Geminate Inalterability And Lenition

וְאִם־יִתְקְפוֹ הָאֶחָד הַשְּׁנַיִם יַעַמְדוּ נֶגְדּוֹ
Ecclesiastes 4:12

0. Introduction

As Guerssel (1979) originally observed, phonological processes that apply to short segments frequently fail to apply to corresponding long ("geminate") segments. For example, post-vocalic spirantisation of velars in Tigrinya yields [ʔa-xalɨb] 'dogs' (cf. [kəlbi] 'dog'), but [fəkkərə] 'boasts', not [fəxkərə] nor [fəxxərə] (Kenstowicz 1982).[1] This phenomenon of geminate "inalterability" or "blockage" has been the subject of a number of proposals within the framework of Autosegmental Phonology, most influentially Hayes 1986 and Schein & Steriade 1986. Subsequent research, however, has revealed that these proposals make seriously incorrect predictions as to the class of processes which display inalterability (see Inkelas & Cho 1993). As Churma (1988) observes, geminate inalterability holds true as a universally inviolable condition only with respect to *consonant lenition* phenomena, a generalisation which the classic inalterability approaches fail to capture. Moreover, as Elmedlaoui (1993) notes, within the domain of lenition phenomena, the classic approaches are insufficiently restrictive: they fail to rule out processes which specifically target geminates for lenition, e.g. /kk/ - *[xx], or which convert an underlying singleton to a lenited geminate, e.g. /k/ - *[xx], though such processes appear to be completely unattested; and these approaches fail to draw a connection between inalterability and the general markedness of "weaker" (i.e. continuant and voiced (obstruent)) geminates, whether they are derived via some lenition process or present underlyingly.

[1]Here and throughout, transcriptions have been modified to conform with IPA. For consistency, I transcribe geminates with doubling (e.g. kk) rather than the length diacritic (kː); this practice, however, is without theoretical import.

As a preliminary matter, I must make clear the scope of the term “lenition,” as used herein. Traditionally, the class of lenition processes includes degemination, voicing (in medial position), flapping, spirantisation, reduction to sonorants, debuccalisation, and elision, cf. Lass & Anderson 1975, Hock 1991. As a first approximation, these processes can be characterised as uniformly involving temporal or spatial reduction of articulatory gestures.[2] Building on the work of Churma, Elmedlaoui, as well as a survey of lenition typology which expands upon that of Lavoie 1996, I identify the following specific generalisations concerning geminates and lenition:

(1) a. Geminate continuant consonants and voiced geminate obstruents are “marked.” That is, the presence of a geminate continuant consonant, or voiced geminate obstruent, in the segment inventory of a language (whether derived or underlying) implies the presence of a corresponding non-continuant or voiceless geminate (section 1.2.1).
b. No process converts a stop (geminate or otherwise) to a geminate with reduced oral constriction (section 1.2.2).
c. No process converts a (tautomorphemic) geminate stop to a "half-spirantised" cluster, e.g. /kk/ - *[xk] (section 1.2.3).
d. No process converts a voiceless segment (geminate or otherwise) to a voiced geminate obstruent (section 1.2.4).
e. "Partial geminates" (i.e. homorganic nasal + stop or lateral + stop clusters) behave identically to full geminates with respect to reduction of oral constriction; but, unlike full geminates, they readily undergo voicing (section 1.2.5).
f. No occlusivisation nor obstruent devoicing process targets singletons to the exclusion of geminates (section 1.2.6).

In contrast with the classic geminate inalterability proposals, and previous formal approaches to lenition, which I review in section 2, I suggest that the geminate lenition generalisations in (1) reflect certain considerations of relative articulatory effort:

(2) a. Plausibly, more effort is required to produce a voiced geminate obstruent than avoiceless geminate (the inverse of the situation in singleton obstruents in medial position), due to the aerodynamic conditions required to sustain voicing, cf. Ohala 1983. Therefore it is undesirable, from the perspective of effort minimisation, to voice a geminate obstruent.
b. Plausibly, more effort is required to produce a geminate continuant consonant than a geminate stop (the inverse of the situation in singletons), due to the precision involved in maintaining a steady-state partial constriction for a prolonged interval. Therefore it is undesirable, from the perspective of effort minimisation, to reduce the oral constriction of a geminate stop (except by shortening it).

[2] A more precise characterisation is given in section 2.2.5.2.

After outlining a proposal for a general effort-based approach to lenition, within the framework of Optimality Theory (section 3), I show how the phonetic assumptions in (2) can be incorporated into an elegant formal account of the geminate lenition generalisations in (1) (section 4). Finally, I argue that the (often distinct) behaviour of heteromorphemic geminates does not require a representational distinction between “true” (multiply linked) and “fake” (singly linked) geminates, as claimed in the autosegmental inalterability literature: rather, these facts can be handled in terms of paradigmatic (output-output) faithfulness constraints (e.g. Benua 1995; Flemming 1995).

