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OCP effects: Gemination and antigemination

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Few putative properties of phonological organization have had as erratic a history as the Obligatory Contour Principle (hereafter the OCP). Originally proposed to account for distributional regularities in lexical tone systems (Leben (1973)), its role in tone was later either modified (Leben (1978)), rejected (Goldsmith (1976)), or limited to the phonetic level (Goldsmith (1976) as well). The OCP has enjoyed considerably greater success in its application to nonlinear segmental phonology (McCarthy (1979)), and a fairly detailed examination of its role in such nonprosodic domains is the focus of this article.

Leben's (1973) original argument for the OCP came from the distribution of tone melodies in morphologically simplex nouns in Mende. Mende has a system of lexically assigned tone melodies, and simple observation of the surface tone patterns reveals the following set of possibilities for words of one to three syllables:

(1) H^+ HL^+ LHL
L^+ LH^+

There are not as many surface tone patterns as we would expect, given a system with two tones (H and L) and free combination of one, two, or three of them. The only occurring patterns are those where each nonfinal tone is associated with exactly one syllable and where the final tone, as indicated by Kleene +, is replicated to fill up all syllables not occupied by other tones. In particular, there are no trisyllabic words displaying a HHL or LLH tone pattern, although straightforward consideration of the combinatorics would expect these melodies to be represented among the possibilities.

Leben's account of these observations invokes two principles. First, only the rightmost tone is subject to autosegmental spreading (although this is characterized in a different but essentially equivalent way in Leben's nonautosegmental theory). Second, the only source of identical tones on adjacent syllables is through spreading; primitive melodies like HHL or LLH are excluded, so the left-right asymmetry introduced by the first principle cannot be subverted simply by lexical listing. Goldsmith (1976) dubs the

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second provision the Obligatory Contour Principle, a regrettably imperspicuous name that is intended to suggest that only contour sequences rather than level sequences can occur in melodies. We may formulate this principle as follows:

(2) *Obligatory Contour Principle*
At the melodic level, adjacent identical elements are prohibited.

As I have noted, the role of the OCP in tonal phonology is a matter of some controversy (but see Kenstowicz and Kidda (1985) for a recent positive assessment). This is, however, orthogonal to the issues I treat here. Rather, I investigate the OCP as a constraint on the organization of nonprosodic or segmental phonology, particularly the representation of phonemic melodies and tiers in nonlinear morphology. I first review and expand considerably on the evidence that the OCP governs lexical representations, just as in the Mende case. I then present an extended argument that the OCP operates not only in a passive way, on the lexical listing of morphemes, but also actively in the course of the phonological derivation. Its function in the derivation, I claim, is not that sporadically assumed in the tonal literature (a process that fuses adjacent identical tones into a single one), but rather is more typical of other principles of grammar, accounting for a hitherto unnoticed constraint, called antigemination, which prohibits syncope rules from creating clusters of identical consonants.

The full treatment of antigemination necessarily takes us into a domain of great intrinsic interest: the relation between phonological and multitiered morphological representations in Semitic-type languages. This relation is mediated by an operation called Tier Conflation, originally proposed for quite different reasons by Younes (1983). I show that morphologically characterized autosegmental tiers, with the OCP and Tier Conflation, provide an interface between two formerly separate domains of theoretical discourse, lexical phonology and nonlinear phonology. The implications of this proposal ultimately extend well beyond the issues discussed here.

I conclude the article by addressing two other areas of current concern: the distinction between phonetic and phonological rules and the independence and universality of the OCP.

1. Lexical Evidence for the OCP

The original arguments for resurrecting the OCP from the limbo to which it had been consigned, and the first arguments for this principle from any nontonal data, were the distributional constraints on Semitic roots analyzed in McCarthy (1979; 1981b). I shall briefly review those arguments and then adduce a number of new ones that have come to light in other Semitic languages. This section concludes with a discussion of lexical evidence for the OCP in non-Semitic languages.

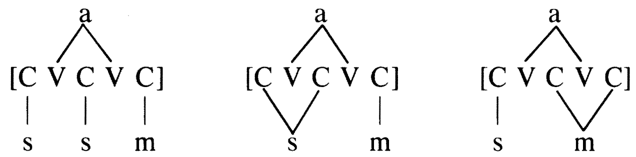
An often noted phenomenon of Semitic languages, first characterized rigorously by Greenberg (1960), is the virtually complete absence of nominal and verbal stems of the pattern $C_iVC_iVC_j$. Thus, Arabic for example contains no verbs with stem *sasam*. In fact, the observation can be made somewhat stronger, since no classical Semitic language contains stems [C_iVC_iX], where the left bracket marks the beginning of the stem and X is nonnull. On the face of it, this restriction is puzzling for several reasons. First, there is no phonotactic basis for ruling out the stem-initial C_iVC_i sequence—although there are no stems like *tatak*, there are inflected or derived verbs like *tatakallam* 'you converse', where the *t*'s are heteromorphemic. Second, a simple prohibition against having identical consonants separated by a vowel within a stem is wrong, because stems of the form *samam* 'poison' are quite common, with about 200 types occurring in a large Arabic dictionary.

We observe, then, that a conspicuous right-left asymmetry is built into this claim, since the C_iVC_i sequence is prohibited in stem-initial but not in stem-final position. The explanation for this property in McCarthy (1979; 1981b) has two parts:

(3) a. Arabic roots are subject to the OCP.
  b. All autosegmental spreading in Arabic is rightward.

These two clauses exclude the two possible representations of prohibited *sasam* in (4a,b), while permitting the derivation of occurring *samam* in (4c):

(4) a. *sasam b. *sasam c. samam



Both the OCP and rightward spreading are essential to obtaining this result, the OCP excluding the root /ssm/ in (4a) and rightward spreading providing no mechanism to derive the pattern of association in (4b).

There are other reasons for supposing that the OCP is part of the correct account of this exclusion. Arabic enforces a constraint prohibiting homorganic consonants in adjacent positions of a triconsonantal root (Greenberg (1960)). If there were roots /smm/ rather than /sm/, then we would obviously need to complicate this condition considerably, as in fact Greenberg does, by excluding adjacent homorganic consonants *unless they are identical*. The analysis based on the OCP, then, renders this homorganicity constraint considerably more simple and plausible.

Finally, it is worth noting that there are no quadriliteral verb forms with doubling of any consonant except the final one, as we would expect under the OCP and rightward spreading. Thus, paralleling a quadriliteral verb like *daḥraj* 'roll', we do not find verbs *dadraj* or *darraj* (the latter identifiable as a quadriliteral rather than a triliteral root with medial gemination by its morphological behavior elsewhere).

In addition, the OCP has a number of consequences that are not dependent on rightward spreading. These consequences are of two types: cases where we can show that there must be a single consonant in the phonological representation when phonetically there are two, and more weakly cases where we can show that there is no ambiguity, that the language does not support a contrast between one geminate consonant and a sequence of two tautomorphemic identical ones even when such a contrast would in principle be learnable.

Consider first the structural parallel between the ninth binyan verb *ḥmarar* 'to be red' and the first binyan verb *samam*. The final root consonant is productively doubled in the former, since this verb is transparently related to *ḥumr* 'red'. The root is therefore /ḥmr/, with spreading of the final consonant as a mark of the ninth binyan. On the other hand, the OCP forces us to say that there is also spreading of the single root consonant *m* in *samam*, even though this verb and all forms related to it invariably have at least two *m*'s on the surface. This in itself is remarkable, since it means that the OCP actually demands a certain measure of abstractness in phonological representations even when unsupported by alternations. The structural parallel between the productively reduplicated ninth binyan verb and the invariably reduplicated first binyan one, however, is clear—both have exclusively rightward spreading, and both undergo a metathesis/syncope rule. This rule, called Identical Consonant Metathesis and first discussed by Brame (1970), provides further support for the OCP. Metathesis is responsible for the alternations in (5a), but it is inapplicable to the apparently parallel forms in (5b):

(5) a.	/sm/ Binyan I		
	samamtu	'I poisoned'	samma 'he poisoned'
	yasmumna	'they (f.) poison'	yasummu 'he poisons'
	/ḥmr/ Binyan IX		
	ḥmarartu	'I reddened'	ḥmarra 'he reddened'
	yaḥmarirna	'they (f.) redden'	yaḥmarru 'he reddens'
b.	/ktb/ Binyan VIII		
	k*t*atab	'he copied'	*ka*t*tab
	/tbʕ/ Binyan V		
	ya*t*atabbaʕu	'he pursues'	*ya*t*tabbaʕu
	/mqt/ Binyan I		
	maqata*t*aa	'they (f. du.) detested'	*maqat*t*aa

The Metathesis rule seen in (5a) actually includes both metathesis and deletion, depending on whether a consonant cluster precedes or not. Of interest to us now is the contrast between (5a) and (5b). Tautomorphemic identical consonants undergo Metathesis (5a), but heteromorphemic ones do not (5b). In (5b) the italicized *t*'s are not part of the root—they are derivational infixes or prefixes in the first two examples and an inflectional suffix in the last. This restriction of Metathesis to tautomorphemic identical consonants can easily be accounted for in structural terms: the tautomorphemic consonants alone are represented by one-to-many association. Thus, Metathesis can be formulated as follows:

(6) *Arabic Identical Consonant Metathesis*

$$\begin{array}{l} \qquad\quad \alpha \\ \langle V\rangle_i\ C\ V\ C\ V \rightarrow 1\ \langle 3\rangle_j\ 2\ 4\ 5 \\ \\ \quad 1\ \ \ 2\ 3\ 4\ 5 \end{array}$$

Condition: $i \supset \neg j$

Later we will discuss the fact that this metathesis/syncope rule can create geminates, a property that is of direct relevance to one major point of this article.

Two features of Metathesis argue for the OCP. First, this rule confirms the parallel between productively copied consonants and invariably copied ones, supporting the claim that there is a single melodic *m* in *samam*. Second, the absence of *roots* that are systematic exceptions to Metathesis (although individual lexical items may be) is what we expect under the OCP. Without the OCP, some verbs might arbitrarily have $C_1C_2C_2$ roots, which would prevent them from undergoing Metathesis. Such roots would be straightforwardly detectable by this behavior, so this is a genuine result of the absolute constraint the OCP places on the Arabic lexicon.

A related result comes from the language games that occur in some Arabic dialects (McCarthy (1982; forthcoming)). In a Bedouin Hijazi Arabic language game, the root consonants may be freely permuted, with all vocalism, affixal consonants, canonical pattern, and association lines remaining unchanged. A verb form like *kattab*, for example, yields exactly five (3! − 1) distinct results in this game:

(7) battak
kabbat
takkab
bakkat
tabbak

Biconsonantal roots, however, have only one (2! − 1) possible output in the game, regardless of their pattern:

(8) /ḥl/ Binyan I
ḥall → laḥḥ 'he solved'
/sm/ Binyan II
sammam → massas 'he poisoned'

Again, this result is what we expect under the OCP—if these forms had triconsonantal roots, we would expect them to display the same variety of patterns as (7). In particular, we would expect **mammas* to be a well-formed result of the language game. The OCP further predicts that all putative biliteral roots in the language will behave in exactly this way, since the OCP tolerates no variation in the representation of such forms.

Another language game—this time from Amharic—provides a very different kind of evidence for the OCP (McCarthy (1985; forthcoming)). A secret language used by prostitutes in Addis Ababa uses a quasi-morphological pattern of CV skeleton and associated vocalism, very much like the real morphology of the host language. A few representative forms appear in (9):

	Amharic	*Argot*	
(9) a.	bet	baytət	'house'
	g^{w}aro	g^{w}ayrər	'backyard'
	bιrr	bayrər	'dollar'
	bədda	baydəd	'make love'
	k'əlləla	k'ayləl	'wishy-washy person'
	t'ətt'a	t'ayt'ət'	'drink'
b.	kəbad	kaybdəd	'heavy, difficult'
	gabbəzə	gaybzəz	'invite to'

The basic analysis is that the root is extracted from the actual Amharic form and submitted to a disyllabic prosodic template, with *ay* in the first syllable and *ə* in the second. We stipulate as well that the final root consonant is associated to both the onset and the coda of the second syllable:

(10) a. Apply the consonantal root to the following skeleton:

σ σ (which generates [CV(C)CVC], and up to three medial consonants)

a y ə

b. with the association rule:

. . . C V C]

α

The OCP effect that is of interest concerns the distinction between (9a) and (9b). In (9a) all roots are biconsonantal under the OCP, even though they display from two to four consonants in the surface form. In (9b) the roots are triconsonantal, with three or four phonetic consonants. The canonical pattern of the result is determined by the number of consonants in the root, where the root is determined modulo the OCP. I have argued elsewhere (McCarthy (1982)) that a disyllable template like that of the Amharic game is expanded minimally to accommodate the available consonantism, given the language-particular association rule (9b). Thus, the distinction between (9a) and (9b) requires that Amharic roots be represented by exactly as many consonants as the OCP permits.[1]

[1] Broselow (1984; 1985) has argued that Amharic does not in fact respect the OCP and that the evidence from this language game may be spurious. In McCarthy (to appear a) I consider the full range of her evidence and show that there are many advantages to enforcing the OCP in Amharic just as in Arabic.

Another Ethiopian Semitic language, Chaha, provides a very different source of evidence for the OCP (McCarthy (1983)). Chaha has morphological mutation rules of palatalization and labialization, rules that mark certain morphological categories either by themselves or with concomitant suffixes. These rules can be expressed informally as follows:

(11) a. *Chaha Labialization*

Attach [+round] to the rightmost labializable (labial or velar) consonant in the root.

b. *Chaha Palatalization*

Attach [+high, −back] to the last root consonant if it is palatalizable (coronal or velar).

A few simple examples of these two phenomena appear in (12):

(12) a. *Labialization*

Personal	*Impersonal*	
dänäg	dänäg^w	'hit'
näkäs	näk^{w}äs	'bite'
mäsär	m^{w}äsär	'seem'

b. *Palatalization*
Imperative

2nd m. sg.	*2nd f. sg.*	
g^{y}äk^{y}ət	g^{y}äk^{y}ət^y	'accompany'
nəmäd	nəmäd^y	'love'
nəqəṭ	nəqəṭ^y	'kick'

When the palatalized or labialized root consonant is the result of a one-to-many autosegmental association, however, all surface copies of the consonant display the secondary articulation:

(13) a.

Personal	*Impersonal*	
säkäk	säk^{w}äk^w	'plant in the ground'
gämäm	gäm^{w}äm^w	'chip the rim'

b.

Masculine	*Feminine*	
bätət	bät^{y}ət^y	'be wide'
səkək	sək^{y}ək^y	'plant in the ground'

This result is derived from two things: Chaha Palatalization and Labialization affect the root tier directly; and the OCP ensures that all "copies" of a root consonant originate in a single element on the root tier. The OCP further ensures that there will not be any roots where Palatalization or Labialization fails to display this across-the-board behavior.[2]

Similar properties may be found in Rotuman, a language outside the Semitic family that Saito (1981; see also McCarthy (forthcoming)) has shown to have the characteristic Semitic segregation of vowels and consonants onto separate tiers. An important feature of Rotuman morphology is the distinction between complete and incomplete phase (a kind of free versus bound form, respectively) that is marked on the surface by a complex pattern of vowel alternations in the final syllable of the stem. The alternations group into four types depending on the quality of the last two vowels in the stem, but I will confine myself only to the Metathesis and Umlaut patterns here, which are exemplified in (14):

(14)	*Complete*	*Incomplete*		*Complete*	*Incomplete*	
	a. *Metathesis*					
	pure	pu͡er	'to decide'	hosa	ho͡as	'flower'
	tiko	ti͡ok	'flesh'	pepa	pe͡ap	'paper'
	b. *Umlaut*					
	fuʔi	füʔ	'kava-food'	mose	mös	'to sleep'
	futi	füt	'to pull'	hoti	höt	'to embark'

The incomplete phase invariably has a single vocalic mora in the final syllable, so the ligatures in (14a) mark short diphthongs.

