association — left-to-right and edge-in — are necessary parts of phonological theory. It does seem, however, that right-to-left may be unneeded as an independent association type in templatic morphology (see Itô 1989 for syllabification).

4. Apparent OCP violations

A major piece of evidence for the Obligatory Contour Principle in Semitic languages (generally using Arabic as the prime example) is the frequency of roots of the form $C_1C_2C_2$ but the lack of roots of the form $C_1C_1C_2$. This skewed distribution has been explained by McCarthy (1981) as due to two factors operating in the languages in question: left-to-right association (and spreading) and the OCP. Because of the OCP, roots with adjacent identical consonants must be derived by spreading, and because of L-R association these identical consonants can only be on the right edge of the root. Thus a root such as {sm} 'poison' surfaces as *samam* due to left-to-right spreading, but never surfaces as **sasam*. This intuition has been translated into the edge-in analysis of Arabic by Yip (1988): there is only a rule of leftward spreading, so that the /m/ of {sm} will spread to the medial C-slot, but never the /s/. The same explanation holds for my analysis of Tigrinya with edge-in association and leftward spreading.

Ignoring for the moment these root patterns, there is another important piece of evidence for the OCP in Tigrinya. A number of authors have commented on the relationship of the OCP to Tigrinya spirantization (see Schein 1981, Kenstowicz 1982, Schein and Steriade 1986, Hayes 1986, Lowenstamm and Prunet 1986). Basically, the OCP must operate within a morpheme to prevent the representation in (24a):

(24) (a)

```
V C  C     —>   V C  C
 |   |            |   |
 k   k            x   k
```

(b)

```
C   C
 \  /
  k
```

Only the representation in (b) can be permitted, since (a) would allow post-vocalic spirantization of the first stop, but not the second, to yield [xk]; this sequence is impossible within a morpheme in Tigrinya. If the OCP is a constraint on lexical roots, then roots containing two adjacent tokens of /k/ are ruled out, correctly eliminating the possibility of monomorphemic representations of the type in (a).

Initial Spreading. Having illustrated the usefulness of the OCP in Tigrinya, we return to root patterns. As shown in section 2, Tigrinya does have many roots of the Arabic {sm} type, where the surface form is $C_1C_2C_2$ (e.g. *gʌdʌd* 'worsen').

However, it also has a smaller but still noteworthy number of roots of the type not found in Arabic, where spreading seems to take place on the left (a total of 51 verbs, 1.9% of the corpus). The Tigrinya examples have apparently not been discussed previously, though Broselow (1984) and McCarthy (1985) give a few similar verbs in Amharic; my examination of Leslau (1976) suggests that they are even less common in Amharic than in Tigrinya.

$C_1C_1C_2$. Just over half of these verbs (a total of 26) have the surface form $C_1C_1C_2$. For example:

(25)

lʌlʌw	'scorch'
lʌlʌy	'sort (grains)'
mʌmʌy	'winnow'
mʌmʌt	'pick out loot'
ɬʌɬʌm	'strip off leaves'

They appear superficially to be triliterals (type A). Assuming that association proceeds as argued for all other verbs, the roots must violate the OCP: e.g. *lʌlʌw* 'scorch' would come from {llw}. It turns out, however, that these verbs have surprising template patterns. As we see below, the active perfect of *lʌlʌw* appears the same as a triliteral, but the other forms show important differences:

(26)

	Triliteral	'scorch'	*Quadriliteral*
active perfect	CʌCʌC	lʌlʌw	CʌCCʌC
causative perfect	CCʌC	lʌlʌw	CʌCCʌC
active jussive	CCʌC	lʌlɨw	CʌCCɨC
causative jussive	CCɨC	lʌlɨw	CʌCCɨC
infinitive	CCaC	lɨlaw	CɨCCaC

In fact, the root seems to associate to a quadriliteral template, except that there are only three consonant slots. Simply assuming right-to-left association or left-edge extraprosodicity will not explain these templates.

Many of the roots, if taken to be originally reduplicated biliterals, would now be missing a glide in C_2 position: for example {lw} 'scorch', {ly} 'sort (grains)', {my} 'winnow'. In this case *lʌwlʌw* would have become *lʌlʌw* by loss of the glide. We have historical evidence that this is precisely the change that took place. Geez, the liturgical language of the Ethiopian church, is probably not a direct ancestor of Tigrinya but rather a closely related dialect of the speech from which it descended (Hetzron 1972); for present purposes, however, Geez can be taken as representative of an earlier form of Tigrinya. The Geez data given here are from Leslau (1987).

