On Geminates
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1. Introduction

The subject of this article is the well-known generalization in (1), established by Guerssel (1978) and Kenstowicz and Pyle (1973).

(1) Geminate structures cannot
   a. be split by epenthesis;
   b. allow one half of the cluster to undergo a rule that the other half does not undergo.

(1) is better known under the (not entirely equivalent) formulation given to it by Guerssel (1978) and named the Adjacency Identity Constraint.

(2) Given a string $A_1A_2$, where $A_1 = A_2$, a rule alters the adjacency of $A_1A_2$ if and only if it alters the identity of $A_1$ or $A_2$.

Both generalizations cover instances of phonological rules being blocked from applying to a geminate input, instances that we refer to (for want of a better term) as geminate blockage. In this article we will explore what types of rules are subject to geminate blockage and what types of clusters these rules fail to apply to.

We begin by discussing the notions in terms of which these questions are formulated.

1.1. Geminates

The autosegmental analysis of geminates first defended by McCarthy (1979) and Leben (1980) asserts that geminates are single segments mapped onto several, typically two, skeleton slots. We assume such representations as those in (3), where X is a skeleton slot unspecified for syllabicity (see Levin (1983; 1984; 1985)).

(3)      
   t  a
   X X = geminate t
   X X = long a

Throughout the article we will refer to the structures in (3) as monosegmental geminates.
Kaye (personal communication, cited in Halle and Vergnaud (1980)) and Kenstowicz, Bader, and Benkeddache (1982) have independently suggested that the geminates in (3) resist being split by epenthesis because any inserted vowel will cross association lines with the geminate segment.

(4) * t a
   C V C

If so, the representation of geminates as single segments with multiple associations to the skeleton explains generalization (1a).¹

We can turn now to (1b): one half of a geminate cannot undergo a phonological rule unless the other half also does. Unlike the well-documented effect of geminate clusters on vowel epenthesis, this observation has thus far been supported by only a few examples, not all well understood. One of our purposes in writing this article is to bring to light more examples illustrating this generalization. But our main goal is to gain an understanding of why it appears to hold.

As a first step, note that (1b) relates to the monosegmental nature of the geminate sequences in (3). The single segment in (3) may undergo a rule, in which case every skeleton slot associated with it will be affected, or the geminate cluster may block the rule, in which case the segmental content of no slot will change. There is no third alternative.

Consider Semitic Spirantization, a family of rules that turn a postvocalic stop (any nonemphatic stop in Hebrew, only [+back] stops in Tigrinya) into a spirant.² Let us assume, anticipating some results of section 2.4, that the Tigrinya version of the rule is stated as follows.

(5) [+ back] → [+ cont] /
    X X
    N

where N stands for syllable nucleus

¹ Since cases of this type are amply documented in the literature, we merely list here some of the relevant studies: Kenstowicz and Pyle (1973), Steriade (1982) (on Kolami epenthesis), Guerssel (1978) (Berber; Moroccan and Algerian Arabic epenthesis), Abu-Salim (1980) (Palestinian Arabic epenthesis).

Kenstowicz, Bader, and Benkeddache (1982) and Steriade (1982) mention one assumption required by this explanation: inserted vowel segments belong to the same tier as the consonantal segments of the string into which they are inserted (see Younes (1983)). A further necessary assumption is that epenthesis does not consist of simply inserting into the skeleton tier a V slot to be segmentally filled later. If this were actually so, then the V insertion process, epenthesis itself, would not be blocked from applying into a geminate sequence: only the later process whereby the V slot acquires segmental specifications would be blocked in the case of split geminates, since at that point the crossing lines problem would occur. Since the resolution of this problem has more to do with the analysis of epenthesis and of syllabicity distinctions than with the analysis of geminate structures, we will not discuss it here. For several possible approaches to this problem, see Dresher (1985), Levin (1985), Steriade (1985a).

What are the options in applying this rule to a form like fäkkärä ‘he boasted’ (surface fäkkärä)?

(6) f ä k ä r ä
    X X X X X X X
    N N N

Spirantization has the choice of either affecting k, even though the second X in the cluster associated with k is not postvocalic, or failing to apply to k, even though the first X associated with k does meet the specifications of the rule. What it cannot do is apply to the segmental content of the first X without also affecting the other: no rule of this type ever turns a monosegmental geminate kk into a heterogeneous cluster xk. By this, we are not denying the existence of diphthongization rules (in the sense of Andersen (1972)), which typically split a homogeneous feature specification into two opposite values linearly distributed: for example, the diphthongization of Finnish long e: into ie or of Romanian o into oa. But we claim that diphthongization is never the incidental result of applying a rule [aF] → [βG] / X ___ Y to an input that happens to contain a geminate [aF]. Rather, every single application of a diphthongization rule yields a sequence of heterogeneous specifications for some feature. In contrast to such feature-splitting processes, a rule like Spirantization has instructions not to split a specification but merely to change it: witness the fact that it turns simple k’s into x’s, not xk’s. Our observation, and that of earlier authors, is that such feature-changing (and feature-deleting) rules will always affect or fail to affect the two halves of a geminate in the same way.

Simply noting that the geminate kk in (6) cannot be turned into xk by Spirantization does not fully account for the Tigrinya situation. A rule like Spirantization has only two options: it can affect both halves of the geminate sequence or it can fail to affect either. By itself, the monosegmental representation of geminate sequences does not predict which option a given rule might take. We need to know why Spirantization does not turn the geminate kk’s into geminate xx’s.

This question is the main focus of the article. Younes (1983), Hayes (1984), and Steriade and Schein (1984) have observed that rules that are subject to geminate blockage always involve in their structural description some mention of the skeleton or its syllabic organization. We call skeleton- or syllable-sensitive rules structure-dependent and the complement class segmental rules. Rules that apply freely to simplex and geminate segments alike tend to belong to the class of segmental rules in the sense that they require only segmental information. We will refine this generalization here and show that the phenomenon of geminate blockage is entirely predictable from the statement of the rule. We will also extend the notion of geminate blockage to cases in which a segmental rule fails to affect a partially assimilated cluster. Our general claim is that a rule’s applicability to a multiply linked autosegment (in a geminate cluster or in a partially assimilated
cluster) can always be predicted from the way the rule must be formulated when only singly linked autosegments are considered. Consider a doubly linked autosegment, next to a singly linked one:

\[
(7) \begin{array}{c}
\text{a. } \alpha \\
\beta \\
\text{b. } \alpha \\
\beta \\
\end{array}
\]

tier A \\
tier B

We claim that if the structural description of some rule affecting \(\alpha\) imposes conditions that are met by \(\beta\) but not by \(\gamma\), then the rule will not apply to a multiply linked structure like (7b). On the other hand, if the rule affects some element \(\alpha\) on tier A and no conditions are imposed on elements of tier B associated to this \(\alpha\), then the rule will apply to both (7a) and (7b), without distinguishing a multiply linked structure from a singly linked one.

To support this generalization, we present both rules in which the two tiers are the skeleton and some segmental tier (in which case the doubly linked structure represents a geminate) and rules in which the two tiers are two segmental tiers. We show that both types of rules treat doubly linked matrices according to the generalization outlined.

1.2. Rule Formalism and Matrix Structure

We follow Clements (1985), Mascaro (1986), and Mohanan (1983) in assuming that every matrix consists of “individual features organized under hierarchically superordinate nodes . . . [called] class nodes” such as the laryngeal and supralaryngeal nodes, the place and manner nodes, and the tonal node. “The class nodes themselves are dominated by a yet higher-level class node . . . [called] the root node. The root node in turn is directly linked to the CV tier” (Clements (1985)). A sequence of nodes of the same category defines a tier: the theory just cited recognizes (at least) a root tier, a laryngeal and supralaryngeal tier, and, subordinate to the supralaryngeal tier, a place and a manner tier. We have incorporated into this conception of matrix structure certain additional proposals. From Halle (1983; 1986), Steriade (1985b), and Sagey (1986) we adopt a further differentiation of the place component into the nodes coronal (dominating the features [anterior], [distributed], [lateral]), dorsal (dominating [back], [high], [low]), and labial, a terminal node. We follow Sagey (1986) in assuming that continuancy and, by extension, all other stricture features do not form a distinct stricture tier; we assume that stricture features ([consonantal], [continuant], [sonorant]) label root nodes, as shown in figure 1.4 What is represented in figure 1 is the relative position of the segmental tiers, as assumed in the remainder of this study. Class tiers are signaled by capitals. In what follows we simplify the display of matrix structure by representing only association lines, not the planes they belong to. We also occasionally omit intermediate class nodes, where

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3 We have not been able to consult this last reference, cited and discussed in Clements (1985).

4 Supporting this suggestion is B. Hayes’s observation (personal communication) that stricture features are unique in that they never occasion partial assimilation: Hayes notes that if the position of stricture features is that shown in figure 1, any rule spreading [sonorant] or [consonantal] will be indistinguishable from a gemination rule. The place of stricture features in the matrix is further discussed in Steriaide (1985a).
their presence can be inferred by reference to figure 1. We use the following abbreviations: \( r \) = root node; \( sl \) = supralaryngeal node; \( l \) = laryngeal node; \( pl \) = place node; \( nas \) = nasal node; \( cor \) = coronal node; \( dor \) = dorsal node; \( lab \) = labial node. Other abbreviations used are standard.

As Clements (1985) notes, this hypothesis about matrix structure allows association and dissociation to take place at several levels: for example, spreading of a root node results in total assimilation (gemination); spreading of the place node results in the creation

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**Figure 1**

Relative position of segmental tiers
of a homorganic cluster; spreading of the coronal node results in a multiply associated coronal node (see section 4.1). Individual features may also propagate.

We now turn to the mechanics involved in the rule types to be discussed later. Consider the following three rules: (a) the rounding of \(aw\) to \(ow\); (b) the shortening of the heavy (bivocalic) diphthong \(aw\) into the light (monovocalic) diphthong \(aw\); and (c) the contraction of \(aw\) into \(o\). In stating these and later rules, we represent the temporal sequencing of autosegments as usual by the linear order between corresponding symbols; association between two elements by a line connecting the two; associations introduced by the current rule by a dotted line; and associations being severed by the current rule by \(\times\). We indicate prosodic constituent structure by the use of labeled bracketings: \(N = \text{Nucleus}, R = \text{Rime}, \text{and } \sigma = \text{Syllable.}\) We depart from conventions currently in use in only one way: when adjacency between two nodes is a condition stipulated by the rule, we state it separately; the absence of such a condition indicates either that a long-distance assimilation (vowel or consonant harmony) is involved or that the observed adjacency between factors in the rule follows from other aspects of the statement (see also section 6.1).

Rounding involves two matrices, \(r_1\) and \(r_2\), by extending the span of the labial node of one of them over the other.

\[
\begin{align*}
\text{(8) Rounding } \ (aw &\rightarrow ow) \\
\text{[ - low]} &\quad \text{[ + back]} &\quad \text{[ + high]} \\
\text{dor}_1 &\quad \text{dor}_2 \\
\text{pl}_1 &\quad \text{lab} &\quad \text{pl}_2 \\
\text{r}_1[ - \text{cons}] &\quad \text{r}_2[ - \text{cons}] \\
\end{align*}
\]

However, Rounding alters the contents of only one matrix, that of \(a\): the contents of the matrix of \(w\) remain the same in the output of the rule. This distinction will become important shortly: we claim that a rule may be subject to geminate blockage only when it alters the contents of some multiply linked autosegment.

Consider now Shortening and Contraction.

\[
\begin{align*}
\text{(9) a. Shortening } \ (\text{heavy } aw &\rightarrow \text{light } aw) \\
d &\quad w \\
r_1 &\quad r_2 \\
\text{X} &\quad \text{X} \\
\end{align*}
\]
b. *Contraction* \((\varphi w \rightarrow o)\)

\[
\begin{array}{cc}
[-\text{low}] & [+\text{back}] \\
\text{dor}_1 & \text{dor}_2 \\
\text{pl}_1 & \text{lab} \\
\text{r}_1[-\text{cons}] & \text{r}_2[-\text{cons}] \\
\end{array}
\]

\(r_2\) is pruned

(We use \(w\) and \(\varphi\) as abbreviations for the features of each matrix.) Shortening maintains intact the distinct identity of the matrices \(w\) and \(\varphi\) but compresses the overall duration of the sequence. We discuss below a case identical to (9a) in connection with Tigrinya Spirantization. A rule with the formal properties of (9a) is discussed in Keyser and Kiparsky (1984).

In contrast to Shortening, Contraction merges the feature specifications of two matrices into one: this is achieved in (9b) by reassociating the features of \(w\) to the root node of \(\varphi\). We assume that linear precedence can only be defined between root nodes (that is, between segments in their entirety) or between skeletal units, but not between other constituent elements of the matrix. Thus, the linear order between the \(\varphi\)-features and the \(w\)-features is lost in the output of (9b), because they are now dominated by the same root node, but not in (9a). Since the two dorsal nodes and the two place nodes are now interpreted as being simultaneous, each pair is reinterpreted as a single node. It is intuitively obvious that Shortening, whatever its formalization, does not change the contents of either matrix undergoing it; and equally so that Contraction, in anyone’s statement, changes both matrices participating in it. These observations are reflected in our statements: Contraction associates new features to one root node and eliminates the other, whereas Shortening preserves the contents of both unchanged. We will observe below that rules with the properties of Shortening apply to geminates, whereas rules like Contraction do not.

