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Dependent Tier Ordering and the OCP

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0. INTRODUCTION

This paper explores some consequences of the Obligatory Contour Principle (Leben 1973, Goldsmith 1976, McCarthy 1979, 1981, 1986) given in (1) in a model which recognizes dependency relations between features.

(1) Obligatory Contour Principle (OCP)

Adjacent identical autosegments on an autosegmental tier are prohibited.

It will be argued that evidence for dependent tier ordering can be found in feature cooccurence restrictions which manifest themselves as morpheme structure constraints and as harmony processes. Dependent tier ordering means that a hierarchical organization is imposed on the set of features so that for example the vocalic features might be arranged as in (2).[1]

(2)
```
[round]
   |
[back]
   |
[high]
   |
   v
```

In structures like (2) individual features, while occupying separate tiers, are not entirely autonomous and are dependent on other tiers which have a more central location. Such dependently ordered models have been proposed by several researchers (see e.g., Steriade 1982, McCarthy 1983, Archangeli 1985),[2] but have not been fully explored in light of the OCP and of Tier Conflation (Younes 1983, McCarthy 1986). Section 1 investigates morpheme structure entailments of the OCP in a dependently ordered tier system, introducing and motivating a distinction between parametric and universal tier ordering. Section 2 illustrates the effects of Tier Conflation on dependently ordered structures through an analysis of the height-stratified vowel harmony system of Yawelmani Yokuts, noting some of the consequences of the approach for phonological theory (in particular regarding the availability of coefficient-variables in language-particular rules).

1. TIER ORDERING

Two kinds of dependent tier ordering can be distinguished: parametric and universal. Parametric ordering between two features means that either feature can be dependent on the other, with characteristic consequences in each case. An examination of the vowel cooccurrence restrictions of *Ngbaka* (1.1) and *Ainu* (1.2) demonstrates that the crucial difference between the two systems is captured in a revealing way by parametric ordering, with [back] dependent on [high] for Ngbaka and vice versa for Ainu. It is clear that ordering of tiers is parametrized only for certain pairs of closely related features, and most dependent ordering relations are non-reversible and hence universal, as discussed and illustrated in section 1.3.

1.1. Height-dependent Ordering: Ngbaka

Dependent tier ordering, together with the OCP, can explain the intricate patterning of root vowels in Ngbaka (Congo-Kordofanian, Eastern branch) first reported by Thomas (1963, 1970) (see also Wescott 1965, Chomsky and Halle 1968, Clements 1982, Churma 1984, and Itô 1984).

Ngbaka has the vowel system in (3), where ɛ and ɔ stand for [-ATR] mid vowels, *e* and *o* for [+ATR] mid vowels (I follow Churma (1984) in this interpretation of the mid vowel contrast).

(3)

i		u
e		o
ɛ		ɔ
	a	

In disyllabic words the following restrictions on vowel sequences are observed (Wescott 1965):

If a disyllabic word contains /i/, it does not also contain /u/; if /e/, it does not also contain /ɔ/, /ɛ/, or /o/; if /u/, it does not also contain /i/; if /o/, it does not also contain /e/, /ɛ/, or /ɔ/; and if /ɔ/, it does not also contain /ɛ/, /e/, or /o/."

These exclusion relations can be expressed more perspicuously by referring to a feature representation as in (4).

(4)

	−back	+back	
	i	u	+high
+ATR	e	o	−high
−ATR	ɛ	ɔ	
	a		+low

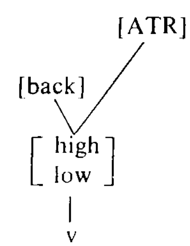
By redundancy rule, the high vowels are [+ATR], the low vowel [−ATR, +back, −high], and the nonlow back vowels [+round].[3]

The restriction on vowel sequences can then be stated as follows:

(5) Elements from the two classes [+high] and [−high] do not cooccur with a different element from the same class.

