82 Featural Affixes

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1 Characteristics of featural affixes

Featural affixes are phonological features that function as grammatical morphemes. The most commonly found cases are tonal (Akinlabi 1996). An example is the associative marker in Bini (Amayo 1976), exemplified in (1). (The forms before the arrow indicate the isolation forms of the nouns and the forms after the arrow are associative constructions. For clarity the tones in the examples in (1) are indicated with both tone marks and the letters L, H for Low, High respectively. $^{\downarrow}$ indicates a downstepped tone on the following vowel.)

(1) *Bini* (Amayo 1976)

òwɛ̀	ɔ̀sà	→	òwɛ́	ɔ̀sà	[òwɔ́$^{\downarrow}$sà]
| |	| |		| | | |		
L L	L L		L H L L		'a chimpanzee's leg'
leg	chimpanzee				
àmɛ̀	èhj̃ɛ̃́	→	àmɛ́	èhj̃ɛ̃́	[àmɛ́$^{\downarrow}$hj̃ɛ̃́]
| |	| |		| | | |		
L L	L H		L H L H		'solution of water and pepper'
water	pepper				
òwɛ̀	ɔ̀nà	→	òwɛ́	ɔ̀nà	[òwɔ́$^{\downarrow}$nà]
| |	| |		| | | |		
L L	L L		L H L L		'this one's leg'
leg	this one				

However, several cases of non-tonal features functioning as grammatical morphemes have also been described in the literature. A representative list is given in (2).[1]

[1] See the references cited here for additional examples. Reviewers have pointed out a number of other examples which might have been included here. Two of them are: (a) in Coatzospan the 2nd person familiar is marked by nasality (Gerfen 1999: 127), and (b) in Shuswap, glottalization is a floating feature (Kuipers 1974; Idsardi 1992). The list in (2) is not intended to be exhaustive.

(2) *Non-tonal examples of featural morphemes*

a. In Chaha, the third masculine object is indicated by labialization.
(Johnson 1975; McCarthy 1983; Hendricks 1989; Archangeli & Pulleyblank 1994; Rose 1994, 2007)
b. Nuer indicates tense/aspect distinctions with the features [continuant] and [voice].
(Crazzolara 1933; Lieber 1987; Frank 1999)
c. In Zoque, the 3rd person singular is marked by palatalization.
(Wonderly 1951)
d. [nasal] is the 1st person possessive marker in Terena.
(Bendor-Samuel 1960, 1966)
e. The feature of "uncontrolledness" is signaled by palatalization in Japanese.
(Hamano 1986; Mester & Itô 1989; Archangeli & Pulleyblank 1994; Alderete & Kochetov 2009)
f. Noun class 5 is marked by voicing the first consonant of the root in Aka (Bantu, Zone C).
(Kosseke & Sitamon 1993; Roberts 1994)
g. Noun class morphemes in Fula include the features [continuant] and [nasal].
(Arnott 1970; Lieber 1984, 1987)
h. The Athapaskan D-classifier consists solely of the feature [–continuant].
(Rice 1987)
i. In Seereer Siin, an Atlantic (Niger Congo) language, consonant mutation (involving the features [voice] and [continuant]) constitute all or part of the noun class prefix in nouns and dependent adjectives, and number in verbs.
(Mc Laughlin 2000, 2005)
j. In Mafa, a central Chadic language of Cameroon, imperfectives of verbs ending in a consonant are formed with a palatal featural affix.
(Ettlinger 2003, 2004)

The features in (2), like segmental morphemes, often refer to specific edges of stems, and thus are featural affixes (e.g. Chaha labialization and palatalization, Aka voicing, Zoque palatalization). While the fact that phonological features may function as grammatical morphemes is uncontroversial, the status of such features as prefixes or suffixes often remained muted in spite of traditional intuition, with some scholars contented with referring to the morphemes simply as "floating autosegments."[2] The reason that the status of featural affixes as prefixes or suffixes is often problematic is that while segmental affixes may be phonetically realized independently, featural affixes are always phonetically realized as part of some other segment or segments of the stem. The question therefore is why featural affixes get realized as part of the stem. The answer to this is that features have to be "licensed" (i.e. their occurrences have to be sanctioned) in order to get phonetically realized, therefore featural affixes must associate with a licensor in the stem or elsewhere.

[2] Most studies on tone are exceptions to this generalization (see Clements & Goldsmith 1984; Pulleyblank 1986; Anderson 1991; van der Hulst & Snider 1993).

In this chapter I am assuming a feature geometry in which all segments have a root node, which "gathers" the features into one unit (CHAPTER 27: THE ORGANIZATION OF FEATURES). In addition, I assume that vowels (and all syllable peaks, including syllabic nasals) are dominated by a mora (CHAPTER 33: SYLLABLE-INTERNAL STRUCTURE). Finally, I assume that class nodes, such as those for place of articulation, are monovalent. However, terminal features, such as aperture features, are bivalent. Since this chapter has a constraint-based, optimality-theoretic bias, I will not be assuming underspecification here (CHAPTER 7: FEATURE SPECIFICATION AND UNDERSPECIFICATION).

Universally, feature licensors can (only) be either a mora or a root node (Itô 1989; Itô & Mester 1993; Itô *et al*. 1993; etc.). Therefore, while edges in tones refer to the initial or final mora, edges in nasal harmony and the like may refer to the first or last root node; i.e. a real morphological edge, since the last licensor also coincides with the last segment of the morpheme (see Archangeli & Pulleyblank 1994).[3] But with featural affixes, an edge does not necessarily mean a morphological edge; an edge is defined for a feature based on a possible licensor in a language.

Another characteristic of featural affixes, as distinct from segmental affixes, is their domain. While most segmental affixes occur at the beginning, middle, or end of a base, featural affixes often occur throughout the base, or span it. Features that commonly have this characteristic are the "prosodic" features, in the Firthian sense of the word. As is well known, such features may include pitch, nasality, roundness, palatalization, and the like (see Firth 1948). Since these are the featural spell-out (or content) of the morphological categories in question, they are featural affixes.

In their study of alignment in (regular) segmental affixation, McCarthy and Prince (1993b: 103) observe that an alignment constraint, such as one that aligns the left edge of one morpheme with the right edge of another (as in Tagalog *-um-* prefixation) may be violated when dominated by a prosodic constraint, such as one that disallows a coda. This may force a prefix to be realized as an infix. The Tagalog affix *-um-* "falls as near as possible to the left edge of the stem, so long as it obeys the phonological requirement that its final consonant *m* not be syllabified as a coda" (McCarthy & Prince 1993b: 79). Therefore, it appears as a prefix before a vowel-initial word: /um + aral/ → [um-aral] 'teach,' but as an infix when the word is consonant-initial: /um + sulat/ → [s-um-ulat] 'write,' /um + gradwet/ → [gr-um-adwet] 'graduate.'

A similar characteristic is found in featural affixes. One important distinction from segmental prefixes/suffixes is that featural affixes often behave like "infixes," because they frequently do not occur at an edge of the stem. A feature may be forced away from an edge when the feature cannot co-occur with another feature(s) of the segment at the edge (see Pulleyblank 1993), leading to

[3] It should be noted that the accounts in this chapter allow for affixes which involve more than one autosegmental feature, though we do not discuss such cases here. For example, in Mokulu (Eastern Chadic, Chad republic) the completive aspect marker consists of the features [voice] and [high] (Jungraithmayr 1990; Roberts 1994). The first consonant of the stem becomes voiced while the first vowel becomes high, even if it was a low vowel in the input. In the approach taken here, both features constitute parts of a featural prefix. However such features may be realized on the same segment in the stem, or on different segments, depending on licensing. In the case in question, licensing forces [voice] and [high] on different segments.

misalignment. A featural suffix may for example be realized elsewhere in the stem, resulting in featural infixation. However, featural affixes occur as "infixes" more often than segmental affixes.