Saito shows that the apparent morphological metathesis—and in fact all the alternations in Rotuman—can be subsumed under a small number of general properties:

(15) a. Vowels and consonants are on separate tiers.
b. A final skeletal element V that is present in the complete phase is absent in the incomplete phase.
c. Vocalic melodies that are otherwise unassociated reassociate leftward.
d. Some of the resulting short diphthongs undergo coalescence or are otherwise simplified to yield monophthongs, according to their feature make-up.

Departing somewhat from Saito's analysis, which derives incomplete phase from complete by a morphological truncation rule, we can suppose that the complete phase is marked by a V suffix that is unspecified for vowel quality, and that the lexical representations of Rotuman roots appear as in (16):

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(16) p   r       m   s
     |   |       |   |
     C V C       C V C
       |           |
       u  e        o  e
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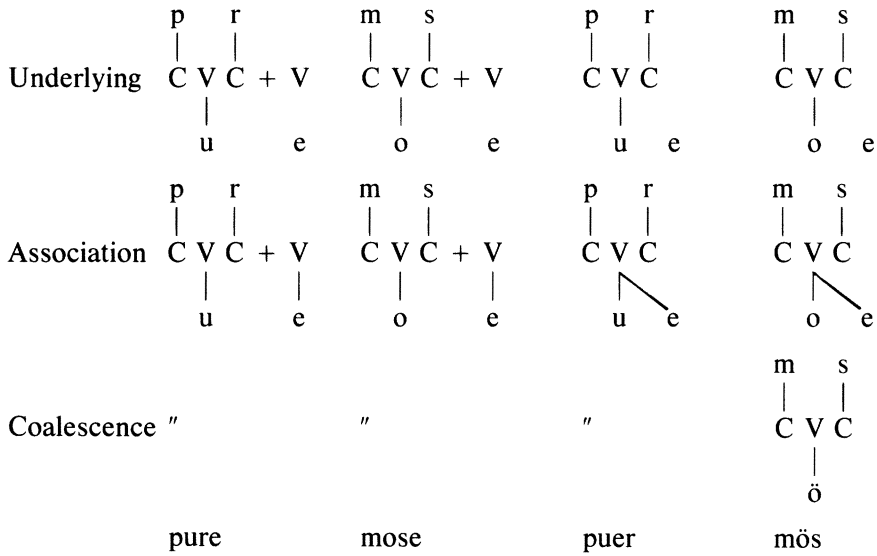
[2] The obvious hypothesis that identical consonants in sequence harmonize with respect to palatalization or labialization applied to the rightmost one in the sequence is shown to be incorrect in McCarthy (1983).

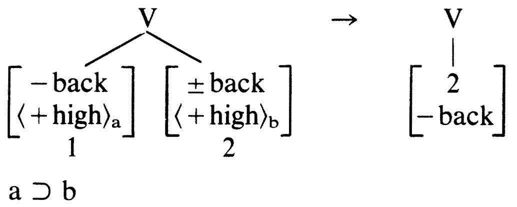
Derivations of the complete and incomplete phases of these two nouns then proceed as follows:

(17) *Complete Phase* *Incomplete Phase*



It is apparent that, under this analysis, the Metathesis pattern of incomplete phase formation involves nothing more than association of a floating vowel to the stem V slot to yield a short diphthong. The Umlaut pattern, which derives from an intermediate stage with short diphthongs *oe, oi*, and *ui*, is produced by the application of the following rule of Coalescence, an operation on the melodic level affecting two vowels associated with the same V position:

(18) *Rotuman Coalescence*



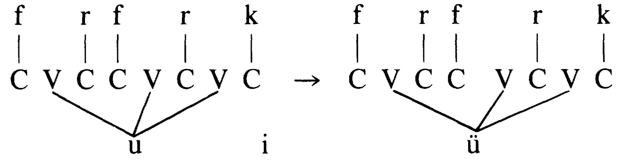
This rule can be simplified in various ways by acknowledging its interaction with other aspects of Rotuman phonology, but it will suffice for our purposes here.

The OCP requires that Rotuman lexical representations have a single vocalic melody for sequences of tautomorphemic identical vowels separated only by consonants. Under appropriate conditions, this single melody ought to display apparent across-the-board application of the umlauting effect of Coalescence, just as in Chaha. Saito (1981) points out that this is indeed the case, and a check by me of all relevant forms in Churchward's (1941) dictionary confirms it. Thus, we find the pattern of incomplete phase alternation in (19a), accounted for by the typical derivation in (19b):

(19) a.

popore	pöpör	'suddenly'	pulufi	pülüf	'stick'
roromi	röröm	'dash'	furfuruki	fürfürük	'pimple'
oʔhoni	öʔhön	'mother'	nunuji	nünüj	'stretch arms'

b.



As this analysis further predicts, the apparent leftward propagation of the umlaut effect is blocked by two things, either a morpheme boundary—since at a minimum separate morphemes are on separate tiers and therefore not subject to the OCP[3]—or a nonidentical vowel:

(20) a.	motolori	motolör	'motor-lorry'	(cf. *motokaa, motopäeke*)
	taumuri	taumür	'stern'	(cf. *taumua* 'prow', *tauraṇi* 'dinghy')
b.	Konousi	Konoüs	'proper name'	
	kalofi	kalöf	'egg'	

Precisely this distribution of incomplete phase umlaut is required by the lexical application of the OCP: all tautomorphemic identical vowels that are separated only by consonants should show nonlocal effects of Coalescence, and none should ever do otherwise.

Yet another rule of Rotuman, somewhat different from Coalescence, also provides support for the OCP. The rule of *a*-Umlaut fronts stressed *a* when it is followed immediately on the melodic tier by *e*:

(21) a-*Umlaut*

$$\begin{array}{cc} \text{á} & \text{e} \\ 1 & 2 \end{array} \rightarrow \begin{array}{cc} 1 & 2 \\ \text{[-back]} & \end{array}$$

Unlike Coalescence, this rule is indifferent to whether the two vocalic melodies are associated with the same V slot or not; thus, it applies in complete and incomplete phase alike:

(22) *Complete*	*Incomplete*	
lämäne	lämän	'lemon'
säkänäve	säkänäv	'sandal'
käkäʔe	käkäʔ	'finger'

[3] A further consequence of having separate morphemes on separate tiers is that a nonroot vowel cannot reassociate leftward in the incomplete phase and therefore cannot trigger Coalescence. Thus, *hotome*, derived from the root *hoto* 'to jump' and the classificatory suffix *me* 'toward speaker', forms the incomplete phase form *hotom* and not *hötöm* (Churchward (1941, 79)).

As with Coalescence, the across-the-board application of *a*-Umlaut is interrupted by morpheme boundary or a nonidentical vowel:

(23) a.	sagaväne	sagavän	'brother, male first cousin (of woman)'	(cf. *väne* 'husband')
	kapatäke	kapatäk	'copper-tack'	(cf. *kapa*)
	fakväre	fakvär	'to attract'	(cf. *fak(a)* 'causative', *värväre* 'to like')
b.	ṭaniäle	ṭaniäl	'yam species'	

Again, the distribution of Umlaut is exactly as we would predict under the OCP.[4]

Yet another non-Semitic language with segregation of vowels and consonants onto separate tiers is Sierra Miwok, whose morphology is the subject of two insightful papers (Smith and Hermans (1982), Smith (1985); cf. Broadbent (1964)). Sierra Miwok has a system of root-and-pattern morphology that places considerable emphasis on counting the number of consonants in the root in determining the type of pattern to use. For example, the qualitative morphology involves a kind of root reduplication for biconsonantal roots but spreading of the last root consonant for triconsonantal ones:

(24) a.	kyw-	'get cold'	kywkywwe-	'be cold'
	ciile-	'red pepper'	cilcille-	'taste peppery hot'
	kojjo-	'salt'	kojkojje-	'taste salty'
b.	hulaw-	'forget'	hulwawwe-	'be late'
	hitpyp-	'get cold'	hitpyppe-	'be cold'

The computation of the number of consonants in the root is again performed modulo the OCP—there are evidently no cases like *kojjo-* that form qualitatives in **kojjojje-*, as they would if there were two *j*'s in the melodic representation. (In part, this OCP consequence is independent of whether Miwok consonants are on their own tier or not.) Other rules of Miwok morphology also have this character, and we can find them in modern Semitic languages as well. For example, Egyptian Arabic excludes all verbs of the *samam* type from the III and VIII binyanim, an exclusion that requires that all such verbs have biconsonantal roots without any lexical variability, as the OCP guarantees. Once again, this is a case where the language could sustain a lexical distinction between

[4] Saito (1981) actually uses the *a*-Umlaut rule, together with a rule raising *a* before a high vowel, to argue that low vowels are not subject to the OCP in Rotuman, although he concedes that nonlow vowels are. That is, he finds that there are *a* sequences that do not display across-the-board umlaut, and concludes from this that they are represented by several *a*'s on the melodic tier. This peculiar and unexpected state of affairs is, I think, based on an erroneous interpretation of the apparent counterexamples to across-the-board application of *a*-Umlaut. My search of Churchward's (1941) dictionary has produced many forms that conform with the OCP generalization and only six that do not. Of these, two are transparently morphologically complex and are dealt with as such in the text of this article. Another two have a nonproductive prefix blocking umlaut, so there are only two remaining exceptions. Both of these are of the form *CaCäe* and are plausibly derived by a different rule of Rotuman applying to *a* immediately preceding *e*.

The other rule Saito cites, which raises *a* when followed by a high vowel (Churchward (1941, 76)), in fact never applies to more than one vowel at a time. This sort of behavior is irrelevant to the OCP, since it can be built into the rule itself or otherwise accounted for without involving an OCP violation.

two types of tautomorphemic identical consonants but does not. Essentially the same argument can also be made for Takelma (Goodman (1983)).

One effect of the OCP in languages both with and without Semitic structure is the enforcement of conditions of the sort "a value for X may appear only once in a domain Y." That is, a constituent (like a morpheme or a word) may bear only one value for some feature or set of features. Such conditions come in two flavors. The values of X may be allowed to spread, so that they are instantiated on more than one surface segment, as in Itô's (1984) analysis of Ainu vocalism. Or the values of X can be restricted to a single segment, as in Itô and Mester's (1986) treatment of Japanese voicing. In an appendix to their article, Itô and Mester vigorously pursue the idea that the OCP is responsible for the distribution of voiced obstruents in Japanese. In either case, only one value of the relevant features may appear on the appropriate melodic tier, and the spreading or lack of spreading of this value is a separate parameter of the theory. Connections with more familiar conditions of this sort, like Semitic or Indo-European root co-occurrence restrictions, naturally suggest themselves.

The remaining consequences of the OCP can also be found in any non-Semitic language, regardless of its morphological typology, providing it has distinctive quantity. Prince (1984) and Selkirk (1984, 129) point out that most intersyllabic sequencing constraints can be derived from relatively simple filters on the association of melodic elements with the skeleton. In particular, consider a language that excludes tautomorphemic geminates. This constraint is expressed as follows:

$$\text{(25)}\quad {}^{*}\begin{array}{cc} C & C \\ \multicolumn{2}{c}{\vee} \\ \multicolumn{2}{c}{\alpha} \end{array}$$

Without the OCP, it is possible to subvert the constraint easily by having tautomorphemic clusters of identical consonants. With the OCP, (25) is all the grammar needs to express this very common property.

Second, the OCP is an essential feature of the literature deriving the integrity of geminates from structural properties of the melody-to-skeleton association (Schein (1981), Kenstowicz (1982), Steriade (1982), Hayes (1984), Schein and Steriade (1984)). This literature has grown up around the observation that tautomorphemic geminate consonants or vowels display immunity to certain kinds of phonological rules, an immunity that is attributed to their one-to-many pattern of association (although there is disagreement over the precise mechanism for blocking rule application). Quite a large number of such cases have been found, and they invariably show the property that phonological rules of a particular sort cannot apply to sequences of identical elements within a morpheme. The principles of rule application that derive this result presuppose both the OCP, as I have formulated it, and the segregation of different morphemes onto different tiers, even in systems with purely concatenative morphology. Since there are some possible exceptions to the tautomorphemic/heteromorphemic geminate dichotomy, we shall return to it in section 6.2 when we consider how morphological distinctions are lost in the course of the phonology.

Third, where we have direct evidence for the make-up of the melody from non-concatenative morphological processes in languages with otherwise concatenative morphology, it invariably shows that such languages respect the OCP. For example, the Finnish language game *kontti kieli* 'knapsack language' provides direct evidence that long vowels are represented by a single melodic element. (The same conclusion holds for the quite different Estonian language game described by Lehiste (1985).) *Kontti kieli* abstracts the first consonant and vowel of the phonemic melody from a word, replaces it by *ko*, and associates it with the word *CVntti* (Campbell (1981)):

(26)	Helsingissa	kolsingissa hentti	'Helsinki (iness.)'
	kesän	kosan kentti	'summer (gen. sg.)'
	mitä	kota mintti	'what'
	sikiö	kokio sintti	'embryo'

Formally, the derived representations are something like this:

```
(27) k o       m i
     | |       | |
     C V C V   C V C C C V
         | |       | \/  |
         t ä       n  t  i
```

Crucially, the phonemic melodies are moved and not their associated skeletal positions, just as in many other language games involving transposition (Clements (1984), McCarthy (1982; forthcoming)).[5] The effect of this is clear in the case of long vowels (or surface diphthongs derived from long vowels). The melody of the whole long vowel moves as a unit (28a); in contrast, true underlying diphthongs move only the first vocalic element in the phonemic melody (28b):

(28) a.	riipua	koopua rintti	'to hang'
	röökata	kookata röntti	'to move'
	teeskentely	kooskentelu tentti	'affectation'
b.	keula	koula kentti	'bow'
	nousta	kousta nontti	'to rise'

These facts bear on the OCP in two respects. Generally, the OCP ensures that all long vowels are represented by a single element on the phonemic melody tier. This accounts for the different behavior of diphthongs and long vowels—only a single vowel in the phonemic melody may move. Furthermore, the OCP guarantees uniform treatment of all long vowels—all must behave as a single unit. This behavior is typical of all transposition language games cross-linguistically (McCarthy (1982; forthcoming), Clements (1984), Vago (1984)), so we have here a robust result of the OCP.[6]

[5] For a somewhat different analysis of this Finnish language game, see Vago (1984).

[6] Vago (1984) and Steriade (personal communication) have pointed to Cuna (Sherzer (1970)) as a language where long vowels may violate the OCP on the basis of language game evidence. A Cuna transposition game preposes the final syllable or vowel, depending on one's analysis: *dage* → *geda* 'come', *goe* → *ego* 'deer, baby'. A long vowel, however, shows variation, with some speakers transforming *muu* 'grandmother', *dii*

2. Antigemination

The evidence presented up to this point has argued for only one particular instantiation of the OCP: as a constraint on the representation of unanalyzable morphemes in the lexicon. We now turn to some cases in which the OCP is enforced throughout the derivation—not to fuse sequences of identical elements into a single unit, as is sometimes thought, but rather to prevent the creation of such sequences. Our first two major examples of this come from syncope rules in Afar and Tonkawa.