1.3. *The Distribution of Multiply Linked Matrices*

Schein (1981), Kenstowicz (1982), and Hyman (1982) have shown that, in addition to monosegmental geminates, a language may exhibit clusters of adjacent identical segments.

\[
\begin{array}{cc}
9. & 9. \\
\text{t t} & \text{a a} \\
\text{X X} & \text{X X} \\
\end{array}
\]

The structures in (10) are frequently restricted to heteromorphemic clusters. For ex-
ample, whereas all morpheme-internal geminate $kk$’s of Tigrinya block Spirantization, $kk$ clusters resulting from morpheme concatenation can undergo the rule: /barak-ka/ ‘bless-(PERF)-2sg masc’ (‘you blessed’) becomes [barax-ka], in contrast to /qatälä-kka/ ‘kill-(PERF)-2masc’ (‘he/she killed you’) or /fakkar5/ ‘boast-(PERF)’ (‘he/she boasted’), whose geminates surface intact. Similarly, tautomorphemic $rr$ clusters become $tt$ in Malayalam (Mohanan and Mohanan (1984)), whereas heteromorphemic $rr$ is unaffected: /aarr-il/ ‘river-LOC’ becomes aattil, in contrast to /dur-raani/ ‘bad-queen’, which surfaces as durraani. The situation is accounted for, according to Mohanan and Mohanan, if the $rr \rightarrow tt$ rule is formulated to apply to a monosegmental geminate. The Malayalam and Tigrinya correlation between, on the one hand, monosegmental and tautomorphemic geminates and, on the other hand, bisegmental and heteromorphemic geminates characterizes a majority of the languages investigated so far.

Syllabic geminates, which are typically tautosyllabic if monosegmental (Levin (1983)) and—at least underlyingly—heterosyllabic otherwise, show an identical correlation in Gokana (Hyman (1982)) and Latin: the monosegmental type occurs morpheme-internally, the bisegmental type in morpheme combinations. Compare Latin /sü-s/ ‘sow-NOM sg’ (surface [su:s]) with /su-u-s/ ‘own-theme vowel-NOM sg’ (surface bisyllabic [su.us]) or /ståu-unt/ ‘establish-3pl’ (surface trisyllabic [sta:tu.unt]).

The bisegmental character of heteromorphemic geminates follows simply from the need to list independently distinct morphemes: since Tigrinya -ka and barak- must be stored as distinct morphemes, their concatenation will be expected to contain two instances of $k$ rather than just one. What enforces the monosegmental analysis of geminates found inside a single morpheme is less clear. If Malayalam, Tigrinya, Gokana, and Latin turn out to be representative cases, we could follow McCarthy (1979; 1986b) and assume a universal Obligatory Contour Principle (OCP).

(11) **Obligatory Contour Principle**
In a given autosegmental tier, adjacent identical segments are prohibited.5

(McCarthy (1979, 238))

In this article we will deal exclusively with languages in which the distribution between monosegmental and bisegmental geminates is the one predicted by (11).

Finally, we must mention the existence of a class of heteromorphemic monosegmental geminates discovered by Guerssel (1978). Guerssel observed that heteromorphemic clusters that have become geminates as the result of assimilation rules always behave as if they are monosegmental: they cannot be split by epenthesis, and their members cannot disjointly undergo phonological rules. An autosegmental interpretation of Guerssel’s result was proposed in Steriade (1982): if partial assimilation rules are autosegmental linking operations, as originally suggested by Goldsmith (1979) and Halle and Vergnaud (1980), their outputs are structures sharing relevant properties with the

5 McCarthy’s formulation of the OCP relies on his conclusion that distinct morphemes define distinct autosegmental tiers.
monosegmental geminates. Thus, the immediate output of a place assimilation rule will contain a set of doubly linked submatrices.

\[
\begin{array}{c}
p_I \\
| & | \\
\text{sl}_1 & \text{sl}_2 \\
| & | \\
r_1 & r_1
\end{array}
\]

The shared features in (12) should behave exactly like the set of shared specifications of a monosegmental geminate: the rules that are blocked from affecting the latter should not apply to the former. Moreover, epenthesis rules should fail to split such clusters, since a pattern of crossed association lines would result if a segment were linked to the epenthetic \( X \). Some of the evidence confirming this hypothesis is discussed in section 5. See also Steriade (1982), Kenstowicz and Bader (1984), Clements (1985), Hayes (1986a), Shlonsky (1985).

To sum up, then, the distribution between monosegmental and bisegmental geminates is determined by the OCP in conjunction with morphological structure. Multiply linked submatrices and geminates resulting from partial assimilation rules occur both inside and across morpheme boundaries, wherever such rules have applied.

1.4. Overview

The article is structured as follows. We consider first the behavior of geminate clusters and show that structure-dependent rules are subject to geminate blockage (section 2). We show next that geminate blockage occurs every time a structure-dependent rule has a geminate target but never if the geminate is part of the context or if its segmental make-up is not affected by the rule (section 3). In section 4 we establish that segmental rules, whose statements make no reference to the skeleton, can apply to geminates. In section 5 we turn to the behavior of multiply linked submatrices: we show that these give rise to phenomena entirely parallel to geminate blockage. Finally, in section 6 we present our analysis of the entire paradigm.

2. Geminate Blockage with Structure-dependent Rules

2.1. Feature Change and Contraction: Latin Diphthongs

The first class of cases we discuss involves the diachronic development of Indo-European diphthongs in Latin.

Archaic (before the second century B.C.) Latin had the diphthongs \( ay, aw, ey, ew, oy, ow \) (Sommer and Pfister (1977, 41)). By the classical period these have undergone the following series of changes: (a) \( ew \) becomes \( ow \) before the earliest documents; (b) most instances of \( oy \) contract to \( \ddot{u} \); (c) \( ay \) and the remaining \( oy \) diphthongs become \( ae, oe \); (d) \( ey \) contracts to \( \ddot{i} \). At some stage in this development Latin acquires geminate \( yy \) sequences; geminate \( ww \) did not exist at any point in the history of the language. The
significant fact we deal with here is that both the lowering of ay, oy to ae, oe and the contraction of ey, oy were blocked when the second member of the diphthong was in fact the first half of a geminate y.\textsuperscript{6} In this section we show that the geminate blockage of Lowering and Contraction is a consequence of the structure-dependent status of these rules.

The effects of Lowering are illustrated in (13).

(13) a. oy → oe
   Old Lat. koyrāverunt ‘take care-PERF-3pl’ : koerāverunt : (Class. kūrāverunt)
   Old Lat. loydōs ‘game-ACC pl’ : loedōs : (Class. lūdōs)
   Greek poyna ‘fine’ → Class. poena
   Greek Oybalos (name) → Class. Oebalus

b. ay → ae
   Old Lat. ayde(m) ‘house-ACC sg’ : Class. aedem
   Old Lat. aykwom ‘equal-ACC sg’ : Class. aekwum
   Greek aynigma ‘enigma’ → Class. aenigma
   Greek Aysōpos → Class. Aesōpus

The distribution between i and y is entirely predictable in Latin and supports the view that only syllabic position, not segmental properties, differentiates the two (see Steriade (1984)). When a and i are not tautosyllabic, Lowering fails to take place; hence the contrast between a.is (from underlying /ai-is/ ‘say-2sg’, syllabified a.yis and simplified to a.is) and aes ‘bronze’ (from underlying /ais/, syllabified ais). The same holds for oi: there is variation between trisyllabic co.i.tus ‘meeting, union’, without Lowering, and bisyllabic coe.tus, with Lowering, but there is no option such as *co.e.tus. This too is explained if Lowering takes place only in tautosyllabic oi (i.e. oy) sequences.

(14) Lowering
\[
\begin{array}{cccc}
\text{[- high]} & \text{[+ back]} & \text{[+ high]} & \text{[- back]} \\
dor_1 & & & \\
\Gamma_1 & \Gamma_2 [-\text{cons}] & \\
[X] & X_R
\end{array}
\]

\textsuperscript{6} To avoid any ambiguity in the representations of Latin forms, we will not be using the traditional Latin spelling of sequences containing surface glides. We should also note that many Latin dictionaries mistakenly represent ViīV sequences (i.e. Vy.yV) as ViīV, interpreting the heavy quantity of the first syllable as due to vocalic length rather than presence of a geminate yy. The evidence that forms like aiiō contain a geminate heterosyllabic ii sequence is presented in Niedermann (1953, 105) and Sturtevant (1940, 137).
Despite the fact that very few synchronic alternations support this rule, its synchronic validity for Classical Latin is well established by the consistent treatment of Greek ay, oy diphthongs as ae, oe and by the absence of surface tautosyllabic ay, oy.

Lowering interacts with a rule whereby intervocalic y is geminated. Within single words there are no nongeminated intervocalic y’s in Latin. This distributional fact suggests that the intervocalic geminate y’s in items like pey.yor ‘worse’, may.yor ‘larger’, ay.yo ‘I say’, kuy.yus ‘whose’ result from the gemination of underlying y’s.\(^7\) Further support for a rule of y-Gemination comes from the fact that early loans from Greek that contained intervocalic y show the effect of gemination: thus, Troy.a, Ma.ya, Ai.aks (syllabified in Greek as Troy.a, May.a, Ay.aks) become Latin Troy.ya, May.ya, Ay.yaks (for the evidence, see Niedermann (1953, 105) and Sturtevant (1940, 137)). But the most convincing evidence for y-Gemination is provided by the presence of intervocalic geminate y’s at the beginning of second members of compounds: compare yakio ‘I throw’ with re-yyikio ‘I throw back’, yakto ‘I throw repeatedly’ with re-yyekto ‘I cast back’. (The changes in vowel quality are due to unrelated processes of vowel reduction.) Neither the loanword evidence nor the postvocalic gemination of cycle-initial y’s as in reyyektō can be explained without a synchronic rule of y-Gemination.

\[
\begin{align*}
\text{y-Gemination} & \quad X_1 \text{ adjacent to } X_3 \\
& \quad X_1 \quad \text{ } \quad \quad \text{N} \quad \text{N} \\
& \quad X_1 \quad X_2, \quad \text{X}_3 \quad \quad \quad \quad \quad \quad X_4 \quad \text{X}_1 \text{ adjacent to } X_4
\end{align*}
\]

Gemination is no longer productive in Classical Latin: although early loans from Greek undergo the rule, as shown above, recent loans show no evidence of Gemination. Thus, Greek Aiakos, Aiolo.s, Oiagros, Eubaia (= Ay.a.kos, Ay.o.los, Oy.a.gros, Eu.boy.a) become, after Lowering, Aeacus, Aeolus, Oeagrus, Euboea. Whether native or not, words to which Gemination has applied fail to undergo Lowering. Thus, ay.yo ‘I say’, may.yor ‘bigger’, boy.yae ‘straps’, Gay.yus, Troy.ya, Troy.yu.ge.need ‘Trojan’ fail to become either *ae.yo, etc., or *aē.o. Since recent loans fail to undergo Gemination, we can compare, for example, Ay.yaks with Ae.a.kus, the nativized but ungeminated form of Greek Ay.a.kos, or Troy.ya with Eu.boy.e.a, from Greek Eu.boy.a. The contrast is explained in each case by assuming that Gemination precedes and bleeds Lowering and that Gemination, a minor rule in Classical Latin, fails to take place in the recent loans Ayakus and Euboya. We assume as input strings the Greek syllabifications Ay.aks, Ay.a.kos.

\(^7\) The historical roots of this process bear no resemblance to the rule of intervocalic gemination that describes the synchronic situation. The geminate y’s in items like pey.yor, may.yor are the result of a minor pre-Latin sound change that turned some dy, gy clusters into yy. The absence of nongeminate y’s in intervocalic position is due to another prehistoric sound change, which eliminated them (see Sommer and Pfister (1977, 124)). Neither one of these prehistoric processes is recoverable as such from the synchronic Latin data. Chronologically they both precede the relatively recent phenomena of Lowering and Contraction discussed in the text.
We claim that Lowering is blocked in \textit{ay.yaks} because only one of the two \(X\)’s associated with \(y\) is tautosyllabic, as required, with a preceding nonhigh vowel. Since the rule cannot apply in such a way that only the segmental content of the first \(X\) will be affected, it does not apply at all.

We turn now to Contraction, the sound change responsible for the fact that Old Latin diphthongs \(ey, oy, ow\) monophthongize as \(i, u, u\), respectively. Like Lowering, this sound change fails to affect diphthongs containing the first half of a geminate \(y\).

\[(17)\]

\textbf{a.} \(ey \rightarrow i\)
- Old Lat. \textit{deywos} ‘god’ : Class. \textit{dīwus}
- Old Lat. \textit{deykerent} ‘say-SUBJ-IMPF-3pl’ : Class. \textit{díkerent}
- Old Lat. \textit{keywis} ‘citizen’ : Class. \textit{kiwis}

\textbf{b.} \(oy \rightarrow ū\)
- Old Lat. \textit{oytile} ‘useful’ : Class. \textit{ūtile}
- Old Lat. \textit{koyrāverunt} ‘take care-PERF-3pl’ : Class. \textit{kūrāverunt}
- Old Lat. \textit{oynos} ‘one’ : Class. \textit{ūnus}

\textbf{c.} \(ow \rightarrow ū\)
- Old Lat. \textit{dowkit} ‘leads’ : Class. \textit{dūkit}
- Old Lat. \textit{lowkos} ‘sacred grove’ : Class. \textit{lūkus}

The chronology of the competing sound changes of Lowering \((oy \rightarrow oe)\) and Contraction \((oy \rightarrow ū)\) bears some discussion. If we assume that Lowering precedes Contraction, then the input to Contraction in forms like \textit{ūnus} from \textit{oynos} must be lowered \(oe\) rather than \(oy\). However, it is highly unlikely that the high vowel \(ū\) results from the contraction of two mid vowels. This suggests that Contraction precedes Lowering, a hypothesis supported by the observation that most recent loans from Greek (such as \textit{Oedipus} from \textit{Oydipous}, etc.) fail to undergo the former but never the latter. It follows that the only native \(oy\) sequences that surface in the classical language as \(oe\) rather than
û involve some early failure of the Contraction rule: such is the case with the oy diphthongs following an initial labial consonant (*poena ‘fine’ from *poyna, moenia ‘walls’ from *moynia, foedus ‘contract’ from *foydus) and with oi sequences separated by a prefix boundary (*koetus from /ko-itus/).