Finally, one characteristic that has recently been observed in featural affixation is one in which a grammatical category is marked by a feature, which has both segmental and featural allomorphs, as in Mafa (Ettlinger 2003, 2004).

In the following sections I illustrate each of the above characteristics of featural affixes. Each case study discussed below has been selected because it illustrates a particular characteristic or characteristics of featural affixes.

In the discussion of Chaha (§2.1), I show that a featural suffix [round] is realized as a featural infix or even as a featural prefix, when the featural affix is forced away from the edge. The opposite effect is illustrated with Nuer mutation (§2.3).

Tonal data from Etsako, an Edoid language, and nasalization data from Terena show situations in which featural morphemes span the entire base of affixation. In the discussions of Terena nasalization and the Etsako tone, I suggest that these are still cases of prefixation and suffixation respectively, but in conjunction with harmony. Therefore there are no special treatments of featural affixes required.

Mc Laughlin (2000, 2005) notes that taking into consideration featural affixes, a morphological category can be expressed in one of three ways: as a segmental affix, as a featural affix or as a combination of both segmental and featural affixes (CHAPTER 103: PHONOLOGICAL SENSITIVITY TO MORPHOLOGICAL STRUCTURE).

In summary, the primary focus in this chapter will be illustrating the characteristics of featural affixes. To do this, I will provide short descriptions of several of the featural affixes listed in (2). The characteristics include (a) marking morphological categories (like segmental affixes), (b) occurring as part of other segments rather than independently, (c) varying between prefixes and suffixes, (d) occurring elsewhere in the stem (because of feature co-occurrence constraints), (e) spanning the entire base of affixation, and (f) the varying occurrence of a feature or a segment in the same language. I will argue that these characteristics of featural affixes do not require any new type of morphology, because the same machinery already developed for segmental affixes can handle them as well.

I discuss seven case studies in all, divided into four groups. The first group, Chaha and Zoque, illustrates most of the basic characteristics of featural affixes mentioned above, that of directionality. Chaha illustrates suffixation and Zoque shows prefixation. The second group, Nuer and Seereer Siin, combines featural affixes with consonant mutation. Nuer is suffixal, and Seereer Siin is prefixal. The third group, Etsako and Terena, shows featural affixes that span the whole stem domain. They illustrate featural affixation combined with "harmony." Again Etsako shows the harmony from the right (suffixal), and Terena shows it from the left (prefixal). The fourth group contains only one language, Mafa. Mafa shows a special case of affixation, in that the segment involved is at the same time a segment and a feature. I refer to this as segmental realization of a featural affix.

2 Directionality

The first case studies illustrate the need to consider featural morphemes as either prefixes or suffixes, a property that is formally accounted for by the directional

component of alignment. In this light, Chaha illustrates prefixation, and Zoque illustrates suffixation.

2.1 Chaha labialization

In Chaha, a Gurage language of Ethiopia, the 3rd person masculine singular object is indicated by labialization (with the suffix /n/) (Johnson 1975; McCarthy 1983; Hendricks 1989; Archangeli & Pulleyblank 1994; Rose 1994, 2007). Labialization surfaces on the "rightmost labializable consonant" of the stem. Labializable consonants in Chaha include labial and dorsal consonants, but not coronal consonants.[4] The data in (3) (from McCarthy 1983: 179) show the surface realization of this morpheme.

(3)

	without object	with 3rd masc sg object	
a.	*Rightmost consonant of the stem is labializable*		
	dænæg	dænæg^{w}	'hit'
	nædæf	nædæf^{w}	'sting'
	nækæb	nækæb^{w}	'find'
b.	*Medial consonant of the stem is labializable, final is not*		
	nækæs	næk^{w}æs	'bite'
	kæfæt	kæf^{w}æt	'open'
	bækær	bæk^{w}ær	'lack'
c.	*Only the leftmost consonant of the stem is labializable*		
	qætær	q^{w}ætær	'kill'
	mæsær	m^{w}æsær	'seem'
	mæk^{j}ær	m^{w}æk^{j}ær	'burn'
d.	*No labializable consonant*		
	sædæd	sædæd	'chase'

A number of observations are important here. Labialization must be realized only on the rightmost labializable consonant, and on no other. This is obvious from the third example in (3a), /nækæb/ → /nækæb^{w}/. Both of the last two consonants of the verb root in this example are labializable, but only the root-final consonant is labialized. The medial consonant is not labialized because of this requirement of rightmostness. In the forms in (3b), all of the final consonants of the verb roots are coronal, e.g. /nækæs/, therefore only the root-medial consonants, which are either labial or dorsal, are rightmost; and so only these receive the labialization feature. Note further that the initial consonants in the last two examples, /kæfæt/ and /bækær/, are labializable, but again are not labialized because of the requirement of rightmostness. In (3c) the only labializable consonants of the verb root are the leftmost consonants, /qætær/ → /q^{w}ætær/, and so by rightmostness receive labialization. Finally, in (3d) none of the consonants is labializable and so the feature is not realized.

An explanation of the above facts is as follows. Following earlier analyses we assume that the 3rd person masculine singular object marker in Chaha is

[4] This statement is from McCarthy. Rose (2007) states the labialization rule as "labialize the rightmost velar or labial consonant, unless already palatalized." The key point in both definitions is that labialization targets dorsal and labial consonants.

the feature [round]. It must be a featural suffix, as indicated by the insistence on rightmostness. The 3rd person masculine singular object [round] aligns with (or coincides with; Zoll 1996) the right edge of the stem. In Chaha, [round] may be licensed by any consonantal root node. The position explicitly treats the morpheme as a suffix, but the segmental content is a feature [round], hence what the constraint aligns is the feature [round]. The right edge of the stem has to coincide with the feature [round], the featural content of the affix. Thus the feature [round] seeks out the rightmost consonantal root node in the verb root for licensing, given the discussion of licensing and edges above. As noted in our description of the facts, coronal consonants cannot receive the labialization feature. This means that the feature [round] cannot be articulated with a coronal consonant in Chaha. We can bar this with a feature co-occurrence constraint, which forbids [round] from linking to a root node associated to [coronal].

To conclude, there are several characteristics of featural affixes, which this affix illustrates. First, it marks a morphological category, the 3rd person masculine singular object. Second, the realization is a feature, the feature [round]. Third, it must be realized as part of another segment, a consonant, because it is not a segment. Fourth, like any affix, it has a position. However, like a featural affix it seeks the rightmost dorsal or labial consonant for licensing. Therefore it is a suffix. Fifth, like segmental affixes, it can be pushed from the suffix position. As a featural affix however, co-occurring with other features is what matters. It cannot co-occur with a coronal consonant; therefore it gets pushed more and more inwards until it finds the right consonant to co-occur with. Sixth, if it does not find the right licensor, it simply does not get realized. This is comparable with the null realization of certain segmental morphemes in language, as for example where a segmental affix is not realized for some phonotactic reason. One example is Dutch, which does not have geminate consonants. Here the 3rd person singular ending [-t] is not realized on verbs which end in a coronal plosive.[5]

(4) *Dutch 3rd person suffix:* [-t] *absent after verb-final* [t]

a.	*ik lees*	[ɪk leːs]		'I read'
	hij leest	[hɛi leːst]		'he reads'
b.	*ik zie*	[ɪk ziː]		'I see'
	hij ziet	[hɛi ziːt]		'he sees'
c.	*ik eet*	[ɪk eːt]		'I eat'
	hij eet	[hɛi eːt]	*[eːtː]	'he eats'

2.2 *Zoque palatalization*

In this section, I consider the process of morphological palatalization in Zoque (Zoque-Mixe of southern Mexico). Zoque palatalization contrasts with Chaha labialization (§2.1) in some crucial senses. First, while Chaha labialization illustrates a case of long distance realization of an affix, Zoque palatalization illustrates local realization; i.e. the affix must be realized at the edge, and nowhere else (Akinlabi 1996). Second, Zoque differs from Chaha in the sense that the featural affix is a prefix as opposed to a suffix.