1. GENERALISATIONS

1.1. THE NON-UNITY OF INALTERABILITY EFFECTS. Note that I am *not* claiming that geminate inalterability effects are to be found only in the domain of lenition processes; nor is it my goal to develop a unified account of all inalterability effects. For example, rounding harmony, i.e. unbounded extension of a lip rounding gesture, is not plausibly regarded as a species of lenition. Yet, in Maltese, rounding harmony (e.g. /kitbuulik/ - [kitbuul**u**k] (‘he wrote it to you’)) fails to apply to long vowels: /ʃurbitiilim/ - [ʃurbut**ii**l**i**m] (‘she drank it (fem.) from them’), not *[ʃurbut**uu**l**u**m]; and virtually the same pattern obtains in Tigre (McCarthy 1979, Schein & Steriade 1986). Such resistance to rounding neutralisation is plausibly analyzed in terms of interaction between a constraint which induces rightward spreading of [round] (e.g. ALIGN(rnd,R), cf. Kirchner 1993; McCarthy & Prince 1993) and a *positional faithfulness* constraint (Beckman 1997), specifically referring to vowel features in long-vowel position:

(3)

		IDENT(rnd/long V)	ALIGN(rnd,R)	IDENT(rnd)
	ʃurbitiilim - ʃurbitiilim		***!	
☞	ʃurbitiilim - ʃurbutiilim		**	*
	ʃurbitiilim - ʃurbutuulum	*!		***
	kitbuulik - kitbuulik		*!	
☞	kitbuulik - kitbuuluk			*

Presumably this positional faithfulness constraint reflects the greater perceptibility of vowel quality distinctions in long vowels, cf. Kaun 1994, Jun 1995, Flemming 1995. For present purposes, the important observation is that the blocking effect under this analaysis is *violable*. For under the opposite ranking of IDENT(rnd/long V) and ALIGN(rnd,R), no geminate blocking obtains. This prediction is confirmed by Khalkha Mongolian (Street 1962, Schein & Steriade 1986), in which [round] (and [back]) harmony targets long and short vowels alike: [aabaas] ('father-abl.'), [odoogoos] ('now-abl.'), [gerees] ('house-abl.'), [tœrœœs] ('state-abl.').

In contrast, an examination of the behaviour of geminates under lenition reveals cross-linguistically robust generalisations, namely the geminate lenition generalisations in (1), documented below. I take this as motivation for a distinct account of geminate inalterability under lenition: it is the goal of this article to develop such an account. I shall not address the question of whether the remaining (non-lenitional) geminate inalterability effects can be handled exclusively in terms of the positional faithfulness approach sketched in (3), or whether there may be yet further sources of geminate inalterability effects.

Note that, in assuming that geminate inalterability is not a unified phenomenon, I am not diverging from the consensus of previous approaches. For example, Schein & Steriade attribute the Maltese and Tigre blocking not to their general principle of geminate blockage, but to a language-specific metrical condition on the harmony rule: [round] can only spread rightward within a foot; and the long vowel serves as the head of a new foot. More explicitly, Inkelas & Cho (1993: 557) take the position that the mere failure of a rule to apply to geminates "does not necessarily mean that a genuine case of geminate blocking has occurred." They identify a large class of "pseudo-inalterability" effects, which they attribute to counterfeeding rule ordering, or to the fact that, for various reasons, geminates fail to meet the structural description of the rule in question.

1.2. DOCUMENTING THE GENERALISATIONS

1.2.1. THE "MARKEDNESS" OF GEMINATE CONTINUANTS AND VOICED OBSTRUENTS. *The presence of a geminate continuant consonant, or voiced geminate obstruent, in the segment* *inventory of a language (whether derived or underlying) implies the presence of a corresponding non-continuant or voiceless geminate, respectively.*[3] This generalisation is supported by an examination of the segment inventories collected in Maddieson 1984. It can be seen from the following table that languages with geminate obstruents overwhelmingly have geminate stops, and voiceless geminates:

Table 1. Segment inventories, from Maddieson 1984: geminate stops and fricatives.

Language	*has geminate stops/ affricates*	*has geminate fricatives*	*has voiceless geminate obstruents*	*has voiced geminate obstruents*
Punjabi	✓	✓	✓	✓
Finnish	✓	✓	✓	
Yakut	✓	✓	✓	✓
Japanese	✓	✓	✓	
Maranungku	✓		✓	
Delaware	✓		✓	
Lak	✓	✓	✓	
Wolof	✓			✓
Arabic	✓	✓	✓	✓
Shilha	✓	✓	✓	✓
Somali	✓			✓
Greenlandic		✓	✓	✓
Iraqw		✓	✓	
Kaliai	✓		✓	
Wichita	✓	✓	✓	
Ngizim	✓		✓	

The only reported cases of inventories with a geminate fricative but no corresponding stop are Greenlandic and Iraqw; and the only reported cases of inventories with voiced geminate obstruents without voiceless counterparts are Somali and Wolof. However, these apparent counterexamples prove, upon closer examination, to be spurious. Regarding Greenlandic, it is clear from Rischel's (1974) description that the language does in fact have surface geminate stops as well as fricatives :

[3]Cf. Elmedlaoui's (1993) claim that segment inventories never have "weaker" (i.e. higher sonority) geminates without also having "stronger" geminates. To the extent that Elmedlaoui generalises this claim in terms of the sonority hierarchy, however, it is false. Elmedlaoui's claim predicts, for example, that all languages with long vowels also have geminate consonants (falsified by a significant share of the world's languages, including Yidiɲ, Dixon 1977); and that all languages with geminate sonorant consonants also have geminate obstruents (falsified by Ponapean, which has geminate nasals and liquids, but no geminate obstruents, Rehg & Sohl 1981).