2.1. Afar

The Lowland East Cushitic language Afar is the subject of an extremely thorough and insightful description and analysis by Bliese (1981). Afar has a rule of syncope that deletes an unstressed vowel in a peninitial two-sided open syllable. Since Afar stress is a lexical property of some roots and some suffixes, with the rightmost one winning, the most conspicuous vowel/zero alternations occur when an inherently stressed suffix draws the accent off of the root (29a). There are also numerous alternations where suffixation closes or opens the second syllable (29b) (Bliese (1981, 213–214)):

(29)	a.	xamíla	xaml-í	'swampgrass (acc./nom.-gen.)'
		ʕagára	ʕagr-í	'scabies'
		darágu	darg-í	'watered milk'
	b.	digib-t-é	digb-é	'she/I married'
		wager-n-é	wagr-é	'we/he reconciled'
		meʕer-tá	meʕr-á	'you/he kills a calf'

I will formulate this syncope rule in the familiar way, although it surely ultimately de-

---

'water' to *umu, idi,* and other speakers leaving them unchanged. This difference correlates with a difference in stress treatment; speakers with the transposed language game forms treat long vowels as two syllables for the purposes of Cuna's penultimate stress rule (*andíi* 'my water'), whereas speakers with the unchanged forms treat long vowels as a single syllable in penult stress assignment (*ándii*). If the first "dialect" has the representation in (i) and the second dialect the representation in (ii), then these facts purportedly fall out:

(i)  (ii) 

There are reasons to be skeptical about this analysis. Only about ten words in the whole language have long vowels (Sherzer (personal communication)), so they are an extraordinarily marginal piece of Cuna phonology. Thus, the stress and language game facts may indicate nothing more than that speakers in the second group are confused about the ill-attested long vowels of their language and analogically group them with words ending in short vowels. This is confirmed by Sherzer's observation that speakers of the second group tend in fact to produce the putative long vowels as short, in which case there is no length contrast at all. Furthermore, no dialect split is observed with another language game in Cuna, one that inserts *ppV* after every vowel: *pia* → *pippiappa*. In this game, putative *muu* becomes *muppu* for everyone. Even if these objections could be circumvented, (i) and (ii) take a difference between speakers that ought to involve a single parameter of variation and express it by two distinct formal properties—different syllable structure and different melodic structure.

pends on higher-level syllabic information (cf. Archangeli (1984)):

(30) *Afar Syncope*

$$\underset{[-\text{str}]}{\text{V}} \rightarrow \emptyset \ / \ \#\text{CVC} \underline{\quad\quad} \text{CV}$$

Afar Syncope systematically fails to apply when the consonants on both sides of the potential deletion site are identical:

(31)	miḍaḍí	'fruit'
	sababá	'reason'
	xarar-é	'he burned'
	ʕalal-ée-ni	'they competed'
	gonan-á	'he searched for'
	aḍaḍ-é	'I/he trembled'
	danan-é	'I/he was hurt'
	modod-é	'I/he collected animals to bring home'

As Bliese notes, this condition on Syncope is rather unexpected, since Afar otherwise shows no aversion to geminate consonants (which would result if Syncope applied in (31)). Afar has both tautomorphemic and heteromorphemic geminates in underlying and surface representations—in fact, some parts of the verb system use gemination in a way formally identical to Arabic: *t-uktubé* 'you wrote' against *t-un-kuttubé* 'it was written'. There is, then, no conspiratorial interpretation of the failure of Afar Syncope between identical consonants, whereby the special condition on this rule might be derived from a general prohibition against geminates in this language.

The explanation for the Afar antigemination effect is, instead, a universal one: syncope of a vowel between identical consonants would produce a configuration that violates the OCP and is therefore blocked. That is, the putative output of Syncope is checked against this universal principle, and if the output would violate the OCP, Syncope does not apply. The derivation in (32) is therefore prohibited:

(32)

```
                e                    e
                |                    |
[[C V C V C] V]   -/->   *[[C V C C] V]
  | | | | |                 | | | |
  w a l a l                 w a l l
```

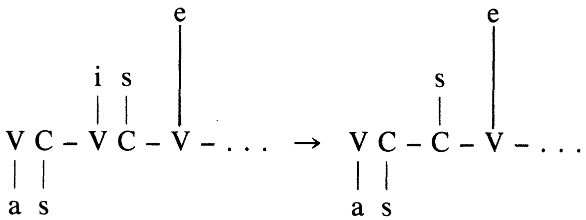
This otherwise puzzling restriction on Syncope follows from a universal principle, the OCP, rather than an arbitrary stipulation in the grammar of Afar.

The OCP account of antigemination in Afar has one significant empirical consequence that is not readily available by language-particular stipulation: Syncope *can* apply between heteromorphemic identical consonants. All of the cases above where Syncope is blocked have tautomorphemic consonants abutting the expected deletion site. In some dialects of Afar these are the only possible cases, since the rule is restricted to root vowels. But in the Aussa and Shewa dialects Syncope is more general and can apply to the vowels of some closely bound suffixes (the benefactive *-it* and causative *-is*). In such cases syncope between identical consonants is permitted:[7]

(33)	as-is-é-y-yo	→	asséyyo	'I will cause to spend the day'
	xas-is-é-y-yo	→	xasséyyo	'I will cause him to motion'
	sas-is-é-tto	→	sassétto	'you will cause (him) to hide'

Because different morphemes are represented on different autosegmental tiers, no violation of the OCP results from Syncope, as the following derivation demonstrates:

(34)



Afar antigemination—its enforcement of the OCP on the application of Syncope—provides a close parallel to the integrity of geminates discussed in section 1. Just as languages typically distinguish between hetero- and tautomorphemic geminates with respect to integrity, so does Afar antigemination. In both cases these effects are attributable, at least in part, to the segregation of different morphemes on different tiers and to the OCP.

The interpretation of Afar presented here provokes two questions, one generally applicable to all the examples discussed in this article and the other specific to this language. The first question concerns the interpretation of the OCP as a constraint on phonological well-formedness that blocks the application of syncope rules. Discussions of the OCP in its relation to phonetics (Goldsmith (1976)) and to tone (Leben (1978)) have sometimes assumed that the OCP, in addition to blocking ill-formed lexical representations, fuses derived sequences of identical elements into a single one. This more active OCP is, of course, completely incompatible with the account given for Afar, since it would allow syncope rules to apply but would then restructure their outputs.

There are three reasons why I reject the fusion interpretation of the OCP and hold instead to its blocking effect. First, the cases like Afar adduced here all point to blocking over fusion—we never find application of syncope followed by restructuring of the output. Second, the idea that universal or language-particular constraints on phonological well-formedness function as negative rather than positive filters is far more typical of the vast majority of uses of constraints in the literature. For instance, languages that display a conspiracy to block the creation of unsyllabifiable clusters by syncope are almost commonplace—the interpretation in that case is that principles of syllabification

[7] The examples in (33) were provided by Loren Bliese. No verbs in final *t* subcategorize for the benefactive suffix.

constrain the output of a syncope rule. Third, as I show in section 6.2, whatever fusion effects might be attributed to the OCP are better dealt with in a far more general way, as one instantiation of the principle of Tier Conflation.

In view of the provenance of Afar, we should address one issue: does this language have vowels and consonants on separate tiers like Arabic, so that the verbs in (31) are instances of spreading of the last root consonant? Afar, a distant relative of Arabic, does have Semitic-style morphology (as in the verb *tunkuttubé* already cited), but it also has conventional roots. The language makes a clear distinction between the two types, confining Semitic morphology to a small number of verb roots of the prefixing class—those that conjugate with prefixes. Such verbs show all the hallmarks of Semitic morphology, including variable vocalism and some morphological determination of CV skeleton. The vast majority of verbs and apparently all nouns have roots that are not decomposable into separate vowel and consonant morphemes, since they have invariant vocalism and canonical pattern. The verbs of this class, which conjugate with suffixes, are the only forms besides nouns represented in the data in (31)—apparently the crucial conditions for testing the OCP via Syncope are never met in the prefixing class (Bliese (1981, 215; personal communication)). We will, however, have occasion to examine OCP effects on Semitic languages later in this article.

2.2. *Tonkawa*

One of the best-studied syncope rules in the phonological literature also shows the OCP sensitivity observed in Afar. Tonkawa, a Coahuiltecan language of central Texas, has been the object of considerable research since the original investigations by Hoijer (1946; 1949) and continuing through papers by Kisseberth (1970) and Phelps (1975).[8] The ultimate product of this work, again ignoring the simplifications possible under syllabic treatment, is a rule deleting a stem vowel in a two-sided open syllable when the following vowel is in the stem as well:

(35) a. *Tonkawa Syncope*

$$\underset{[+\text{stem}]}{\mathrm{V}} \rightarrow \emptyset \ / \ \mathrm{VC} \_\_ \mathrm{C} \ \underset{[+\text{stem}]}{\mathrm{V}}$$

b. notoxo- 'to hoe' notxoʔ 'he hoes it'
picena- 'to cut' picnoʔ 'he cuts it'

The alternations in (35b) are typical, and considerable justification for them can be found in the literature.

Kisseberth (1970, 127–128) originally observed that Tonkawa Syncope is inapplicable between identical consonants. Since he is cautious in claiming that this is regularly true, I have confirmed it by a search of all examples in Hoijer's (1949) dictionary, where no vowels between identical consonants are marked as members of the deletable mor-

[8] My understanding of Tonkawa phonology has been aided by a close reading of Lee (1983).

phophonemes. Thus, this condition appears to be completely general in Tonkawa. A few representative examples appear in (36):

(36)	hewawa-	'to die'	hewawoʔ	'he is dead'
	ham'am'a-	'to be burning'	ham'am'oʔ	'he is burning'

The same condition accounts for a pervasive fact in the language not previously noted. Although the output of CV reduplication in Tonkawa is ordinarily submitted to Syncope, a vowel never deletes between the reduplicated consonants:

(37) /yakapa/ 'to hit'

/yakapa + oʔ/		/yakakapa + oʔ/	
yakpoʔ	'he hits him'	yakakpoʔ	'id. (repeatedly)'
/ke + yakapa + oʔ/		/ke + yakakapa + oʔ/	
keykapoʔ	'he hits me'	keykakpoʔ	'id. (repeatedly)'

This pattern of deletion is inexplicable under virtually any assumptions about where the stem boundary is or in what direction Syncope iterates, but it is entirely consistent with a condition prohibiting deletion between identical consonants.

Again, the OCP provides an account of this peculiar condition on Syncope. Just as in Afar, the derivation that yields a violation of the OCP is blocked:

(38)
```
                  o ʔ                    o ʔ
                  | |                    | |
[[C V C V C V] V C]  -/->  *[[C V C C V] V C]
  | | | | | |                | | | | |
  h e w a w a                h e w w a
```

One caution: we cannot test Tonkawa Syncope on heteromorphemic consonants (as we did in Afar) because of the [stem] features in the context of the rule—they, together with the fact that stems are always consonant-initial, ensure that Syncope cannot apply to a vowel abutted by heteromorphemic consonants in any case. There is, however, a much more poorly studied rule that deletes final vowels before certain suffixes and before following stems in compounds. This rule, which I will call Final Apocope, is exemplified by the forms in (39):

(39)	taʔane-	'to pick it up'	taʔan-ta:hacoxo-	'to pick (him) up'
	yakona-	'to punch (him)'	yakon-yapalʔa-	'to knock (him) down with a fist'
	yakexe-	'to push (him)'	yakex-ta-	'to push (it) this way'

It is difficult to be more precise at present about the character of this rule, since it does not invariably apply: compare *taʔane-ta-* 'to bring (it) here' with the forms above. Final Apocope is evidently indifferent to whether the (invariably heteromorphemic) abutting consonants are identical or not. It can yield a geminate that is only optionally simplified, indicated by Hoijer (1949) with parentheses (cf. also Hoijer (1946, 292)):

(40)

	Underlying	*Derived*	*Gloss*
	taʔane + nisʔo:yta-	taʔan(n)osʔo:ta-	'to stretch (e.g. a rope)'
	yakona + nacaka-	yakon(n)acaka-	'to kill (him) with a blow of fist'
	yakexe + xakana-	yakex(x)akana-	'to push (it) down hard'

This result is, of course, precisely what we expect under the OCP account, given that morphemes are segregated onto tiers. Final Apocope, which applies only between heteromorphemic consonants, may create geminates, but Syncope, which applies only between tautomorphemic consonants, may not.

Let us counter a possible objection to this argument that is implicit in the discussion in Kisseberth (1970). Tonkawa lacks tautomorphemic geminate consonants in underlying representation, and Kisseberth suggests that the failure of Syncope to create geminates is an effect of a conspiracy to maintain this generalization, on a par with the failure of Syncope to create triconsonantal clusters, which are also prohibited underlyingly. This conclusion, if correct, would not falsify the OCP (in fact, it would confirm it in exactly the way other intersyllabic distributional constraints do, as discussed in section 1), but it would remove Tonkawa as a case of antigemination via the OCP, since the language-particular constraint does the job whether the universal principle is there or not.

There are compelling reasons why the language-particular account does not go through. First, surface triconsonantal clusters may not arise by morpheme concatenation, but surface geminates can, either by Final Apocope (39) or by morpheme concatenation. This difference is inexplicable under the conspiracy account but follows from the OCP. Second, once the prohibition on underlying geminates is stated formally, it is clear that it is inapplicable either to heteromorphemic geminates or to geminates derived by Syncope. A prohibition on tautomorphemic geminates is stated as follows:

(41) *C C
 \/
 α

This configuration is clearly prohibited in Tonkawa. On the other hand, this is not the structure that arises under morpheme concatenation, under the application of Final Apocope, or under the application of Syncope, yet the creation of geminates is ruled out in the last case—a distribution of data that is predicted by the OCP but clearly not by (41). Finally, apart from the triconsonantal cluster conspiracy and the putative geminate conspiracy, constraints on Tonkawa underlying forms are not terribly robust in their effect on the application of Syncope. For example, Kisseberth (1970, 126–127) observes that glottalized consonants do not occur as the second member of a cluster in underlying representation, but in the output of Syncope this restriction is observed only when the first consonant is an obstruent. Syncope also routinely creates clusters violating another underlying distributional constraint, the prohibition against syllable-final *h*—witness the derivation /ke + hayoxo + oʔ/ → (Syncope) *kehyoxo + oʔ* → (other rules) *ka:yoxoʔ* 'he mounts me' (Hoijer (1946, 295)). I conclude that a language-particular well-formedness condition is insufficient to account for the antigemination effect in Tonkawa.

3. Tier Conflation

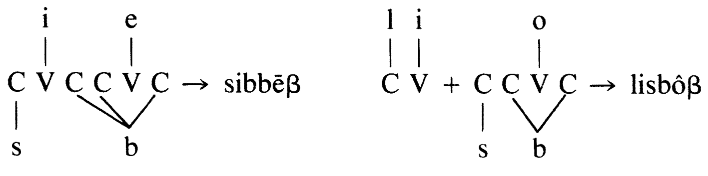
3.1. Introduction

There is considerable evidence in Semitic morphological systems that vowels and consonants are represented on separate tiers. Apart from the fact that the root consonantism and stem vocalism are largely independent morphemes, a body of material like that in sections 1, 3.2.2, and 5.1 has been amassed showing that vocalic and consonantal melodies must be represented on separate tiers for the purposes of morpheme structure conditions (or the OCP), for morphological rules, and for at least some early phonological ones. Similar considerations obtain in the non-Semitic languages with morphology of this sort like Rotuman and Sierra Miwok.

There is, however, a problem inherent in the morphological separation of the vowels and consonants: it appears that at least the later phonological rules in Semitic are not strikingly different from those of the more familiar languages in the vowel/consonant interactions they permit. That is, we might expect Semitic systems, with their very different mode of representation, to reflect this difference throughout the phonology just as they do throughout the morphology. Such is not the case.

One problem of this sort emerges in work by Steriade (1982), although there are additional complications that may ultimately make this example irrelevant. Tiberian Hebrew Spirantization takes any nonpharyngealized oral stop to its corresponding continuant postvocalically. This rule is inapplicable to geminate consonants, a condition that can be derived from essentially any nonlinear formulation of the geminate integrity constraint (cf. section 1), since the one-to-many representation of the geminate will suffice to block postvocalic Spirantization. Steriade observes, however, that the one-to-many representation that blocks Spirantization in geminates is also found in cases of spreading of a root consonant across vowels, where Spirantization may apply freely:

(42) a. b.



'he surrounded' 'to surround'

Although there are various baroque reconstructions of these representations or of the principle of geminate integrity that might solve the problem, a basic difficulty remains: the purely structural characterization of segments subject to geminate integrity fails in a system where one melodic element spreads "across" another on a different tier. Only surface tautomorphemic geminates count for integrity.