[5] I am grateful to Marc van Oostendorp for this example from Dutch.

Wonderly (1951: 117–118) describes a process of palatalization (CHAPTER 71: PALATALIZATION) in Zoque, which marks the 3rd person singular. He represents this morpheme as a prefix [j],[6] and treats this process of palatalization as "metathesis" of [j] and the following consonant. A rule-based treatment assuming metathesis is proposed in Dell (1980). The relevant examples are listed in (5), with the morpheme transcribed as [j], following Wonderly.[7] My interpretation here is that Wonderly's [j] is a palatal feature, which I will assume is [–back].

(5) *Zoque 3rd person singular*

a.	*With labial consonants*			
	j - pata	pʲata		'his mat'
	j - pʲesa	pʲesa		'his room'
	j - buro	bʲuro		'his burro'
	j - faha	fʲaha		'his belt'
	j - mula	mʲula		'his mule'
	j - wakas	wʲakas		'his cow'
b.	*With alveolar consonants*			
	j - tatah	tʲatah	[catah]	'his father'
	j - tih	nʌ tʲihu	[nʌ cihu]	'he is arriving'
	j - duratsʌhk	nʌ dʲuratsʌhku	[nʌ ɟuratsʌhku]	'it is lasting'
	j - tsʌhk	tsʲahku	[ʧahku]	'he did it'
	j - sʌk	sʲʌk	[ʃʌk]	'his beans'
	j - swerte	ʃwerte	[ʃwerte]	'his fortune'
	j - nanah	nʲanah	[ɲanah]	'his mother'
c.	*With palatal consonants (no change)*			
	j - ʧoʔngoja	ʧoʔngoja		'his rabbit'
	j - ʃapun	ʃapun		'his soap'
d.	*With velar consonants*			
	j - kama	kʲama		'his cornfield'
	j - gaju	gʲaju		'his rooster'
e.	*With laryngeal consonants*			
	j - ʔatsi	ʔʲatsi		'his older brother'
	j - hajjah	hʲajah		'her husband'
	j - huj	hʲuju		'he bought it'

All words in Zoque are consonant-initial. The data in (5) shows that the 3rd person singular morpheme produces secondary palatalization of the first consonant of stem if is labial (5a), velar (5d), or laryngeal (5e); it turns alveolars

[6] Wonderly used the symbol [y]. I have re-transcribed Wonderly's examples to be as close as possible to the IPA.

[7] The transcription here (from Wonderly 1951) is somewhat misleading, because one can be led to believe that the morpheme here is indeed /j-/, and not a feature. However if this were a full segment as opposed to a feature, it would be completely unnecessary for the segment to seek licensing from another segment. It would also be completely accidental that metathesis is limited to glide–consonant sequences in this language. Note that this cannot be blamed on the sonority rise in an onset (i.e. [jC] → [Cj]), because the so-called metathesis also occurs in a sequence of two glides (which in many accounts are equal in sonority); /j - wakas/ → /wʲakas/ 'his cow.'

into alveopalatals in (5b), and has no phonetic effect on underlying palatals (5c). As Wonderly (1951: 118) puts it, "when y [i.e. [j]] precedes an alveopalatal consonant č, š, the y is lost." In this analysis we assume that the morpheme is not "lost," but that it has no phonetic effect if the initial consonant of the stem is palatal.

I assume that the 3rd person singular in the above data is the feature [–back] (see Sagey 1986). [–back] is licensed by any root node in Zoque. It is apparently a featural prefix, given its restriction to the first (or leftmost) consonant.

The palatalization case in Zoque is completely straightforward. All consonants participate in the palatalization, regardless of place of articulation. For example, labials are not barred from being palatalized, as coronals are barred from being labialized in Chaha.

The only set of consonants that require additional comment is the set of palatal consonants, as seen in (5c) (/[–back]-ʃapun/ → [ʃapun] 'his soap'). There are two approaches to this set of consonants. One is to assume that the [–back] 3rd singular morpheme is unparsed when the first segment is underlyingly palatal. The second approach is to assume that [–back] links vacuously to a palatal segment. I adopt the second position here, since linking [–back] to a palatal consonant will not change the consonant's realization. If palatal consonants are assumed to have underlying tokens of [–back], then linking the morpheme in this case simply implies that the [–back] specification in the surface representation corresponds to two tokens of the same feature in the input. Phonetically, it is will be impossible to distinguish one or two tokens of the same feature.

In conclusion, Zoque provides evidence for featural affixes which must be realized, and which must be realized at an edge and nowhere else. In Chaha, a co-occurrence constraint forces a featural affix away from the edge. In Zoque, such co-occurrence constraints (which must be universal) have no surface effect. In Chaha, a featural affix may not be realized if none of the segments can license it. In Zoque, the affix can be licensed by all consonants, and so it is always realized.[8]

In the two case studies of featural affixes discussed above, one is a suffix (Chaha [round] or Labial), and the other is a prefix (Zoque [–back] or Coronal). Both of these involve only features. I now turn to cases in which the affix has both segmental and featural content.

3 Features plus segments: Segment mutations

Systematic alternation in homorganic segment classes that reflect morphological distinction is often called mutation (CHAPTER 65: CONSONANT MUTATION; CHAPTER 117: CELTIC MUTATIONS). The second group of case studies consists of languages which combine featural affixes with consonant mutation.

[8] There are two important issues here. First, there is a technical complication for feature geometry. If [–back] is dependent on some supralaryngeal node, and if laryngeal consonants have no supralaryngeal specification, then what does [–back] dock on? A possible explanation is that the addition of [–back] automatically generates a place node. The second issue is whether palatalized sounds occur outside of the contexts described here. If they do, it will confirm that these are not clusters, but single segments. Wonderly is silent on this question.

What is interesting about these cases is that languages with consonant mutations often combine both featural as well as segmental affixation. That is, the featural affix may occur by itself or with additional segments. In this section, we examine two cases, Nuer and Seereer Siin. Nuer is suffixal and Seerer Siin is prefixal.

3.1 Nuer mutation

The consonant mutation process of Nuer, a Nilo-Saharan language of Sudan, presents an interesting contrast to Chaha, in that the featural suffix must be realized at the very right edge of the verb stem rather than anywhere else in the stem. If the featural suffix cannot be realized on the last consonant of the stem due to a co-occurrence constraint, it is simply not realized at all (see Chaha palatal prosody). But our interest in Nuer mutation is that the suffixes do not just consist of features, but segments and features.

In the Nuer verb roots, final consonant mutation is associated with various tenses and aspects in the verbal paradigms, as the following examples illustrate. The alternation is only productive in verbs and not in nouns. (All data presented here are from Crazzolara 1933: 156–160; see Frank 1999 for more details on Nuer morphology.) Rule (6) summarizes the observed consonant alternations and (7) provides examples. In the following examples each place of articulation is represented by two verb paradigms. I have converted Crazzolara's representations to IPA, following his descriptions.

(6) *Nuer final consonant alternation* (Crazzolara 1933; Lieber 1987)[9]

	labial	interdental	alveolar	palatal	velar
voiced	b	ð	d	j̵	ɣ
voiceless continuant	f	θ	r̥	ç	h
voiceless stop	p	t̪	t	c	k

(7) *Verbal paradigms*[10]

a. *Labial final verbs*	'to overtake a person'	'to scoop (food) hastily'
3rd sg indic pres act	cóbɛ́ jɛ̀	kɛ́bɛ́ jɛ̀
1s pl indic pres act	còɔfkɔ̀ jɛ	kɛ̀afkɔ̀ jɛ
pres pple neg	còp	kɛp
past pple	cof	kɛ̀f

[9] Following Crazzolara's descriptions, his transcriptions have been modified as follows. [dh] and [th] (interdental) are transcribed here as [ð] and [θ] respectively. [ṯ] (a trilled alveolar continuant) is [r̥]. Finally, [y] (palatal fricative) is retranscribed as [j̵]. Cazzolara suggests that what he writes as [b] is actually the continuant [β] in final position (Crazzolara 1933: 6). One can imagine that the same is true for what he writes as [d], since he notes that Nuer stems can have up to three forms, one ending with a voiceless stop, one with a voiceless continuant, and the third with a voiced sound which in most cases is a continuant.