(4) suraajuwippuq 'is incessant'
kamittaq 'new boot'
puwijuwikkijuppaa 'never forgets it'
qaqqaq 'mountain'

As for Iraqw, Nordbustad's (1985) grammar makes clear that geminate stops are present in the inventory:

(5) a daqqáw 'I am in the act of going'
a tsattá ɬaáʔ 'I want to cut'
ɡwa tuntukká 'she has not covered it'

The Somali geminates in question, according to Armstrong 1964, in fact "do not sound fully voiced," and in some cases are completely voiceless.[4] Finally, Sauvageot's (1965) grammar of Wolof lists a number of forms containing voiceless geminates:[5]

(6) tappu 'needle'
atte 'to judge'
fɛttʲi 'undress, untie'
tɛkki (no gloss)

Furthermore, the generalisation holds true even if these inventories are broken down by place of articulation: that is, in all cases, a geminate continuant consonant at a given place of articulation implies a geminate stop at the same major place of articulation (i.e. labial, coronal or dorsal); and a voiced geminate obstruent at a given place of articulation implies a voiceless obstruent at the same major place of articulation.[6] In sum, the segment inventories collected by Maddieson 1984

[4]An exception are the post-alveolar stops, transcribed as [ɖ]/[ɖɖ] which Armstrong describes as fully voiced, in both the singleton and the geminate. Armstrong notes, however, that this sound is not a simple voiced stop. Unlike the rest of the stop series, it involves pharyngeal constriction, as well as being somewhat implosive. Moreover, there is no voiceless correspondent to [ɖ] in the singleton series, as there are for the other voiced singleton stops.
[5]Maddieson's characterisation appears to be based on Sauvageot's statement (p. 17) that gemination "est, semble-t-il, limitée aux occlusives sonores; ... aux nasales; ... [et] à la latérale." Unfortunately, Sauvageot does not explain how this characterisation is to be reconciled with the voiceless geminate forms cited above, which appear in later sections of the grammar. More recent grammars and dictionaries of Wolof (e.g. Ka 1994, Munro & Gaye 1991) make clear that voiceless geminates are indeed part of the inventory.
[6] For Arabic, the geminate labial which is the voiceless counterpart to /bb/ is /ff/. The presence of /bb/ without /pp/ in the Arabic inventory is nevertheless typologically unusual, and requires some explanation. However, this gap is matched in the singleton inventory: Arabic has /b/ without /p/, though voicing distinctions obtain for stops at the other places of articulation. (Ohala 1983 attributes this gap in the singleton inventory to aerodynamic factors:

unanimously exemplify the geminate continuant and voicing generalisation. Nor have I encountered any other languages which fail to conform this generalisation.

In the remainder of this section, we turn from this generalisation about consonant inventories to actual cases of geminate inalterability, under particular synchronic phonological processes. The generalisations discussed below are supported by a composite of two surveys: (a) first, a partial search of the UCLA University Research Library for grammars which contained some lenition phenomenon, supplemented by a number of grammars passed on to me by advisors and colleagues, yielding 107 languages; and further supplemented by (b) the more extensive lenition survey of Lavoie 1996, covering 165 additional languages, from an exhaustive search of the library of the University of California at Irvine, yielding a total of 272 languages for the composite survey (see Kirchner 1998).

1.2.2. NO ORALLY REDUCED GEMINATE STOPS. *No process converts a stop (geminate or otherwise) to a geminate with reduced oral constriction.* This generalisation, together with several of the generalisations below, is a somewhat narrower restatement of Churma's (1988) original claim that "aside from degemination, no weakening process may affect a geminate consonant."[7]

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voicing occurs more readily (and conversely, devoicing is more problematic) in labials, because the compliance of the cheek walls allows for passive expansion of the oral cavity, thus facilitating the transglottal airflow which is essential for voicing.) Moreover, in Arabic the geminates (e.g. in [ħubbu] ('his love')) are paradigmatically related to singleton consonants (e.g. in [ħabibi] ('my beloved (friend)')) by a root-and-template morphological system (see McCarthy 1981). Thus the presence of /bb/ without /pp/ in this system can be accounted for in terms of gap in the singleton inventory a (perhaps aerodynamically driven, *selon* Ohala); and the voicing of these labial stops carries over to forms such as [ħubbu], due to the effect of a paradigmatic faithfulness constraint, IDENT(voi, Base/Derivative); cf. the discussion of paradigmatic faithfulness constraints in section 4, below.