Following an insight by Churma (1984), this can be understood as a system with height-stratified backness and ATR harmony within morphemes, i.e., vowels of the same tongue height must agree in backness and in ATR. This accounts for all observed restrictions, and the statement itself falls out from the OCP if we assume the following tier arrangement for the vowel features in Ngbaka, with consonants and vowels on different tiers (see Prince (1987) for a discussion of nonmorphemic tier segregation).

(6)



The tongue height features are represented on the most central tier, [back] and [ATR] are each expressed on a separate dependent tier linked to the height tier. Given this tier arrangement, the OCP derives the Ngbaka restrictions. The basic idea is that all restrictions are due to OCP conflicts on the height tier. In particular, no morpheme-internal harmony rule or harmony constraint has to be stipulated.

It is an important feature of the Ngbaka system that the low vowel *a* can be combined with any other vowel. This follows from the fact that the representation of *a* on the height tier -- [+low] -- differs from that of all other vowels (either [+high] or [-high]). Therefore no OCP conflict of *a* with other vowels will ever arise on the height tier. Since necessary agreement in backness and ATR is induced by OCP conflicts on the height tier, it is clear why *a* is the neutral element in the system. Since the mode of explanation for the ATR feature is exactly parallel to the backness feature, I will only discuss the latter.

The structures in (7) show combinations of *a* with back and front vowels (all examples are taken from Thomas (1963)).

```
(7)  a.                [+bk]
                         |
            [+lo]      [+hi]
              |          |
        nz    a    mb    u        'pulpe de noix de palme'

     b.     [-bk]
              |
            [-hi]      [+lo]
              |          |
        k     e    m     a        'singe'
```

Ngbaka tolerates disharmony in backness if the vowels involved also differ in height, one being a high vowel and the other being a mid vowel. This follows because high and mid vowels have different representations on the height tier ([+high] vs. [-high]). There is no OCP conflict on the height tier, therefore no backness harmony is induced. For example, ɛ can be combined with *u*:

```
(8)       [-bk]    [+bk]
            |        |
          [-hi]    [+hi]
            |        |
     p      ɛ    p   u            'vent'
```

A further interesting aspect of the Ngbaka system lies in the fact that there is no absolute constraint against the occurrence of two high vowels or two mid vowels in a morpheme. Such cooccurrences are permitted provided the vowels are *identical*.[4]

We can account for the admissibility of the identity cases on principled grounds because they correspond to multiply linked structures as in (9).

Since no sequences on the height tier are involved, there are also no OCP conflicts. After all, a single melody element cannot enter into OCP conflicts with itself.

```
(9)       [-bk]
            |
          [+hi]
           / \
     l   i  k  i          'chauffer'
```

What is impossible in Ngbaka is a vocalism consisting of two mid vowels with different values for [back]. Similarly it is impossible to have two high vowels with different values for [back] in one morpheme. The reason becomes clear when we inspect the representations in (10) and (11). Using the hypothetical case of a morpheme with two mid vowels differing in backness as an illustration, consider the representation (given in (10)) which such a morpheme would receive. Two different [-high] autosegments on the height tier are needed to carry the different backness features, but this is impossible, given the OCP. The case with two different high vowels in (11) is entirely parallel.

```
(10)  *   [+bk]     [-bk]
            |         |
          [-hi]     [-hi]   →      OCP-violation
            |         |
      C     o    C    e

(11)  *   [-bk]     [+bk]
            |         |
          [+hi]     [+hi]   →      OCP-violation
            |         |
      C     i    C    u
```

1.2. Backness-dependent Ordering: Ainu

Ainu, an almost extinct language spoken in northern Japan (Hokkaido) whose genetic affiliation is unclear, has a regular dissimilation process insightfully analyzed in Itô (1984). The vocalism of the transitivizing -V suffix (and of another -V suffix deriving possessed forms of nouns) depends in intricate ways on the vocalism of the root (generally of the form CVC) and displays both 'harmonic' and 'disharmonic' behavior.