In both Geez and Tigrinya, vowel coalescence takes place whereby /ʌy/ —> [e] and /ʌw/ —> [o] (see Buckley 1989). For those Tigrinya verbs which have a corresponding form attested in Geez, the glide which is missing in Tigrinya is present in Geez:

(27)

lolʌw	<	*lʌwlʌw* by vowel coalescence	'inflame'
lelʌy	<	*lʌylʌy*	'separate'
memʌy	<	*mʌymʌy*	'distinguish'

At this point in time the roots were regular, although in the surface forms the vocalisms were unusual due to coalescence. The apparent explanation for the modern Tigrinya forms is that these unusual vocalisms were regularized, with the result that the consonantal root was made irregular. Note that this 'regularization' was not complete, since there are still a few reduplicated verbs in Tigrinya with glides in this position that have not disappeared; in most cases, however, they seem related to OCP violations, thereby providing strong synchronic evidence to confirm the diachronic data. For example, *ṡʌwṡʌw* 'drain, gulp down' is almost identical in meaning to

ṡʌṡʌw ‘finish off a drink’. Similarly, *nʌwnʌw* ‘push (away)’ is similar to *nʌnʌw* ‘shake, push, rock’; the latter verb has a variant form *nʌnʌy* which suggests a relationship to *nʌynʌy bʌl* ‘move easily, swing’.[14]

Not all verbs with unusual template patterns as shown in (26) can be described in this way, however. For many there is no available evidence of glides, past or present: for instance, *mʌmʌt* ‘pick out loot’, *ɬʌɬʌm* ‘strip off leaves’, *ɬʌɬʌf* ‘prune a tree’. These verbs may have been analogical formations based on the original glide-deletion pattern, but now they are lexical exceptions. That this process cannot be predicted phonologically is illustrated by the following minimal pairs:

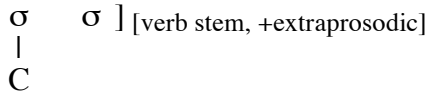
(28)

Root	*Reduplication only*	*With Deletion*
{t̓f}	*ɬʌfɬʌf* ‘smear wall with mud’	*ɬʌɬʌf* ‘prune tree’
{t̓m}	*ɬʌmɬʌm* ‘wrap turban around head’	*ɬʌɬʌm* ‘strip off leaves’
{k̓ʷb}	*k̓ʷʌbk̓ʷʌb* ‘be thin with swollen belly’	*k̓ʷʌx̓ʷʌb* ‘bloom (sorghum)’

What was perhaps originally a regular phonological rule deleting glides has become morphologized due to analogical formations, and must now be lexically marked.[15]

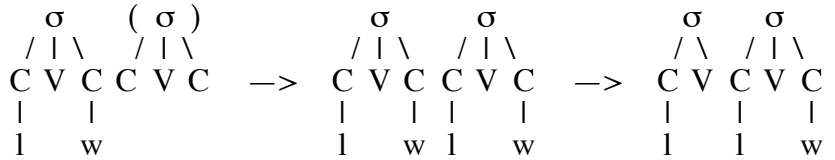
I propose an analysis which in effect recapitulates the historical origin of the forms. The lexical entry for the verb includes the biliteral root, with the [+extraprosodic] feature discussed in section 2, along with a diacritic triggering a rule that deletes the coda of the penultimate syllable:[16]

(29) *Slot Deletion*



For example, in the derivation of *lʌlʌw* from {lw}:

(30)



Again, the resulting representation does not constitute an OCP violation since that applies only to lexical entries. This derivation correctly predicts that the only verbs which have the unusual template patterns illustrated by *lʌlʌw* also have apparent initial spreading — and conversely, those with initial spreading also have unusual templates. This follows from the fact that only verbs with reduplication can undergo

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[14] This data comes from Bassano (1918); it appears that for my consultants the regularization is complete, and the rule discussed below always applies to glides.

[15] Bassano (1918) gives one obvious borrowing: perfect *p̓ʌp̓ʌs*, imperfect *p̓ɨp̓ɨs* ‘be consecrated as bishop’, from Greek *pappas*. The imperfect vocalism is that of a quadriliteral (a triliteral would be *p̓ʌp̓p̓ɨs*), suggesting that it has been analyzed along the same pattern as the native words with initial ‘spreading’ and is underlyingly {p̓s}, reduplicates, and undergoes Slot Deletion.

[16] In a more sophisticated representation of the syllable, this rule would single out the coda consonant by means of a mora or coda constituent dominating the relevant segment. Since this issue is orthogonal to the matter at hand, I have avoided such representations for the sake of simplicity.