[7]That some "weakening" (i.e. effort-reducing) processes, other than spirantisation and obstruent voicing, do apply to geminates is documented in section 2.2.1.4 below. As Elmedlaoui 1993 notes, Churma's claim bears some resemblance the earlier "Inertial Development Principle" of Foley 1977, which states, in essence, that "weak" segments are preferentially targeted by weakening processes, and "strong" segments for strengthening processes. But since Foley explicitly refuses to attribute any consistent phonetic content to his notions of weakening or strengthening, it is difficult to evaluate the empirical predictions which follow from this principle.

1.2.2.1. SPIRANTISATION. A classic example of such geminate resistance to oral reduction is the Tigrinya spirantisation pattern, alluded to in the Introduction, and more fully exemplified below:

(7)	a.	kəlbi	'dog'
		ʕarat-ka	'bed-2sg.m.'
		qətəl-ki	'kill-2sg.f. perfect'
	b.	kətəma-xa	'town-2sg.m.'
		mɨrax-na	'calf-3sg.f.'
		ʔa-xalɨb	'dogs'
		ʔɨti xalbi	'the dog'
	c.	k'ətəl-a	'kill-3pl.f. perfect'
		tɨ-χətl-i[8]	'kill-2sg.f. imperfect'
	d.	fəkːərə	'boasts'
		k'ətəl-na-kːa	'we have killed you (masc.)'

That is, post-vocalic plain (7b) and ejective (c) velars spirantise, but geminates (d) remain stops. Tiberian Hebrew, with a similar pattern of post-vocalic spirantisation of labials, velars, and (non-emphatic) coronals, does indeed display alternations between geminate stops and fricatives (data from Elmedlaoui 1993).[9]

(8)	Causative Perfect	Basic Perfect	Gloss
	zikkeer	zaaxar	remember
	kippeer	kaaɸar	cover
	biddeel	baaðal	separate
	pitteeah	paaθah	open
	piggeeʃ	paaɣaʃ	meet

[8] The postvocalic allophone of the velar ejective (conventionally transcribed by Semiticists as /q/) can vary, from a uvular or pharyngeal fricative to a glottal stop (Rose 1998).

[9] Previous treatments of blocking of lenition in the emphatic (pharyngealised) stops have assumed some property, shared with geminates, that made them immune to spirantisation namely [+tense] (Prince 1975) or [-released] (McCarthy 1981), but without presenting any argument that the emphatics actually had these phonetic properties. Moreover, these previous treatments conflate a cross-linguistic generalisation (geminate inalterability under lenition) with a language-specific blocking effect (compare spirantisation of /q/ in Quechua vs. blocking of /q/ spirantisation in Hebrew). Observe, however, that spirantisation of a pharyngealised stop would yield a pharyngealised continuant with weak (or no) coronal or dorsal friction, i.e. a sound which is perceptually quite close to a true pharyngeal continuant, [ħ] or [ʕ]. (Indeed, in Biblical Aramaic, /dˤ/ neutralised to [ʕ], see Elmedlaoui 1993: 143.) I suggest, then, that the blocking of spirantisation in the emphatic stops was driven by avoidance of near-neutralisation with the true pharyngeals ([ħ] and [ʕ]), which were distinct phonemes in Tiberian Hebrew. Formally, then, I posit a fortition constraint that rules out the intermediate category:
*[+cont,-strid,+cons,phar] = "no non-strident secondarily pharyngealised continuants"
under the assumption that the true pharyngeals are [-cons]). Ranked above LAZY, this constraint blocks spirantisation of the pharyngealised consonants.

But, crucially, the spirantised class is limited to surface singletons, thus illustrating a corollary generalisation: geminate stops can undergo oral reduction, but only if they surface as singletons.[10] As Elmedlaoui (1993) observes, the generalisation properly focuses not on whether geminates are licit *inputs* to spirantisaton processes, but whether spirantisation processes may yield *output* geminates. Further examples of geminate blocking of reduction of stops to continuants appear in the following table.

Table 2. Blocking of spirantisation in geminates.

Language	Reference	Description of process
Florentine Italian	Giannelli & Savoia 1979	Lenition (ranging from spirantisation to complete elision, depending on rate and register) blocked in geminate obstruents and non-continuants
Hausa	Klingenheben 1928	b,d,g - w,r,w in coda, blocked in geminates
Malayalam	Mohanan 1986	Stops - approximants (or apical tap) in the context /[+son,-nas]__V, blocked in geminates.
(Proto-) Berber	Saib 1977	Stops - fricatives (context-free), blocked in geminates[11]
Tamil	Christdas 1988	Voicing and spirantisation in medial position, blocked in geminates
Tiberian Hebrew	Malone 1993	Post-vocalic non-emphatic stops spirantise, blocked in geminates
Tigrinya	Kenstowicz 1982	Post-vocalic velars and uvulars spirantise, blocked in geminates
Tümpisa Shoshone	Dayley 1989	Spirantisation, flapping blocked after a homorganic nasal and in geminates; voicing blocked in geminates