For roots ending in true consonants (≠ glides), two cases have to be distinguished. In one class of roots, the suffix vowel is identical to the root vowel (12) (all examples from Chiri (1952) via Itô (1984)).

(12)

mak-a	'to open'	tas-a	'to cross'
ker-e	'to touch'	per-e	'to tear'
pis-i	'to ask'	nik-i	'to fold'
pop-o	'to boil'	tom-o	'to concentrate'
tus-u	'to shake'	yup-u	'to tighten'

In a second class of roots, the suffix vowel differs from the root vowel: When the root vowel is nonlow, the suffix vowel is a high vowel opposite in backness to the root vowel (13). When the root vowel is low, the suffix vowel can be a front or back high vowel, with the choice lexically determined (14).[5]

(13)

hum-i	'to chop up'	mus-i	'to choke'
pok-i	'to lower'	hop-i	'to leave behind'
pir-u	'to wipe'	kir-u	'to alter'
ket-u	'to rub'	rek-u	'to ring'

(14)

kar-i	'to rotate'	sar-i	'to look back'
ram-u	'to think'	rap-u	'to flutter'

To capture the dissimilation facts, Itô (1984) assumes that consonantal and nonconsonantal melodies are segregated onto different tiers and proposes the melodic dissimilation rule (15).

(15) $[+\text{high}] \rightarrow [-\alpha\ \text{back}]\ /\ [\alpha\ \text{back}]$ ——

The obvious move here is to derive the effects of (15) from the OCP. This calls for the following feature structure for Ainu, where the feature [back] occupies a separate and more central tier on which the height tier is dependent (*a* is unspecified for backness, as in Itô (1984)).

(16) [high, low]
|
[back]
|
v

Given this tier arrangement, the OCP derives all dissimilation effects without the dissimilation rule (15) stated with coefficient variables. As shown

in (17) it is impossible to represent two successive vocalic melodies which agree in backness but differ in height.

(17) a. * [-hi] [+hi]
[+bk] [+bk] → OCP-violation
C o C u

b. * [-hi] [+hi]
[-bk] [-bk] → OCP-violation
C e C i

Agreement in backness is only possible if there is at the same time agreement in height. In that case we are dealing with a monovocalic root whose vowel melody has spread to the suffixal V slot, as illustrated in (18).

(18) [+hi]
|
[-bk]
/\
p i s i 'to ask'

In this analysis, Ainu differs from Ngbaka in the ordering of tiers. In Ngbaka the height tier is more central, and the backness tier is dependent on it. As a consequence, we get height dissimilation effects: if two successive (nonlow) vowels in a morpheme are not identical, they must be taken from different height classes. In Ainu, the backness tier is more central, and the height tier is dependent on it. Therefore we get backness dissimilation effects: nonidentical successive vowels in a morpheme must differ in backness. Viewed in this light, the observed cooccurrence restrictions are simply consequences of feature structure. Given the OCP and parametric ordering, no separate morpheme structure constraints need be stipulated.

1.3. Universal Tier Ordering

Most dependency relations between tiers are nonreversible and hence universal. This is in particular true for primary and secondary articulation, where we expect secondary articulation to be dependent on primary articulation (note the strangeness of the opposite situation). This section examines two cases of universal tier ordering and their consequences in morpheme structure.

The Micronesian language Ponapean, as described in Rehg and Sohl (1981), shows a tier dependency effect involving the primary articulator feature [labial] and the secondary articulator feature [back]. Ponapean distinguishes plain labials *p m* and velarized labials p^w m^w and imposes a morpheme-level velarization harmony on labials: Plain and velarized labials cannot be mixed in a morpheme, multiple labials within a morpheme are either all velarized (19) or all plain (20).