Rules of a different sort also lead to geminate integrity problems in Semitic. Epenthesis rules cannot break up tautomorphemic geminates because the inserted vowel would cross an association line linking a single consonantal melody to two C slots of the skeleton. As Steriade (1982) and Younes (1983) note, this condition is normally enforced in Semitic languages like Palestinian Arabic even though vowels and consonants are represented on separate tiers. If the epenthetic vowels were to emerge on the same tier as the other vowels, then no violation of geminate integrity would result.

A proposal made by Younes (1983) allows us to overcome these phonological problems while still retaining the not inconsiderable morphological advantages of having vowels and consonants reside on different tiers. Younes suggests that representations like those in (42) are subject to a general process, which we will call Tier Conflation, whereby the elements on the independent vocalic and consonantal tiers are folded together into a single linearized tier according to the information provided by associations with the CV skeleton. By virtue of Tier Conflation the representations in (42) are mapped onto those in (43), to which Spirantization then applies in the correct and familiar way:

```
(43) a.                 b.
                        l i
                        | |
     C V C C V C        C V + C C V C
     | |     | |              | | | |
     s i   b e b              s b o b
```

Likewise, once vocalic and consonantal melodies have been conflated onto a single tier, epenthesis into tautomorphemic geminates will be blocked in Semitic just as it is in other languages. The fundamental idea here is that Tier Conflation in systems with morphologically characterized tiers provides phonological representations that are essentially similar to those of other languages with more familiar structure. No new information is created by Tier Conflation, but some information may be lost, as we will now see.

Referring to work by Kiparsky (1982) and Mohanan (1982), Younes further proposes that Tier Conflation is a way of discarding morphological information at some point in the phonological derivation. Departing slightly from her discussion, I will claim that Tier Conflation is to be identified with Bracket Erasure (Pesetsky (1979), Kiparsky (1982), Mohanan (1982), Halle and Mohanan (1985), a mechanism that removes morphological boundaries as they become inaccessible to subsequent phonological rules. Tier Conflation simply generalizes Bracket Erasure to nonconcatenative morphological systems, systems in which morphological structure is indicated not only by bracketed domains but also by separate tiers.

We can, in fact, go a step further and eliminate Bracket Erasure completely, passing its entire burden to Tier Conflation. In McCarthy (1981b) it was proposed that all morphemes are lexically represented on separate tiers from all other morphemes not only in clearly nonconcatenative systems like Arabic root-and-pattern morphology but also in the largely concatenative agreement morphology of the same language. Since the segregation of different morphemes on different tiers provides all of the morphological information that bracketing does, and since Tier Conflation then destroys information in exactly the way that Bracket Erasure does, it follows that the former properly includes the latter, so Bracket Erasure may be safely dispensed with.

It remains to consider an important question: when in the derivation does Tier Conflation occur? The literature on Bracket Erasure is instructive in this regard, but also inconclusive. Proposals have been made that Bracket Erasure is invoked at the end of each cycle on the subjacent one, at the end of each morphological stratum or level, or at the end of the lexicon. The problem is no different for Bracket Erasure generalized as Tier Conflation. Therefore, I shall adopt a relatively conservative strategy in the analyses that follow, avoiding the general question of when (or whether) Tier Conflation applies universally and concentrating instead on how it functions in individual analyses. At a minimum I will show that the rule at issue is not sensitive to any phonological or morphological information that Tier Conflation/Bracket Erasure would have destroyed and I will consider the rule's place in the lexical/postlexical typology. In other words, I will demonstrate that the conditions on the rule under investigation as well as adjacent rules are consistent with the proposed state of the tiers at the time the rule applies, and I will also suggest at what well-defined point in the derivation Tier Conflation has taken place. The ultimate success of this program rests, of course, on exhaustive analyses of the phonologies of these languages according to this new view of how the tiers interact.

Younes's arguments for Tier Conflation come from the cases already discussed: Tiberian Hebrew Spirantization (and a similar rule in the Ethiopian Semitic language Tigrinya (Schein (1981), Kenstowicz (1982), Steriade (1982)) and Palestinian Arabic Epenthesis. Here we shall look at a number of arguments of a different sort for Tier Conflation and for its place in the phonology, before considering the implications of Tier Conflation for the antigemination effect.

3.2. Evidence for Tier Conflation

3.2.1. Rules Applied after Tier Conflation

3.2.1.1. Moroccan Arabic. The Moroccan Arabic dialect described by Heath (1984; personal communication) has a language game that, although generally similar to the Saudi Bedouin Arabic one described in section 1, differs from it in certain crucial respects. The Moroccan Arabic game reverses the root, respecting the canonical pattern and vocalism of the input. Unlike the Saudi Arabic game, however, it treats identical consonants separated by a vowel as separate units and not as single ones, whereas those not separated by a vowel are still treated as single units for the purposes of transposition:

(44)	*Moroccan Arabic*	*Disguised Form*	
	kubb	bukk	'he poured'
	gərr	rəgg	'he confessed'
	ḥbib	bˆbiḥ	'maternal uncle'
	xmməm	mˆmməx	'he thought'

The symbol ˆ indicates a separate release of the first consonant to keep the two identical consonants separate. Heath reports that, although this pattern was typical of his principal informant, from another in a different region he obtained forms like *bḥiḥ* equivalent to those I elicited from a Saudi speaker (cf. (8)). Although all informants treated surface geminates as single units, they differed in the treatment of identical consonants separated by a vowel.

This is precisely what we would expect, given Tier Conflation and one additional assumption. Evidence for ordering the transposition language game at some particular point in the derivation will be sparse, being confined largely to data of the sort discussed here. If we suppose that different speakers in effect "guess" differently about the place of the transposition game in the lexical phonology, exactly the observed distribution will result. If Tier Conflation applies before transposition—that is, if the language game is a word-level rule—then the pattern in (44) is derived. But if transposition applies at the earliest lexical stratum, before Tier Conflation, then the language game forms are like those in (8). All informants will treat identical consonants not separated by a vowel as single units because Tier Conflation has no effect on them, but they will differ in the treatment of identical consonants with an intervening vowel depending on the relative ordering of the two operations.

3.2.1.2. Ennemor. A very different source of evidence for Tier Conflation comes from the phonology of Ennemor, an Ethiopian Semitic language. Like most such languages, Ennemor has a morphological pattern of frequentative/intensive formation that is derived historically from a [CVC$_i$VC$_i$C$_i$VC] skeleton, with spreading of the medial root consonant to all of the indexed C slots. The history of Ennemor includes a rule of degemination that wiped out the gemination, but not before the distinction between geminate and simplex consonants was encoded in their segmental make-up; some simplex consonants were spirantized. As I have argued for the related language Chaha (McCarthy (1983; forthcoming)), this distinction is captured formally by indicating values of the feature [cont] on the CV skeleton itself:

(45) *Ennemor Frequentative Skeleton*

[+cont] [−cont]
[C V C V C V C]

For a root like /fnd/, this skeleton requires Tier Conflation to produce a meaningful surface representation (vocalism is suppressed to simplify the structure):

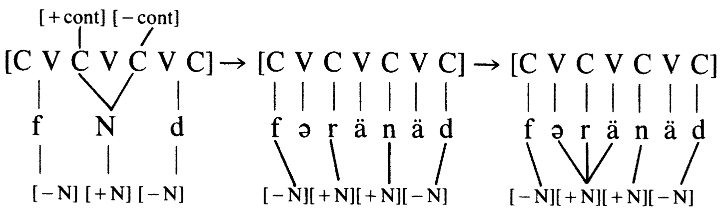
(46)
[+cont] [−cont]
[C V C V C V C] → [C V C V C V C] = fəränäd+ä
f N d   f ə r ä n ä d

'cut in many small pieces'
(cf. *fänd+ä* 'cut in half')

In this case, the conflation of the tiers not only unites the vowels and consonants but also supplies the archisegment *N* with values of the feature [cont] from another tier.

Of course, it is possible to write a complex procedure for interpreting phonological representations that would have the desired result without Tier Conflation, but a rule of nasal harmony (Hetzron and Habte (1966)) in the same language demonstrates that this is incorrect. Ennemor Nasal Harmony is triggered by nasalized *r̃*, among other segments, and it spreads bidirectionally until it encounters a nasal or oral consonant. Thus, the actual surface representation of 'cut in many small pieces' is *fə̃r̃ä̃nädä*, with a nasal domain initiated by *r̃*. Under the usual assumptions about how such harmony systems work, we need Tier Conflation to split the single root consonant *n* into two pieces: the Nasal Harmony trigger *r̃* and the opaque segment *n*. Thus, a more complete derivation of this form is that in (47):[9]

(47)



The last stage of the derivation represents the output of Nasal Harmony, a rule that spreads [+N] bidirectionally from *r̃* or any other nasalized continuant until it encounters a specified value for nasality.

3.2.1.3. Hausa Palatalization. Halle and Vergnaud (1980) have argued that autosegmental spreading is involved in the derivation of class III plurals in Hausa (as well as several other categories in this language). Representative examples appear in (48):[10]

(48) a.	bak'i	bak'aak'ee	'black (thing)'
	fari	faraaree	'white (thing)'
	wuk'a	wuk'aak'ee	'knife'
	wuri	wuraaree	'place'
b.	birni	biraanee	'(walled) city'
	jirgi	jiraagee	'boat'

Halle and Vergnaud analyze the plural forms in (48) as having the structure in (49); the vocalic melody of the affix is represented on a separate tier by the usual segregation of

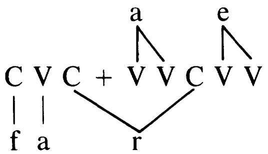
[9] Thanks to Nick Clements for help in understanding the implications of the Ennemor material.

[10] I ignore here the two irrelevant cases of class III plurals where the final consonant does not spread: when it is already geminate and when the root contains a long vowel. More detailed discussion can be found in Leben (1980) and Tuller (1981).

Tone is suppressed in the Hausa forms, since it is not relevant to the exclusively segmental issues we are dealing with.

morphemes rather than some special (Semitic) status of vowels:

(49)



The argument that these plurals are formed by spreading rather than reduplication comes from (48b). When the form ends in a cluster, there is no spreading because the C slots of the skeleton are already filled. As we will see below, palatalization in participles provides another argument for spreading over copying.

Hausa has a phonological rule palatalizing a coronal obstruent before a front vowel. This rule is responsible for the alternations in (50), all of which involve plural class III or one of the other spreading plural classes in Hausa:

(50)

	Singular	*Plural*	
	mota	motoci	'car'
	gida	gidaje	'home'
	tasa	tasoši	'bowl'

Palatalization also applies in participial forms, which are also derived by spreading the last root consonant:

(51)

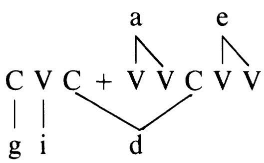
	Verb	*Participle (m.)*
	fita	fitacce
	guda	gudajje
	fasa	fasašše
	baza	bazajje

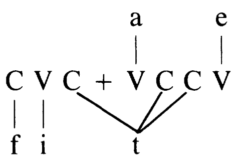
The forms in (50) show that Palatalization is interrupted by a vowel—that is, it does not apply to identical consonants, even though derived by spreading, when separated by a vowel. The data in (51) show the same thing and something else as well: Palatalization does apply to both members of a geminate.

This distribution of the facts is exactly what we would expect if Palatalization is applied after Tier Conflation. Tier Conflation folds the morphologically characterized tiers containing the affixal vocalism into the tier containing the root (vowel and consonant) melody. At that point Palatalization can apply on the melodic tier alone, affecting both members of a geminate. The following derivations demonstrate this result:

(52) a. b.

Morphology





Conflation	C V C + V V C V V	C V C + V C C V
	g i d a d e	f i t a t e
Palatalization	C V C + V V C V V	C V C + V C C V
	g i d a j e	f i t a c e

Additional data involving Palatalization are of some interest as well. Gregersen (1967) reports the recent development of participial forms (but not plurals) where Palatalization applies across the board to all surface instantiations of a spread consonant, even across a vowel. These innovative forms are in variation with those showing the pattern described above:

(53)	fašaššee	~	fasaššee	'broken'
	išaššee	~	isaššee	'sufficient'
	macaccee	~	mataccee	'dead'
	gujajjee	~	gudajjee	'run away'

Evidently the forms on the left in (53) are derived by applying Palatalization before Tier Conflation. How did this come about?

I suggest that the development of these novel forms reflects a change in Palatalization from a postlexical to a lexical rule. The original Palatalization rule in Hausa is postlexical by the criteria of Kiparsky (1982)—it is not structure-preserving because it is the sole source of palatoalveolar consonants, it applies in underived environments, since it affects coronals even before a tautomorphemic vowel, and it is exceptionless. But loanwords have introduced into Hausa many palatalized consonants in nonpalatalizing environments: *cooci* 'church', *jooji* 'judge', *firij* 'refrigerator', *wašaa* 'washer'. And loans have also produced nonpalatalized coronals before front vowels: *asibiti* 'hospital', *dozin* 'dozen', *reediyoo* 'radio'. Other sources of exceptionality in the distribution of Hausa palatoalveolars are detailed by Gregersen (1967). The upshot of these observations is that Palatalization is moving out of the postlexical category and into the lexicon. As we expect if Tier Conflation marks (at a minimum) the end of the lexicon, we begin to see cases like (53) where Palatalization applies before Tier Conflation.

3.2.2. Rules Applied before Tier Conflation. Essentially all of the lexical evidence for the OCP in section 1 involves rules applied before Tier Conflation. For example, the morphological mutation rules of Palatalization and Labialization in Chaha must precede Tier Conflation to have across-the-board effects. This is precisely what we expect of morphological operations, and it can be directly contrasted with the strictly local application of a phonological rule of palatalization in another Ethiopian Semitic language, Amharic. Similarly, the effects of the OCP on morpheme structure in Semitic and elsewhere must naturally precede Tier Conflation, since morpheme structure constraints are enforced prior to any morphological operations. These observations lead us to wonder whether any phonological rules precede Tier Conflation, an issue we shall address here and take up again in section 5.1.

3.2.2.1. Harga Oasis Arabic. An Upper Egyptian dialect spoken at the Harga Oasis is reported (Behnstedt (1980)) to have a phonological rule of Umlaut with a very interesting characteristic—it affects both copies of a spread stem vowel. This rule raises *a* to *i* or *ɨ* before *i* or *u*, respectively, applying only to stem vowels:

(54)	a.	yinzal	3rd m. sg.
		tinzili	2nd f. sg.
		tinzɨlu	2nd c. pl.
	b.	yikallam	3rd m. sg.
		tikillimi	2nd f. sg.
		tikɨllɨmu	2nd c. pl.

This rule is triggered only by the subject agreement suffixes; homophonous object agreement suffixes/clitics do not trigger Umlaut: *yidbaḥu* 'he slaughters it'.

Although the vast bulk of Arabic phonology occurs after Tier Conflation (as we shall see), this particular rule does not. It affects both copies of the single stem melody /a/ when the stem is disyllabic (longer stems do not occur), and this is no doubt related to the fact that this rule has conspicuous morphological conditions: it affects only the verbal stem vowel *a*, and it is triggered only by the subject agreement desinences.

3.2.2.2. Rotuman. We have already discussed some aspects of Rotuman phonology in considerable detail, showing that certain processes of vowel fronting affect sequences of identical vowels, understood as single units on the vocalic melody tier. It is interesting to consider how these rules and other aspects of Rotuman phonology interact with Tier Conflation.