Note that inalterability under spirantisation holds true for geminate nasal as well as oral stops, as seen in Tümpisa Shoshone:

[10]Under traditional analyses of data such as (8), the target consonant is underlyingly a singleton, and the gemination in the 'causative' column is derived, in which case Tiberian Hebrew does not exemplify degemination-cum-spirantisation of underlying geminates. In the OT framework, however, since all inputs are admitted by GEN ("Richness of the Base," Prince & Smolensky 1993, ch. 9), the systematic absence of geminates in the 'basic perfect' column cannot be attributed to the absence of geminate inputs; rather, there must be an active constraint prohibiting geminates in perfect forms, just as there is an active constraint requiring medial geminates in the 'causative' forms. That is, if an input to a perfect form were to contain a geminate stop, it would degeminate and spirantise on the surface.

[11]At some point prior to Modern Berber, this spirantisation pattern came to be reanalyzed as a process occlusivizing geminate fricatives, see Saib 1977.

(9)	a.	sɨɨmɔɔtɨ	-	sɨɨw̃ɔɔɾɨ	'ten'
		senu	-	sej̃u	'therefore'
	b.	tapettʃi	-	taβettʃi	'sun'
		tsitoohi	-	tsiðoohi	'push'
		puhakantɨ	-	puhaɣandɨ	'shaman'
	c.	kimmakinna	-	kimmaɣinna	'to come here'
	d.	patɨasɨppɨ	-	paɾɨasɨppɨ	'ice'
		uttunna	-	uttunna	'to give'
		punikka	-	punikka	'see, look at'
	e.	taziumbi	-	taziumbi	'star'
		ɨntamɨʔi	-	ɨndaw̃ɨʔi	'your little brother'
		tɨppisipuŋki	-	tɨppiʃiɸuŋgi	'stinkbug'

Non-initial singleton nasals spirantise (9a), as do oral stops (b);[12] but this lenition is blocked in geminate nasal (c) and oral stops (d), as well as partial geminate clusters (e).

1.2.2.2. FLAPPING. Tümpisa Shoshone (and Hausa) further demonstrate that the geminate inalterability effect is not limited to spirantisation per se: geminate inalterability also obtains under *flapping* (i.e. reduction of closure duration in coronal stops, see Banner-Inouye 1995). Nor is this so merely by definition (i.e. the closure duration of stop cannot be radically temporally reduced, as in a flap, and still remain a geminate): for it is logically possible, though unattested, that a flapping process applying to a geminate stop would yield a long trill. Moreover, the same effect shows up in partial geminates in Lamani (Trail 1970): flapping is blocked after a homorganic nasal or lateral.

1.2.2.3. THE GENERALISATION. In contrast to this wealth of cases showing geminate inalterability under processes of spirantisation, flapping, and reduction to approximants, cases where these processes apply to geminates (without concomitant degemination) appear to be completely unattested, based on the previous inalterability literature, and the lenition surveys of Lavoie 1996 and Kirchner (1998). (Indeed, far from reducing their oral constriction, there is a positive tendency for geminate consonants to occlusivise, see section 1.6.)

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[12]/t/ lenites by flapping rather than spirantizing when it follows a back vowel. The nasal spirantisation, according to Dayley, applies to /n/ and /ŋʷ/ in post-front-vowel position, and to /m/ in any non-initial position.

To my knowledge, the only ostensible (partial) counter-example to geminate inalterability under spirantisation involves a detail of the Florentine Italian facts (Giannelli & Savoia 1979). Singleton intervocalic stops lenite, from fricatives all the way to Ø, depending on speech rate and register, particularly in intervocalic position:

(10)		*Slow/ Careful*	*Moderate/ Natural*	*Fast/ Careless*	*Extremely Fast/Careless*	
	/la tavola/	la θavola	la θ̞avola	la (ð̞)aol̞a	la aol̞a	‘the table’
	/e dɔrme/	e dɔrme	e ð̞ɔrme	e ð̞ɔrm̞e	e ɔɹm̞e	‘s/he sleeps’

This spirantisation (and further reduction) is generally blocked in geminate stops. However, at the fastest rate and lowest register of speech, in intervocalic position, even geminates can spirantise, to very close fricatives.[13]

(11)		*Slow/ Careful*	*Moderate/ Natural*	*Fast/ Careless*	*Extremely Fast/Careless*	
	/bɾutto/	bɾutto	bɾutto	bɾutto	bɾuθ̝θ̝o	‘ugly’
	/fɾeddo/	fɾeddo	fɾeddo	fɾeddo	fɾeð̝ð̝o	‘cold’