(19)	m^wop^w	'out of breath'
	p^wup^w	'to fall'

(20)	pap	'to swim'
	madep	'species of sea cucumber'

Agreement in velarization holds for the whole domain of a morpheme, intervening vowels and even intervening consonants do not render the constraint inoperative. On the other hand, velarization harmony is a strictly morpheme-internal phenomenon. Across morpheme boundary, plain and velarized labials can freely co-occur, as shown in (21).[6]

(21)	la*p*^{w}ad – *p*eseng	'to untie apart'
	*p*aa – *p*^{w}oad	'four long objects'

Our hypothesis is that the feature [labial] and the feature [back] (characterizing velarization as a secondary articulation) are geometrically arranged as in (22), with [back] dependent on [labial], and with [labial] occupying a tier separate from the other primary articulator features.

(22)

```
secondary
articulator:     [back]
                   |
primary            |
articulator:     [labial]
                   |
                   c
```

The OCP demands that morphemes with several labials be represented with a single [labial] feature. The tier structure in (22) then immediately derives the morpheme-internal velarization harmony of Ponapean as a tier dependency effect: The single [labial] feature can carry a secondary [back] specification, then all labials contained in the morpheme will surface with labialization, as in (23a) p^wup^w. Or the [labial] feature does not carry such a specification, then all labials contained in the morpheme will appear without labialization, as in (23b) *pap*.[7]

(23)

```
a.  [back]                b.
      |
   [labial]                  [labial]
    /    \                    /    \
   p  u   p                  p  a   p
```

a. p^wup^w 'to fall' b. *pap* 'to swim'

These are the only two possibilities, given the dependent tier ordering and the OCP. The representation (24), with mixing of velarized and plain labials, is ruled out.

(24)

```
*[back]
   |
[labial]  [labial]   → OCP violation
   |         |
   p    a    p
```

*p^wap

Strictly speaking, all of this holds only when two labials are adjacent (across a vowel). To complete the analysis and to account for the fact that velarization harmony is enforced across different intervening consonants, we can assume that the feature [labial] occupies a tier by itself, separate from other primary articulator features like [coronal]. Such a separation of primary articulator tiers, which leads to long-distance OCP effects, has been argued for by McCarthy (1985) on the basis of the Semitic root structure constraints. Similar evidence is found in the extensive system of cooccurrence restrictions governing morphemes in the Western Austronesian language Javanese and discussed in Mester (1986).

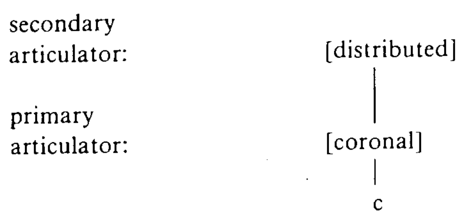
The fact that tautomorphemic labials in Ponapean have to agree in velarization does not mean that they always have to be totally identical. As is often the case, nasality behaves as an independent articulatory parameter. Thus, *p* and *m* as well as p^w and m^w are allowed to cooccur in Ponapean morphemes (eg. *parem* 'nipa palm', *madep* 'species of sea cucumber', and m^wop^w 'out of breath'). This shows that the nasal feature is not dependent on the place features, but rather independently linked to the melodic core.

A similar example involving the universal ordering of primary and secondary articulation comes from Alur (Northeast Congo). Summarizing results of a study by Burssens (1969), Tucker (1969:126) mentions the following restriction on possible root shapes:

> [...] the alveolar plosives *t* and *d* and interdental plosives (written *th* and *dh*) are mutually exclusive in CVC roots, i.e. words such as *dhetho* and *thedho* are possible, as are words such as *tado* and *tato*, but roots of the type *dh-t*, *th-d*, *t-dh*, *t-th*, etc. are not. This situation exists in Luo and Shilluk as well [...].

This is again a tier dependency effect. The feature [distributed] distinguishes interdentals and alveolars, and as a secondary feature it is linked to the primary place feature [coronal], as indicated in (25).