Slot Deletion: the consonants on either side of the deleted slot are necessarily identical.[17]

A smaller number of verbs with apparent initial spreading (7) are type C triliterals: *zazʌm* 'level off, finish', *gagʌr* 'make bread'. Since the vocalisms for type C verbs and quadriliterals are the same (modulo a rule inserting /a/ before the final syllable; see Buckley 1989), a form like *zazʌm* will appear to be a regular type C even if it 'really' has the vocalism of a quadriliteral. In other words, the loss of the penultimate coda consonant does not create an unusual template. Since their surface consonant pattern is the same, however, I assume that these verbs are underlyingly biliterals — e.g. {zm} and {gr} — with the feature [+extraprosodic] and derived by Slot Deletion. The only difference is that they also are treated as type C in that the rule inserting /a/ applies to them.

$C_1C_2C_2C_3$. There are four apparent quadriliterals with the pattern $C_1C_2C_2C_3$ which also have unusual templates, e.g. *ẋrʌrʌy* 'sing war songs', *ẋʷlʌlʌw* 'suffer labor pains'. All are found in the causative only (like most *quinqui*literals):

(31)

	Quadriliteral	*{ƙry}*	*Quinquiliteral*
causative perfect	CʌCCʌC	ẋrʌrʌy	CCʌCCʌC
causative jussive	CʌCCɨC	ẋrʌrɨy	CCʌCCɨC

Comparison shows that these verbs are actually reduplicated roots on a quinquiliteral template which undergo the same rule of Slot Deletion (a conclusion supported by the glide in *ƙɨlɨwlaw* 'labor pains', related to *ẋʷlʌlʌw* 'suffer labor pains'):

(32)

Association		*Copying, Association*		*Slot Deletion*
σ' σ (σ)		σ' σ σ		σ' σ σ
| / | \ / | \		| / | \ / | \		| / \ / | \
C C V C C V C	—>	C C V C C V C	—>	C C V C V C
| | |		| | | | |		| | | |
ƙ r y		ƙ r y r y		ƙ r r y

Thus the unusual templates in (26) and (31) are predicted by the same rule.

While all the quinquiliterals which undergo Slot Deletion lose a glide by it (the other two are {msw} 'delay, linger' and {mšw} 'accommodate'), not all such verbs with glides in Bassano (1918) seem to trigger the rule. The causative verb *sƙoẋʌw* 'sob, cry softly' is from {sƙw} by reduplication and coalescence, without losing the glide; the infinitive *mɨ-sƙɨƙƙaw* lacks the first /w/ and has a geminate /ƙ/ medially — suggesting application of Consonant Deletion (described below). This verb is perhaps related to *ƙʌẋʌw* 'squawk, cackle', which does undergo Slot Deletion. The quinquiliteral *xʷzʌyzʌy* 'turn around (dancing); loiter idly' is another verb which does not lose its glide. For the dialect represented here, at least, the application of Slot Deletion cannot be predicted phonologically.

$C_1C_1C_1C_2$. There is an additional pattern (14 verbs) with apparent initial spreading over the first three slots ($C_1C_1C_1C_2$); unlike the case above, they have four surface slots in the template and follow a regular quadriliteral pattern:

(33)

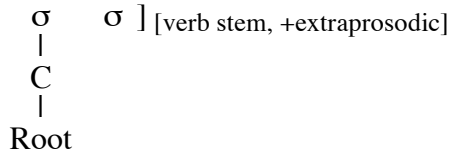
sʌssʌn	'increase'
dʌddʌẋ	'stay small, not grow'
kʷʌkʷƙʷʌd	'tie up animal'

[17] There is a complication with respect to verbs like *ƙʌrdʌd*, which also have the [+extraprosodic] feature but do not undergo this rule — it would yield *ƙʌdʌd*, a pattern which exists but is distinct and does not have an unusual template. The rule actually applies only to verbs where the final *syllable* is extraprosodic during association.

Once again, these forms would have to be OCP violations, e.g. {ssn}, to fit the normal means of association. Note that two logically possible patterns are, however, not found: *$C_1C_1C_2C_2$, *$C_1C_1C_2C_3$. An adequate analysis should account for the gap.

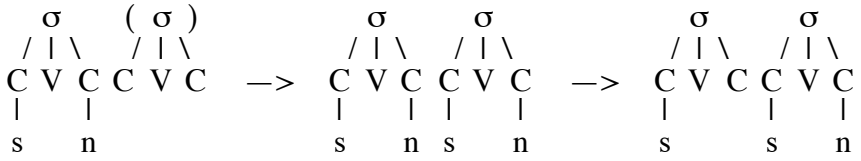
This patterning can be explained with similar reference to reduplication. Assume that *sʌssʌn* comes from {sn}, as the OCP demands. I propose a second rule, slightly different from Slot Deletion, which deletes only the autosegment. The C-slot is left to be filled by the autosegment to its right (by regular Leftward Spreading), thereby deriving a geminate.