However, it is not clear, despite the transcription, that these spirantised segments are in fact phonetically geminates. Giannelli & Savoia give no data on the actual duration of these consonants; but as this spirantisation (as it applies to the “geminates”) is a concommitant of very fast speech, it is unlikely that the duration of the fast-speech “geminate” approaches the typical duration of a geminate in slow or normal speech. Giannelli & Savoia could reasonably transcribe these spirantised segments as "geminates," notwithstanding their *phonetic* degemination, i.e. a substantial reduction in their duration, because they do not neutralise with the category of short consonants. In Florentine the consonant “length” contrast is supported by at least three cues in addition to consonant duration itself: (a) the shortened duration of the vowel that precedes the geminate (Smith 1992); (b) in the case of the voiceless geminate, an aspirated release, as Gianelli & Savoia note; (c) reduced acoustic energy compared to corresponding singletons, due to the more

[13]Such a counterexample might be dismissed as mere “phonetics,” beyond the purview of phonological theory. However, since my approach recognises no modular distinction between phonological and phonetic processes, I cannot avail myself of this traditional “out.”

fortis constriction in the geminates (i.e. the lenited geminates are near-stops whereas the lenited singletons are weak approximants or Ø). Assuming that the lenited geminates in fact degeminate, in the phonetic sense of having significantly reduced closure duration, in fast speech, they do not constitute a counterexample to the generalisation. On the contrary, these facts provide a striking example of geminate resistance to lenition. In this dialect, in which all singleton stops reduce to weak approximants or Ø, even in normal speech, geminates do not spirantise at all, except in the fastest speech style, when they (arguably) are no longer realised with typical geminate duration.

1.2.2.4. LENITION OF GEMINATES OTHER THAN REDUCTION OF ORAL CONSTRICTION IN STOPS. Finally, note that the generalisation distinguishes between reduction of oral constriction in geminate stops and other forms of lenition. It has already been noted that geminates can lenite by degeminating, and that degemination potentiates further lenition in Tiberian Hebrew (8) and Florentine (11). Hebrew also contains a case of degemination tout court: "guttural" (pharyngealised) consonants degeminate, context-free (Hayes 1986). Although such degemination does constitute (temporal) reduction, the output ceases to be a geminate, and thus the NO ORALLY REDUCED GEMINATE STOPS generalisation is maintained.

Geminates also commonly undergo loss of a distinct release of the first half of a geminate, e.g. in English /bʊk/ (with optionally released [k]) + /keis/ - [bʊk̚kʰeis] ('book-case'). This elimination of the opening gesture is clearly a species of articulatory reduction, although this occurs so ubiquitously in geminates that its status as a lenition process is easily overlooked. This absence of release presumably lies behind Ancient Greek “deaspiration” of the first half of a geminate stop (Hayes 1986). For aspiration (in the typical sense of *post*-aspiration, i.e. long lag voice onset time) is a property of the stop's release; thus an unreleased stop cannot bear (post-)aspiration.

The distinction between oral reduction of stops and other forms of lenition also appears in Florentine rhotic reduction (Giannelli & Savoia 1979). Florentine, like many Romance dialects, has a contrast between a long alveolar trill (e.g. [korriðojo] ‘corridor’) and a short trill or tap (e.g. [la ʃe{ɾ/r}a] ‘the wax’). In natural speech styles, both the long trill (e.g. [korriðojo] ‘corridor’) and the short trill or tap (e.g. [la ʃe{ɾ/r}a] ‘the wax’) optionally lenite to approximants, without any temporal reduction of the the longer rhotic: [koɹɹiðojo] vs. [ʃeɹa].[14]

1.2.3. NO HALF-SPIRANTISATION. *No process converts a (tautomorphemic) geminate non-continuant to a "half-spirantised" cluster, e.g. /kk/ - *[xk].* We have already seen in the previous section that spirantisation processes are no more able to yield half-spirantised clusters than they are able to yield fully spirantised geminates. Thus, in Tigrinya, [fəxkərə] and [fəxxərə] are both equally impossible outputs for /fəkkərə/. More generally, cases of spirantisation of the first half of a (tautomorphemic) geminate appear to be unattested, based on the previous inalterability literature and the lenition surveys.[15] In heteromorphemic geminates, however, half-spirantisation is attested, to wit, in Tigrinya, e.g. /mɨrak-ka/ - [mɨraxka] ('calf-2sg.m.'). On the other hand, this distinct behaviour of heteromorphemic geminates under spirantisation in Tigrinya is not universal: in Tiberian Hebrew, heteromorphemic geminates resist spirantisation just as the tautomorphemic geminates do: e.g. [kaarattii] ('I cut'), cf. [kaaraθ] ('he cut').