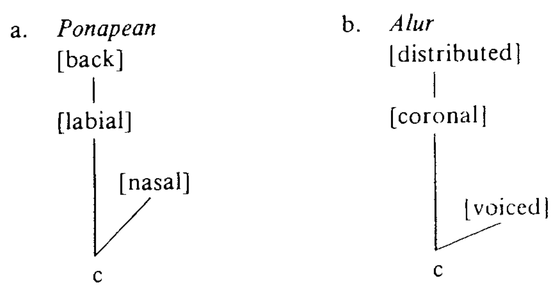
(25)



The OCP requires that morphemes containing more than one coronal plosive on the surface be underlyingly represented with a single occurrence of the feature [coronal]. Given the tier structure in (25), the root-internal [distributed] harmony for coronals then follows as a dependency effect. Voicing is independently linked to the melodic core, so coronals differing in voicing can cooccur in a root (e.g. *thadh-o*).

The full melodic tier structures for Ponapean labials and Alur coronals are given in (26); secondary articulation is dependent on primary articulation, and the nasal and voicing features are directly linked to the melodic core.

(26)



2. FUSIONAL HARMONY

The consequences of tier dependency considered so far all fall in the domain of morpheme structure. In this section, we will examine heteromorphemic effects, in particular, harmony processes where triggers and undergoers are governed by specific similarity conditions like the equal-height requirement of Yokuts Rounding Harmony. With the conditioning feature expressed on the central tier and the harmonizing feature on a dependent tier, the harmony process itself can be viewed as a manifestation of Tier Conflation (Younes 1983, McCarthy 1986), which folds the separate morphemic tiers together into a single tier at a certain point during the derivation, accompanied by fusion of identicals in derived adjacency. A feature F on the dependent tier acquires an extended domain whenever its anchor on the central tier fuses with an identical autosegment previously not linked to F. No particular harmony rule with coefficient variables has to be stipulated.

2.1. Yokuts Rounding Harmony

The height-stratified vowel harmony system of Yawelmani Yokuts originally described in Newman (1944) has been the object of a number of analyses (Kuroda 1967, Kenstowicz and Kisseberth 1979, Archangeli 1984, 1985). The underlying vowel system of Yawelmani Yokuts is given in (27), where each vowel can be long or short.

(27) i		u
		o
	a	

Long high vowels are subject to a postlexical lowering rule which is responsible for the appearance of surface *e* and for many instances of surface *o*. As is well known, Yawelmani has a pervasive process of rounding harmony which is height-stratified in the way indicated in (28).

(28)	*u* rounds a following *i*:	u C_o i	$\rightarrow$	u C_o u
	o rounds a following *a*:	o C_o a	$\rightarrow$	o C_o o
	u does not round a following *a*:	u C_o a	$\not\rightarrow$	u C_o o
	o does not round a following *i*:	o C_o i	$\not\rightarrow$	o C_o u

The following examples (from Newman 1944) illustrate harmonic alternations in suffixes. The effects of two postlexical rules, Lowering and Shortening, have been suppressed in these forms in the interest of clarity; capital letters stand for retroflex consonants; page numbers refer to Newman (1944).

(29) a. *Aorist*

?ugun-h*u*n	'drank'	151	
c'uum-h*u*n	'devoured'	122	(→[o] by Lowering and Shortening)
t'uy-h*u*n	'shot'	163	
duyduy-h*u*n	'stung rep.'	122	
duulul-h*u*n	'climbed'	122	(→[oo] by Lowering)
?ohyoo-h*i*n	'search'	163	
c'ow-h*i*n	'touched'	164	
lihim-h*i*n	'ran'	137	
Sil'-h*i*n	'saw'	145	
ninii-h*i*n	'became quiet'	122	(→[ee] by Lowering)
xayaa-h*i*n	'placed'	166	
wan-h*i*n	'gave'	166	
caw-h*i*n	'shouted'	135	
?agay-h*i*n	'pulled'	134	
tan-h*i*n	'went'	134	
yawal-h*i*n	'followed'	122	

b. *Dubitative*

Suug-*a*l	'might pull out'	120	(→[oo] by Lowering)
hoTn-*o*l	'might take the scent'	120	
di?S-*a*l	'might make'	120	
xat-*a*l	'might eat'	120	

c. *Imperative*

t'uy-k'*a*	'shoot!'	118
yolow-k'*o*	'assemble!'	118
xoSxoS-k'*o*	'rub repeatedly!'	118
t'oyix-k'*a*	'give medicine'	118
lan-k'*a*	'hear!'	118

d. *Passive Verbal Noun*

lox-h*onoo*	'being eaten'	149
gob-h*onoo*	'being taken in'	22
luk'ul-h*anaa*	'being buried'	149
hudhud-h*anaa*	'being repeatedly recognized'	149