Both *a*-Umlaut and Coalescence in Rotuman must precede Tier Conflation, since both rules affect multiply attached vowels that will be split apart when consonantal and vocalic tiers are folded together. This result is consistent with what we know of rule ordering in Rotuman; both rules fail to propagate the across-the-board effect across any morpheme boundaries, and there is considerable evidence of a more direct sort for the cyclicity of *a*-Umlaut. Recall that *a*-Umlaut applies only to a stressed vowel (and any of its sisters in the across-the-board fashion). Rotuman has two stress-determining suffixes, modificatory *ạki* and gerundial *ga*. When either or both of these suffixes appear on a form, the vowel that would have borne the stress except for the presence of the suffix still undergoes *a*-Umlaut: *pärēga* 'protection' from *päre* (Churchward (1941, 78)). This sort of effect is characteristic of cyclic rules, and it is accounted for by applying stress and then *a*-Umlaut on the first cycle, with stress (and vacuously *a*-Umlaut) reapplied on the second cycle. Since any rule that is cyclic can be expected to apply before Tier Conflation, this result is expected under the account given here.

Another consequence of the relatively early application of *a*-Umlaut is that it cannot apply across the stress-neutral affix boundary—that is, it is confined to the earliest stratum of the lexicon. Stress-neutral suffixes like *ne, te*, and *ke* cannot trigger Umlaut in a preceding stem-final *a*. I conclude, then, that Tier Conflation is not applied to the immediate output of the morphology but rather, like Bracket Erasure, it is preceded by lexical phonological rules proper to the stratum at hand.

4. Tier Conflation and Antigemination

Tier Conflation has considerable significance for antigemination effects. As I will show, syncope rules in Semitic languages respect the antigemination consequence of the OCP in a principled way, and this requires prior conflation of the vocalic and consonantal melody tiers, as well as affixal melody tiers in some cases.

4.1. Tiberian Hebrew

The language of the Tiberian recension of the Bible has been the object of intense linguistic scrutiny in recent years. The issues are made more complicated by the difficulties of interpreting the complex Tiberian system of vowel signs and accents as a phonetic record. In particular, the issue of the conditions under which orthographic schwa was pronounced is quite controversial. Since space does not permit full treatment of the philological issues here, I will simply assume what I believe to be the correct transcriptions here and deal with the textual record elsewhere (McCarthy (to appear b)).

In Tiberian Hebrew, schwa deletes in a two-sided open syllable:

(55) *Tiberian Hebrew Schwa Deletion*

$ə \rightarrow \emptyset$ / VC ____ CV

This rule, like the other syncope rules discussed here, systematically fails to apply between identical consonants, as the following contrasting columns demonstrate:

(56)	a.	zaaχrúu	'they recalled' Ju 8, 34	saaβəβúu	'they surrounded' Jos 6, 15
		yaaδʕúu	'they knew' Gn 19, 8	daaləlúu	'they hung' Is 19, 6
		ʔaaχláa	'she ate' Nu 21, 28	naaδəδáa	'she fled' Is 10, 31
		haalχúu	'they walked' Gn 14, 24	ṣaaləlúu	'they darkened' Neh 13, 19
	b.	malχê	'kings of' Gn 17, 16	harərê	'mountains of' Nu 23, 7
		qiβrê	'graves of' Je 26, 23	ʕaməmê	'people of' Neh 9, 24

In all of the forms in (56), a medial syllable has been reduced to schwa by a well-studied rule of this language (Prince (1975), McCarthy (1979), Rappaport (1984)). Only in the forms on the left, where the abutting consonants are nonidentical, is the resulting schwa deleted; it is retained between identical consonants.

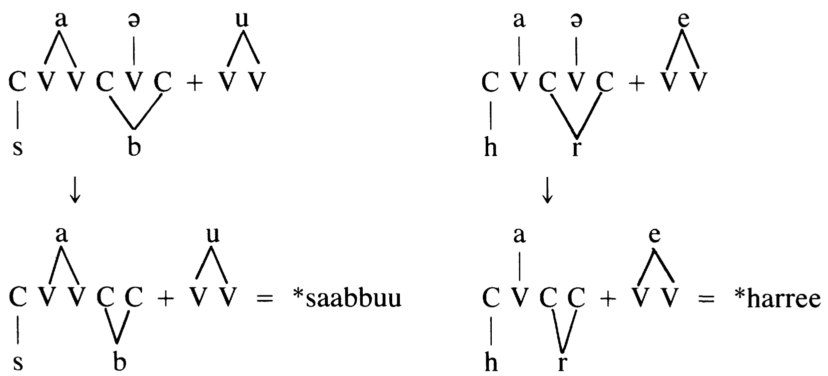
Another source of schwa in a two-sided open syllable is the combination of vowel reduction and a rule degeminating a consonant before schwa (Malone (1984, 81)). The contrast due to abutting identical consonants is seen in the following examples:

(57)	/hammәbaqqәšiim/		/ˀăhallәlekkaa/	
	hamәβaqšîm	'the seekers'	ˀăhalәlekkā	'I will praise you'
		Ex 4, 19		Ps 35, 18

And to complete the parallel with Afar or the other non-Semitic cases of antigemination, we note that heteromorphemic identical consonants do not block the syncope of schwa in Tiberian Hebrew. This circumstance arises chiefly in two classes of examples. The first is verbs in final *k* followed by the pronominal suffix *-әkaa*. The best-attested form of this type is *tәβaareχχáa* 'she will bless you' (Gn 27, 4 and more than 25 similar attestations), where schwa deletes between identical (spirantized) heteromorphemic consonants. The second class is composed of the heavily attested forms *hinnî* 'behold me' and *hinnû* 'behold us', which are derived from /hinn + enî/ by vowel reduction, degemination of *n* before the resulting schwa, and finally Schwa Deletion.

Now that we have established what the facts are (subject to the orthographic interpretation in McCarthy (to appear b)), we can turn to explaining them. Evidently, Tiberian Hebrew displays the characteristics of the antigemination effect of the OCP: failure of Deletion between tautomorphemic identical consonants versus successful application of Deletion between heteromorphemic identical consonants. Simply drawing on the same resources used in the analysis of Afar, however, leads us to the wrong conclusion. Syncope in Hebrew appears to create no violation of the OCP. To see why, consider the following partial derivations:

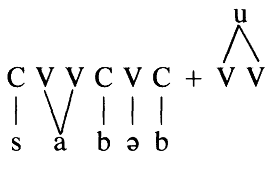
(58) a. b.



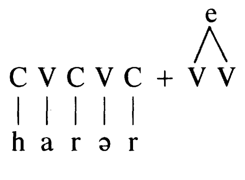
No identical consonant sequence is created by Schwa Deletion since vowels and consonants are represented on separate tiers, as required by the morphology.

The solution to this problem is evident from the discussion of Tier Conflation: if vowels and consonants are folded onto the same tier before the application of Schwa Deletion, then deletion in these cases will be blocked by the OCP. That is, after Tier Conflation the representation of these forms is formally indistinguishable from that of a language like Afar with more conventional morphological structure. In fact, then, the input to Schwa Deletion is the structures in (59), which cannot undergo this rule because of the OCP.

(59) a.

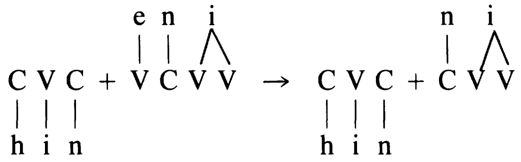


b.



The fact that Schwa Deletion does apply between heteromorphemic identical consonants in Hebrew is accounted for in exactly the same way as in Afar—the stems and the suffixes of the relevant forms are represented on separate tiers, as in the following partial derivation:

(60)



We shall see in a moment why the root and vowel tiers but not the affixal tier in (60) have been conflated.

This account of one small portion of Tiberian Hebrew phonology makes a number of quite strong and testable claims about the interaction of phonological and morphological rules. In particular, to the extent that Tier Conflation is identified with Bracket Erasure, it ought to occur at well-defined levels of the morphophonological derivation. Furthermore, there must exist an ordering consistent with the major ordering principles of lexical phonology by which Schwa Deletion interacts with other relevant rules.

One claim made by this analysis is that Schwa Deletion is a lexical rule, since it is insensitive to the root/vowel melody distinction but does have access to the stem/suffix distinction. If Schwa Deletion were postlexical, the OCP would apply to all adjoining consonants, whether tautomorphemic or not, since morphological structure cannot escape the lexicon. This claim is supported by a wide variety of independent arguments. First, Schwa Deletion is inapplicable with certain proclitic/stem combinations even if its structural description is otherwise met (Malone (1984)). Second, Schwa Deletion does not apply across word or compound boundaries. Third, as Rappaport (1984) has argued, it precedes a lexically governed rule taking *a* to *i* in a closed syllable.

On the other hand, Schwa Deletion must also be ordered late enough in the lexical derivation for conflation of the root-and-pattern morphology to a single melodic tier to have occurred. This is consistent with the way this rule applies: in all cases at issue, it is triggered by the affixation of a suffix to a stem. Thus, on the minimal assumption that nonconcatenative and suffixing morphology are separate lexical strata or cycles, the ordering of Schwa Deletion in the lexical phonology is confirmed.

The interaction of Schwa Deletion with Spirantization also provides internal confirmation for this analysis. It has long been known that Hebrew postvocalic Spirantization must precede Schwa Deletion because of the existence of forms like *malχê* from /maləkee/ with *k* spirantized before the deletion of the preceding schwa. The facts of heteromorphemic *kək* sequences, where both *k*'s spirantize before the deletion of schwa, is exactly what we expect given this ordering of rules, since ordinarily even heteromorphemic geminates do not spirantize.

A more indirect argument for the overall model concerns the interaction of these rules with a quite different one, an early phonological rule applied to verbs with identical second and third consonants in their stems (and therefore with biliteral roots). This rule is heavily lexically governed; as (61) shows, some verbs undergo it and some do not:[11]

(61)	/tamam/	/sabab/
	tamm	saabáb
	támmû	saabəbû́
	'finish'	'surround'

That is, when the final two consonants are identical, the vowel between them may be deleted (or metathesized in other cases) under lexical government, with a general tendency for stative verbs like 'finish' to undergo the deletion:

(62) *Geminate Verb Deletion*

$$\begin{array}{l} V \rightarrow \emptyset \,/\, VC \_\_\_ C \\ \qquad\qquad\qquad \alpha \end{array}$$

This deletion rule looks like a fairly clear-cut contravention of the antigemination effect, so there should be a reasonable story to tell in terms of Tier Conflation. In fact there is. Note that Deletion must be applied before Tier Conflation because of the way it is formulated. The formulation of the rule is correct—it does not apply to heteromorphemic identical consonants, so the one-to-many association of α in (62) is actually required. Furthermore, there is ample evidence that Geminate Verb Deletion is ordered extremely early in the phonological derivation. In particular, it must precede one of the earliest rules of the phonology, Main Stress Assignment, to account for the penultimate stress in *támmû*, since stress otherwise shifts rightward when a vowel is deleted. In fact, no rule of Hebrew demonstrably precedes Geminate Vowel Deletion, and there is no reason to suppose that it applies any later than the construction of the root-and-pattern mor-

[11] A general rule of final degemination later changes /tamm/ into *tam*.

phology. More detailed consideration of the cognate process in Arabic, which is much more general, appears in section 5.1.1.

4.2. Modern Hebrew

Like Biblical Hebrew, Modern Hebrew enforces an antigemination constraint on its syncope rule. There are, however, some not inconsiderable differences in the two syncope rules and they are applied in a number of different contexts, so we are in fact dealing with two distinct cases rather than a single process seen over time. My understanding of the Hebrew facts has benefited from study of Bolozky (1977; 1984).

At a very early stage of the derivation Modern Hebrew eliminates tautomorphemic geminates but allows heteromorphemic geminates to arise freely under morpheme concatenation. In forms where we would expect tautomorphemic geminates on the basis of morphological patterning, Hebrew has *e*, which we will call schwa in conformity with usage, in the middle of the geminate cluster. This schwa may be the result of vowel reduction leading to syncope, just as in Tiberian Hebrew, or it may arise by epenthesis in forms that would otherwise show a tautomorphemic geminate at underlying representation. The forms in (63a) contain examples of heteromorphemic geminates that may remain unaltered (or may undergo degemination in fast or casual speech). The contrast in (63b) is the familiar one: Schwa Deletion is blocked between identical consonants. Finally, the morphologically contrasting forms in (63c) show that schwa is inserted into tautomorphemic geminate clusters:

(63) a.	dan + nu		yašan + nu	
	'we discussed'		'we slept'	
	šavat + ti		kišat + ta	
	'I was on strike'		'you (m. sg.) decorated'	
	it + tamem			
	'he pretended naivete'			
b.	kašar	kašru	nadad	nadedu
	'he/they tied'		'he/they wandered'	
	kušar	kušra	kucec	kuceca
	'he/she was tied'		'he/she was cut'	
	hitkašer	hitkašru	titpalel	titpaleli
	'he/they contacted'		'I/thou (f.) will pray'	
c.	dabran		zalelan	
	'talkative'		'glutton'	
	zaxlan		xatetan	
	'very slow'		'meddler'	
	malxut		noxexut	
	'kingdom'		'presence'	

These three sets of facts are the basis of the analysis. First, we note that the difference between permissible heteromorphemic geminates in (63a) and impermissible tautomorphemic ones in (63c) is fundamentally to be attributed to the segregation of different morphemes on different tiers; heteromorphemic geminates are not multiply attached. Thus, at an early stage of the derivation an epenthesis rule interrupts multiply attached geminates, as in the examples in (63c):

(64) *Geminate Epenthesis*

$$\begin{array}{ccccccc} & & \text{e} & & & & \\ & & | & & & & \\ \emptyset & \rightarrow & \text{V} & / & \text{C} & \_\_ & \text{C} \\ & & & & & \alpha & \end{array}$$

On the other hand, the failure of schwa to delete between identical consonants in (63b), despite the existence of an independently motivated rule of Schwa Deletion, is a typical antigemination effect, one that we can attribute to the OCP after Tier Conflation. Thus, the structure that is input to Schwa Deletion is as follows:

(65)

$$\begin{array}{ccccccccccccccc} & & & & & & \text{u} & & & & & & & & \text{u} \\ & & & & & & | & & & & & & & & | \\ \text{C} & \text{V} & \text{C} & \text{V} & \text{C} & + & \text{V} & \not\rightarrow & {}^*\text{C} & \text{V} & \text{C} & \text{C} & + & & \text{V} \\ | & | & | & | & | & & & & | & | & | & | & & & \\ \text{r} & \text{i} & \text{n} & \text{e} & \text{n} & & & & \text{r} & \text{i} & \text{n} & \text{n} & & & \end{array}$$

Of course, the OCP blocks the output in this derivation. It also prevents deletion of the schwas inserted by rule (64); they are preserved in exactly the same way that the schwas derived by vowel reduction are.[12]

It might be thought that these various properties of Hebrew geminates could be subsumed under a single generalization without invoking the OCP, a goal that is pursued by Cole's (1973) invocation of a conspiracy. Specifically, let us suppose that the derivations of the verb forms in (63b) proceed /nadadu/ → *naddu* → *nadedu*, with the last stage accomplished by Geminate Epenthesis (64). If this is correct, then Modern Hebrew at worst contradicts the OCP (and the geminate integrity principle discussed in sections 1 and 3.1) and at best is simply irrelevant to it, since the apparent antigemination effect is accomplished by the independently motivated rule of Geminate Epenthesis.

In fact, it is possible to show that this alternative analysis is incorrect because the rule of Geminate Epenthesis is no longer in force at the level of inflectional affixation

[12] It is sometimes suggested that Modern Hebrew does not observe the prohibition on $C_1VC_1VC_2$ verbs that holds in Arabic. If this were the case, then there would be no OCP in the Modern Hebrew lexicon, much less in the phonology. The two examples of such verbs cited are *mimen* 'finance' and *mimeš* 'realize', putatively from roots /mmn/ and /mmš/. There is, however, an alternative analysis of these verbs, deriving them from roots /mn/ and /mš/ by spreading the initial consonant by a special, lexically governed association rule. This correctly predicts that there exist related verbs without the doubled initial radical: *minen* 'dispense; apportion' and *mišeš* 'feel; grope'. Bat-El (1984) has in fact shown that this special right-to-left association enjoys a mild degree of productivity in Modern Hebrew.

when vowel reduction/deletion occurs. The *n*'s at either end of the verb *natan* assimilate totally to an adjoining affixal *t*:[13]

(66)	natan	'he gave'
	yitten, *yiteten	'he will give' (< yinten)
	natatti, *natateti	'I gave' (< natanti)
	natatt, *natatet	'you (f. sg.) gave' (< natant)
	natattem, *natatetem	'you gave' (< natantem)

The geminates in the forms on the left are usually simplified in faster speech, but they can be retained and are clearly audible. The starred forms, however, are absolutely impossible—they are not even recognizable as forms of this verb.