Like Lowering, Contraction is structure-dependent: any sequence of vocoids undergoing it must be tautosyllabic. This is revealed by the contrast between prevocalic ow, as in o.wis ‘sheep’, no.wa ‘new-fem’, a sequence that is necessarily heterosyllabic and immune to Contraction, and preconsonantal ow, as in dow.kit, which contracts to û (compare Classical Latin du.kit). As a rule, no preconsonantal sequence of nonhigh vowel followed by high vowel is heterosyllabic in Latin unless a word or prefix boundary separates the two.⁸

Contraction appears to involve the merger of height and back/round specifications contained in the input sequence. The values favored by this articulatory compromise are [+ high] and [+ back, + round]. We assume that these values are in fact the only place specifications present in the input string of Contraction: we assume that [− high] and [− back, − round] are default values filled in by later rules. We state Contraction as the process whereby the place features of the sequence V₁V₂ become associated exclusively with the root node of V₁. As a result, the root node of V₂ remains empty and is pruned. Compensatory Lengthening (see Ingrina (1980), Steriade (1982)) ensures that the resulting empty X slot is linked to the new matrix. Since Compensatory Lengthening is an independent mechanism, its effect is not encoded in the statement of Contraction. Finally, our rule describes the input sequence very generally as [− low] [− consonantal], taking into account the fact that independent constraints on possible tautosyllabic vowel sequences in Latin will reduce this class of strings to the three diphthongs ei, ou, oi.

(18) **Contraction**

\[
\begin{array}{c}
\text{dor}_1 \\
\text{pl}_1 \\
\text{r}_1 \\
\text{[X]}_R
\end{array}
\quad \begin{array}{c}
\text{dor}_2 \\
\text{pl}_2 \\
\text{r}_2[\text{− cons}] \\
\text{[X]}_R
\end{array}
\]

r₂ is pruned

⁸ No word-final ow is attested or reconstructible. On prevocalic ei, oi, whose i will undergo Gemination, see below.
We should emphasize that, unlike Lowering and Gemination, Contraction is no longer a synchronic process in Classical Latin: there are no synchronic indications that the underlying sources of some surface ui, i vowels are diphthongs. Our discussion concerns only the earliest attested stages of Latin, during which Contraction was an active process in the language.

2.2. Feature-filling Rules: Latin Velarized l

We turn now to a different fragment of Latin phonology: the rules relating to velarized l. The occurrence of dark (velarized) laterals in Latin is known from two sources: their phonological effects on neighboring sounds and the explicit statements of Latin.
grammarians. As with all allophonic variation, the \( l : t \) difference is not reflected in the spelling.

All available evidence converges to show that coda \( l \)'s were velarized throughout the documented history of Latin. The main sources of evidence we use here are two prehistoric sound changes conditioned by the dark \( t \)'s: short \( e \) and \( i \) became \( o \) and \( u \), respectively, before a dark \( t \); and \( o \) was raised to \( u \) in the same context. Some of the examples in (22) illustrate both processes: the backing rule and the subsequent application of raising before \( t \).

(22) a. vul-t, early vol-t vel-im
   'want-3sg' 'want-OPT-1sg'
   vol-tis, vul-tis velle
   'want-2pl'
   'want-INF'
 b. sepul-chrum sepel-i-o
   'grave'
   'bury-1sg'
 c. facul facil-is
   'easy-neut'
   'easy-masc, fem'
   facul-tas
   'ability'
 d. exsul exsil-ium
   'exile'
   'banishment'

Below is some of the evidence for the rule raising \( o \) in syllables closed by dark \( t \).

(23) a. cul-men col-umen
   'summit'
   'summit'
 b. stul-tus stol-idus
   'stupid'
   'stupid'
 c. adul-tus adol-eo, adol-itus
   'burnt'
   'burn', 'burnt'

The alternations in (22a) indicate that the vowel resulting from Backing, as well as underlying \( o \), is subject to this rule.

We note a difference in the chronology of Backing and Raising before \( t \): forms like volt, which antedate Raising, are attested, whereas forms like *sepelchrom, which antedate Backing, are mere reconstructions. We are therefore dealing with two distinct

\[9\] It is generally assumed that dark \( t \) also occurred before a back vowel, in forms like famulus 'servant' or exulans 'exile' (see, for example, Niedermann (1953) and Sturtevant (1940)). The basis for this hypothesis is that historically front vowels were backed before this category of \( t \)'s: thus, the \( u \) in famulus is related to the \( i \) of familia, and the \( u \) of exulans is related to the \( i \) of exilium. The Latin grammarians are quite clear in their statements on the matter, however: dark \( t \) does not occur before back vowels (Sturtevant (1940, 149)). There is also a more compelling reason why the sound change that created famulus, exulans from *famil-, *exil- could not have involved a back \( t \): only reduced, noninitial vowels participate in alternations like famulus : familia, whereas back \( t \)'s affect the quality of a preceding vowel regardless of whether or not it is reduced. The famulus : familia alternations can be accounted for by noting that \( l \) was clearly unspecified for backness and could allow the reduced high vowel in *familius to take on the backness value of a following vowel as though the two were adjacent. This backness assimilation rule will not be discussed further here.
sound changes, of which Backing is the earliest. Backing may be identified with the equally early process that turns *ew* diphthongs into *ow* (as in *brewma* → *browma* → *brūma* ‘winter solstice’; compare brewis ‘short’). Both *w*-Backing and *t*-Backing fail to affect *a* (for example, *awdio* ‘I hear’, *alter* ‘other’). Backing before *t* is necessarily limited to tautosyllabic sequences, since *t* occurs only in the rime. Whether or not *w*-Backing is also restricted to tautosyllabic sequences cannot be determined with any certainty. But, whether or not Backing is a structure-dependent rule, its effect on geminate (long) vowels cannot be ascertained, since no rimes of Latin contain the sequence of nonhigh long front vowel followed by *t* or *w*. The informal statement given below is only meant to summarize the known facts.

\[(24) \text{Backing} \]

\[[-\text{cons}, -\text{low}] \rightarrow [+\text{back}] / \underline{\text{___}} [+\text{cont}, +\text{back}]\]

Like Backing, Raising is not in fact exclusively triggered by laterals: mid vowels are raised in early Latin before tautosyllabic *η* as well: *septem* ‘seven’ but *septēn-genti* ‘seventy’, *dek-et* ‘it is appropriate’ but *dig-nus* ‘suitable’. Once again, the low vowel *a* fails to be affected by either *η* or *t*: *aggulus* ‘angle’, *aykeps* ‘two-headed’, *animal*, *alter*. The least inclusive common denominator of *t* and *η* is the [+high, +sonorant] class, which includes not only *t*, *η* but also the high vocoids *i/y*, *u/w*. The necessary inclusion of these sounds among the triggers of Raising dictates a structure-dependent formulation, since heterosyllabic *ew*, *ow* do not undergo this rule: *bre.wis*, *o.wis*, *no.wa*. In the case of tautosyllabic *ew*, *ow*, *ey*, *oy* the assumption that Raising applies to yield *iw*, *uw*, *iy*, *uy* is consistent with the attested outcome of these sequences, which eventually undergo Contraction and become *ū* and *i*. Thus, the most natural assumption is that Raising applies to any sequence of [−low][+high, +sonorant] segments that belong to the same rime.

\[(25) \text{Raising} \]

\[[-\text{low}] \quad [+\text{high}]\]

\[
\begin{array}{c}
\text{dor}_1 \quad \text{dor}_2 \\
\text{r}_1 \quad \text{r}_2[+\text{son}] \\
[\text{X}_1 \quad \text{X}_2]_R
\end{array}
\]

\[\text{X}_1 \text{ adjacent to } \text{X}_2\]

10 Recall that heterosyllabic *ey*, *oy*, *et*, *ot* do not exist; moreover, note that any sequence *Vη* is always tautosyllabic, since *η* occurs only when followed by a velar or nasal stop.
We turn now to the geminate blockage effects observed in conjunction with these rules. First, Raising, the sound change whose structure-dependent status is clear, may apply only to short vowels: compare *sōl ‘sun’, sēnīs ‘lazy’, whose long vowels fail to raise, with consul (early consol), septingenti (from *septegenti). Second, neither Raising nor Backing may be triggered by a geminate ll, even though part of this cluster is always a coda and should in principle be velarized.

(26) a. pollen ‘fine flour’ cf. pulvis ‘powder’
   b. mollis ‘soft’
   c. sollus ‘whole’ cf. solidus ‘firm; whole’
   d. vel-le ‘to want’ cf. vul-tis ‘you want’
   e. vell-ō ‘to pluck’ cf. vul-sus ‘plucked’
   f. per-cell-ō ‘strike’ cf. per-cul-sus ‘struck’
   g. mel(l), mell-is ‘honey’,
       fel(l), fell-is ‘gall’

Raising fails to affect long vowels because only one of the two X’s associated with the vowel matrix is adjacent to the tautosyllabic X of the trigger segment.

But why should geminate ll be excluded as a context in these rules? The reason is apparent from the description of l-types given by Latin writers: ll is never velarized.11 This fact is readily explained: l becomes t only in the rime, whereas, given Latin syllabification patterns, a geminate ll cluster is necessarily heterosyllabic.12

(27) l-Rule
    [+ lat] → [+ high, + back] / ___
        | X
        | R

Note that (27) is quite likely a feature-filling rule: there is no reason to attribute any height or backness specifications to underlying laterals. It appears, then, that feature-filling rules may be subject to geminate blockage under the same circumstances as feature-changing rules.

Finally, note the absence of Raising in forms like mel, fel. The oblique forms mell-is, fell-is indicate that the stem ends in a geminate ll. The unsuffixed nominatives are derived as follows: underlying /mell/ is syllabified partially as mel.l, since no consonantal geminate can be tautosyllabic in Latin. The string mel.l, containing a syllabically stray final X, is the input to the l-Rule. But the rule cannot affect this string, since only one

11 According to Plinius (Sturtevant (1940, 148)), ll is “lighter” than the l that occurs before a vowel, including a front vowel: Plinius refers to the former as exilis, to the latter as medium. Both contrast with the dark (plenus) l that occurs in the coda. Consentius, however, who admits only a binary distinction between light and dark l’s, simply states that ll belongs to the light class.
12 On the syllabic assignment of Latin consonant clusters, see Devine and Stephens (1977).
X in the geminate /l/ cluster belongs to the rime. Consequently, Backing (24) and Raising (25) also fail to take place.\(^{13}\)

2.3. Feature Deletion and Contraction: Tigrinya Geminate Glides

The data presented in this section concern the behavior of Tigrinya geminate glides under deletion and contraction. Our discussion is based on Leslau's (1941) grammar and takes off from Leslau's observation that the numerous processes of coalescence between tautosyllabic vowels and glides never apply to geminate glides: "un w géminé ne produit jamais de réduction de diphthongues" (1941, 116); "un y géminé ne produit pas de réduction de diphthongues" (1941, 119). We do not present here all the vowel coalescence rules described by Leslau; in some cases the data are incomplete, and in others the coalescence rules would require a lengthy discussion of the nature of syllabicity. A preliminary analysis of the latter class appears in Steriade and Schein (1984).

The monophthongization processes considered here appear to operate productively only within the verbal system of Tigrinya; we have been unable to find in Leslau's grammar nonverbal forms showing their effects. We assume that all rules formulated below carry appropriate morphological restrictions.

The vowel system of Tigrinya is given below. We include in angle brackets the symbols used by Leslau, which we adopt. Practically the only underlying nonsuffixal vowels of the verbal system are a, ä, ø, i, and u.

\[
\begin{align*}
\text{i} & \langle i \rangle \\
\text{e} & \langle e \rangle \\
\text{a} & \langle a \rangle \\
\text{u} & \langle u \rangle \\
\text{o} & \langle o \rangle \\
\text{å} & \langle å \rangle \\
\text{ø} & \langle ø \rangle
\end{align*}
\]

Tigrinya has an optional rule whereby a tautosyllabic sequence äy loses its second member. This process gives rise to pairs of variants like those in (29). The roots involved are sty 'drink', fty 'love', syt 'sell', kyd 'go'.

\[
\begin{align*}
\text{a. } & \text{satay, sota 'drink-IMP'} \\
\text{b. } & \text{sätäy-ka, sätä-ka 'drink-PERF-2sg'} \\
\text{c. } & \text{fätäy-ka, fätä-ka 'love-PERF-2sg'} \\
\text{d. } & \text{yə-šät-u, yə-šät-ə 'sell-IMPF-3pl'} \\
\text{e. } & \text{yə-ñaýd-u, yə-ñaýd-u 'go-IMPF-3pl'}
\end{align*}
\]

When ä and y belong to different syllables—as in tä-šät-u 'sell-REFL-GERUND', šät-ə 'sell-NOM', tä-fatəy-u 'love-RECIPE-PERF'—y may not be deleted. This observation justifies a structure-dependent formulation of y-Deletion.

---

\(^{13}\) That geminate clusters persist in word-final position until the postlexical stages of the derivation is shown not only by mel, fel but also by the metrical behavior of forms such as miles(s) 'soldier', ter(t) 'three times' (Niedermann (1953, 119-120)). The explanation for the vocalism of mel, fel can be extended to that of vel 'or' (compare related velle 'want').
(30) **y-Deletion**

\[
\begin{array}{c|c}
  r_2 & \emptyset / \ r_1 \\
\end{array}
\]

\[X \quad X]_R

As expected, forms containing äyy have no possible variants: despite the fact that the first part of the geminate y is tautosyllabic with ä, it fails to delete because its loss would affect not only the coda X of the first syllable but also the onset X of the following one.

(31) a. qāyyād-a ‘bind-PERF-3sg’
    b. qāyyād-u ‘bind-PERF-GERUND’
    c. yə-śāyyət ‘sell-IMPF-3sg’

Another optional rule of Tigrinya reduces iiw diphthongs to o. The verbal forms below are based on the roots ворот ‘carry’ and 负责同志 ‘love’. The uncontracted forms are subject to an optional rule that rounds a to ə before or after w.

(32) a. yə-ṣāwr-u, yə-ṣor-u ‘carry-IMPF-3pl’
    b. tə-ṣāwr-i, tə-ṣor-i ‘carry-IMPF-2sg fem’
    c. yə-ftāw, yə-ftō ‘love-IUSS’
    d. yə-fāttāw, yə-fattō ‘love-REFL-IMPF’
    e. fātāw-ka, fātō-ka ‘love-PERF-2sg’

The contraction of äw is impossible in heterosyllabic sequences: forms such as sāwar-i ‘carry-NOM’ have no alternative pronunciation *soari. This establishes the structure-dependent nature of Contraction: its input sequences must be tautosyllabic.