(34) *Consonant Deletion*



Such verbs seem to result historically from complete assimilation,[18] which this rule suggests. The stem *sʌssʌn* is derived as follows:

(35) *Association* *Copying, Association* *C Deletion, Spreading*



The deletion of the /n/ creates a derived environment where Leftward Spreading can apply to create a geminate. We know that it is a 'true' geminate in the sense of Hayes (1986) because Spirantization does not apply: *ƙʌƙƙʌl* 'cook' (**ƙʌx̌ƙʌl*). Similar to the case of *ƙʌrdʌd*, there is no evidence to show whether the first two slots are linked to the same melodic element, so we do not need to assume spreading there. The template is regular since no slot is lost.

Again, it is not possible to predict on a strictly phonological basis which verbs will undergo this assimilation:

(36)

Root	*Reduplication only*	*With Consonant Deletion*
{sn}	*sʌnsʌn* 'burn (clay pot)'	*sʌssʌn* 'increase'
{k^wr}	*k^wʌrk^wʌr* 'interrogate'	*k^wʌ$k^w$$k^w$ʌr* 'waste away, be emaciated'
{k^wʕ}	*k^waʕk^wɨʕ* 'start to form pods'	*k^wʌ$k^w$$k^w$ɨʕ* 'clean wax from ears'

It is unclear whether the assimilation in verbs like *sʌssʌn* was ever productive for particular classes of segments. Note that there is one minimal pair distinguished by Slot and Consonant Deletion:

(37)

Root	*Slot Deletion*	*Consonant Deletion*
{ṡy}	*ṡʌṡʌy* 'peel vegetables'	*ṡʌṡṡʌy* 'be clean, pure'

[18] Greenberg (1950:167) notes the existence of these types of roots in Geez ('Ethiopic'), writing that 'these, it is usually assumed, result from quadriconsonantal forms involving reduplication of a biconsonantal nucleus, e.g. Ethiopic *ssl* 'to leave' < *slsl*. The six instances of this type in Ethiopic find no correspondences in other Semitic languages.' He also notes a few such verbs in Assyrian and one in Hebrew.

This difference must be marked lexically, though it may be possible to say that Slot Deletion is the default case for a root ending in a glide, and that only *śʌśśʌy* must be marked.

This treatment explains why there are no forms *$C_1C_1C_2C_2$ or *$C_1C_1C_2C_3$. Since the rule deriving these verbs applies only to reduplicated roots, the first (C_1) and third (C_2) surface consonants would have to be identical, ruling out both of these patterns. If the OCP were not in force in Tigrinya, then these predictions would not follow from the rule I have proposed. If the initial consonant can be given twice underlyingly, then *$C_1C_1C_2C_3$ should be possible. In other words, the apparent violations of the OCP are actually best accounted for in a framework which assumes the OCP.

Another analysis could posit underlying roots which contain 'dummy' consonants of some kind rather than a regular consonant, e.g. {lClw} instead of {lw} which reduplicates. It is more restrictive, however, to have concrete roots, for two reasons. First, we avoid positing abstract consonants whose sole function is to trigger a morphological rule, or to take up space in the skeleton without ever surfacing. Second, by restricting the morphological rules to roots with reduplication, we make the correct prediction that the unusual template patterns occur only when the consonants on either side of the deleted consonant are identical (due to reduplication). This rules out nonexistent forms such as causative stem **mʌlʌw* (corresponding to *lʌlʌw*); such a root would always have to follow the regular pattern *mlʌw*. There is no inherent reason why a dummy C could not appear anywhere in a root. Also, dummy consonants do not explain why there are no verbs of the type *$C_1C_1C_2C_2$ or *$C_1C_1C_2C_3$.

An attempt to deal with the OCP 'violations' by extraprosodicity of the leftmost C-slot (*lʌlʌw*) or syllable (*sʌssʌn*), or by idiosyncratic right-to-left association, would be problematic for two other reasons. First, it would not explain the unusual template patterns and vocalisms found with these verbs; we would expect a root such as {lw}, if it associated leftward, to associate to a standard template, e.g. causative **llʌw*. Second, neither of these solutions would by itself generate verbs like *ẋrʌrʌy*, where the irregularity is internal to the root. In this case edge-in association could be used, but the form of the template would be arbitrary, whereas my solution derives it directly from the normal quinquiliteral template.

5. Conclusion

I have argued for exclusive edge-in association in Tigrinya, giving evidence from the templatic morphology of both nouns and verbs. I have also shown that a set of verbs which seem to violate the OCP can be derived by two lexically dependent rules which, in the edge-in framework developed and together with the OCP, predict the correct distribution of forms. This is a positive result, since it removes a potential counterexample to the postulated universal status of the OCP. While edge-in association is needed for Tigrinya and can be motivated for many other languages, still others appear best treated within a left-to-right framework; for now, then, it seems we must conclude that two types of association — left-to-right and edge-in — are necessary parts of phonological theory.

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