Furthermore, it is necessary to distinguish between half-*spirantisation* (in the narrow sense of reduction to a fricative), and half-*gliding* of geminates, which is attested in Maxakalí (Gudschinsky, Popovich and Popovich 1970; Hayes 1986): /mattɨk/ - [m^{b}aətɨx] ('happy'), /kaktʃoppit/ - [kakʃoəpiyə] ('boy'), /kɨtʃakkɨk/ - [kaʃaɨkɨx] ('capybara (type of rodent)'). For our purposes, the crucial observation is that the Maxakalí vocoid corresponding to the first half of the geminate is not a *steady-state constriction*, but a (somewhat attenuated) transition from the

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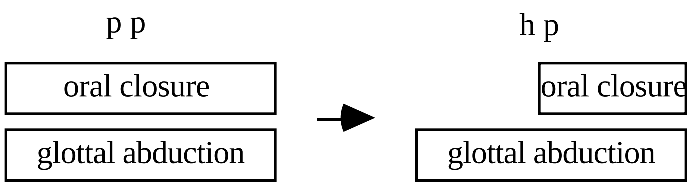
[14]This reduction is not restricted to extremely fast speech; moreover, the two lenited rhotics appear to be distinguished solely by duration; thus it does not seem plausible to claim here, as I did with regard to spirantisation, that the lenited geminate is in fact phonetically degeminated.
[15] This is not to say that geminate stops cannot undergo *affrication.* As an anonymous reviewer notes, the voiceless geminate stops of Old High German, for example, underwent affrication: e.g. E. *dapper* vs. OHG. *tapfer.* However, this affrication process also applied to singleton voiceless stops, in initial and post-consonantal position, e.g. E. *plant* vs. Ger. *[pf]lan[ts]e* (Prokosch 1939: 81). Since this affrication applied to singletons as well, it cannot be characterized as lenition of the second half of a geminate; rather it must be characterized as the addition of an interval of fricated release, presumably for purposes of making the release more perceptually salient (see section 3.2 below). This view of OHG affrication as fortition rather than lenition is corroborated by the fact that it was conditioned by initial and post-consonantal contexts, which, typologically speaking, frequently serve as fortition contexts, and rarely if ever as lenition contexts. I conclude, then, that this sort of affrication is a (perceptually-driven) fortition; not an example of half-spirantizing lenition.

vowel into the following (singleton) obstruent.[16] It is also necessary to distinguish half-spirantisation from half-debuccalisation, attested in the Icelandic process of "pre-aspiration," Thráinsson 1979, whereby voiceless geminate stops reduce to h + stop clusters (e.g. /kappi/ - [kahpi] ('hero'). This is simply *degemination of the oral constriction gesture,* leaving the long glottal abduction gesture unchanged (cf. Clements 1985).

(12)



Since the oral constriction degeminates, this process (vacuously) conforms to the NO HALF-SPIRANTISATION generalisation, as well as the NO ORALLY REDUCED GEMINATE STOPS generalisation.

1.2.4. NO VOICING OF GEMINATES. *No process converts a voiceless segment (geminate or otherwise) to a voiced geminate obstruent.* Blocking of voicing in geminate obstruents has already been exemplified in the Tümpisa Shoshone data (9). That is, all obstruents undergo voicing, except in utterance-initial position, and in (full) geminates (Dayley 1989).[17] Additional examples of geminate inalterability under voicing include:

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[16]Gudschinsky et al., p. 77, explicitly describe these vocoids as "phonetic transition phenomena."
[17]In addition, utterance-final syllables devoice in their entirety, e.g. [...tɨppiʃiɸuŋki̥]$_{\text{Utterance}}$ ('stinkbug').

Table 3. Blocking of voicing in geminates

Language	Reference	Description of process
Berber	Inkelas & Cho 1993	Pharyngealised obstruents - voiced (context-free), blocked in geminates
Cuna	Sherzer 1975	Voicing in medial position, blocked in geminates
Florentine Italian	Giannelli & Savoia 1979	In fast/casual speech styles, voiceless stops, which otherwise spirantise to voiceless fricatives or approximants, further reduce to voiced approximants; this is blocked in geminates.
Gallo-Romance	Bourciez & Bourciez 1967	Sound change: intervocalic /t/ underwent voicing, while /tt/ degeminated without voicing
Malayalam	Mohanan 1986	Stops become voiced in the context /+son__V or /+nas__; blocked in geminates
Somali	Armstrong 1964	Intervocalic voicing, blocked in geminates
Tamil	Christdas 1988	Voicing (and spirantisation) in medial position, blocked in geminates
Tümpisa Shoshone	Dayley 1989	Non-initial obstruents are voiced, blocked in geminates

In contrast, voicing processes which do apply to full geminates appear to be unattested, based on the previous inalterability, and the lenition surveys. See also Hock 1991, who concurs that such processes are unattested, but views this as an accidental gap. Indeed, far from undergoing voicing processes, geminate stops show a positive tendency to devoice, as discussed in section 1.6 below.

A further question is whether there is a "no half-voicing" generalisation, paralleling the NO HALF-SPIRANTISATION generalisation above. Dayley's (1989) description of Tümpisa Shoshone indicates that geminates can indeed be "split" with respect to voicing (contrary, as we shall see, to the claims of the autosegmental treatments of geminate inalterablity).