The äw-Contraction rule involves the same process as Latin Contraction: a merger of the supralaryngeal features of ä and w. Unlike in Latin, the only underlying specification for the feature [high] is assumed to be [- high] in Tigrinya, consistent with the fact that the epenthetic vowel, typically the least specified element in the vowel inventory, is the high vowel ə. The effect of the feature merger between ä (underlying [- low, - high]) and w (underlying [+ round]) should then be a [- low, - high, + round] segment; this is indeed the composition of o. In further contrast to Latin, Tigrinya does not allow doubly linked [+ syllabic] segments (that is, long vowels). Hence, the result of Contraction is short o: Tigrinya falls in the class of languages in which the absence of underlying vowel length makes Compensatory Lengthening impossible (see De Chene and Anderson (1979)).

---

14 On the relation between epenthesis, vowel inventories, and underspecification, see Archangeli (1984).
Since no further rules of association exist, the X slot left without segmental content in the output of (33) will not be realized phonetically.

For our purposes, the significant aspect of aw-Contraction is that the second element of the aw diphthong loses its supralaryngeal specifications. When applied to a äwVwV sequence, this step of rule (33) would give rise to the familiar dilemma: either remove the segmental content of both X slots associated with w, even though only one of them meets the rule, or fail to affect either one. As in all cases encountered so far, the rule fails to apply:

(34) a. yo-shawwar ‘carry-IMPF’
    b. zawwara ‘turn-PERF’
    c. zawwiru ‘turn-GERUND’
    d. sëwwr ‘call-PERF’

2.4. Structure-dependent Contexts: Tigrinya Spirantization

The rules examined so far identify their targets in structure-dependent terms: the target segment either must be tautosyllabic with the trigger or must belong to a particular position in the syllable. In this section we analyze a class of rules that are structure-dependent only by virtue of requiring adjacency to a skeletal position. A family of Semitic rules spirantize an obstruent if it follows and is adjacent to a syllable nucleus. Although the context predicate of these rules is identified by its syllabic position, the target is defined in segmental terms (it must be an obstruent in Tiberian Hebrew, a velar obstruent in Tigrinya) and may occupy any position in the syllable.

Tigrinya Spirantization obligatorily turns a postvocalic velar or uvular stop into a spirant. The rule may optionally apply across an intervening [−consonantal] segment.
(We follow Leslau's practice of representing the effects of Spirantization by underlining the segment.)

(35) a. mə-btāk 'to cut'
   b. bātāk-na 'we cut'
   c. sānduq-ay 'my box'
   d. bārāk-a 'he blessed'
   e. māqāddātī 'instrument for well-digging'
   f. māqāmmācā 'buttocks'
   g. sārāh-ka or sārāh-ka 'work-PERF-2sg'
   h. nay bəfray kosad or nay bəfray kəsād 'the ox's neck'

The target of Spirantization must be a [+back] segment in either a coda (35a,b,e) or an onset (35c,d,f–h) position. In contrast, the context of Spirantization is not segmentally but structurally defined as the syllable nucleus. Our interpretation of the optional Spirantization across a glide is that suggested by Lowenstamm and Prunet (1985), who draw attention to the fact that Tigrinya glides may also be optionally overlooked in the context of Epenthesis. Thus, Epenthesis is obligatory when triggered by a final C₁C₂ cluster but becomes optional when C₁ is a glide: /kālb/ 'dog' is always realized as kālbi, but /bāyt/ 'house' may surface intact. Lowenstamm and Prunet suggest that the optionality of Epenthesis and Spirantization after postvocalic glides can be attributed to a rule formally equivalent to Shortening (9b).

(36) Tigrinya Shortening (optional)

Given an underlying representation /bāyt/, with a one-to-one mapping between segments and X's, Shortening may bleed Epenthesis, in which case bāyt is derived, a syllable with a light diphthong and a single coda segment. Shortening may also fail to apply, in which case the yt cluster remains biconsonantal, triggers Epenthesis, and yields bāyti.

The optional application of Epenthesis derives the variation illustrated in (35g) and (35h). Spirantization is triggered by a nuclear X—the rime-initial X—regardless of its segmental contents. If this X belongs to a sequence that has undergone Shortening, the result is forms like sārāhka. If Shortening has failed to apply to the sequence, the glide will not be in nuclear position, and forms like sārāhka will be derived.¹⁵

The interaction of Spirantization and Shortening is a persuasive argument for iden-

¹⁵ We can support Lowenstamm and Prunet's suggestion with the following observation: Pam (1973) describes a variety of Tigrinya that, unlike the variety spoken by Leslau's or Lowenstamm and Prunet's informants, disallows Spirantization after glides, and has obligatory Epenthesis before all C₁C₂ clusters, even when C₁ is [-consonantal]. Both facts can be explained if Pam's dialect lacks Shortening.
tifying the trigger of Spirantization in structural terms as a nucleus (N). The optimal statement of Spirantization should then be the one given in (37).

(37) **Spirantization**

\[
\begin{array}{c}
\text{[+ back]} \\
\text{r} \rightarrow \text{[+ cont]} / \\
X_1 \quad X_2 \\
\text{N} \\
\end{array}
\]

It is obvious that the proper formulation of Spirantization must require adjacency between the context N and the target velar: had adjacency not been a factor in the rule, any velar, preceded anywhere in the word by a vowel, would have spirantized.

As shown by the forms in (38), Spirantization is subject to geminate blockage.

(38) a. fākkārā 'boasts'
    b. yā-btākk-o 'let him sever it'

Rule (37)—in particular, the fact that the rule stipulates adjacency between X's—will explain the blockage of Spirantization in (38): both X's in the geminate cluster k: cannot be adjacent to the context nuclear X. This case reduces then to the general observation made so far for every case of geminate blockage: a rule is blocked when only one X in the target geminate sequence satisfies its structural description.

3. Geminates and Spreading Rules

3.1. Partial Spread: Tigrinya Rounding Rules

One aspect of geminate behavior that is abundantly illustrated in the phonology of Tigrinya is that geminates are never restricted from participating in rules that do not affect their segmental make-up.

Tigrinya has several rules that assimilate a vowel to the roundness of a neighboring w. None of these rules fail to be triggered by geminate ww's. Of particular interest are those rounding assimilation rules that are structure-dependent. In sharp contrast with the structure-dependent rules seen so far, which could apply only to strings containing nongeminate glides, these rounding rules apply to geminate and nongeminate glides alike. The difference lies solely in the fact that Rounding does not alter the matrix of a participating glide but simply extends some of its specifications to a neighboring vowel.
The mid vowel ā is subject to optional rounding when adjacent to w. Rounding is obligatory when ā and w belong to the same rime.16

(39) a. /šāwār-a/ → šāwāra and šāwāra ‘carry-PERF-3sg masc’
   b. /šāwir-u/ → šāwiru and šāwiru ‘carry-GERUND-3sg masc’

(40) a. /yə-sāwwr/ → yəsāwwər ‘carry-IMPF-3sg masc’
   b. /yə-sāwwr-u/ → yəsāwwru ‘carry-IMPF-3pl masc’
   c. /sāwwár-a/ → sāwwāra ‘turn-PERF-3sg masc’
   d. /sāwwəə/ → sāwwəə ‘call-PERF-3sg masc’
   e. /yə-fəttāw/ → yəfattāw ‘love-REFL-IMPF-3sg masc’
   f. /fattāw-kā/ → fāttāwkā ‘love-PERF-2sg masc’
   g. /yə-wləd/ → yəwləd ‘engender-CAUS-IUSS-3sg masc’

A similar rule assimilates ā in rounding to a following tautosyllabic w.

(41) a. /yə-wləd/ → yuwləd ‘engender-IUSS-3sg masc’
   b. /yə-ʃəwwər/ → yəşəwwər ‘carry-REFL-IMPF-3sg masc’
   c. /yə-ʃəwwr-u/ → yəşəwwru ‘carry-REFL-IMPF-3pl masc’
   d. /yə-fəttw/ → yəfattw > yəfattuw ‘love-IMPF-3sg masc’

Note that in (40a–d) and (41b–c) the geminate ww can trigger rounding assimilation.

3.2. Turkish Velar Palatalization


16 Leslau records the effects of this and the following rule with full consistency in the body of his grammar. The tables of verb conjugations found at the end of the grammar contain a more erratic record of these rules. Because of the inconsistency in spelling it is impossible to tell whether the rule of ā-Rounding is obligatory or merely very frequent. Another source of uncertainty is the fact that sequences like āwā, āwwā, which contain two vowels eligible for Rounding in the context of the same w segment, are systematically transcribed by Leslau as if only one vowel can undergo the rule. Thus, Leslau always writes şawārā, zāwwārā and never writes *şawārā, *zāwwārā for /sāwārā/, /zāwwārā/. If the transcriptions are accurate, then a further rule appears necessary, whereby a triply associated [+round] feature has its rightmost association line severed. This will correctly characterize the facts presented by Leslau: an intermediate āwā will undergo partial derounding and yield āwā.
It is significant, then, that Velar Palatalization takes place regardless of whether the trigger front vowel is long (ha.ḵi.ḵat ‘truth’) or short (fa.ḵir ‘poor’).\textsuperscript{17}

Facts like these establish that the problem of geminate blockage cannot be approached by issuing a blanket prohibition against geminates participating in structure-dependent rules. The significance of this conclusion will become apparent below.

### 3.3. Total Spread: Romance Affrication

A different instance of spreading, this time involving an entire matrix rather than one of its components, is found in the Romance pattern of gemination and affrication before y.\textsuperscript{18} Here too a structure-dependent rule may apply to a geminate cluster as long as its segmental contents remain intact.

Posttonic sequences of ty and tty merge as [tt\textendash] in Proto-Romance and are preserved as such (spelled zz) throughout the history of Italian: capitium ‘belonging to the head’ becomes *capityu and eventually capezza; puteus ‘well’ (→ *putyu) becomes pozzo. Examples of tty becoming tts are bottia (→ bottya) → bozza ‘lump, growth’, gutteola ‘little drop’ (→ *gluttyola) → ghiozzo, mattea ‘cudgel’ (→ *mattya) → mazza.\textsuperscript{19} We discuss here only the facts of Italian, the Romance language that never lost the inherited Latin distinction between long and short consonants.

Two elements must be distinguished in the evolution of posttonic (t)ty clusters: the gemination of the stop before y, a process that affects all stops in Italian, and the strengthening of y into s after t. Examples of the former are sapiat ‘know-SUBJ-3sg’ (→ *sapya) → sappya, spelled sappia; rabies ‘rage’ (→ *rabya) → rabbya, spelled rabbia. In the

\textsuperscript{17} We would expect that the targets of such rules (Tigrinya ə and ā; Turkish velars) should never be geminates, since the contents of their matrices do change in the process. This prediction cannot be tested since Tigrinya does not have long vowels and Turkish lacks monosegmental consonantal geminates.

\textsuperscript{18} We are grateful to Y.-C. Morin for bringing to our attention the phenomenon discussed in this section.

\textsuperscript{19} Data from Meyer-Lübke (1930). See also the discussion in Meyer-Lübke (1890, 452–461).
case of (t)ty clusters the ultimate result of this development is a geminate affricate, as in (43), not a (t)ts cluster.

(43) \[ \begin{array}{c}
\text{X} \\
\text{X}
\end{array} \]

Bearing in mind that the structural outcome of the development must be the affricate in (43), we propose a general spreading rule, (44), and a stridentization rule, (45). The details of the latter may well differ, in ways irrelevant to our argument, from the statement in (45). What we focus on is the Spreading rule. As Y.-C. Morin (personal communication) points out, this rule must be structure-dependent on two counts: first, because it must mention the skeleton slot onto which a root node spreads and, second, because the Proto-Romance distinction between y and i is predictable in structural terms, with y occurring in the onset and i occurring elsewhere.

(44) \[ \text{Spreading} \]

(45) \[ \text{Stridentization} \]

By stating (44) as spreading rather than gemination (the insertion of an X slot), we explain why the sequence of changes (44)–(45) ultimately results in the affricate structures in (43) and we relate this development to the gemination of other stops before y.

If (44) is allowed to apply to simplex as well as geminate stops, the partial derivations in (46) result.

(46) \[ \begin{array}{c}
\text{p u t y u} \\
\text{X X X X X}
\end{array} \quad \begin{array}{c}
\text{m a t y a} \\
\text{X X X X X}
\end{array} \]

(44) \[ \begin{array}{c}
\text{p u t y u} \\
\text{X X X X X}
\end{array} \quad \begin{array}{c}
\text{m a t y a} \\
\text{X X X X X X}
\end{array} \]

(45) \[ \begin{array}{c}
\text{p u t s u} \\
\text{X X X X X}
\end{array} \quad \begin{array}{c}
\text{m a t s a} \\
\text{X X X X X}
\end{array} \]

We attribute one step in the derivation of mattsa, the reduction of the trigeminate after...
Spreading, to convention rather than to specific rule: no known language makes this type of geminate:trigeminate distinction.

The significant fact here is that Spreading applies indifferently to singly and doubly linked t’s. By its very nature this rule is structure-dependent and thus potentially subject to geminate blockage. However, Spreading does not result in any change at the segmental level: the root nodes participating in it are maintained distinct and intact, even though their temporal spans are changed. This, we claim, is the reason why Spreading can apply to geminates.

4. Geminates and Segmental Rules

The central question of this study is, What are the conditions under which geminate blockage occurs? One aspect of the hypothesis we investigate here is that structure-dependent rules will be, by their very nature, the only ones to “notice” the difference between singly and multiply associated segments and, consequently, the only ones to be blocked from affecting monosegmental geminates.

We turn now to a category of rules that, on this hypothesis, would be expected to affect the segmental content of geminate sequences. These are rules whose structural description provides information limited to the segmental tier. Our observation is that all rules of this type affect geminates and nongeminates alike.

Some context-free examples first: the rule that turned Latin y into Italian [j] (spelled gi) affected both forms like yam ‘already’ (Ital. gia) and forms like mayyorem (Ital. maggiore). The Attic sound change that fronted u to ù applied to both the long and the short version, as did the Indo-Iranian sound change that lowered the mid vowels e and o to a.