[10] I will not discuss the vocalic changes, since they are largely unpredictable from Crazzolara's transcriptions.

b.	*Interdental final verbs*	'to suck'	'to wade'
	3rd sg indic pres act	lóðɛ́ jɛ̀	jɟæðɛ́ jɛ̀
	1st pl indic pres act	loɔ̀θkɔ̀ jɛ	jɟæθkɔ̀ jɛ
	pres pple neg	loṯ	jɟæṯ
	past pple	loθ	jɟæθ
c.	*Alveolar final verbs*	'to sharpen'	'to cut a point'
	3rd sg indic pres act	paádɛ̀ jɛ́	wɨ́dɛ́ jɛ̀
	1st pl indic pres act	páaṛkɔ́ jɛ̀	wəṛkɔ̀ jɛ
	pres pple neg	paat	wɨt
	past pple	pàaṛ	wɨṛ
d.	*Palatal final verbs*	'to hit'	'to dismiss a person'
	3rd sg indic pres act	jáaɟɛ̀ jɛ	jɟéeɟɛ̀ jɛ
	1st pl indic pres act	jáaçkɔ́ jɛ̀	jɟáaçkɔ́ jɛ̀
	pres pple neg	jaac	jɟèec
	past pple	jaaç	jɟeeç
e.	*Velar final verbs*	'to throw away'	'to find'
	3rd sg indic pres act	ɟáɣɛ́ jɛ̀	jəɣɛ́ jɛ̀
	1st pl indic pres act	ɟàkɔ̀ jɛ	jəkɔ̀ jɛ
	pres pple neg	ɟæk	jək
	past pple	ɟæh	jəh

First, Crazzolara (1933: 102) notes that the verb root is monosyllabic in Nuer. Second, all verbs begin and end in consonants. I assume, following Lieber (1987), that the features implicated here are [continuant] and [voice]. I will also that the morphemes involved in the mutation consist of the following inputs.[11]

(8) *The Nuer suffixes*

indic pres act	=	[jɛ]
3rd sg	=	[cont] [ɛ]
1st pl	=	[cont] [kɔ]
pres pple neg	=	Ø
past pple	=	[cont]

The most important illustration of the theme of this section is the past participle morpheme, which under any analysis must include the feature [continuant], and the 1st plural morpheme, which, in addition to the feature [continuant], also includes the segment sequence [kɔ]. A comparison of all the past participle forms with the 1st plural indicative present active forms shows that the latter always includes the additional [kɔ]. What is interesting is that the suffix [kɔ] also triggers spirantization of the preceding stop.[12] Therefore we must assume that this suffix has a preceding floating [continuant]. Finally, we must assume that Nuer also has intervocalic voicing, as seen in all the 3rd singular forms.

[11] But see Lieber (1987) for a different assumption on input.

[12] In the case of the forms "throw away" and "find," there is no spirantization. I assume that this is because the final consonant of the verb and the 1st plural suffix [kɔ] are identical. Crazzolara apparently transcribes the unspirantized sequence [hk] as a single stop [k].

It is clear from the mutation cases in Nuer that the features involved are suffixes, since in two cases the free feature [continuant] is paired with traditional segmental suffixes. In the case of the past participle morpheme, the entire content of the morpheme is the free feature [continuant]. [continuant] is licensed by a root node in Nuer. This feature links to the rightmost consonant of the verb. This association formally defines the past participle morpheme in Nuer as a suffix. This morpheme happens to have just a single featural content [continuant].

The derivation of all the forms with the past participle suffix [continuant] is the same as that of the 1st plural forms, except for the additional segments [kɔ] in the suffix. This example actually shows that if we must call the segments [kɔ] a suffix, we must treat the preceding [continuant] the same way, since they, together, mark the same morpheme. And if this feature [continuant] of the 1st plural is a suffix, so is the feature [continuant] that marks the past participle alone.

Crazzolara notes that a number of segments do not undergo this mutation processes in Nuer. These segments are the nasals /m n n̤ ɲ ŋ/, the liquids /l r/ and glide /w/. I will split these segments into two groups, the nasals on the one hand and the liquids and glide on the other.

I suggest that the nasals do not undergo mutation because of a co-occurrence constraint forbidding the association of [continuant] to a consonant specified for [nasal]. The examples in (9) illustrate this.

(9) *Non-alternating final consonant*

	'to see'[13]	'to hear'
3rd sg indic pres act	nɛ́ɛnɛ̀ jɛ	lɨ̀ɨŋɛ́ jɛ̀
1st pl indic pres act	nɛ́ɛankɔ́ jɛ̀	lɨɛŋkɔ̀ jɛ
pres pple neg	nɛ̀ɛn	lɨŋ
past pple	nɛ̀ɛn	lɨ̂ŋ

Since morphemes with final nasals never alternate, and since [continuant] does not show up anywhere else, we must assume that in these cases [continuant] must remain unrealized (i.e. unparsed). This is parallel to the case of the non-realization of [round] in Chaha.

I assume that the remaining sonorants, liquids, and glide undergo the process, though the surface forms appear invariant; i.e. [continuant] links vacuously to stems whose final consonants belong to this class, but without any apparent surface effect since they are already continuants.[14]

In conclusion, [continuant] in Nuer provides a significant contrast to labialization in Chaha and palatalization in Zoque. In both Chaha and Nuer, the featural affix is a suffix, given the insistence on linkage to the final consonant. In both languages, the featural content of the affix cannot co-occur with a class of segments.

[13] Crazzolara (1933: 124) points out that there is a separate negative particle /cɨ/ which occurs before the subject clitic. Forms with nasals are the only complete paradigms that Crazzolara gives, and in these cases he provides no forms in which the first consonant is an oral stop and the second is a nasal. In all the other forms where the stem consonant does not alternate he provides the 3rd singular indicative present active and the 1st plural indicative present active for the rest of the cases.

[14] This implies that a single [continuant] specification on the final consonant on the surface corresponds to two in the input. See also the discussions of Zoque palatalization (§2.2) and Edoid tone (§4.1) for similar characteristics.

This results in the non-realization of the featural suffix on the final segment. This fact is captured by the co-occurrence constraints between the feature content of the affix and the feature content of the class of segments. Thus it is co-occurrence constraints that force featural affixes from edges. The substantive difference between the two languages is seen in Chaha's insistence on realizing the featural suffix on other segments even if it cannot be realized on the edgemost segment, while Nuer will not realize the featural suffix at all.

It is important to note that other languages with consonant mutation have been identified in the literature, e.g. Fula (Arnott 1970), North Atlantic languages (Mc Laughlin 2000, 2005), which confirm the above analysis of Nuer mutation. These languages also differ significantly from Nuer. I will briefly discuss the case of one, Seereer Siin (Mc Laughlin 2000).

3.2 Seereer Siin consonant mutation

In her work on several Northern Atlantic languages of Niger Congo (Pulaar, Seereer Siin, Wolof), Mc Laughlin (2000, 2005) argues that *consonant mutation* can be viewed and accounted for as the prefixation of a floating feature to the root node of the stem-initial consonant.[15] She proposes a constraint-based account to locate the feature on the left edge of a word.

Seereer Siin consonant mutation is morphologically conditioned by *noun class* in nouns and dependent adjectives, and by number in verbs. There are two patterns of consonant mutation in Seereer: (a) voicing mutation, and (b) continuancy mutation. In each, there is a three-way homorganic range of alternations, called *grades* (Arnott 1970). I will only discuss the voicing mutation, and I will discuss only the fully mutating forms. The reader is referred to Mc Laughlin's work for the partially mutating forms, and the continuancy mutation.