On the assumption that total assimilation of *n* to a following *t* is expressed by a lexically restricted rule of deletion plus autosegmental spreading (McCarthy (1981a)), the output of *n*-Assimilation is the representation in (67):

(67)
```
              t   i
             / \  |
C V C V C + C V
| | | |
n a t a
```

The multiply associated *t* clearly meets the structural description of Geminate Epenthesis, yet it does not undergo it; the explanation is that Geminate Epenthesis applies only at the earliest stratum of the derivation and is no longer available at the time when inflectional affixation and *n*-Assimilation apply. A similar argument can be made from the far more general pattern of assimilation and epenthesis with roots ending in *t* or *d*.

In sum, Geminate Epenthesis is not applicable at the level of agreement marking, and therefore it cannot be appealed to as an alternative explanation of the OCP's anti-gemination effect in Hebrew. This restriction on the domain of Geminate Epenthesis, a rule that breaks up geminates, is not surprising—as I noted in section 3.1, epenthesis rules applied after Tier Conflation cannot break up tautomorphemic geminates even in Semitic. But as long as vowels and consonants are on different tiers—as they are at the early stage where Geminate Epenthesis applies—no problem arises and Epenthesis may apply freely. This sort of rule interaction is precisely what we expect from the operation of Tier Conflation.

4.3. Modern Arabic Dialects

Syncope in the Arabic dialect spoken in Iraq is ordinarily applicable in any circumstance that does not yield an unsyllabifiable consonant. This means, given the syllable canons of this language, that Syncope can apply either in a two-sided open syllable or in an open syllable preceded by a geminate. The latter circumstance is permissible because the language's independently motivated rule of syllable-final degemination then applies

[13] Thanks to Nirit Kadmon for confirming these data.

to eliminate the unsyllabified consonant. I shall express these conditions in a somewhat ad hoc way, since the obvious syllabic conditions are not my concern here:

(68) *Iraqi Arabic Syncope*

$V \rightarrow \emptyset \, / \, V(C_i)C_i \_\_\_ CV$

Like the other languages discussed here, Iraqi Arabic cannot delete a vowel between identical consonants; contrast the forms in (69a) and (69b):[14]

(69) a.	šaʕar	'hair'	šaʕrak	'your hair'
	ykassir	'he breaks'	ykasruun	'they break'
	xaabar	'he telephoned'	xaabrat	'she telephoned'
b.	yɣaddid	'he limits'	yɣaddiduun	'they limit'
	mʔaθθaθ	'furnished'	mʔaθθiθa	'furnished (f. sg.)'
	ḥaajaj	'he argued'	ḥaajijat	'she argued'
	mḥaadid	'bordering (m.)'	mḥaadida	'bordering (f.)'

The raising of *a* to *i* is regular in an open syllable; it may precede the application of Syncope, although no evidence bears on this question. So far as I know, heteromorphemic identical consonants that also meet the structural conditions of Syncope are not attested in Iraqi Arabic, so we cannot test that particular aspect of the antigemination effect.

As Erwin (1963) points out, the antigemination condition on Syncope is otherwise puzzling. It cannot be explained by a general prohibition against geminates, which abound in the language both intra- and intermorphemically. Thus, the OCP must again be implicated here, with Syncope applied to the output of Tier Conflation. Similar facts hold in Tunisian Arabic (Wise (1983)).

Phenomena of roughly the same sort can be found in the Damascene dialect. In this dialect Syncope applies to any schwa (which may be the result of reducing a nonlow vowel) in an open syllable:

(70) *Damascene Syncope*

$ə \rightarrow \emptyset \, / \_\_\_ CV$

Like Iraqi Arabic, Damascene exhibits the familiar contrast brought on by identical consonants:

(71) a.	btəskon	'you dwell'	btəskni	'you (f. sg.) dwell'
	bisaaʕed	'he helps'	bisaaʕdu	'they help'
b.	bisabbeb	'he causes'	bisabbəbu	'they cause'
	taxaṣṣoṣ	'specialization'	taxaṣṣəṣak	'thy (m.) specialization'
	biḥaažež	'he argues with'	biḥaažəžu	'they argue with'

[14] Erwin (1963) reports some variability in the adjectival forms, with *mitraaṣiṣ* 'crowded together' showing up sometimes in the feminine as *mitraaṣṣa* rather than the expected *mitraaṣiṣa*. It is difficult to know what to make of this variation, although it seems to be paralleled by some sort of metathesis effect in another class of forms: *mxarbuṭ* 'having mixed up' has feminines *mxarbuṭa* ~ *mxarubṭa*. Similar difficulties arise in the Tunisian Arabic data discussed by Wise (1983).

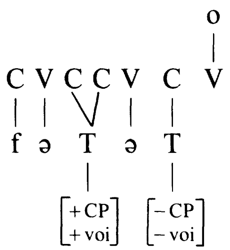
This much is familiar, but an added twist to the Damascene facts is very revealing. Syncope is also blocked by adjoining heteromorphemic consonants that are merely similar, differing in voicing and/or pharyngealization:

(72)	madd + et	'she stretched'	maddəto	'she stretched it'
	ḥaṭṭ + et	'she put'	ḥaṭṭəto	'she put it'
	fəḍḍ + et	'silver of'	fəḍḍəto	'your (f. sg.) silver'

The fact that the antigemination effect holds for heteromorphemic consonants in these examples is a consequence of the conflation of all tiers, including those containing suffixes, as I will explain in the following section. Our concern at the moment is with the fact that strict identity of the adjoining consonants is not required for antigemination to be in force.

The explanation for this phenomenon is well within the purview of the OCP, providing we make one auxiliary assumption. First, we should note that the limitation of this aspect of the antigemination effect to heteromorphemic consonants is not directly relevant; the Arabic root canons are such that no root could exist that had adjacent consonants differing only in voicing and/or pharyngealization. Second, that only coronal consonants happen to be involved follows from the fact that *t* is the only consonant occurring in the suffixes that would display this alternation. Cowell's (1964) intuition as to why deletion is prohibited in the cases in (72) is valuable; he points out that voicing and pharyngealization are the properties with respect to which the cluster resulting from deletion would assimilate by independently motivated rules of the language. Under the assumption that all assimilation is autosegmental spreading, we can put this intuition to work. Since voicing and pharyngealization assimilate, the features underlying them—[voice] and [constricted pharynx] ([CP])—must be represented on a separate autosegmental tier from the rest of the phonemic melody. From this it further follows that OCP effects on vowel syncope will be modulo differences in the values of these two features—they do not count for identity because they have been segregated onto a separate tier:

(73)



Here the *T*'s indicate segments unspecified for the assimilating features, and they are obviously identical in this case.

This account of assimilating features and consonant identity enjoys some independent support from a different rule in the Tunisian Arabic dialect. According to Wise (1983), some speakers of Tunisian Arabic—call them dialect B speakers—apply a further rule to the dialect A pattern in (74):

(74)	*Underlying*	*Dialect A*	*Dialect B*	
	/sibt + it + i/	sibtiti	sibitti	'my belt'
	/rabṭ + it + i/	rabṭiti	rabiṭṭi	'my knot'

The dialect B pattern deletes a vowel between heteromorphemic identical consonants, with the deletion limited to stems CVCC ending in *t* or *ṭ* followed by the feminine suffix *it*. The property of interest here is that this rule, whatever it is, treats *t* and *ṭ* as a class under some condition of identity with the *t* of the suffix. Again, the relevant segments are identical modulo the assimilating feature [CP].

These considerations of partial identity are of some interest, since, like the antigemination facts, they represent the antithesis of the behavior of adjacent segments. Just as tautomorphemic geminates resist separation by epenthesis or other means, so it has been observed (Tuller (1981), Steriade (1982), Hayes (1985)) that certain homorganic clusters show the same property. The antigemination effect, I claim, applies in a principled way to pairs of consonants that differ only in features that regularly assimilate. This suggests an interesting convergence of these two distinct lines of investigation.

4.4. Yup'ik Eskimo

The final case of antigemination under the OCP is the Central Yup'ik dialect of Alaskan Eskimo. This language has a phonological rule deleting schwa in a two-sided open syllable (Reed et al. (1977), Woodbury (1982), Miyaoka (1971)):

(75) a. *Yup'ik Syncope*

$ə \rightarrow \emptyset$ / VC ____CV

b.			
kəməni	→	kəmni	'his own flesh'
qatəgak	→	qatgak	'upper torso'
avəgȧ	→	avga	'its half'

When the consonants on both sides of the potential deletion site are identical, Syncope is blocked in a way that is by now familiar. Instead, the consonant following the schwa geminates, rendering the syllable closed:[15]

(76)				
	atətəŋ	→	atəttəŋ	'their own names'
	kəməmi	→	kəməmmi	'of his own flesh'
	naŋtəqəqapixtuq	→	naŋtəqəqqapixtuq	'he is very sick'

[15] Discussions of the antigemination condition on Syncope in Yup'ik usually consider it on a par with the failure of Syncope in the following sequences as well: *γ̇əγ, cən, təc, cət*. There is a difference, however, between the antigemination condition on Syncope and the prohibition of these clusters. The former is restricted to the rule of Syncope, whereas the latter holds throughout the language—such clusters cannot occur at all, from any source. They are, then, irrelevant to the issues discussed here.

I am indebted to Tony Woodbury for his considerable help with the Eskimo data. My use of the material is, of course, my responsibility.

The complementarity between deletion and gemination is not unexpected—in another dialect, that of Norton Sound, there is gemination in all cases. The basic observation is that schwa may not occur in a stressed open syllable, and either gemination or deletion produces that result. Thus, in Central Yup'ik, gemination applies in only those forms where Syncope fails because of the OCP.

Since Yup'ik shows no resistance to hetero- or tautomorphemic geminates at underlying or surface representation, it provides yet another clear case of the OCP blocking Syncope. What distinguishes Yup'ik from languages like Afar or Tonkawa is that the antigemination condition is enforced in Yup'ik regardless of whether the consonants are contained in the same morpheme or not. This difference is attributable to the Tier Conflation operation and to the status of the syncope rules in the respective languages, as I will now show.

The syncope rules in Afar and Tonkawa have the character of rather remote morphophonemic processes. In Tonkawa, Syncope bears various conditions limiting its domain to the stem and, so far as I know, no phonological rules demonstrably precede it. In Afar, there are direct ordering arguments, given by Bliese (1981, 213), demonstrating that Syncope is quite early. Afar Syncope is bounded by proclitic and compound junctures (77a), it must precede a (postlexical) rule that destresses the second of two adjacent stressed syllables (77b), and it is preceded only by Afar's (cyclic) rule by which the rightmost stress wins (cf. (29)):

(77) a. ma#t+akuma → matakma, *matkuma 'you don't eat'
daro-h-ata → *darhata, *darohta 'weevil'
b. daró##ubulé → daró##ublé → daróblé → daróble 'I saw grain'

In contrast, Yup'ik Syncope is a very late phonological rule. It is demonstrably very close to the last rule in the phonological derivation (Woodbury (1984)). It is in all respects indifferent to morphological information.

This distinction between two rule types can readily be identified with Kiparsky's (1982) distinction between lexical and postlexical phonological rules, although this is not essential to the analysis. Rules sensitive to morphological information and ordered early, even if not demonstrably cyclic, are applied in the lexicon. Afar and Tonkawa Syncope are instances of these. Yup'ik Syncope, on the other hand, is quite clearly postlexical.

Integrating these observations with Tier Conflation, we now see how it is that languages can differ in the apparent morphological sensitivity of the OCP. If Tier Conflation, like Bracket Erasure, prevents morphological information from escaping the lexicon, then we expect postlexical rules like Yup'ik Syncope to be systematically indifferent to whether the adjoining consonants are tautomorphemic or not. In other words, in Yup'ik Tier Conflation folds all morphemes onto one tier before Schwa Deletion applies, so the OCP effect is indifferent to morphological constituency. This is in fact the case. Lexical rules, like Afar or Tonkawa Syncope, ought instead to differ in this regard, or at least to show some morphological sensitivity, depending on whether Bracket Erasure (and consequently Tier Conflation) is applied cyclically, at the end of each level, or only at the end of the lexicon. The rules at issue are not sufficiently subtle measures to settle this last issue, which is in any case a quite separate one, since they invariably distinguish between hetero- and tautomorphemic cases.

The clinching argument comes from comparing the general Central Yup'ik pattern above with the treatment of schwas in the Hooper Bay Chevak dialect described by Woodbury (1982). In Chevak the speech of young people sometimes conforms to the general Yup'ik pattern, but the more usual situation is for schwa to delete freely even when adjoined by identical consonants:

(78)	ənəni	→	ənni	'house'
	maliiɣutətuləmni	→	maliiɣuttuləmni	'when I always tagged along'
	atətuluutəŋ	→	attuluutəŋ	'they always putting on'

The result of deleting schwa between identical consonants in no case merges with a true, one-to-many geminate. Rather, the cluster of identical consonants is produced with a medial release that, in sonorant environments, is a full-fledged vowel. In this respect, the geminate clusters derived by Syncope are indistinguishable from all other clusters in the language in a similar prosodic environment. In no case does the derived cluster merge with a true geminate.

How can we reconcile what appears to be an interdialectal difference in the antigemination effect? The answer lies in considering the morphological context of syncope of schwa between identical consonants. In all cases the syncope happens between morphemes that are part of the productive morphology—it never occurs either morpheme-internally or across morphemes that are lexicalized. Although in the general Yup'ik pattern Syncope is postlexical, in Chevak it applies in the last lexical stratum, the one that incorporates the so-called internal syntax of productive morphology. When Syncope applies in general Yup'ik, all morphemes have been conflated to a single tier, so the antigemination effect of the OCP is in full force. In Chevak, on the other hand, applications of Syncope see productively derived heteromorphemic sequences on separate tiers, and so in that context antigemination is regularly suspended. This distinction in the domain of Syncope in the two dialects is consistent with their overall properties, but it cannot as yet be independently motivated.

The upshot is that rule typology largely derives the interlinguistic differences observed here, a conclusion that is supported in subsequent discussion of apparent violations of the antigemination effect of the OCP.

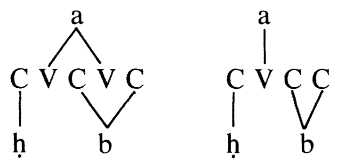
5. Apparent Lapses of Antigemination

5.1. Rules Applying before Tier Conflation

The theory developed up to this point predicts that, at least in principle, there ought to exist rules of syncope that are immune to the OCP antigemination effect. Such rules can arise in a language with Semitic-like structure (vowels and consonants on separate tiers) providing that they apply relatively early in the derivation, before Tier Conflation. In those circumstances, a syncope rule can create a tautomorphemic geminate consonant without triggering an OCP violation; the result is indistinguishable from a tautomorphemic geminate in underlying structure. Two such rules are known to me: the class of phenomena involving metathesis and syncope between identical consonants throughout Arabic and Northwest Semitic, and the syncope rule in the East Semitic language Akkadian.

5.1.1. Semitic Metathesis. In Classical Arabic, all modern Arabic dialects, and all Northwest Semitic languages like Tiberian Hebrew or the various Aramaic languages, verbs whose last two root consonants are identical have somewhat different paradigms from normal triliteral verbs. Recall that a verb like *ḥabab* 'love' is derived from a root /ḥb/ by spreading of the final root consonant. Thus, the underlying structure of such a verb is as shown in (79a), whereas deletion of the second vowel before Tier Conflation would produce a structure like (79b):

(79) a. b.