The most frequently encountered examples of segmental rules that apply without discriminating between geminates and simplex segments are harmony rules. Thus, the Khalkha ablative suffix /-aas/ alternates according to the rules of Front Harmony and Round Harmony: aab-aas ‘father-ABL’, odoog-oos ‘now-ABL’, ger-ees ‘house-ABL’, tör-oös ‘state-ABL’. Neither Front Harmony nor Round Harmony is structure-dependent; neither requires information about the syllabic or skeletal structure of the string. Most harmony rules we know are of this type. A source of apparent difficulty is the harmony rules whose domain of spreading is metrically delimited. Two examples of this type—Tigre and Maltese Rounding Harmony—are analyzed in McCarthy (1979): in both cases a harmony rule applies within the confines of a quantity-sensitive unbounded foot whose head is the trigger vowel. As a result, long vowels are restricted to head position and may only trigger harmony, not undergo it. An interesting confir-

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20 We need not belabor the point that rules that remove skeletal slots, without directly affecting their segmental content, will be free to apply to geminate clusters. For some examples, see Hayes (1984).
22 For a general discussion of this phenomenon, see Steriade (1981) and Van der Hulst and Smith (1984).
mation of McCarthy’s hypothesis that Tigre and Maltese harmony spreads within a metrically delimited domain is the fact that in both cases harmony is directional: thus, Maltese /šurbitiilim/ ‘she drank it (fem.) from them’ becomes šurbitiilim, but /kitbuulik/ ‘he wrote it to you’ becomes kitbuuluk, without leftward spread, since the harmony feet are left-headed ([kit]_[buulik]_φ). Thus, it is not geminate blockage but rather metrical weight that explains why long vowels block these harmony rules. We would predict, then, that no comparable consonant harmony rules would be blocked from affecting geminates, since no theory of metrical weight can distinguish between a single consonant and a geminate one.

4.1. Sanskrit ṉati I

A case in point is Sanskrit n-Retroflexion or ṉati. This long-distance rule has a single focus: the first n found to the right of the retroflex continuants r and s is turned into ɳ. The string intervening between target and trigger is virtually unbounded in length but may not include coronals. A further restriction is that n must be followed by a nonliquid sonorant. On this aspect of the rule, see section 5.1. Anticipating our conclusions there, we will ignore this restriction in the statement of ṉati. All limitations on the applicability of the rule are segmental: as the examples below indicate, the structural properties of the trigger, target, or intervening segments have no bearing on the applicability of ṉati.23

<table>
<thead>
<tr>
<th>Sanskrit</th>
<th>Transliteration</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>-na-</td>
<td>-nā-</td>
<td>'present'</td>
</tr>
<tr>
<td>pr-na-</td>
<td>pr-nā-</td>
<td>'seek'</td>
</tr>
<tr>
<td>mṛd-nā-</td>
<td>mṛd-nā-</td>
<td>'be gracious'</td>
</tr>
<tr>
<td>-na-</td>
<td>pūr-na-</td>
<td>'fill'</td>
</tr>
<tr>
<td>bhug-na-</td>
<td>'be gracious'</td>
<td></td>
</tr>
<tr>
<td>-na-</td>
<td>vṛk-na-</td>
<td>'cut up'</td>
</tr>
<tr>
<td>'bend'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-āna-</td>
<td>pur-āṇa-</td>
<td>'middle'</td>
</tr>
<tr>
<td>marj-āna-</td>
<td>'wipe'</td>
<td></td>
</tr>
<tr>
<td>kṣubh-āṇa-</td>
<td>'quake'</td>
<td></td>
</tr>
<tr>
<td>kṣved-āna-</td>
<td>'hum'</td>
<td></td>
</tr>
<tr>
<td>caks-āṇa-</td>
<td>'see'</td>
<td></td>
</tr>
<tr>
<td>-māna-</td>
<td>kṛṣ-a-māṇa-</td>
<td>'middle'</td>
</tr>
<tr>
<td>kṛt-a-māṇa-</td>
<td>'cut'</td>
<td></td>
</tr>
</tbody>
</table>

23 For more details, see Whitney (1889, 64). Previous analyses of ṉati include those of Vergnaud and Halle (1978) and Selkirk (1980).

24 The right-hand column shows morpheme alternants in forms where ṉati is either blocked or lacks a trigger.
bhrham-  bhrman
brahman-LOC sg  'brahman-VOC sg'

bhrman-y
'relating to a brahman'

-na/-n-  tr-na-t-ti  tr-n-t-te
'represent' 'present-3pl active' middle'

The triggers of Nati can be the nucleus, as in pr.na.ti, the coda, as in pür.na-, or the onset, as in pu.r.ṇa-, brah.m.a.ny.a-, kṣu.bhā.na-. The target of the rule can be in the rime, as in trn.man, or in the onset, as in iṣ-ṇa-. The segments blocking Nati can be codas, as in trnt.te, mrd.nāti, or onsets, as in tu.sa.yan_ti, mār.ja.na-. No restriction can be observed on the number or weight of syllables intervening between target and trigger. We formulate Nati below, exploiting our assumption that coronal is a class node rather than a feature. (The statement of Nati is further discussed in Steriade (1985b).)

(48) Nati

If the formulation in (48) is correct, Nati should be able to affect geminate as well as simplex n's. We have not found reliable examples of tautomorphemic nn sequences that could qualify as targets for (48). We have found, however, a phonological rule that creates nn sequences out of heteromorphemic d-n clusters. This rule assimilates in nasality only d-n sequences that involve the na participial suffix (Whitney (1889, 343-344)). Its effect can be observed in forms like unna- ‘wet-PPLE’ from /ud-na/, chinna- ‘cut off-PPLE’ from /chid-na/, bhinna- ‘split’ from /bhid-na/. Consider now the na-participles of roots that contain the triggers of Nati: kṣviṇṇa- on kṣvid- ‘hum’, kṣuṇṇa- on kṣud-‘crush’, chrṇṇa- on chrd- ‘eject’, trṇṇa- on trd- ‘cleave’. We must assume derivations as given in (49), where Nasal Assimilation feeds Nati.
This completes our case for analyzing Ɲati as a rule whose purely segmental description allows it to affect an entire geminate cluster.

4.2. Japanese Palatalization

Japanese Palatalization, a local rule with properties similar to those of Ɲati, palatalizes s when immediately followed by a high front vowel or glide: compare das-anai ‘go out-NEG PRES’ with daš-imasu ‘go out-FORMAL PRES’. Palatalization takes place before y as well, followed in this case by the loss of y: French Saussure is borrowed as Sošuru, analyzable within Japanese as underlying /sosyur/; before the hortative ending yoo (tabeyoo ‘let’s eat’) palatalization is observed with certain verbs (des-yoo → desoo ‘let’s be’) as an alternative to the more general treatment that would simplify the cluster (das-yoo → das-oo ‘let’s go out’).25 Once again, the information necessary to determine whether the rule can apply is of a purely segmental nature. W. Poser (personal communication) notes that Palatalization does apply to geminate ss, as predicted. This is indicated by the alternations in the paradigm of ass- ‘exert pressure’: ass-azu ‘without exerting pressure’, ass-u-ru ‘exerts pressure’ but ašš-ita ‘exerted pressure’, ašš-ite ‘exerting pressure’, ašš-inai ‘does not exert pressure’. Facts essentially identical to those of Japanese Palatalization are reported by Newton (1972, 92, 133, and passim) about Modern Greek dialects.

4.3. Malayalam Palatalization I

An interesting example of a similar nature is presented by Mohanan and Mohanan (1984): Malayalam palatalizes velars after a front vowel. The rule may apply to geminates: /kutti-kka/ ‘child-DAT’ surfaces as kuttik’k’a, whereas /awar-kka/ ‘they-DAT’ surfaces as awarkka. Mohanan and Mohanan note that Palatalization fails to apply in preconsonantal position—/wi-kramam/ ‘good deed’, for example, does not surface as *wik’ramam—and they write this into their statement of the rule. But this fact appears to require no additional restriction on the palatalization rule: as Mohanan and Mohanan

25 See Grignon (1980), whose study of Japanese palatalization we rely on, for a different analysis of dešoo.
note, Malayalam palatal consonants regularly depalatalize in preconsonantal and final position. We suspect that the Depalatalization rule is syllabically conditioned and that the disjunction of environments \{\_\_ C, \_\_ \#\} should be interpreted as indicating that the targets of the rule are segments in the rime. If so, Malayalam Depalatalization is identical to the Spanish Depalatalization rules discussed by Harris (1983). More significantly, its failure to affect geminates follows from its structure-dependent status. Our analysis thus explains both the fact that Palatalization, a segmental rule, may turn /kuttik'k'a/ into kuttik'k'a and the fact that Depalatalization, a structure-dependent rule, may not turn kuttik'k'a into *kuttikk'a. We will have more to say about the formulation of Palatalization below.

5. Geminate Blockage and Partially Assimilated Clusters

Partial assimilation is assumed here to involve autosegmental spreading rather than copying. Several considerations support this assumption: some are presented by Clements (1976), Goldsmith (1979), and Steriade (1982). The argument for spreading that is relevant for this study is based on geminate blockage: this phenomenon, the trademark of a multiply linked matrix, can be caused not only by geminates but also by the outputs of partial assimilation.

Thus, epenthesis rules are blocked from inserting a segment inside a cluster that has undergone a partial assimilation rule: relevant cases include place assimilation in Kolami, voicing assimilation in Tamazight Berber (Steriade (1982), Shlonsky (1985)). Rules merging identical place components into a single one (Sierra Popoluca in Clements (1985), Tangale in Kenstowicz and Kidda (1985)) result in clusters with identical properties: epenthesis cannot separate their members.

Rules altering the contents of a matrix may also be blocked by the effects of partial assimilation. We discuss below three such cases.

5.1. Sanskrit ṇāti II

Recall that ṇāti is claimed not to apply unless the following segment is a nonliquid sonorant: compare brahman with brahman-ya, trn-man with trnt-te. Whitney’s statement to this effect covers the lack of ṇāti effects in the following cases: (a) before a liquid; (b) before a continuant obstruent; (c) in word-final position; (d) before a stop.

It turns out, however, that only n before stops (class (d)) involves a clear failure of ṇāti: this will be shown to result from geminate blockage. All other classes of contexts enumerated above either undergo the rule and have their effect neutralized by a later rule or else do not contain, when ṇāti applies, a proper target for it.

Thus, n becomes a nasalized vowel ( anusvāra, spelled \(\dot{n}\)) before all nonsyllabic continuants (s, ś, ś, r, and h): mañ-ya-te ‘think-FUT-3sg’; da-daṅs-ur ‘bite-PERF-3pl’; rañ-ran- ‘take pleasure-INTENSIVE’; vṛṅ-h-ati ‘roar-3sg’. Since anusvāra appears to
lack an independent point of articulation, it is impossible to tell if Nati has applied to the nasal stop underlying it. This eliminates class (b) contexts and part of the contexts from class (a). The remaining class (a) sequences, the nl clusters, undergo a rule whereby n becomes a nasal lateral (Whitney (1889, 24, 69)). Although Whitney appears to restrict this rule to external sandhi, no evidence for word-internal nl sequences can be found. Since the place of articulation of nasal laterals is not distinctive, it is once again impossible to claim that Nati has failed to apply in such cases. Finally, the class (c) potential inputs to Nati, word-final n’s, turn out to be subject to a pair of neutralization rules. Word-final nasals belonging to an inflectional suffix are invariably realized as m (for example, -m ‘1sg’, -dhvam ‘2pl middle’, -tām ‘3dual’, -m ‘ACC sg’, -bhyām ‘INSTR/DAT/ABL dual’, -(n)ām ‘GEN pl’), whereas other word-final nasals are always realized as n. In the case of verbal roots like gam ‘go’ the word-final neutralization leads to alternations: /a-gam-∅/ ‘AORIST-go-2sg’ → surface agan, but a-gam-a-m ‘AORIST-go-1sg’. We propose the pair of N-Neutralization rules (50a) and (50b).

(50) N-Neutralization
   a. [+ nas] m / ____] in inflectional affixes
   b. [+ nas] n / ____] elsewhere

If (50) follows Nati, the absence of retroflex consonants in word-final position is explained: forms like /brahman/ become intermediate brahman, through Nati, and then brahman, through subrule (50b) of N-Neutralization.

We can turn now to class (d) sequences: n followed by a stop. Two place assimilation rules affect the nasal-stop clusters of Sanskrit: (a) an underlying retroflex nasal (not derived by Nati) triggers progressive place assimilation onto a following coronal stop; and (b) all other nasal-stop clusters undergo regressive place assimilation. Examples of both assimilation types appear in (51).

(51) a. /phānta-/ ‘spring-PASSIVE PART’ → phañta-
   b. /gan-gant-ti/ ‘slay-INTENSIVE-3sg’ → jaṅganti
   c. /bhaNj-/ ‘break’ → bhaṅj-
   d. /bhaNj-ta-/ ‘break-PASSIVE PART’ → bhaṅkta-
   e. /bhaN-bhaNj-/ ‘break-INTENSIVE’ → bambaṅj-

These data are characterized by the rule of Nasal-Stop Assimilation.

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26 Apparent exceptions to subrule (50a), such as -n ‘ACC pl’ and -n ‘3pl’, contain underlying clusters: -ns in the first case (Whitney (1889, 113)), -nt in the second. These data show that N-Neutralization must precede the deletion of word-final obstruents, on which see Whitney (1889, par. 150).

27 As in the traditional transliteration, ŋ stands for n.
We can now identify a case of geminate blockage resulting from the interaction of this rule and \( N\)ati. First, we note that \( N\)ati must follow (52): whereas underlying sequences \( nt \), as in /phan-ta/, surface as \( nt \) (phanta), sequences containing an underlying \( nt \) cluster in the scope of a \( N\)ati trigger, as in /t\( r\)-n-t-te/, surface as \( nt \). Had \( N\)ati preceded (52), the surface result of underlying \( nt \) and of \( N\)ati-derived \( nt \) could not be distinguished. Let us therefore assume that (52) precedes \( N\)ati and consider the consequences of this hypothesis: as a result of the prior operation of (52), the n-stop clusters blocking \( N\)ati in cases like trntte, krandati, ksubhanti are all homorganic sequences, in which a single place node is shared between the nasal and the stop.