The interesting point here is that rounding disharmony is permitted if the vowels involved differ in height, but not if they agree in height. The analysis in dependent ordering terms is quite clear: two tiers in the vowel

feature plane, occupied by the features [high] and [round], are aligned as in (30) (following Archangeli 1985).

(30)
```
[round]
   |
[high]
   |
   V
```

The [round] tier is dependent on the [high] tier and has no immediate access to the skeleton, all connections are mediated through the [high] tier.

I will assume, following Kuroda (1967) and in particular Archangeli (1984, 1985), that suffix vowels in Yokuts are unspecified for rounding. The unmarked value [-round] is assigned by default to all vowels still unspecified for roundness at the end of the derivation. The only way in which vowels underlyingly unspecified for [round] can receive the specification [+round] is through the action of Tier Conflation. Let us consider one of the examples given in (29) above, the aorist form *t'uy-hun* 'shot'. The underlying representation after affixation of the nonfuture suffix is (31), with the root vowel specified as [+round], but without rounding-specification on the suffix vowel.

(31)
```
[+rd]
  |
[+hi]     [+hi]
  |         |
t'u y  +  h i n
```

Through the action of (morphemic) Tier Conflation, the vocalic melodies of root and suffix come to occupy the same tier. McCarthy (1986) suggests that, as part of Tier Conflation, heteromorphemic adjacent identicals are fused. This has interesting consequences for a melody plane with dependent tiers. Consider again the representation in (31): both root and suffix vowel are [+high], and fusing the two [+high] autosegments into one will result in the representation given in (32).

(32)
```
   [+rd]
     |
   [+hi]
   /    \
t'u y h u n
```

Although only the feature [+high] is directly involved in the fusion effected by Tier Conflation, the hierarchical tier structure has the consequence that the second vowel is derivatively also specified as [+round] in this case.

The form *hoTn-ol* 'might take the scent' (from underlying /hoTn-al/) is derived in an entirely parallel fashion, the only difference being that [-high] is fused instead of [+high].

```
(33)  [+rd]                              [+rd]
        |                                  |
      [-hi]  [-hi]        ===>           [-hi]
        |      |                           |\
      h o T n+a l                        h o T n o l
```

The crucial advantage of this approach over spreading analyses is found in the case of vowels which differ in height, as in *c'ow-hin* 'touched' (34a) and *t'uy-k'a* 'shoot!' (34b). The representations of these forms do not induce any fusion on the [high] tier when Tier Conflation takes place, because the two height values are different.

```
(34)  a. [+rd]                b. [+rd]
           |                       |
         [-hi]   [+hi]           [+hi][-hi]
           |       |               |    |
         c' o w  h i n           t' u y k a
```

Since in this analysis rounding harmony is a derivative effect of the fusion of identical [high] autosegments by Tier Conflation and not a process in itself, we have an immediate explanation for its absence in vowel sequences which differ in height. For a form like *c'owhin* the only respect in which underlying and surface representation differ is due to the operation of default [-round] insertion, which specifies the suffix vowels as unrounded (see (35)). As a result, 'rounding disharmony' is permitted in vowels differing in height.

```
(35)  [+rd]   [-rd]   ← by default
        |       |
      [-hi]   [+hi]
        |       |
      c' o w  h i n
```