In the voicing mutation, the three grades are "voiced stop," "voiceless stop," and "prenasalized voiced stop." Grade-a refers to the voiced set, grade-b to the voiceless set, and grade-c to the prenasalized set.

Seereer Siin has sixteen noun classes. Of the sixteen, classes 2, 3a, 5, 7, 8, and 10 condition the a-grade mutation, while classes 3b, 6, 12, 13, and 14 condition the c-grade mutation. The remaining classes (1, 4, 9, 11, and 15) condition the b-grade mutation.

I will now illustrate the above statements with the examples in (10), from Mc Laughlin (2000: 339–340). The numbers in parenthesis beside the forms indicate the noun classes of the forms.

(10) *Voicing mutation* (fully mutating)

voiced	voiceless	nasal[16]	
a-grade	b-grade	c-grade	
ogac (10)	akac (4)	foŋgac (13)	'stone'
ɟir (5)	acir (4)	aɲɟir (3b)	'illness'
oɓaj (10)	xaƥaj (11)	foƥaj (13)	'hand, arm'

[15] For reasons of space, only a brief summary of the facts of Seereer Siin is given here.

[16] Voiceless implosives cannot be prenasalized in Seereer Siin.

I follow Mc Laughlin in assuming that the b-grade forms constitute the "underlying" forms in the stems with voicing mutation. The stem patterns show that the features involved in the class prefixation are [+voice] and [+nasal]. [+voice] drives the voicing of underlying voiceless-initial stems, which are fully mutating. In addition, one must conclude that the class 10 prefix has both segmental and featural contents: /[o] [+voiced]/, as Mc Laughlin does. Finally, class 13 also has both segmental and featural contents: /[fo] [+nasal]/. "There is a [+voice] floating feature that drives the a-grade mutations . . . and there is a [+nasal] floating feature that drives the c-grade mutations" (Mc Laughlin 2000: 340).

Comparing the Seereer Siin forms with those from Nuer, the mutating consonants in Seereer Siin are the stem-initial consonants. The mutating features [+voiced] and [+nasal] are prefixes. They must link to the stem-initial consonant and no other. In Nuer on the other hand, the mutating feature is a suffix. The system in Seereer Siin sometimes includes featural affixes alone, and sometimes featural affixes as well as segmental affixes. As seen above the class 10 prefix includes both segmental and featural content: /o [+voiced]/, and the class 13 prefix also has both segmental and featural content: /fo [+nasal]/. These combinations are in fact more apparent than the Nuer combinations. The segmental features causing the mutation either get associated or not, and are never pushed inwards in the stem. They only occur at the edges.

4 Harmony: Featural affixes with stem domains

The third set of case studies consists of languages that combine featural affixes with featural harmony. By "harmony," I mean featural propagation that is domain-based.

The domain of a featural affix is often the entire stem. By definition, we must take these features to be affixes, since they are the featural spell-out of some morphological category. Since the domain of the featural affix is the entire stem, I take the phenomenon to be the combination of a featural prefix or suffix, plus harmony involving the feature in question. I will illustrate with two languages. I will discuss one case involving a featural suffix (Edoid tone), and one involving a featural prefix (Terena nasalization).

4.1 Edoid associative construction

Tonal data from Edoid languages (Niger Congo, Nigeria) provide the first example of featural suffixation plus harmony. Suffixation is detectable from the fact that priority is given to right alignment, and harmony is seen in the transmission of the feature throughout the entire domain.

In several Edoid languages the "associative morpheme" is a free (floating) High tone. The list includes Etsako (Elimelech 1976), Yekhee (Elugbe 1989), Bini (Amayo 1976), Isoko (Donwa 1982), and Emai (Egbokhare 1990). In this section I will only examine Etsako (Ekpheli dialect). Several other Edoid languages have similar tonal systems to that of Etsako.

Etsako is a two-tone language, with High and Low tones (Elimelech 1976: 41). (Recall that full specification is assumed in this chapter.) In this language, the associative High tone links to the head noun, replacing all Low tones in a

right-to-left manner, until it reaches a segmental High tone. The examples below consist of disyllabic nouns, but they are representative of what happens in longer forms. The forms cited here (from Elimelech 1976: 55) exhaust all possible tonal combinations of disyllabic nouns. The tones in the first row in each of (11)–(14) indicate the underlying tone pattern of the head noun in isolation, and the corresponding tones after the arrow indicate its tone pattern in an associative construction. For clarity, I have indicated the tonal pattern of the first example in each set with the tone letters H and L, in addition to the tone marks. The crucial tones to focus on are those of the first noun, since the tones of the second noun remain constant.

(11)

	L			H	
a.	àmɛ̀	èθà	→	ámɛ́èθà	[ámêθà]
	L (H)	L		H L	
	water	father			'father's water'
b.	àmɛ̀	òké	→	ámɛ́òké	[ámôkê][17]
	water	ram			'a ram's water'
c.	àmɛ̀	ɔ́mɔ̀	→	ámɛ́ɔ́mɔ̀	[ámɔ́mɔ̀]
	water	child			'a child's water'
d.	àmɛ̀	ódzí	→	ámɛ́ódzí	[ámódʒî]
	water	crab			'a crab's water'

(12)

	H L			H(H)	
a.	únò	èθà	→	únóèθà	[únêθà]
	H L (H)	L		H L	
	mouth	father			'father's mouth'
b.	únò	òké	→	únóòké	[únôkê]
	mouth	ram			'a ram's mouth'
c.	únò	ɔ́mɔ̀	→	únóɔ́mɔ̀	[únɔ́mɔ̀]
	mouth	child			'a child's mouth'
d.	únò	ódzí	→	únóódzí	[únódʒî]
	mouth	crab			'a crab's mouth'

[17] At the phrasal level, a phrase final high tone is realized as a fall, hence the final falling tones in forms with underlying final highs such as (11b, d), etc.

(13)

		H			H	
a.	ódzí		èθà	→	ódzíèθà	[ódʒêθà]
		\/			\/ \/	
		H	(H) L		H L	
	crab		father			'father's crab'
b.	ódzí		òké	→	ódzíòké	[ódʒôkê]
	crab		ram			'a ram's crab'
c.	ódzí		ɔ́mɔ̀	→	ódzíɔ́mɔ̀	[ódʒɔ́mɔ̀]
	crab		child			'a child's crab'
d.	ódzí		ódzí	→	ódzíódzí	[ódʒódʒî]
	crab		crab			'a crab's crab'

(14)

		L H			L H	
a.	ɔ̀tɛ́		èθà	→	ɔ̀tɛ́èθà	[ɔ̀tɛ̂θà]
		| |			| | \/	
		LH	(H) L		LH L	
	cricket		father			'father's cricket'
b.	ɔ̀tɛ́		òké	→	ɔ̀tɛ́òké	[ɔ̀tôkê]
	cricket		ram			'a ram's cricket'
c.	ɔ̀tɛ́		ɔ́mɔ̀	→	ɔ̀tɛ́ɔ́mɔ̀	[ɔ̀tɔ́mɔ̀]
	cricket		child			'a child's cricket'
d.	ɔ̀tɛ́		ódzí	→	ɔ̀tɛ́ódzí	[ɔ̀tódʒî]
	cricket		crab			'a crab's cricket'

The tone changes on the head noun in associative constructions may be summarized descriptively as follows:

(15) a. L → H (11)
b. H L → H H (12)
c. H → H (13)
d. L H → L H (14)

In (11) we assume there is a single Low tone associated with both syllables (moras) of the noun, following the Obligatory Contour Principle (Leben 1973; McCarthy 1986). The associative High tone replaces this underlying Low tone, and this Low tone itself is not realized on the surface. That the assumption made here with disyllabic forms is true of longer forms is confirmed by the trisyllabic examples in (16), where the three syllables of the head noun are now realized on a High tone in the associative constructions. Therefore all adjacent Low tone syllables become High regardless of the number of syllables.