If \( N\)ati were to apply to \( n \) in such a sequence, it would necessarily affect not only the place node of the nasal but also the place node of the nonnasal obstruent. Yet \( N\)ati
is not otherwise applicable to nonnasals. The situation leading to blockage in this case is then entirely comparable to that arising in the application of a structure-dependent rule to a "real" geminate: for example, a geminate /l/ blocks the Latin /l/-Rule because the second X in the geminate cluster is not in the rime, as required by the rule. In the case at hand a place node shared between n and t blocks ṇati because it is associated not only to a segment that satisfies ṇati's requirement of being a nasal but also to a segment, t, that does not.

5.2. Visarga

In Sanskrit postvocalic word-final s becomes visarga (spelled ḷ), a sound described as aspiration homorganic to the preceding vowel (Whitney (1889, 23)). The process creating this sound is represented in (54) as delinking the supralaryngeal features of the word-final s.

(54) Visarga

\[
\begin{array}{c}
\text{sl} \\
\downarrow \\
\text{r[+cont, -son]} \\
\text{X} \\
\end{array}
\]

Visarga may be bled by two other phrase-level rules: both assimilate the final s to the place features of a following obstruent. Of these, one rule applies optionally to s before any obstruent; the other obligatorily assimilates any coronal obstruent to the place features of a following coronal stop.

(55) Assimilation to Obstruent (optional)

\[
\begin{array}{c}
\text{pl}_1 \\
\downarrow \\
\text{sl}_1 \\
\downarrow \\
\text{r}_{1[+\text{cont, -son}]} \\
\end{array}, \begin{array}{c}
\text{pl}_2 \\
\downarrow \\
\text{sl}_2 \\
\downarrow \\
\text{r}_2 \\
\end{array}
\]

Examples: manus 'man', svayam 'self': manus svayam or manuh svayam; Indras, śuras 'hero': Indraś śurah or Indraḥ śurah; tās 'those-fem', śaṭ 'six': taṣ šaṭ or taḥ šaṭ; divas 'god-GEN sg', putras 'son': divaṇ putraḥ or divaḥ putra²⁹

²⁸ The analysis presented here follows the main lines of that given in Steriade (1982).
²⁹ c notes the palatal affricate [c]; s is the palatal fricative [ɕ].
(56) Assimilation to Coronal Stop (obligatory)

\[
\begin{array}{c}
\text{cor} \\
\text{pl}_1 \\
\text{sl}_1 \\
\text{r}_1[+\text{cont}, -\text{son}] \\
\text{pl}_2 \\
\text{sl}_2 \\
\text{r}_2[-\text{cont}, -\text{son}]
\end{array}
\]

Examples: tat 'that', caksus 'eye': tac caksuh or caksus tat; tatas 'thence', ca 'and': tatas ca; padas 'foot', talati 'stumbles': padaš talati

Both assimilations must precede Visarga; otherwise, forms like tatas ca, manus svayam could not be derived, since Visarga would bleed both (55) and (56), yielding *tatah ca in one case and incorrectly ruling out manus svayam in the other. For our discussion, the significant observation is that Visarga, an otherwise obligatory rule, does not apply to any s that has undergone either assimilation rule: this is what phrases like manus svayam and caksus tat illustrate.

According to Kiparsky (1973), the first to draw attention to these facts, the blockage of Visarga in manus svayam, etc., ought to be attributed to the effects of the Elsewhere Condition, since Visarga applies everywhere the assimilation rules do not. However, the Elsewhere Condition is not really applicable to this case: first, for the general reason that the class of sequences covered by the structural description of Visarga (X [−cons] s # Z) does not properly include the class covered by either one of the two assimilation rules (X s # [−son] Z); and second, because (56) is in fact applicable to a wider class of segments than just s—as phrases like tac caksuh indicate, (56) applies to all coronal obstruents. Thus, regardless of how Visarga is formalized, its relation to (56) cannot be disjunctive and the Elsewhere Condition may not be invoked.

Geminate blockage offers the explanation for the effect place assimilation has on the later applicability of Visarga. In the output of either assimilation rule a cluster like st will contain a single place node, immune to the application of any rule that, like Visarga, is satisfied by s but not by t.

(57)
The second member of the cluster shown in (57) fails to satisfy Visarga for two reasons: it is not [+continuant] and it is not word-final. The second member of an assimilated ss cluster, such as the one in manus svayam, will likewise be ineligible for Visarga, since it is not word-final. In both cases Visarga cannot proceed without affecting the matrix of the ineligible member in the homorganic cluster; this is what blocks the rule.

5.3. Malayalam Palatalization II

The extension of geminate blockage to partially assimilated clusters allows us to explain a neglected detail of Malayalam Palatalization: homorganic ųk, ųg clusters resulting from Nasal Place Assimilation fail to undergo Palatalization. Mohanan and Mohanan (1984) report that forms like kingar’an ‘follower’ do not allow either member of the velar cluster to palatalize. Palatalization does not affect glides, so its target must be specified as [+consonantal, +back].

(58) Malayalam Palatalization

\[
\begin{array}{ccc}
\text{[-back]} & \quad & \text{[+back]} \\
\text{dor}_1 & & \text{dor}_2 \\
\text{r}_1 & & \text{r}_2[+\text{cons}] \\
\text{r}_1 \text{ adjacent to } \text{r}_2
\end{array}
\]

Consider now the output of Nasal Place Assimilation as input to Palatalization.

(59) \[
\begin{array}{ccc}
\text{[-back]} & & \text{[+back]} \\
\text{dor}_1 & & \text{dor}_2 \\
\text{pl}_1 & & \text{pl}_2 \\
\text{nas} & & \\
\text{sl}_1 & & \text{sl}_2 \quad \text{sl}_3 \\
\text{r}_1 & & \text{r}_2[+\text{cons}] \quad \text{r}_3[+\text{cons}]
\end{array}
\]

In a structure like (59) Palatalization must inspect both the (shared) place features
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node and the consonantal specifications attached to the root node: but in (59) only the leftmost \ [+high, +consonantal] root node can be adjacent (as required by (58)) to the \ [-back, -consonantal] trigger matrix. Since only the left member of the \(yg\) cluster meets the adjacency requirement and since the rule cannot apply without affecting both members, geminate blockage ensues.

Segmental, multitiered rules like Malayalam Palatalization may be blocked by partially assimilated clusters but not by full geminates: both Palatalization and \(\breve{\text{nati}}\) apply to geminates, and neither applies to homorganic nongeminate sequences. The reason for this is clear. On the tiers mentioned by a segmental rule like Palatalization (height, back, and root tiers in this case) no distinction is visible between a simplex and a geminate velar: both the geminate and the simplex consonant will appear on each of these tiers as a single node. In contrast, a homorganic cluster like \(yg\) will be identified on those same tiers as a sequence of distinct root nodes, albeit linked to a single place component.

Obviously nothing rules out the possibility that a structure-dependent rule will also be blocked from affecting the contents of a multiply linked submatrix resulting from partial assimilation. A possible example of this sort is presented next.

5.4. Turkish Palatalization and Depalatalization

The Turkish rule of Palatalization discussed in Clements and Sezer (1984) offers a final example of the blocking effects multiply linked submatrices may have on phonological rules.

As in Malayalam, Palatalization interacts in Turkish with a rule that depalatalizes velar obstruents in syllable-final position. We shall depart slightly from Clements and Sezer's formulation of this rule and state it as the feature-changing process in (60).

\[
(60) \quad \text{Turkish Depalatalization} \\
[ + \text{high}] \rightarrow [ + \text{back}] / \\
\hspace{1cm} \text{dor} \\
\hspace{1cm} \text{R(\text{-son})} \\
\hspace{1cm} \text{X} \\
\hspace{1cm} \text{R}
\]

The striking fact about this rule is that, according to the data presented by Clements and Sezer, it can affect only underlying palatal velars, not those derived by the rule of tautosyllabic Palatalization. Thus, underlying \(k\) in /infilak/ ‘explosion’ is depalatalized and yields infilak (compare the oblique form infila\(\breve{k}\), where \(k\) is an onset), but the derived \(k\) of forms like malik ‘owner’ (compare malik-ane ‘residence’) remains unaffected. A simple explanation for this asymmetry is that Depalatalization can apply to an underlying palatal stop because such a segment has inherent \([-\text{back}]\) specifications, unlinked to
those of a neighboring segment. In contrast, the [−back] feature of a palatal stop derived by assimilation to a tautosyllabic vowel is necessarily shared with that vowel and cannot be changed without affecting the vowel’s place component.

6. Analysis

6.1. Uniform Applicability

The results of our survey of geminate blockage can now be summarized. We have isolated three distinct aspects of geminate blockage.

(a) The rule subject to geminate blockage alters, by changing or by removing, the segmental contents of some node. Rules that do not have this effect may always apply to multiply linked nodes (section 3).

(b) The blocking configuration consists of a node \( n \) to be altered, linked to several nodes, say \( \alpha \) and \( \beta \), on some tier.

\[
\begin{array}{c}
n \\
\downarrow \\
\alpha \\
\beta
\end{array}
\]

One of these autosegments, \( \alpha \) or \( \beta \), fails to satisfy some element of the structural description of the rule.

(c) The node \( n \) in the blocking configuration (61) may be a root node multiply linked to the skeleton (a geminate proper; section 2) or a root-internal node shared by two class nodes (a sequence resulting from partial assimilation; section 5). Thus, although most of the well-known examples of geminate blockage involve structure-dependent rules failing to apply to geminates, it appears that the phenomenon covers more generally all multitiered rules failing to affect a multiply linked autosegment. The distinction between segmental and structure-dependent rules, although useful heuristically, turns out to play no role in understanding geminate blockage. The relevant distinction is that between singly linked and multiply linked autosegments.

The remainder of this section concentrates on making precise the formal content of observation (b). We have so far said informally that geminate blockage arises when part of a linked structure fails to meet a structural description. More precisely, we will suggest that the principle underlying geminate blockage requires that in a configuration like (61), where \( n \)’s contents are to be altered by a rule, both \( \alpha \) and \( \beta \) must satisfy the same conditions in the structural description of the rule.

(62) **Uniform Applicability Condition**

Given a node \( n \), a set \( S \) consisting of all nodes linked to \( n \) on some tier \( T \), and a rule \( R \) that alters the contents of \( n \): a condition in the structural description of \( R \) on any member of \( S \) is a condition on every member of \( S \).

The Uniform Applicability Condition (UAC) is formulated here as the marked case. The unmarked case is that in which the contents of \( n \) are not being affected, either because
n is a context node or because it is the target of a rule that simply alters its temporal span, leaving its contents intact: in such circumstances, any condition imposed by R on some member m of the set S in (62) is a condition on m alone.

We begin investigating the properties of the UAC by looking at five familiar cases.

(a) Latin Lowering. The node n is in this case the root node of y (r(y)), whose [high] specification is being changed to [−high]. The set S is the set of X’s to which r(y) is associated. The condition imposed by Lowering is that some member of S be tautosyllabic to a. By (62), every member of S must be tautosyllabic to a. This rules out application of Lowering to a geminate cluster yy, whose two X’s cannot belong to the same syllable.

(b) Tigrinya Spirantization. The node n is in this case the root node of a velar (r(k)), which is being specified [+continuant]. The set S is the set of X’s to which r(k) is associated. The condition required of some member of S by Spirantization is right-adjacency to a nuclear X. By (62), this condition must be met by every member of S; therefore, a geminate velar, one of whose X’s cannot be postnuclear, will block the rule.

(c) Sanskrit Visarga. The node n is in this case the supralaryngeal node of s (sl(s)), which is being removed by Visarga. The set S is the set of root nodes to which sl(s) is associated. The conditions imposed by Visarga are that (a) some member of S must be a continuant obstruent and (b) some member of S must be associated to a word-final X. By (62), these conditions must be met by all members of S. Two types of sequence block Visarga: in forms like manus svayam (\(\text{manus} : \text{vayam}\)) the blocking sequence is a geminate s: whose second X is not word-final. In forms like caksus tat the blocking sequence is a supralaryngeal node, one of whose associated root nodes (r(t)) is neither word-final nor continuant.

(d) Malayalam Palatalization. The node n is in this case the place node of a velar (pl(k)), whose [back] specification is being turned into [−back] by assimilation to a preceding [−back, −consonantal] segment. The set S is the set of root nodes (r(k)) to which pl(k) is (indirectly) associated. Malayalam Palatalization requires that r(k) be adjacent to the root node of the [−back, −consonantal] segment. When pl(k) is associated to more than one root node, as in the case of a homorganic yg cluster, this condition cannot be met by every member of S: the second root node in this cluster will not be adjacent to that of the context segment (see (59)).

(e) Sanskrit Nati. The node n is in this case the place node of a coronal consonant (pl(t)), whose specifications are being changed to [−anterior, −distributed]. The set S is the set of supralaryngeal nodes (sl(t)) associated to pl(t). The condition is that sl(t) contain the specification [+nasal]. When pl(t) is simultaneously linked to several sl(t) nodes of which one is not [+nasal], the rule is blocked.

We should compare these cases of geminate blockage to cases in which a rule alters a multiply linked node.

(f) Yokuts Lowering (Newman (1941), Archangeli (1984)). This rule lowers long high vowels to mid. The structural description of Yokuts Lowering is given in (63).
In this case $n$ is the root node, whose [high] specification is changed to [-high]. The set $S$ is the set of $X$’s linked to such a root node: the condition imposed by (63) is that every member of $S$ must belong to the same Nucleus as another $X$ that is itself linked to the same root node. Note that every $X$ in a long vowel sequence will meet this condition.