The configuration in (79b) does not violate the OCP, so a derivation of this sort ought to be possible. In fact, such a rule exists and it is demonstrably ordered at a suitably early point in the derivation.

Let us examine two languages displaying this rule, Classical Arabic and Egyptian Arabic, since the facts are well understood and since they cover the range of variation that the languages display. In Egyptian Arabic we find the differences between /ḥb/ and the ordinary triliteral root /ktb/ shown in (80):

(80)	katab	ḥabb	3rd m. sg. perfective
	katabt	ḥabbeet	1st, 2nd m. sg. perfective
	katabu	ḥabbu	3rd pl. perfective
	yiktib	yiḥibb	3rd m. sg. imperfective
	tiktibi	tiḥibbi	2nd f. sg. imperfective

With all investigators, I assume that the pattern on the left in (80) is the normal one, and that the verbs on the right are derived from more abstract representations in which the two identical consonants are not contiguous: /ḥabab/, /ḥbib/. There are good reasons to believe, however, that the rule responsible for this alternation is a rule of allomorphy rather than part of the phonology. First, the forms with consonant-initial suffixes show a linking vowel *-ee-* after the stem. This is not some automatic result of epenthesis, however; Egyptian Arabic epenthesizes *i*, and so far as I know no language has epenthetic long vowels. (This linking vowel is generally taken to be the result of analogy with verbs whose third root consonant was *y*, like *rameet* 'I threw'.) Second, no phonological rule can be shown to precede this rule, and a considerable number of phonological rules must follow it. These ordering properties are exactly what we expect of a rule of allomorphy or a very early phonological rule.

Therefore, we will say that there are two allomorphs of the verb from the root /ḥb/—*ḥVbbee* prevocalically and *ḥVbb* otherwise—which are created by a morpholexical rule at the earliest level of the phonology. This rule is an operation on CV skeleta only:

(81) $$[\mathrm{C}\ (\mathrm{V})\ \underbrace{\mathrm{C}\ \mathrm{V}\ \mathrm{C}}_{\alpha}] \rightarrow [\mathrm{C}\ \mathrm{V}\ \mathrm{C}\ \mathrm{C}] \pm \mathrm{ee}$$

The deletion operation in (81) could equally well be formulated as it is in the cognate rule (62); the point is that such rules specifically apply only to create tautomorphemic geminates.

The alternations are somewhat different in Classical Arabic, but several facts point to the same conclusion. Consider the Classical forms for the roots /ktb/ and /md/ 'measure':

(82)	katabu	maddu	3rd pl. perfective
	katabtu	madadtu	1st sg. perfective
	yaktubu	yamuddu	3rd m. sg. imperfective
	yaktubna	yamdudna	3rd f. pl. imperfective

This rule has often been taken to be phonological (Brame (1970)), and it can be formulated in a straightforward way (6) that is not in conflict with what we know about the formal properties of phonological rules. Nevertheless, certain aspects of this process point to its very early ordering. First, it is sensitive to the difference between hetero- and tautomorphemic identical consonants; this is indicated by the formulation of rule (6), a formulation that clearly presupposes that root and vowel melody tiers have not yet been conflated. Second, the rule has many exceptions, some of them showing consistent lexical characteristics. Verbs describing colors or bodily defects in the first binyan do not undergo this rule, and some other stative verbs (like *ḍabib* 'abound in lizards') are systematic exceptions as well. Exceptionality depending on lexical or morphological class membership is an obvious characteristic of morpholexical or early phonological rules. Third, as with the Egyptian Arabic rule, no phonological rule demonstrably precedes this Classical Arabic one. Fourth, the most compelling evidence is that it must precede at least some morphological rules. The formation of plural nouns by infixation is a well-understood characteristic of Classical Arabic: it is essentially universal in nouns of four consonants, like *madras+at* 'school'; plural *madaaris*. Nouns of this type whose last two consonants are identical undergo the metathesis/syncope rule, so their surface forms are *midaqq+at* 'pestle' or *milaff* 'reel'. Of these, about half show the expected infixed plural with subsequent metathesis (*madaaqq*), but the other half have suffixing plurals (*milaff+aat*) and do not undergo infixing pluralization. The correct analysis of this otherwise anomalous second class requires that these nouns have already assumed the CVCVC_iC_i pattern at the time pluralization applies. Thus, metathesis/syncope must precede pluralization. Furthermore, metathesis precedes the formation of the jussive mood. Jussives are derived from corresponding indicative imperfectives by truncating the final vowel *u*. The jussive of *yamuddu* is *yamudd* (with a final "euphonic" vowel), showing that metathesis, which is sensitive to the presence of the final vowel, must have already applied before the morphological truncation rule.

In sum, the metathesis rules in various Semitic languages not only are consistent with application before Tier Conflation but in fact require it, since they apply subject to the one-to-many melody-to-skeleton mapping that obtains only before Tier Conflation has applied. These metathesis rules are all ordered at the beginning of the phonology or earlier, and are therefore consistent as well with the idea that Tier Conflation is applied at each stratum of a lexical derivation.

5.1.2. Akkadian Syncope. A more challenging but also more interesting case of syncope that creates geminates is presented by the Semitic language Akkadian. The situation I describe obtains in the Old Babylonian dialect, but in general outlines it holds for Assyrian and for other eras in this language as well.

Akkadian has a familiar rule deleting any vowel in a two-sided open syllable (83a). Examples of adjacent heterogeneous and identical consonants appear in (83b) and (83c):

(83) a. *Akkadian Syncope*

$V \rightarrow \emptyset$ / VC __ CV

b.	damiqat	→	damqat	'she is good'
	lemunu	→	lemnu	'he is bad (subjunctive)'
	rapašum	→	rapšum	'wide (m. nom. sg.)'
c.	dububii	→	dubbii	'speak! (f. sg.)'
	šakikat	→	šakkat	'it (f.) was harrowed'
	iššalilu	→	iššallu	'he was led forth'

There is no doubt that the OCP is in force in the Akkadian lexicon; this language is subject to exactly the same root structure constraints as Arabic. Furthermore, we cannot appeal to the idea that Syncope in Akkadian is a rule of phonetic implementation (as described in section 5.2) because it never applies across word boundary (except in compounded proper names or other fixed expressions), it is apparently not optional, and it is often suppressed in loans and systematically in one suffix.

There is, however, reason to believe that this rule is instead a relatively early one, although clearly phonological. A rigorous demonstration of this is quite lengthy (McCarthy (ms.; forthcoming)), but I can at least make some suggestive remarks here. It has long been known that Syncope in Akkadian is involved not only in the word-level alternations in (83) but also in stem-level ones, involving the affixes that form the various derived binyanim of the verb. Compare the imperatives and participles for different derived forms of the citation root *prs* 'decide':

(84)

Binyan	*Imperative*	*Participle*
Gt	pitras	muptarsum
Š	šupris	mušaprisum
Št	šutapris	muštaprisum

The Gt is a mediopassive of the underived form (Grundform) of the verb; the Št is the mediopassive of the causative Š. Even casual inspection of these data reveals the pervasive influence of Syncope; there are vowel-zero alternations across the stem. In fact, we can set up underlying stem forms /pitaras/, /šutaparis/, and /naparis/, and derive the surface forms from them by Syncope. These are composed of a basic root-containing stem /pVrVs/ and three affixes: prefixes /šV/ and /nV/ and infix /tV/.

The mode of application of Syncope is what concerns us, so we first note that this rule may apply at several foci in the same form. Left-to-right iteration of a word-level syncope rule has initial plausibility, but it is easily dismissed. Consider the pattern of vowel deletion in the Š form *mušaprisum* from /mušaparisum/. With a left-to-right iterative Syncope rule insensitive to morphological structure, this underlying representation would be expected to yield surface **mušparsum*. Right-to-left iteration produces the same incorrect result, but cyclic application of Syncope is successful:

(85)

Stem formation	paris
Syncope	DNA
Š prefixation	šaparis
Syncope	šapris
Prefixation	mušapris
Syncope	DNA
Suffixation	mušaprisum
Syncope	DNA

The order of morphological operations in this derivation is easy to justify; after initial formation of the stem by autosegmental association, the causative morphology and then participial morphology are added. The final stage adds the nominative case-marking suffix *-um*.

What we have, then, is a rule that must apply cyclically, something that is clearly not true of the Semitic syncope rules that respect the OCP. Cyclic Syncope in Akkadian is different, and therefore it plausibly sees stem forms before they undergo Tier Conflation. Thus, Akkadian Syncope is insensitive to the OCP antigemination effect, since no violation of the OCP is created.

5.2. Phonetic Implementation Rules

Just as the very earliest rules in Semitic languages do not show the antigemination effect, so too do the very latest rules in any language. Rules of phonetic implementation, distinguished from phonological rules by their gradient effect, their variability, their dependence on speech rate, and their lack of interaction with the phonology, create what appear to be geminates but in fact are not, at least of the phonological sort. The evidence for this claim and the reasons behind this apparent exemption of phonetic implementation rules from the OCP are of some interest, so we shall consider them in detail.[16]

Table 1 lists a number of apparent syncope rules that may create geminates, along with details of their formulation.[17]

These observations are not exactly equivalent cross-linguistically; we have considerably more detailed information on some languages. Nevertheless, some fairly robust generalizations emerge. First, all known rules deleting a vowel between tautomorphemic identical consonants are optional under some conditions, and nearly all are reported to be dependent on speech rate or style, with deletion occurring only in the more casual or reduced register. Second, these rules typically are not structure-preserving; as in English, they create configurations that are not possible in the lexicon. Third, the cluster resulting from syncope has properties that ordinary geminate clusters—hetero- or tautomorphemic—do not have in these languages. The first of the two identical consonants does not become the coda of the preceding syllable after schwa deletion; resyllabification is suspended.[18] Rules of degemination do not apply to this configuration either. These effects are, in themselves, quite remarkable, since they mean that the putative geminate clusters derived by syncope do not merge with other geminates, even though we usually find that languages make no phonetic distinction between hetero- and tautomorphemic geminates, despite their different melodic representation. Fourth, the rules often have gradient effects, eating up more of the vowel at faster speech rates rather than obliterating it categorially. Finally, in the Japanese case, where instrumental phonetic data are available, we see that low-level coarticulatory processes must precede syncope.

I suggest that we identify this constellation of properties with rules of phonetic implementation (Liberman and Pierrehumbert (1984)) and that all instances of syncope of a vowel between tautomorphemic identical consonants are consequences of phonetic implementation rules rather than phonological rules. Why should rules of phonetic implementation be exempt from the antigemination effect of the OCP? There are two possible answers that come from very different views of rule typology. If phonetic implementation rules are formally largely homogeneous with phonological rules, then we can understand the phonetic version of syncope as a rule deleting a skeletal element only,

[16] I am greatly indebted to Mark Liberman and Janet Pierrehumbert for their assistance in formulating the results of this section.

[17] It is likely that syncope in Moroccan Arabic is of the same character—for example, it is gradient depending on the consonantal context—but other details are not available.

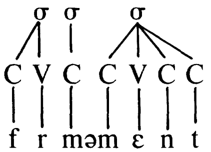
[18] English speakers who are dubious about the suspension of resyllabification may wish to conduct a small experiment. Performing the word *firmament* in front of the mirror at successively faster speech rates will eventually yield a production where the lips do not open during the medial *mam;* at that point the vowel is gone. Nevertheless, the form remains clearly trisyllabic with a syllabic *m*. In no case will this form merge with the initial-stressed noun *ferment*.

Table 1
Apparent Syncope Rules

Language	Odawa (Piggott (1985, 138))	
Examples	tatanisi-w → ttanisi 'he stays for a while'	
	sisiikkisi-w → ssiikkisi 'he is the older/oldest'	
	kikikkaa → kkikkaa 'you (sg.) are old'	
Remarks	A general rule reduces unstressed vowels to schwa, and under poorly understood conditions (sometimes optionally) schwa is further reduced to zero.	
Language	Modern Hebrew (Bolozky (1977; 1984))	
Examples	nadedu → naddu	
	rinenu → rinnu	
Remarks	Occurs only at speech rates greater than those required for creation of other lexically impermissible clusters. Resulting geminate is neither simplified (although geminate simplification is typical of fast speech) nor resyllabified.	
Language	English	
Examples	allelism	baroreceptor
	canoness	canonist
	holily	oilily
	sillily	synonym
	firmament	
Remarks	Only in very fast speech. Resulting geminate is not submitted to geminate simplification or resyllabification.	
Language	Japanese	
Examples	kiku → kku 'chrysanthemum'	
	susumu → ssumu 'given name'	
Remarks	Vowels are optionally deleted (via devoicing) adjacent to voiceless consonants and word boundary. Quality of deleted vowel is recoverable from spectral energy distribution of preceding consonant (Beckman and Shoji (1984)).	

leaving the associated melodic element stranded. For the reduced pronunciation of *firmament,* this yields the representation in (86):

(86)



This accounts for the apparent surface OCP violations—there is no violation of the OCP in this structure. But it fails to explain many of the other characteristics of such rules, their gradient character and failure to induce resyllabification in particular.

The alternative is to take seriously the idea that phonology and phonetic implementation are separate components with distinct vocabulary and formal properties. This is, in fact, Liberman and Pierrehumbert's tack, and they propose that phonetic implementation consists of rules for interpreting (rather than transforming) the output of the phonology. Under this strictly modular way of looking at things, "syncope" in phonetic implementation is not deletion at all, but rather a failure to interpret the phonological symbol V by producing sufficient opening in the oral vocal tract. The fact that resyllabification and degemination, for example, do not apply to the output of this "syncope" follows completely automatically, since nothing has changed in the representation. This, of course, explains as well why the OCP is apparently no longer in force—the unchanged representation conforms to the OCP even though the phonetic interpretation does not express a particular vowel articulatorily.[19]

Similar considerations of rule typology also suggest an account of the occasional paradoxical cases of rules that violate principles of geminate integrity. For example, Southern Paiute vowel devoicing is known to affect only one mora of a long vowel (Sapir (1930)), contrary to what we might predict. Rather than say that vowels in Southern Paiute are exempt from the OCP (it is certainly enforced in consonants), we should consider what sort of rule vowel devoicing is. It creates a segment type that is impossible in Southern Paiute underlying representations and arguably in those of every other lan-

[19] One could imagine an alternative, phonetic interpretation of the antigemination effect, as an anonymous reviewer has suggested to me. The underlying premise is that gestures by the same articulator are difficult to produce if they follow too quickly on one another. It follows from this that languages should avoid shortening vowels adjoined by identical consonants. This articulatory principle would then affect vowel reduction rules as they entered a language, suppressing them when the adjoining consonants are too similar, and this result would be inherited by the phonologized syncope rule that eventually emerged.

There are strong reasons to dismiss this hypothesis. First, the putative articulatory phonetic principle underlying it is surely wrong. Kupin (1982) observes that alliterative tongue twisters—like *Peter Piper* . . .— are not especially difficult, whereas tongue twisters involving consonants of similar manner and different point of articulation—like *She sells sea shells* . . .—are extraordinarily challenging. The articulatory load is minimal from repeating exactly the same gesture. Second, this phonetic account predicts that the antigemination effect should be just as robust with homorganic nonidentical segments as with identical ones, since the same articulator is involved. This is false; the only cases where nonidentical segments exhibit antigemination are those in which the segments differ only in an assimilating feature, as discussed in section 4.3. Third, the phonetic account of antigemination is completely at odds with the observations of this section—that phonetic implementation rules specifically are not subject to the antigemination condition.

guage as well. If a rule creates a distinction no language exploits lexically, then surely it is part of phonetic implementation. Phonetic implementation rules, conceived of interpretively rather than generatively, will not necessarily be sensitive to geminate integrity.[20]

6. Remaining Issues and Assessment

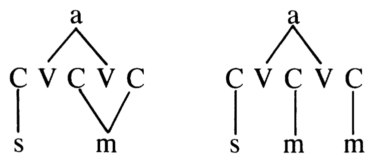
6.1. The Independence and Universality of the OCP

Up to this point, the investigation has been conducted under two assumptions: that the OCP is an independent principle of phonological organization applying to lexical representations and lexically derived forms, and that the OCP is observed without exception cross-linguistically, at least in the nontonal domain. Neither of these assumptions is obviously correct, although the evidence introduced to this point is certainly germane to the issue. I will now treat each of these points in some detail, marshaling arguments provided by material already considered as well as other factors.