(16)

L			→	H	
àɣòɣò	òké			áɣóɣóòké	[áɣóɣôkê]
L (H)	L H			H L H	
skull	ram				'a ram's skull'
àjɛ̀jɛ̀	èθà		→	ájɛ́jɛ́èθà	[ájɛ́jêθà]
butterfly	father				'father's butterfly'

In (12) (with the HL pattern), the final Low tone of the head noun becomes High. Given the forms in (16), we assume that any number of adjacent syllables with Low tones will become High. Therefore we predict that HLL head nouns will be realized as HHH. This prediction cannot be confirmed because our sources do not have any examples with such patterns. The forms in (13) are unremarkable, since the head noun is underlyingly High-toned. Finally, in (14), underlying LH remains the same. Our assumption here is that the associative High tone links vacuously to the final syllable of the head noun just as [–back] links to palatal consonants in Zoque.

The above facts can be analyzed as follows. Following Elimelech I assume that "the associative marker (AM) . . . is underlyingly a High floating tone" (Elimelech 1976: 42). Tone is licensed by any *mora* in Etsako. Only vowels and syllabic nasals can be moraic in this language. Based on the facts in (11)–(15) above (especially (14)), as well as facts presented in the Edoid studies cited at the beginning of this section, I suggested that the associative High tone is a featural suffix. It is suffixed to the head noun. However, a (separate) process of tonal harmony transmits the associative High tone throughout the entire head noun. Therefore the domain of the associative High tone is the entire head noun, a prosodic word (Nespor & Vogel 1986; Selkirk 1986; McCarthy & Prince 1990).

This type of phenomenon must be handled with two constraints. One is a morphological alignment constraint, the type of which we have seen so far. This alignment places the featural affix at a particular edge of the stem, characterizing it as a prefix or as a suffix (see Kirchner 1993; Pulleyblank 1993, 1994; Akinlabi 1994, 1997; Cole & Kisseberth 1994). The second is phonological feature spread: harmony. This handles feature propagation by establishing the fact that the domain of the feature is a phonological category, such as the prosodic word.

It is crucial to note that the associative High tone is different from an underlyingly linked segmental High tone of a head noun (the segmental High tone). First, while the associative High tone is a morpheme the segmental High tone is not. And second, the segmental High tone is underlyingly linked, while the associative High tone is underlyingly free, i.e. it belongs to a morpheme with no other content. Any analysis of Etsako must recognize these differences.

4.1.1 H-tone opacity

In Etsako, the segmental High tone is "opaque": it blocks the propagation of the suffixal High tone. That is, the suffixal H tone cannot spread through the lexical H tone. The examples in (14) demonstrate this fact. In the LH head nouns, the output associative construction begins as LH, which does not become HH, as one would expect if the suffixal H tone were to spread through the segmental H tone. This indicates two things. First, only the suffixal H tone spreads, while

the segmental H tone does not; otherwise we would once again have HH on the head noun in the output. Second, the segmental H tone is opaque to the spread of the suffixal H tone. We must assume that the constraint responsible the association of a segmental H supersedes the one for tone spreading.

4.1.2 German sign language

In concluding, Pfau (2000) has found a parallel of this type of affix in an unexpected place, the negative morpheme in the German Sign Language (DGS).[18] Pfau proposes an analysis of the negative headshake of DGS as an autosegment, in other words as a featural affix [headshake], which is associated with a manual form. The negative headshake, he argues, behaves in a way similar to tonal prosodies in tone languages. He proposes that this feature represents the negative morpheme, in the same way as tone functions as a grammatical morpheme associated with an entire base.

The main goal of §4.1 has been to show first that the domain of a featural affix may be the whole lexical category, but that it can still be identified as a prefix or suffix. Second, the featural affixation, unlike segmental affixation, may combine with harmony involving the feature itself. In §4.2, we show that non-tonal featural affixes also behave the same way, using Terena nasalization as illustration.

4.2 Terena nasalization

The second example of a system that combines featural affixation with harmony is Terena. In this section I argue that the feature [nasal] in Terena is a featural prefix given the insistence on association to the initial consonant of the stem (in direct contrast to the Edoid associative High tone), and that the featural prefixation is accompanied by harmony. Terena also confirms the accounts already given in the preceding sections about both featural alignment and misalignment. In contrast to the Edoid associative marker, the lexical feature [nasal] is transparent to the propagation of the featural affix [nasal] (CHAPTER 78: NASAL HARMONY).

In Terena, an Arawakan language of Brazil (Bendor-Samuel 1960, 1966), the category of the 1st person is marked through a process of progressive nasalization. Thus the difference between the Terena examples in the first and the third columns is that the latter are marked for the 1st person.

(17) *1st person in Terena*

a.	ajo	'his brother'	ãj̃õ	'my brother'
	arɪne	'sickness'	ãr̃ĩnẽ	'my sickness'
	unae	'boss'	ũnãẽ	'my boss'
	emoʔu	'his word'	ẽmõʔũ	'my word'
b.	owoku	'his house'	õw̃õⁿgu	'my house'
	ɪwuʔɪʃo	'he rides'	ĩw̃ũʔĩⁿʒo	'I ride'
	ɪtuke	(POSS PRO)	ĩⁿduke	(1PERS POSS PRO)
	nokone	'need'	nõⁿgone	'I need'

[18] I am deeply indebted to a reviewer for helping to make sense of this section.

c.	takɪ	'arm'	^{n}dakɪ	'my arm'
	tutɪ	'head'	^{n}dutɪ	'my head'
	paho	'mouth'	^{n}baho	'my mouth'
	pɪho	'he went'	^{m}bɪho	'I went'
d.	ahjaʔaʃo	'he desires'	ãⁿʒaʔaʃo	'I desire'
	haʔa	'father'	^{n}zaʔa	'my father'
	hjɪʃoe	'dress'	^{n}ʒɪʃoe	'my dress'

The descriptive generalizations from the above data are as follows. The 1st person pronoun is expressed by nasalizing the noun or verb. Nasalization affects vowels, liquids, glides, and underlying nasal consonants. Therefore, nasalization spreads through underlying nasal consonants. Laryngeal stops, but not laryngeal fricatives, are affected by nasalization. That is, nasalization may spread through a laryngeal stop, but not a laryngeal fricative.

The examples in (17b) show that nasalization proceeds in an apparent left-to-right fashion until it reaches an obstruent. The interesting thing here is that the obstruent becomes prenasalized (and voiced), as in the first example in (17b), but nothing after it is nasalized (except of course it is an underlying nasal consonant, as in the last example in (17b)). Therefore obstruents block [nasal] spreading, but not before they become prenasalized. If a form begins with an obstruent, the effect of the 1st person progressive nasalization is to turn that obstruent into a prenasalized consonant, as in (17c), and there is no nasalization of subsequent segments. I shall not be concerned with further changes in obstruents, other than prenasalization. For example, I shall not discuss the fact that laryngeal continuants change to coronals when nasalized in (17d).

Continuing the discussion in the preceding sections, an analysis of the above Terena facts may be presented as follows. The 1st person marker is a free feature [nasal]. [nasal] can be associated with any root node in Terena, consonant or vowel. Given the insistence on associating to the first segment of the noun or verb regardless of the nature of the segment, it is a featural prefix. However a process of harmony transmits nasality from the prefix through the stem; and thus the apparent domain of the [nasal] morpheme is the entire stem, which is a prosodic word. The surface realization of this morpheme may be accounted for the same way as tone in Etsako. An alignment constraint places [nasal] as a prefix, while a feature spread constraint accounts for spreading to the end of the word.

Just like the High tone in Etsako, [nasal] is both the featural content of a morpheme and a lexically contrastive feature in Terena. These two functions must be recognized by any analysis.