(g) *Menomini Raising* (*Bloomfield* (1962), *Cole* (1985)). This is a vowel harmony rule that assimilates in height a long nonlow vowel to a following high vowel. Its structural description is given in (64).

\[(64) \quad [-\text{low}] \rightarrow [+\text{high}]\]

Does the UAC allow this rule to apply to long vowels? Raising is a long-distance assimilation (for example, in *pu:se-tuaq* ‘when they embark’ from intermediate /po:se-tuaq/; compare related *po:se-t* ‘when he embarks’); therefore, adjacency should not be required between any pair of nodes in its input string. In particular, adjacency is not required between the $X$’s associated to its target root node and any $X$ associated to the context high vowel. It is for this reason that the application of Raising to a long vowel is compatible with the UAC. In the terms of the UAC, the node $n$ being altered is the root node of a [-low] segment ($r([-\text{low}])$); its [high] specification is changed to [+high]. The set $S$ is the set of $X$’s associated to $r([-\text{low}])$. The condition that must be met by every member of this set is merely association to the same Nucleus as an $X$ associated to the same root node. Note that every $X$ in a long vowel sequence will meet this condition.

It is likely that a more detailed study of this rule will conclude that [tense] rather than [high] is the spreading feature. Since our argument does not depend on the choice of spreading feature, we continue to refer to this rule as Raising.
to the same r([-low]) node. As in the case of Yokuts Lowering every X in a long nonlow vowel sequence will meet this condition.

Two types of rules discussed above deserve further comment. The UAC predicts geminate blockage in the case of Tigrinya Spirantization and Malayalam Palatalization because a multiply linked target of these rules (geminate velar in Tigrinya; homorganic \(ng\) cluster in Malayalam) cannot meet the stipulated conditions of adjacency. Adjacency between target and context is clearly required in both cases: what is not immediately clear, though, is that adjacency must be imposed on precisely the tiers where our rules mention it. For example, if Spirantization were reformulated as requiring adjacency between the root node of the target velar and the root node of the context vowel but not necessarily between their associated X’s, the rule would continue to apply as before to simplex velars but the UAC would now allow it to affect geminate velars as well. If Malayalam Palatalization were restated to require adjacency between the place node of the target velar and the place node of the context vowel (rather than their associated root nodes), then a multiply linked place node like that of \(ng\) could undergo the rule. Since no empirical considerations rule in favor of the statements we have chosen and against the alternatives mentioned, the validity of the UAC as a predictor of geminate blockage in these cases could be questioned. Our solution to this problem is based on the observation that some factors in the statements of Spirantization and Palatalization must be invariant. Any description of the context of Spirantization must mention the skeleton and must require adjacency between target and context. Any description of the target and context of Palatalization must mention the root tier (where information about the feature [consonantal] is encoded) and must require adjacency: Palatalization is not a long-distance rule. Suppose now that the format of structural descriptions includes the following elements: (a) the description of the target autosegment; (b) the description of the context autosegments; (c) the list of relations that must hold between target and context (association, precedence, adjacency, constituent structure). Our suggestion is that relations like adjacency and precedence, if mentioned in a rule, cannot be limited to hold on a particular subset of tiers, but must hold on every one of the tiers mentioned in the description of the target and context configurations. The effect of this proposal on the formulation of Tigrinya Spirantization is that adjacency between the context vowel and the target velar will have to hold on the [back] tier, on the root tier, and on the skeleton, since reference to these tiers is independently required in order to properly characterize target and context. In the case of Malayalam Palatalization adjacency must hold on the place and root tiers. Since the syllabic position of both target and context is irrelevant to this rule, the skeleton is not mentioned and adjacency on that tier is not required.

6.2. The UAC and the Linking Constraint

The examples used in the preceding section to illustrate the UAC appear compatible with a different view of geminate blockage: that presented in Hayes (1984; 1986b). Hayes
suggests that when an association line between autosegments on two tiers is represented in a structural description, it is interpreted as the sole association connecting either autosegment to elements on the other tier.

(65) **Linking Constraint** (Hayes (1984))

Association lines in structural descriptions are interpreted as exhaustive.

Put yet another way, the Linking Constraint is a convention that interprets the relation *is associated to* as the relation *is exclusively associated to*.

Consider the application of the Linking Constraint to three rules discussed here: Latin Lowering, Malayalam Palatalization, and Yokuts Lowering. Latin Lowering (14) mentions the association line between a [−back, −consonantal] segment and an X in the rime. The Linking Constraint has the effect of making any string unanalyzable by this rule if it contains a [−back, −consonantal] segment that is linked to more than one X. In the case of Malayalam Palatalization the required formulation (58) makes no mention of association lines to the skeleton. For this reason, the Linking Constraint does not block Palatalization from affecting a doubly linked velar. On the other hand, the (indirect) association between the place node of the velar and its root node must be represented in the rule. For this reason, the Linking Constraint predicts that a doubly linked velar place node will be unaffected by Malayalam Palatalization. This is, again, the correct result: the rule affects geminate velars but does not affect homorganic velar clusters. Finally, the structural description of Yokuts Lowering (63) must mention both X’s in the nucleus of a long vowel and their associations to the target [ + high] segment. This rule is therefore also compatible with the Linking Constraint.

Our proposal makes distinct predictions from Hayes’s in several areas. In one respect the UAC is more limited in scope than the Linking Constraint: it predicts geminate blockage only for rules that change the contents of a segmental node. In contrast, Hayes’s convention interpreting association as exhaustive can describe geminate blockage in a much wider range of cases. Thus, the Linking Constraint appears to predict, incorrectly, that Tigrinya Rounding (see data in (41)) should not be able to spread [+round] from the matrix of a geminate ww; that Turkish Velar Palatalization (42) should not be triggered by the [−back] specification of a long vowel; that Romance Spreading (44) should not apply to a *geminate*-y sequence; and finally that a homorganic cluster like rs should not trigger Nati (48). In each of these cases the simplest statement of the rule, the one adopted in our discussion, mentions a single association line between two autosegments in the relevant configuration. For example, in the case of Turkish Velar Palatalization rule (42) requires that the spreading [−back] be associated to an X that is tautosyllabic with that of the velar consonant: the association between [−back] and this X is interpreted by the Linking Constraint as exhaustive, and this would erroneously block the application of the rule in a form like *haki:kat*.

Perhaps a more revealing difference between the two approaches emerges when we consider again rules like Yokuts Lowering and Menomini Raising, which do affect gemi-
nates. According to the Linking Constraint, what allows such a rule to apply to a long segment is the fact that both its X’s are mentioned in the structural description of the rule. According to the UAC, these rules may take effect not because both X’s are mentioned but because both satisfy the same structural conditions. It should be possible to test these divergent claims, then, by using two types of rules: (a) rules that alter an autosegment n multiply linked on some tier to nodes α and β, where both the association of n to α and that of n to β are mentioned in the structural description, but where α must meet distinct conditions from β; and (b) rules that alter an autosegment linked to some node α but stipulate of this α conditions that could be met by more than one element on α’s tier. According to the UAC, rules of type (a)—fictional examples of which are given below—should never be applicable to any string, since the UAC requires the two nodes α and β in the linked configuration to satisfy exactly the same conditions.

(66) Fictional Spirantization

\[
\begin{array}{c}
X_1 \quad X_2 \quad X_3 \\
\hline
X_1 \text{ adjacent to } X_2
\end{array}
\]

Rule (66) imposes distinct conditions on the X’s associated to the target segment: X_2 must be adjacent to the nuclear X_1, whereas X_3 need not—indeed could not—be adjacent to X_1 but must be linked to the same root node as X_2. Whereas the Linking Constraint permits the application of a rule like (66) to strings that satisfy its description, the UAC predicts that (66) and similar rules will always be blocked. Note that (66) is crucially different from Menomini Raising, a rule restricted to geminates but not requiring adjacency between the geminate configuration and the context segment. Insofar as rules with the essential properties of (66) have not been documented, we claim this to be an advantage of the UAC. A different nonexistent rule type whose absence is similarly explained by the UAC is exemplified in (67).

(67) Fictional Palatalization

\[
\begin{array}{c}
\text{[+ nas]} \quad \text{[− nas]} \\
\hline
\text{sl}_1 \quad \text{sl}_2
\end{array}
\]

Rule (67) is a palatalization rule that applies to homorganic ſk, ſg but not to velars in isolation. The UAC predicts that every application of this rule to a string would be
blocked, since the place node altered must be linked to two supralaryngeal nodes satisfying distinct conditions: \( sl_1 \) must be nasal, whereas \( sl_2 \) must be nonnasal. In contrast, the existence of this class of unattested rules would be fully compatible with the Linking Constraint.

We turn now to rule type (b). An example of a rule that alters a node \( \alpha \) linked to \( \beta \), in strings where \( \beta \) must meet conditions that could be satisfied by more than one element on its tier, is a Menomini rule discussed by Cole (1985). Cole's analysis addresses the observation that Menomini \( u(:), o(:), \) and \( w \) are in complementary distribution: \( w \) occurs in onset and coda position, long \( u: \) occurs in contexts where Menomini Raising has applied, short \( u \) occurs in the diphthong \( ua \), and \( o, \) long and short, occurs elsewhere. Cole argues that part of the account for this distribution must include a rule lowering a nuclear round vowel to mid \( o(:) \).

(68) **Menomini Lowering**

\[
\begin{array}{c}
[+\text{round}] \rightarrow [-\text{high}] / \\
\mid \\
\mid r \\
\mid X \\
\mid N
\end{array}
\]

The autosegment altered here is the \([+\text{round}]\) root node. \( S \) is the set of \( X \)'s linked to it; every member of \( S \) must satisfy the condition of being dominated by \( N \). Obviously, both the unique \( X \) of a short \( u \) and each one of the two \( X \)'s in a long \( u: \) will satisfy this condition. The application of Lowering to a long vowel is therefore sanctioned by the UAC. In contrast, the Linking Constraint will not permit rule (68) to apply to a long vowel.

Of course, the probative value of this example depends on the correctness of the analysis cited. Similarly, the argument based on the nonexistence of rules like Fictional Spirantization and Fictional Palatalization depends on the accuracy of our survey of phonological rules. For this reason, much in our attempt to argue for the superiority of the UAC invites further study. We would like to conclude this comparison between the two approaches, however, by clarifying a point of difference that is unlikely to be affected by future research.

### 6.3. Predicting Geminates Blockage

Our interest in the phenomenon of geminate blockage, and that of earlier writers like Hayes (1984) and Younes (1983), stems from the hypothesis that blockage can be predicted. What sort of information is needed to predict whether a rule will affect a multiply linked node? The answer depends on the principle of geminate blockage that is adopted. The Linking Constraint predicts blockage from the number of association lines mentioned
in the structural description of a rule. The UAC predicts blockage from the type of relation that must obtain between the target node and its context. In this section we explore the predictive powers of the two principles and the conditions under which they can be falsified.

One of the empirical generalizations on which Younes (1983) and Hayes (1984) agree, as do we, is that structure-dependent rules like Latin Lowering are always blocked from affecting geminate segments. If this generalization is upheld—and we have no reason to doubt this—a formal explanation is called for. The Linking Constraint and the UAC provide such an explanation only if these principles would be falsified by structure-dependent rules affecting geminates.

We have observed that both the Linking Constraint and the UAC predict that rules formulated like (14) (Latin Lowering) will not apply to geminates, though they predict this in different ways. The Linking Constraint predicts blockage from the fact that a single association line connects y to the skeleton in the statement of (14). The UAC predicts that geminate yy’s will not undergo the rule because the two X’s linked to a geminate yy cannot both be tautosyllabic to a. On closer examination, we see that Latin Lowering could easily be reformulated to make its application to yy compatible with the Linking Constraint; the structural description of the revised rule is shown in (69).

(69) \[
\begin{array}{c}
a \\
\end{array} \quad y
\]
\[
\left[ \begin{array}{c}
X_1 \\
X_2 \end{array} \right]_N (X_3)
\]

We may paraphrase the description of (69) as follows: a is associated to a sequence X_1, y is associated to a sequence X_2(X_3), X_1 and X_2 are dominated by the same N. The effect of the Linking Constraint on this description is to interpret is associated as is exclusively associated, but this does not rule out the application of (69) to a geminate yy.

Although the addition of the optional X_3 in (69) has the effect of suspending the Linking Constraint, the same change in the formulation of Latin Lowering does not affect the application of the UAC. Even if X_3 is added as an optional factor, the UAC will still prohibit the rule from affecting geminates, for exactly the same reason that it prohibits the original version, (14): because X_3 is not tautosyllabic with X_1. Under an analysis incorporating the UAC, (69) is just an unnecessarily complicated variant of (14).

The UAC predicts geminate blockage from aspects of the rule that must be invariant under any formalization: any statement of Latin Lowering that adequately describes its effects on single y’s must impose the relation of tautosyllabicity between y and a. On the other hand, the aspect of structural descriptions on which the Linking Constraint focuses—the number of association lines mentioned—can be arbitrarily manipulated so as to nullify any predictions made about geminate behavior. This is what (69) shows. We must therefore amend some of our earlier criticisms of the Linking Constraint: the incorrect predictions mentioned earlier can be neutralized, along with the correct ones, by using the notation in (69).

There is a second respect in which the UAC makes a falsifiable claim: it predicts
that segmental rules will always be able to apply to geminates and simplex segments alike. The claim can be fully generalized in the following way.

(70) Given any two tiers A and B, if the effect of a rule on nodes in A singly linked to elements in B can be described without reference to B, then the rule will be able to affect configurations in which some node in A is multiply linked to nodes in B.

To take a concrete example: the effect of Šati on simplex n’s can be described without reference to the skeleton, since neither the target nor the context segments can be identified by their syllabic positions and since adjacency on any tier, including the skeleton, must not be a condition of the rule. The UAC predicts that any rule that affects simplex n’s as Šati does will apply, like Šati, to geminate nn’s as well. The reader can verify that any change in the formulation of Šati that will induce the UAC to predict geminate blockage will also change incorrectly the conditions under which Šati affects nongeminate n’s.