It is sometimes suggested that the OCP is an epiphenomenon derivable from the evaluation metric or Occam's razor, and not an independent principle of linguistic theory.[21] This view, I maintain, reflects implicit assumptions about the role of "simplicity" in phonological representations that the OCP merely makes explicit.

Let us begin with Occam's razor, a principle of linguistic (and scientific) metatheory. The OCP, presented with the data of Arabic, selects the lexical representation for *samam* in (87a) and rejects the one in (87b):

(87) a. b.



Occam's razor would tell us not to make a distinction between these two objects in Arabic without evidence, but it would not tell us which of them the grammar actually contains. There is certainly no way in which (87a) is simpler in a general, nonlinguistic sense than (87b)—the latter uses more ink, but the former uses more structure. Moreover, a psychological interpretation of Occam's razor would lead us to the wrong conclusion—the grammar should contain (87b), where the phonological representation is much closer to what language learners actually observe. In other words, from this view-

[20] I am indebted to John Kingston for discussion of this point. Kingston has observed that epenthesis into geminate sonorants in Klamath, another possible problem for geminate integrity, also bears the stigmata of a phonetic implementation rule.

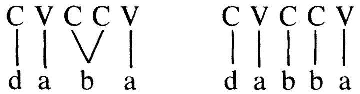
[21] The Occam's razor position is argued for in Odden (1984); the evaluation metric view, although it has not appeared in print, seems to be widely held. Thanks to Donca Steriade for several interesting challenges on the ideas behind this section.

point the OCP is actually the opposite of Occam's razor, since it introduces complexity into the phonological/phonetic mapping that may be unsupported by direct evidence.

Deriving the OCP from the evaluation metric runs into equally serious conceptual problems. Familiarity with the term "evaluation metric" has led to rather loose use of it—we forget that several very different, specific hypotheses have gone under this name. I assume, however, that the evaluation metric intended to derive the OCP is the one defined in Chomsky and Halle (1968), where the value of a grammar is inversely related to the number of nonredundant symbols (= features) in its rules and lexicon. Granted, counting phonological features alone gives us the same result for (87a) and (87b) as the OCP (although as a preference rather than an absolute prohibition), but this is a perversion of Chomsky and Halle's original intention. They are at pains to point out (1968, 340) that the evaluation metric they propose does not incorporate some theory-independent notion of simplicity but rather is embedded within their whole apparatus of notational conventions and phonological representations. It makes little sense to take it over whole into a theory with very different representations. For example, the old evaluation metric also says that arbitrary manipulations of association lines by rules would not complicate grammars, since they involve no features, and contour tones or segments would be no less highly valued than comparable sequences. The representations in (87a) and (87b) involve a trade-off between structural complexity in the former and "orthographic" complexity in the latter. The structural complexity of (87a) exacts its cost in complicating the grammar—(87a) requires a spreading rule that is unnecessary in (87b) (if spreading is rule-governed, as in Pulleyblank (1984))—whereas most of the apparent complication in (87b) is redundant, given independently necessary constraints on the distribution of homorganic root consonants.

This problem for deriving the OCP from a feature-counting evaluation metric is most clear in languages that—unlike Semitic—do not have CV skeleta provided independently by the morphology. In any such language that makes a contrast between tautomorphemic geminates and simplex segments, although the OCP reduces the number of features needed in the lexical entries of phonemic melodies, it actually complicates the lexical entries for CV skeleta and corresponding rules of association. To see why this is so, consider the hypothetical representations from such a language in (88), the first of which respects the OCP and the second of which does not:

(88) a. b.



In general, a language with the configuration in (88b) could invariably project the CV skeleton from the phonemic melody, all other things being equal; thus, the CV skeleton would exact no cost in evaluating the lexicon since it would be purely redundant information. But a language obeying the OCP, with structures (88a), must in general stipulate the number of positions in the CV skeleton of the lexical entry for each morpheme, since by hypothesis we cannot know whether a particular segment is geminate or not from the phonemic melody alone. In other words, for the apparent simplification of phonemic melodies achieved under the OCP there is a corresponding and equal complication of the information residing in the CV skeleton and the association between phonemic melody and skeleton. Since the feature-counting evaluation metric (under any version proposed) behooves us to measure the complexity of entire grammars rather than individual pieces of them, no overall savings in features or in stipulations is achieved by adopting representations like (88a). Thus, the OCP cannot be derived from minimization of features.

I conclude, then, that the machinery available for evaluating the simplicity of scientific theories or of grammars is insufficient to derive the OCP. Of course, we might propose that the evaluation metric be modified to include a clause like (89):

(89) Grammars are highly valued to the extent that they use

$$\begin{array}{c} X\ X \\ \bigvee \\ \alpha \end{array} \text{ instead of } \begin{array}{cc} X & X \\ | & | \\ \alpha & \alpha \end{array}.$$

This, of course, is nothing but a restatement of the OCP as a principle of markedness, since an evaluation metric is presumed to express our conclusions about the relative markedness of grammars as opposed to absolute prohibitions or requirements. Note that what we are doing here is incorporating the OCP into a new evaluation metric rather than erroneously (as I have argued) presuming to derive it from the old one.

The correctness of the relative OCP in (89) as opposed to the absolute OCP is a matter that cannot be fully resolved here. The tonal literature seems to argue for a relative interpretation. But there are a few general considerations that, I think, militate strongly in favor of the absolute interpretation of the OCP, at least for nonprosodic phonology.

First, no language yet analyzed presents a simple contrast between singly associated and multiply associated tautomorphemic geminates, nor do we find a Semitic language with roots *sm* (87a) and *smm* (87b) both yielding the surface form *samam*. Such contrasts are in principle readily learnable—after all, they would conceivably have transparent phonetic consequences (like medial release for clusters versus medial closed transition for geminates). Even without overt phonetic differences between the two sorts of objects, they would still be readily detectable by the language learner from their effects on morphological and phonological rules of the various types discussed in section 1 or on syncope rules, all of which distinguish the two types. This worst-case situation for detecting OCP violations is no more opaque than—and in fact is comparable to—the arguments for empty segments contrasting with zero in studies like Clements and Keyser (1983) and Marlett and Stemberger (1983) or the arguments for abstract segments in earlier literature. The nonexistence of languages making such a contrast in the lexicon is an important result of the OCP.

A corollary of this observation is that systems with purported OCP violations typically make another distinction that goes along with the contrast of single and double segments. This is the case in Cuna (see footnote 6), where, apart from the descriptive problems, it is the case that the two dialects must differ in their syllable structure as well as their melodies. Or Broselow's (1984; 1985) analysis of Amharic roots, which argues that Amharic contrasts roots *fj* and *wdd*, is weakened by the fact that roots of these two classes never appear with the same skeleton under any circumstances—that is, the phonology and morphology conspire to preserve this underlying distinction perfectly.[22] Yawelmani (Archangeli (1983; 1984)), another apparent OCP violator, has exactly the same property. As long as one or more other distinctions are systematically made in tandem with the OCP violation, something that is not typical of parameters of interlinguistic variation, we must entertain explanations that do not involve the OCP. In particular, the possibility exists in both Yawelmani and Amharic that we are dealing with lexically governed choice of skeleton or association pattern by roots that respect the OCP.

A related problem with the markedness interpretation of the OCP is that the languages like Amharic or Yawelmani with apparent OCP violations also eschew autosegmental spreading, so that the one-to-many attachments that obtain in languages respecting the OCP are systematically avoided. This is an extremely peculiar result under the logic of a markedness principle like (89), since it boils down to a situation where a language displays the marked option by adopting the marked representation and dropping the unmarked one—as if a language were to have voiced obstruents without voiceless ones, rather than adding voiced ones to the voiceless set the language must have. A markedness interpretation of the OCP is clearly the wrong way to go about this.

The alternative and, I think, the best way to account for any nonuniversality in the OCP, if clear violations arise that are not susceptible to reanalysis, is to consider the OCP a parameter of Universal Grammar whose unmarked value is "on." That is, the OCP expresses an absolute prohibition, but it is one that grammars will deviate entirely from given evidence to the contrary. This understanding of the OCP is, of course, incompatible with (89), since (89) merely expresses a preference for a particular type of structure rather than an absolute choice between the two. The parametrized OCP also accounts for the fact that, in languages like Arabic where the evidence has been exhaustively pursued, the absolute interpretation of the OCP is the only one that is correct empirically, and it seems in fact to function throughout the derivation in the way that I argue in this article.

In sum, the strongest argument for the absolute prohibition expressed by the OCP is the absence of languages contrasting tautomorphemic one-to-many association with tautomorphemic one-to-one association of identical segments. Such a contrast could have straightforward phonetic, phonological, and morphological consequences, yet it is simply not exploited by the languages analyzed thus far.

[22] The apparent OCP violations in Amharic are treated in McCarthy (to appear a).

6.2. *Tier Conflation and Heteromorphemic Geminates*

What happens when the conflation of tiers would create sequences of identical consonants? That is, what happens when Tier Conflation applies to the hypothetical configuration in (90):

```
(90)              b a
                  | |
        C V C  +  C V
        | | |
        d a b
```

Here we are in the realm of speculation, since evidence about the result is not especially conclusive. On the one hand, it would be consistent to say that nothing special happens, and that the resulting melody is [dabba]. This is a violation of the OCP to the scrupulous mind, but it is not an especially serious one, since it arises from a conflict between the OCP and another universal principle, Tier Conflation. Thus, we are free to dictate priority between the two as we choose. The alternative is to suppose that Tier Conflation, when it folds the two tiers together, fuses the two identical consonants into a single melodic unit, as in (91):

```
(91)    C V C C V
        | |  \/  |
        d a  b   a
```

It is to be noted that this fusion is not effected by the OCP (as it is in some other theories of the OCP), but is rather a consequence of Tier Conflation alone under the second alternative. It is also distinct from the rule-governed fusion of Leben (1980), since here I make the considerably stronger claim that fusion occurs at the same well-defined points in the derivation as Bracket Erasure/Tier Conflation.

A somewhat philosophic argument in support of this alternative is that it is the one more consistent with the interpretation of Tier Conflation as a generalization of Bracket Erasure. Bracket Erasure dismisses the memory of earlier morphological history, and one way it might do so is to erase thoroughly the distinction between hetero- and tautomorphemic geminates. Thus, /dab+ba/ merges completely with monomorphemic /dabba/.[23]

What phonetic evidence there is suggests that the latter alternative—where fusion takes place in conjunction with Tier Conflation—is the correct one. Since phonetic rules are necessarily postlexical, it follows that phonetic rules will be insensitive to information lost by the operation of Tier Conflation/Bracket Erasure. Although various lexical phonological rules make reference to the distinction between hetero- and tautomorphemic geminates, it appears that phonetic rules in general do not. That is, we find complete homophony between the two types of geminates unless a more remote phonological rule,

[23] Thanks to Alan Prince for suggestions along these lines.

applying before Tier Conflation, has intervened. If rules of phonetic interpretation systematically fail to respect the difference between the two types of geminates, then at a minimum this difference should not be accessible in the course of phonetic implementation, a consequence that the fusion interpretation of Tier Conflation has.[24]

Phonological evidence for the same conclusion is a little harder to come by, though the obvious phonological test case is again Tiberian Hebrew Spirantization.[25] Spirantization does not apply to geminates of any kind, whether they are tautomorphemic or heteromorphemic. So, for example, the tautomorphemic geminate *t* of *kittēβ* 'he wrote constantly', the assimilated (from /natan + tî/) heteromorphemic geminate of *nāθattî* 'I gave', and the plain heteromorphemic geminate of *kārattî* 'I cut' all fail to undergo Spirantization. The first two cases come under the one-to-many association rubric that generally blocks rule application to geminates, as described in section 1, the first by virtue of the OCP and the second by the nature of assimilation rules. But the last case does not fall out, unless we assume that Spirantization applies after Tier Conflation, and further that Tier Conflation has the fusion effect in (91). Further facts bear on this conclusion.

Tiberian Hebrew has a rule inserting *e* into word-final clusters: /malk/ → *meleχ* 'king'. This rule, as expected, may not apply to final geminates; instead they are degeminated, so /rabb/ becomes *raβ* 'many'.

As is also expected, Epenthesis does not apply to tautomorphemic geminate clusters derived by assimilation, so /ʔanp/ → /ʔapp/ → *ʔaφ* 'face' (cf. *ʔānaφ* 'be angry'). Nor does it apply to heteromorphemic geminate clusters derived by assimilation: /ban + t/ → /batt/ → *baθ* 'daughter' (cf. *bānôθ* 'daughters'). But it does apply to heteromorphemic geminate clusters that arise by morpheme concatenation alone: /paḥet + t/ → *pəḥeθeθ* 'corruption of a leprous garment' (Lev 13, 55).

The order of operations, then, must be Epenthesis–Tier Conflation–Spirantization, since Epenthesis applies to heteromorphemic geminates before fusion whereas Spirantization applies to them after fusion. As we would expect from this ordering, Epenthesis must precede Spirantization for independent reasons: the epenthetic vowel triggers spirantization of a following obstruent. There is some reason as well to believe that Epenthesis and Spirantization are at different strata, as they must be if the intervening Tier Conflation operation does duty as Bracket Erasure. Epenthesis is a strictly word-internal process, whereas Spirantization can apply phrasally between words that are sisters in the syntactic phrase marker. Thus, Epenthesis is plausibly a lexical rule, whereas Spirantization is postlexical. These factors, although not overwhelming, point to the correctness of Tier Conflation as an account of the fusion of heteromorphemic geminates.[26]

[24] A possible counterexample to this observation about phonetic implementation rules is the treatment of derived geminate clusters in Hooper Bay Chevak, discussed in section 4.4.

[25] Kenstowicz and Kidda (1985) cite two other similar cases, one in Berber (Bader and Kenstowicz (1984)) and the other in Tigrinya (Lowenstamm and Prunet (1985)), but these were not available to me during the preparation of this article.

[26] Tiberian Hebrew Spirantization is ultimately rather tricky to adduce as evidence here. This rule is clearly lexical as well as postlexical, as I show in section 4.1. In its application across word boundaries,

6.3. *Conclusion*

I have shown in this article that the Obligatory Contour Principle has a significant role in the nonlinear phonology of segments, both by constraining lexical representations and by applying throughout the course of the derivation to account for the antigemination effect. Along the way I have elaborated on a theory of the relation between nonlinear and lexical phonology, a relation that makes a wide array of predictions of which the OCP effects are only a small part.

Many issues could receive only imperfect treatment without making a long article even longer. The descriptive coverage of antigemination has not exhausted the available syncope rules, although it has covered most of the well-understood ones. For other cases, I might mention Squamish (Kuipers (1967, 57)) and Lithuanian (Kenstowicz (personal communication)) as languages with rules respecting the OCP and Hindi (Ohala (1972)) as a language with clear lexical enforcement of the OCP but with a syncope rule that seems indifferent to it. The role of Tier Conflation in a lexical phonological model needs considerable development, and the phonological systems putatively displaying Tier Conflation require elaboration in this light. Tonal phonology, which various investigators have argued to violate the OCP, received no shrift at all. The fusion effect of Tier Conflation, by which heteromorphemic geminates are fused into the structure of tautomorphemic ones, was adumbrated in only one somewhat doubtful case. Nevertheless, the overall program and a considerable body of evidence in support of it have been covered in some detail, so the directions for further research are clear.

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moreover, it must precede junctural gemination, a rule that ought to be postlexical as well except that it precedes some clearly lexical rules. With these cautions we cannot be fully confident of the results.

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