4.2.1 Nasal transparency

Forms like /arɪne/ → [ãr̃ĩnẽ] in (17a) reveal that nasal stops do not block the propagation of the [nasal] morpheme in Terena, i.e. underlying nasal stops are transparent to the morphemic [nasal] spread. Our account of this transparency is that (the constraint responsible for) the domain of association of the [nasal] morpheme takes precedence over the segmentally specified [nasal], and could therefore pass "over" the segmentally specified [nasal].

This constitutes an important difference between the underlying segmental High tone in Edoid (as exemplified by Etsako) and the segmentally specified [nasal] in Terena. While the segmental High tone in Edoid blocks the propagation

of the morphemic High tone, the propagation of the [nasal] morpheme in Terena is not blocked by the segmentally specified [nasal].

4.2.2 Obstruents and co-occurrence

We now turn to account for the behavior of obstruents in Terena. As noted above, obstruents block the rightward propagation of the [nasal] morpheme, while becoming prenasalized: /owoku/ → [õw̃õ^{n}gu] 'my house.' To account for this, we assume a co-occurrence constraint forbidding the co-occurrence of [–sonorant] and [+nasal] in Terena (see Pulleyblank 1989: 109). Note however that while nasality is always barred from obstruents in general (as in Orejon; Pulleyblank 1989), Terena obstruents are partly nasalized. We can account for this by assuming that nasality is barred from the release phase of obstruents in Terena, but not from closure phase (Steriade 1993). Prenasalization in Terena can be seen as the association of the [nasal] morpheme to the closure phase of the obstruent stops, and not to the release phase.

Finally, though the domain of the [nasal] morpheme is the entire stem (a prosodic word), like the High tone in Etsako; it is formally a featural prefix, in contrast to Etsako, where H is a featural suffix.

Gerfen (1999: 127–131) describes an interestingly similar case in Coatzospan Mixtec. In this language, the 2nd person familiar is marked by a [nasal] feature. Like in Terena, the entire base is nasalized. However, unlike Terena, the free feature [nasal] is a suffix, because the spreading is from right to left. Furthermore, if spreading is blocked, only the final vowel of the base is nasalized, indicating that the feature [nasal] links to the final vowel. Spreading is blocked when the final syllable has a voiceless obstruent onset. Finally, like Terena, lexical nasal consonants are transparent to nasal spread.

5 Segmental realization: Mafa imperfective

In our fourth case study, the featural affix is at the same time a "feature" and a "segment." I refer to this as segmental realization of a featural affix. The case is exemplified by palatalization in Mafa. This language is interesting because of its unique morphological properties. The affix expressing the imperfective in Mafa can be characterized both as a segmental affix as well as a featural affix at the same time.[19] This allomorphy gives languages like this a special place in the study of featural affixes.

Ettlinger (2003, 2004) describes the morphosyntactic process of imperfective aspect formation in Mafa, a central Chadic language of Cameroon, as follows. The imperfective is formed in one of two ways, depending on the whether final segment of the root is a vowel ([a]), or a consonant. In the case of verbs ending in [a], /j/ is suffixed to the base, as seen in (18). (All vowel-final verb stems end in an /a/ and all other suffixes are positioned after the imperfective suffix.)

[19] Another language with similar properties is Yokuts (Archangeli 1984, 1991; Archangeli & Pulleyblank 1994). In Yokuts, the glottal feature can surface as a segment or as part of another segment (or not surface at all).

(18) *Palatalization of* /a/*-final verbs*

gudza	'tremble'	gudzaj	'is trembling'
bəra	'insult'	bəraj	'is insulting'
^{n}da	'cut a hole'	^{n}daj	'is cutting a hole'
keða	'divide'	keðaj	'is dividing'

The imperfective of verbs ending in a consonant, however, are formed with a palatal featural suffix. Apparently, the palatal prosody targets either vowels or coronal stridents, and no more. There is one complication, regarding the vowel [u]. [u] is not palatalized (to [y]) in two contexts: (a) when it occurs after a dorsal, and (b) after a coronal strident in a disyllabic root. I will not discuss this complication here. Readers are referred to Ettlinger (2003, 2004) for an explanation.

The vowel inventory of Mafa is given in (19).

(19) *Mafa vowel inventory*

i	y	ə	u
e	œ	a	o

The surface realizations of vowels under palatalization are as follows:

(20) /ə/ → /i/
/u/ → /y/
/o/ → /œ/
/a/ → /e/

The forms in (21a) represent monosyllabic verb roots, and those in (21b) represent disyllabic forms. The last two forms in (21) show that both vowel and coronal stridents can be palatalized, if both are present in the verb root. In the forms in (22), palatalization appears to skip some segments while other segments are palatalized (Ettlinger 2004). This is not skipping. The skipped segments are not licensors (Akinlabi 1996) of the palatal prosody in Mafa, hence the apparent skipping.

(21) a. *Palatalization of monosyllabic consonant-final verbs*

pan-	'wash'	pen-	'is washing'
təv-	'light (VB)'	tiv-	'is lighting'
dad-	'add water to'	ded-	'is adding water to'
guts-	'squirt'	gutʃ-	'is squirting'
tsap-	'speckle'	ʧep-	'is speckling with clay'
sur-	'sleep with a woman'	ʃyr-	'is sleeping with a woman'

b. *Palatalization of disyllabic consonant-final verbs*

səban-	'work'	ʃiben-	'is working'
lubat	'twist'	lybet	'is twisting'
suwdək	'miss'	ʃuwdik	'is missing'

c. *No palatalization*

gum-	'carve wood'	gum-	'is carving wood'
gud-	'search with anxiety'	gud-	'is searching with anxiety'
kurk^{w}-	'carve everywhere'	kurk^{w}-	'is searching everywhere'

Following the way featural affixes work, there is no doubt that the imperfective is a featural suffix in Mafa (Akinlabi 1996), as the vowel-final verbs show. It scans the verb root in a right-to-left manner. If the last segment of the verb root is a vowel, then the imperfective is a full segment, i.e. a suffix. If the palatal prosody finds a consonant as the final segment, then it seeks out a licensor, preferably a vowel. I assume that the coronal palatalization is just a default. This is because this is the only consonant that can be changed without actually completely changing the primary place of articulation. Finally, I suggested that the vowel [u] is blocked from change after a dorsal consonant because it shares the dorsal specification with the preceding dorsal consonant.

6 Formal insights into featural affixation

In general, there has not been much disagreement about whether features can be affixes or not. What has varied is the formal approach to featural affixes. Much of the formal work on featural affixes has been carried out within autosegmental phonology, which allows for autonomous representation of features (CHAPTER 14: AUTOSEGMENTS). The featural affix is commonly represented as a floating feature, and linked to a segment by some rule. Work done on featural affixes within this approach includes McCarthy (1983), Lieber (1984), and others.

Feature geometry (Clements 1985; Sagey 1986; Clements & Hume 1995; and others; see also CHAPTER 27: THE ORGANIZATION OF FEATURES) has also provided significant insights. For example, feature geometry provides significant insight into the grouping of features, and why some features co-occur together and others don't. In addition, certain nodes can serve as anchors for some featural affixes while others cannot. Work like Archangeli and Pulleyblank (1994) is situated within this approach.

The formal approach to featural affixation adopted in this chapter is the constraints-based Optimality Theory (Prince & Smolensky 1993). Within this theory, grammars are composed of hierarchies of ranked and violable universal markedness and faithfulness constraints. In the theory, faithfulness constraints monitor inputs and output to ensure that they are the same, and markedness constraints ensure that output structures are unmarked to the highest degree possible, depending on the conflict between all markedness and faithfulness constraints.

However, there are various approaches to featural affixes within Optimality Theory itself. Variations include Zoll's (1998) subsegmental approach, which proposes that the input and output correspondence of "subsegments," which include "floating features" and latent segments (undominated F-element), is monitored by MAX(subseg) (see Lombardi 1998 for similar MAX(F)), stated as in (22).