The generalization in (70) cannot be explained by the Linking Constraint. If geminate blockage depends on the explicit mention of association lines, then two versions of Šati are available: one that is identical to (48) and capable of affecting geminates, and one that differs from (48) only in stipulating a single association from the root node of n to the skeleton. The second version should, according to the Linking Constraint, have an effect identical to that of (48) on single n’s but should be incapable of applying to nn. In contrast, this second version of Šati, in which the root node of n is represented as associated to one X slot, will have no effect on the predictions of the UAC: the condition this one X slot must meet—association to the root node of n—is satisfied by both X’s in a geminate n. Therefore, this variant of Šati continues to be applicable to geminate nn’s under the UAC.

Is (70) too strong a claim? We are aware of apparent counterexamples to it in the form of rules earlier formulated as “Short or nongeminate [αF] becomes [βG].” Many of these rules account for the differential behavior of long and short vowels: thus, Burjat Mongolian ō is derounded to e, whereas long ōō persists (Poppe (1960), Steriade (1981)); Lithuanian short o is derounded to a (Kenstowicz (1970)). For cases of this type there is a wealth of alternative explanations compatible with (70) and the UAC. Long vowels differ from short vowels not only in being long but also in belonging to metrically heavy syllables in languages like Mongolian, where syllable weight is determined exclusively by vowel length; a restriction to short vowels may in fact be a restriction to metrically weak positions. What we know of Mongolian stress (Hayes (1980)) does not rule out this possibility. Second, long vowels frequently differ redundantly in tenseness from their short counterparts: a restriction to short vowels may turn out to be a restriction to (derived) lax vowels. For the Burjat and Lithuanian cases these alternatives appear as valid as the traditional statements. We have found fewer candidate counterexamples to (70) involving consonants. The one prominent case is Berber Spirantization: a context-free rule that would spirantize nongeminate obstruents (Saib (1976), Hayes (1984)). How-
ever, as Shlonsky (1985) shows in detail, this rule must be reformulated as its converse, Berber Stopping: a rule that turns a geminate obstruent unspecified for continuancy into a stop. In short, we are not aware of any data that would require abandoning (70).

The UAC, then, makes the easily falsifiable claim that geminate blockage can always be predicted from independently observable properties of a given rule. The Linking Constraint, on the other hand, does not appear to exclude any rule type or any imaginable case of geminate blockage: it simply provides the formal means of stipulating, for any rule, which nodes, in context or target, can be multiply linked, and to which tiers. Therefore, the strongest argument in favor of the UAC is the observable predictability of geminate blockage and its clearly limited occurrence.

7. Conclusion

We close by mentioning further directions of research suggested by our investigation of multiply linked structures.

The principles that govern the distribution of monosegmental geminates have not been discussed here. We point in the appendix to an argument in favor of McCarthy’s and Younes’s proposal of tier conflation, whose effect is to eliminate long-distance geminates at the end of cyclic domains. Perhaps more important is the fact that the research presented here and in Hayes (1984; 1986b) provides well-understood tests of the internal structure of morpheme-internal geminates. If constraints on the distribution of geminates such as the Obligatory Contour Principle are valid, we expect that all morpheme-internal geminates will obey the principles developed here. The testing ground for the OCP has thus been significantly enlarged.

The possibility of extending principles like the UAC from geminates proper to partially assimilated clusters has provided another argument in favor of the view that assimilation, partial or total, involves multiple association rather than copying. It should be kept in mind, however, that the only partially assimilated structures shown so far to be responsible for geminate blockage involve autosegments multiply linked to adjacent positions on some tier: to our knowledge, no one has investigated the possibility of geminate blockage effects with structures resulting from long-distance partial assimilation.31 Such a study is obviously necessary for a better understanding of geminate blockage and as a basis for research into vowel and consonant harmony.

Finally, this study suggests that the formalization of phonological rules can now be profitably investigated. One immediate consequence of our proposals is that the formal means by which geminate blockage was expressed in previous work32—namely, conditions on individual rules of the form Node $\alpha$ may not be associated to node $\beta$—are unnecessary. In fact, as long as such negative conditions on association are still part of the vocabulary of phonological rules, the UAC or equivalent principles cannot guarantee

31 On geminate blockage with long-distance geminates, see the appendix.

32 See, for example, the formulation of Semitic Spirantization in Leben (1980), Schein (1981), and Kenstowicz (1982) or the statement of Metathesis in McCarthy (1981a).
generalizations like (70). Negative descriptions of the form Autosegment α is not linked to any unit on tier T remain necessary in order to refer to such elements as toneless vowels or segmentally empty syllabic positions (see Levin (1985)). But where association between two specific nodes is involved—rather than association between a node and a tier—phonological rules should be restricted to express only positive conditions. They should never need to know which nodes an autosegment is not linked to.

Appendix: Morphological Tiers, Long-distance Geminates, and Split Geminates

We discuss here three classes of cases in which the apparently aberrant behavior of geminates is explained by the effects of morphology on the phonological representation. The first two involve long-distance geminates: nonadjacent skeletal slots linked to a single segment, as in the representations established by McCarthy (1979; 1981a) for polymorphemic verbal stems in Semitic.

\[(71) \quad \text{linearized samمام-}, \quad \text{on the root sm 'poison')}
\]

We expect that such monosegmental geminates will be subject to the constraints on rule application established so far. They should not undergo structure-dependent rules unless all X slots meet their requirements. It appears, however, that our expectations are challenged in two ways: by long-distance geminates that undergo a rule not met by all the segmentally linked X slots and by long-distance geminates that are split by the application of rules that affect some of the linked X slots and not others.

Examples of the latter type include a number of postcyclic rules operating in Semitic on forms that contain underlying monosegmental long-distance geminates, as in (71). For a Tigrinya verbal form like 2asiir ‘to chain’ the morphology (Leslau (1941)) dictates the representation in (72).

\[(72) \quad ? \quad s \quad r \quad \text{X X X X X a}
\]

Yet the surface representation of this form, ?asär, is the result of a postglottal lowering rule that applies only to the first instance of a. The same rule lowers a after h in perfective verbal stems like hanāq ‘to strangle’, sāhab ‘to drag’, as if the inputs to the rule were bivocalic. A parallel problem is raised by the rule of a-Rounding discussed in section 3.1: underlyingly monovocalic forms like šāwwār, zāwwār allow this rule to apply to only one instance of a (see footnote 16). Finally, Hebrew and Tigrinya Spirantization apply in underlyingly biconsonantal forms such as (Hebrew) sibbeeb (on the Hebrew
root \(sb\) and \(raqqiq\) (on the Tigrinya root \(rq\) ‘small’), also yielding split geminates in surface \(sibbee\beta, raqqix\).\(^{33}\)

All the rules mentioned have postcyclic and/or postlexical properties: they may apply in nonderived environments, and they create segment types (such as the non-coronal spirants and the rounded \(ā\)) that are absent from the underlying inventory of Tigrinya and Hebrew. This makes it possible to resolve the difficulty by adopting a solution proposed by Younes (1983) and McCarthy (1986b): tier conflation. Younes and McCarthy suggest that bracket erasure (Pesetsky (1980), Mohanan (1982)) has an autosegmental counterpart: at the end of every level, when brackets are erased, distinct segmental tiers are conflated into one. In order to avoid line crossing, this step must be accompanied by splitting a long-distance geminate as in (72) into two distinct segments.

\[
\begin{array}{c|c|c|c|c|c}
? & ā & s & ā & r \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c|c}
X & X & X & X & X
\end{array}
\]

Lowering will now be able to apply to the only instance of \(ā\) that occurs in postglottal position. It is critical for this solution that rules like Postglottal Lowering, \(ā\)-Rounding, and Spirantization have postcyclic applications: if Postglottal Lowering, for example, applied cyclically in Tigrinya, it would fail to apply on the stem cycle in \(ʔāsār\)—because tier conflation had not yet taken place—and it would be blocked thereafter by the principle of the strict cycle.

Archangeli (1984; 1985) and Kenstowicz (1985) have drawn attention to a different class of aberrant effects long-distance geminates may have on phonological rules. Archangeli argues that Yokuts Lowering (rule (63) above) applies not only to a monosyllabic geminate vowel but also to structures such as (74), where \(u\) is associated to an \(X\) that cannot be tautosyllabic with the other two (\(X\) stands for \(X\) dominated by \(N\)):

\[
\begin{array}{c|c|c|c|c|c}
\$ & d & k' & & \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c|c}
X & X & X & X & X & X
\end{array}
\]

The data discussed by Kenstowicz (1985) involve a Javanese rule of lowering in closed syllables, applying to long-distance geminate vowels in structures equivalent to (74): one nucleus linked to the vocalic segment is in a closed syllable, but the other nucleus is not.

The suggestion that emerges from Archangeli’s and Kenstowicz’s analyses seems to be this: rule applications affecting an autosegment linked to nonadjacent positions on another tier do not obey the UAC. We have not looked deeper into this possibility, for several reasons: the input representations of the two rules involved, in particular the

\(^{33}\) The problem raised by Spirantization has been noted by McCarthy (1981b), Schein (1981), Steriade (1982), and Younes (1983).
segregation of vowel and consonant segments on separate tiers, is not independently supported by the morphology of Yokuts and Javanese; an alternative account of the Yokuts data is available (Steriade (1986)); and, finally, long-distance geminates virtually identical to those in (74) are shown by McCarthy (1986a) to be responsible for the blockage of a Chaha geminate devoicing rule that is the formal equivalent of Yokuts Lowering. A Chaha representation such as (75) does not undergo the rule (76) that devoices obstruent geminate clusters.

(75) s \[X X X X X\] d [a]

(76) **Chaha Devoicing**

\[
[-\text{son}] \rightarrow [-\text{voice}] / \quad \land \\
X_1 X_2 \quad \land \quad X_1 \text{ adjacent to } X_2
\]

The essential condition that inputs to devoicing must meet is that the two X's linked to the obstruent matrix be adjacent. This condition is not met by the structure in (75), a representation independently supported by the morphology of the language; the result is that geminate blockage occurs and the form surfaces, after a rule of degemination, as sadad. Thus, the Chaha evidence appears to support the null hypothesis, namely that principles like the UAC, which were devised with adjacent geminate clusters in mind, will apply straightforwardly to long-distance geminates as well. How the Javanese data presented by Kenstowicz can be made compatible with this hypothesis remains at present an open question.

Finally, Halle and Mohanan (1985) note that English forms like succeed, accede, acceleration seem to result from a geminate-splitting operation of Velar Softening. As T. Borowsky (personal communication) has pointed out, the key observation in this case is that English prohibits morpheme-internal geminates: the across-boundary geminates occasionally heard in fineness, soulless, immoral have no tautomorphemic counterpart. We may attribute this gap to the cumulative effect of filter (77) and the OCP.

(77) *[-syllabic]

\[
X \quad X
\]

Filter (77) and the OCP conspire to brand as non-English any morpheme containing a long consonant on the surface. Consider imaginary [al:a]: the long l: cannot be a single multiply attached l, since that would violate (77); nor can l: be a sequence of two l's, since that would violate the OCP.

In light of this observation we may derive the intermediate long kk in sukkêd only
as a sequence of two adjacent k's. The final obstruent in the Latinate prefixes /sub/, /ad/, /ob/ is deleted before noncoronal obstruents and leaves behind an empty X (see (78)). Filling that slot by linking it to a following [−syllabic] matrix would violate (77). But copying the matrix will steer clear of both filter (77) and the OCP, since at this level of the derivation the prefix and the root are distinct morphemes, with distinct melodic tiers.

\[
\begin{align*}
(78) \text{a.} & \quad \begin{array}{|c|c|}
\hline
k & e & d \\
\hline
\text{XXX} & & \text{XXX} \\
\hline
s & u \\
\hline
\end{array} \\
\text{b.} & \quad \begin{array}{|c|c|}
\hline
k & e & d \\
\hline
\text{XXX} & & \text{XXX} \\
\hline
s & u \\
\hline
\end{array} \\
\text{c.} & \quad \begin{array}{|c|c|}
\hline
k & e & d \\
\hline
\text{XXX} & & \text{XXX} \\
\hline
s & u & k \\
\hline
\end{array}
\end{align*}
\]

Velar Softening can now apply to derive surface su[ks]eed.

The Latinate morphemes /sub/, /ob/, and /ad/ have been imported into or inherited by several languages that have rules similar to Velar Softening: French, Italian, and Romanian show the effects both of the prefix-final obstruent deletion that derives (78a) and of rules that affricate or spirantize underlying velars before [−back] segments. We call the latter type of process by the collective name of Palatalization. The comparison between the effects of Palatalization in Italian, on the one hand, and in Romanian, French, and English, on the other hand, is illuminating: Italian is the only language of this group that lacks filter (77). Tautomorphemic geminates are allowed in Italian and often account for minimal pairs (sono 'I am' vs. sonno 'sleep'; Vito vs. vitto 'board'). They are disallowed in French and Romanian, as they are in English. Our account of English succeed predicts that applying a prima facie segmental process like Palatalization to the forms prefixed by /ad/, /sub/, /ob/ will produce a geminate čč, jį in Italian but a cluster of unlike consonants in Romanian and French. This is indeed what happens: the Latinate collocations /sub-ked-/, /sub-ger-/, /ad-ked-/ yield, after Prefix Obstruent Deletion and Palatalization, suksed-, sūgžer-, aksed- in French and sukčed-, sujjer-, akčed- in Romanian,\(^{34}\) but suččed-, sujžer-, aččed- in Italian.

In Italian, where the option of multiple association represented in (78b) may be taken, it must be taken. This suggests that whether or not a single empty slot will be

\(^{34}\) Romanian, like English, reduces gj sequences to j.
filled by association to a segment or by copying the segment depends entirely on whether the segment in question can be multiply attached. In languages where segments can be multiply attached single empty slots are filled by association to a neighboring segment. In French, Romanian, and English, where monosegmental nonsyllabic geminates are ruled out by filter (77), preconsonantal empty X slots can only be filled by copying: this then will provide one source of adjacent identical segments. The correlation observed here between the presence of filters like (77) and the copying procedure employed in filling single empty slots can be formulated as follows.

(79) All other things being equal, association is preferred over copying.

(See also Archangeli (1984).) We may attribute (79) to the effects of the evaluation metric, one of whose clearer attributes is that of favoring analyses involving fewer symbols over alternatives involving more symbols: a rule that associates existing autosegments will be simpler than a rule that introduces a new autosegment.

References


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