2.2. Theoretical Consequences

As a first result we note that there is no special rule of rounding harmony in Yokuts which would have to be constrained so as to spread [+round] in a height-stratified manner, i.e. from [+high] to [+high] and from [-high] to [-high]. Rather, Yokuts is characterized by a particular tier structure, with a more central height tier and a tier for the feature [round] which is anchored in the height tier. Tier Conflation fuses identicals on the two tiers. Since only [+round] is underlyingly specified and since suffixes are obligatorily unspecified for rounding, the crucial action of Tier Conflation takes place on the central tier, where the feature [high] is represented. Given the tier arrangement with rounding dependent on height, this results in derivative rounding harmony effects. The precise nature of the harmony effects follows from the fact that Tier Conflation only fuses adjacent identicals on the height tier, therefore rounding harmony, as a derivative effect of fusion, will only appear between vowels of like height.

Looking beyond Yokuts, we see that this approach provides a principled explanation for the existence of height-stratified harmony systems and the absence of harmony systems governed by height polarity (where only vowels opposite in height would show harmonic interaction). If the height-stratified character of Yokuts harmony were encoded in a special harmony rule stipulating height identity by means of a coefficient variable, we could just as well imagine a rounding harmony rule spreading rounding from [α high] to [$-\alpha$ high]. Such systems have not been reported, and the tier structure approach pursued here provides a principled explanation for this. It would be logically possible to encode such a restriction in Universal Grammar by proscribing the polarity use of the α-notation. This would still be an inferior theory, one which needs a special exclusion clause where the theory based on dependent tier ordering and Tier Conflation makes the correct predictions from the start.

Furthermore we can tighten phonological theory by disallowing the use of descriptively powerful coefficient variables in (language-particular) phonological rules. Since Tier Conflation (ultimately, the OCP) detects occurrences of adjacent identical autosegments on a tier, no variable over feature coefficients is necessary to capture the fact that rounding is transmitted only from [α high] to [α high] (earlier analyses had to have recourse to such a device, see e.g. Archangeli (1985:350)). As has been argued by a number of researchers in Nonlinear Phonology (Halle and Vergnaud 1980, Goldsmith 1981, Steriade 1982, Hayes 1986, and others), assimilation processes are best understood as involving autosegmental spreading and not copying of features, so their statement requires no α-notation. In the same vein, the analyses of Yokuts Rounding Harmony and of Ainu Backness Dissimilation (section 1.2) rely on operative principles which are intrinsic to the autosegmental framework (tier ordering, Tier Conflation, OCP) and do not make use of the powerful algebraic device of coefficient variables.

NOTES

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1. It should be noted that the most central feature tier is linked to a melodic core (or root node, in terms of Clements (1985) represented by lower-case c and v, which is in turn linked to a prosodic skeleton in the sense of McCarthy and Prince (forthcoming).
2. Segment-internal dependency relations have also been posited, in a different way and with different motivations, in the framework of Dependency Phonology (see e.g. Anderson and Jones 1974,77 and Ewen 1982) and in the more recent developments of Feature Geometry (see e.g. Clements 1985 and Sagey 1986).
3. While the mid and high vowels receive the feature [-low] by redundancy rule, I am assuming that they are both lexically specified for the feature [high]. This assumption is necessary for the analysis presented below.
4. The importance of this fact for an explanatory account of such cooccurrence restrictions was pointed out by Itô (1984) (see Prince (1984) for general phonotactic considerations along similar lines).
5. The distribution of final glides in roots is restricted by a dissimilation requirement exactly parallel to the one governing the choice of suffixal vowels, see Itô (1984) for discussion.
6. There is one local assimilation process causing labials adjacent across morpheme boundary to agree in velarization (as determined by the second labial), see Itô (1986) for discussion.
7. I am assuming that plain labials are underspecified for backness and also that nonlabials do not carry the feature specification [-labial]. Since the positive feature values are the only ones present in morpheme structure, I will write e.g. [labial] instead of [+labial]. For recent proposals on Underspecification theory see Kiparsky (1982) and Archangeli (1984).

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