(22) MAX(subseg)

Every subsegment in the input has a correspondent in the output.

As Zoll (1998: 44) notes, featural affixes are realized as part of other segments, therefore the correspondence relation returns the output segment that hosts the feature, not the feature itself. If that is the case, Mc Laughlin (2000) argues

that since subsegments do not occur as output forms, there is no evidence for positing a DEP constraint of the sort DEP(subseg). She proposes that we employ IDENT-IO(F) to monitor subsegments in general. This may be stated as in (23):

(23) IDENT-IO(F)

Correspondent IO segments have identical values for the feature F.

Kirchner (1993), Akinlabi (1996), and Zoll (1996) suggest that features are subject to the same kind of alignment or coincide constraints as segments. Akinlabi (1996) suggests that featural affixes are subject to the same kind of alignment constraints as non-featural morphemes. He proposes that alignments constraints account for the determination of featural affixes as prefixes or suffixes. All featural affixes, he proposes, are subject to the featural alignment in (24) (see McCarthy & Prince (1993a, b). The specific morphological alignment constraint in (25) accounts for Chaha labialization (Akinlabi 1996: 246).

(24) *Featural alignment*

ALIGN(PFeat, GCat)
A prosodic feature is aligned with some grammatical category.

(25) ALIGN-3MASC-SG

ALIGN (3MASC SG, R; Stem, R)
The right edge of 3MASC SG must be aligned with the right edge of the stem. 3MASC SG is a suffix in stem.

A constraint like (25) does not say whether 3MASC SG is a segment or a feature; it simply refers to the morphological category. Therefore it should not matter whether 3MASC SG is a feature or a segment. As Akinlabi (1996: 243) points out, PFeat (in (24)) is simply the featural spell-out of the morphological category in question.

Misalignment of featural affixes is controlled by feature co-occurrence constraints (Archangeli & Pulleyblank 1994). An example of this is *NASCONT (Akinlabi 1996: 254), which forbids nasal consonants from be continuants.

(26) *NASCONT

If [nasal] then not [continuant].

The above represents the core of the grammar of featural affixes. The variations are derived from ranking the constraints. This analysis also represents the point of departure for some scholars.[20]

[20] Piggott (2000) argues against the idea that features can align to word edges, like segments. He sees featural alignment as proposed by Akinlabi (1996) as an overly powerful mechanism. He proposes instead that morphological alignment be supplemented by a provision for prosodic licensing, so that, for example, features may be incorporated into a prosodic category such as a foot or a prosodic word. See Mc Laughlin (2000: 344–345) and Horwood (2004) for answers to Piggott's objections. Another notable counterposition is that of Kurisu (2001), who proposes a "relational morphology theory" instead of "featural alignment." I will not discuss this here, since it is an entirely different theory.

7 Are featural affixes really featural?

I will end this discussion by examining whether "featural affixes" are really "featural." We can examine this issue from the theoretical and the empirical points of view. The traditional view of an affix is that of a "whole segment" (or segments), which marks a morphological category. The affix is dependent on, or attached to, some host, a base. The category represented could be inflectional or derivational. By segment is traditionally meant a unity of several articulatory gestures that are produced simultaneously, and that paradigmatically contrasts with another. By this definition [t] and [s] are segments in *tip* and *sip*. [t] and [s] are also segmental affixes (suffixes), representing the English past tense, and third person singular verbal agreement in [sækt] *sacked* and [sæks] *sacks*, respectively. In this definition of an affix, it represents a timing slot or more in the paradigmatic string.

Featural affixes on the other hand, from the cases that we have been discussing, do not always occupy a timing slot. Rather they share the same time slot with one or more of the segments in the base. For example, in Zoque palatalization (Wonderly 1951) (§2.2), palatalization simply changes an alveolar consonant to a palatal ([s] → [ʃ], in [sʌk] 'beans,' [ʃʌk] 'his beans'), yet that difference signifies the distinction between "beans" and "his beans." In some cases, it in fact makes no sense to talk about timing slots in the string. Such is the case in Terena nasalization (Bendor-Samuel 1960, 1966) and Mafa palatalization (Ettlinger 2003, 2004), where the featural affix attaches to more than one segment of the base. In Mafa, [lubat] 'twist,' [lybet] 'is twisting,' the palatal feature is attached to both vowels in the base.

But even with these facts there are problems about what a featural affix really is. The problem is those features that can be realized as full segments as well as features. These include palatalization, labialization, nasalization, and glottalization. Note that in Mafa and languages like it, the palatal feature can be realized as a full segment [j], when the verb is vowel-final. Does this then mean that this is both a segmental affix and a featural affix? Or is it a featural affix that is sometimes realized as a full segment? Mafa is intriguing because, on any account, it would satisfy the definition of a segmental affix as well as that of a featural affix. The same applies to nasalization in Seereer Siin (Mc Laughlin 2000). It is easy to assume that the nasal feature in all these cases is a full segment. However, certain features are never realized as full segments. These include voicing and continuancy. There is no other way that I know of than to analyze the feature [continuant] as a featural affix marking the past participle in Nuer (Crazzolara 1933) (§3.1).

From the theoretical point of view, this question relates to the way a "segment" is defined. If segments (or feature bundles) are the contrastive elements in a language, such that the meaning contrast between [tip] and [dip] is seen as represented by the first consonants [t] and [d] in these words, rather than between the fact that [t] and [d] differ only in that [d] is voiced and [t] is not, then there *are* featural affixes, because the elements that represent featural affixes are "less than" segments, as the empirical facts above reveal.

On the other hand, the current assumption is that the contrastive elements in language are "features," and not "feature bundles." This distinction is captured

by feature theory (CHAPTER 17: DISTINCTIVE FEATURES) and internal organization of segments (e.g. Clements 1985). On this viewpoint, the meaning contrast between [tip] and [dip] is seen as represented by voicing. If we equate minimal units with contrastive units then there are no featural affixes. The only distinction is between affixes that are feature bundles and affixes that are single features.

Empirical data from the Mafa imperfective aspect (Ettlinger 2003, 2004) suggest that the distinction between a segmental affix and a featural affix may not be real. In this case the same feature "palatality" sometimes behaves as a feature bundle, and sometimes as a single feature. The importance of the Mafa data is that even the distinction between "single feature" and "feature bundle" may not be real.

8 Conclusions

In summary, in this chapter I have illustrated the characteristics of featural affixes. These features include (a) marking morphological categories (like segmental affixes), (b) occurring as part of other segments rather than independently, (c) varying between prefixes and suffixes, (d) occurring inside the stem (because of feature co-occurrence constraints at edges), (e) spanning the entire base of affixation, and (f) varying occurrence as a feature or a segment in the same language. I have illustrated these with facts from Dutch, Chaha, Zoque, Nuer, Seereer Siin, Etsako, Terena, Mafa, Coatzospan Mixtec, and German Sign Language.

Comparing featural affixes with traditional regular affixes, featural affixes share four characteristics with the traditional affixes: (a) marking morphological categories, (b) varying between prefixes and suffixes, (c) (sometimes) occurring as independent segments, and (d) occurring inside the stem (because of feature co-occurrence constraints at edges). Other characteristics are unique to featural affixes alone: (a) occurring as part of other segments, (b) spanning the entire base of affixation, and (c) varying occurrence a feature or a segment in the same language.

There are a number of important lessons that the unique characteristics of "featural affixes" teach us. First, the so-called "normal affixes" always contain a timing unit, while "featural affixes" do not normally contain a timing unit. Second, they raise the question of whether segments or features are the basic elements that sound systems manipulate. Finally, they reveal that all features are not the same. Some features can be morphemic but can never be realized independently of some other segments ([continuant], [voice]), while other features that are morphemic may dock on some sound in the stem but may also become segments in their own right ([glottal], [nasal], [palatal], [labial]).

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