(13) a. tahaɸi̥ 'snow'
huβiaɾɨxi̥ 'sing'
peθɨ̥ 'daughter'
mõz̥o̥ 'whiskers'
puhaɣãntɨ̥ 'shaman'
b. pũñĩkkḁ 'see, look at'
c. kĩmmãɣ̃ĩnn̥ḁ 'to come here'
uttũnn̥ḁ 'to give'
suɾ̃ɨmm̥ɪ̥ 'those'
pɨe ðuɣʷãnni ɟ̃ããɣ̃ĩnn̥ḁ 'it's already getting dark'

Specifically, in utterance-final position, the final vowel and the preceding consonant, are optionally realised as voiceless (13a), whereas the consonants would otherwise be voiced in non-initial position. Geminate obstruents (b) are predictably voiceless in all contexts. The important point is that the geminate nasals (c) are split, by application of this devoicing process, into voiced and voiceless components.

Armstrong's (1964) description of Somali further suggests that partial voicing of geminate obstruents can occur. Armstrong observes that the Somali geminate stops, which she transcribes as voiced, in fact "do not sound fully voiced," and in some cases are completely voiceless. That is, the geminates in question are (somewhat variably) realised as partially voiced/partially devoiced. This phonetic description comports well with a characterisation of these Somali geminates as *passively devoiced;* that is, voicing ceases roughly 60 msec into the closure (Westbury & Keating 1986), not due to any active adjustment of the glottis, but due to a build-up of oral air pressure behind the closure, which makes continued transglottal airflow, hence voicing, impossible. An analysis of passive devoicing in geminates is presented in section 4.1.1.

1.2.5. NO REDUCTION OF PARTIAL GEMINATES. *"Partial geminates" (i.e. homorganic nasal + stop or lateral + stop clusters) behave identically to full geminates with respect to reduction of oral constriction; but, unlike full geminates, they readily undergo voicing.* Blocking of spirantisation in partial geminates has already been discussed in connection with Tümpisa Shoshone (9e). This inalterability effect is further exemplified in Spanish (Harris 1969):

(14)	a.	aβa 'bean'	aða 'fairy'	aɣa 'make'
		kalβo 'bald'	--	alɣo 'something'
		aβla 'speak'	aðlateɾes 'lackies'	aɣlomeɾaɾ 'to cluster'
		aɾβol 'tree'	aɾðe 'burn'	aɾɣamasa 'mortar'
		aβɾa 'will have'	paðre 'father'	aɣɾio 'sour'
		xajβo (no gloss)	najðen 'nobody'	kajɣa 'fall'
		aβjeɾto 'open'	aðjestɾaɾ 'to guide'	siɣjendo 'following'
		ewβolja (no gloss)	dewða 'debt'	sewɣma 'zeugma'
		aβwelo 'grandfather'	aðwana 'customhouse'	aɣweɾo 'fortune-teller'
		aðβeɾso 'unfavorable'	aβðomen 'abdomen'	suβɣlotal 'subglottal'
		suβmaɾino 'submarine'	aðmiɾasjon 'admiration'	diaɣnostiko 'diagnostic'
	b.	bomba 'bomb'	donde 'where'	gaŋga 'bargain'
			kaldo 'hot'	

That is, non-initial voiced stops spirantise (14a), except when following a homorganic nasal or lateral (b).[18] Additional cases appear in the following table:

Table 4. Blocking of spirantisation, flapping in partial geminates

Language	Reference	Description of process
Lamani	Trail 1970	Flapping blocked after a homorganic nasal or lateral
Malayalam	Mohanan 1986	Spirantisation, flapping do not apply following a homorganic nasal
Proto-Bantu	Greenberg 1948	Spirantisation (context-free), blocked after homorganic nasal
Tümpisa Shoshone	Dayley 1989	Spirantisation blocked in homorganic nasal-stop clusters

More generally, oral reduction of all or part of a tautomorphemic homorganic nasal stop or lateral-stop cluster is unattested in the inalterability literature and the lenition surveys. Far from spirantizing, consonants show a positive tendency to occlusivise when adjacent to a homorganic nasal, as in the following Kikuyu post-nasal alternations (Padgett 1991):

(15)	mbureetɛ	'lop off'	cf. βura
	mbaareetɛ	'look at'	cf. βaara
	ndeheetɛ	'pay'	cf. reha
	nduɣeetɛ	'cook'	cf. ruɣa
	ŋgoreettɛ	'buy'	cf. ɣora
	ŋgaeetɛ	'divide'	cf. ɣaja

Similarly, pre-nasal occlusivisation is seen in certain dialects of American English, e.g. [bɪdnəs] ('business'), ɪdnɪt ('isn't it').

However, nasal + stop clusters show no parallel blocking of voicing. This is seen in Tümpisa Shoshone (9), where voicing applies to post-nasal stops (though spirantisation is blocked), e.g. /ɨntamiɨʔi/ - [ɨndaw̃ɨʔi] ('your little brother'). A virtually identical pattern of post-nasal voicing, but blocking of spirantisation, is observed in Malayalam (Mohanan 1986). Indeed, Pater 1996, and Hayes & Stivers 1997, observe that stops very commonly undergo voicing in

[18]Note however that in [aðlateres], spirantisation does occur. According to the generalisation, spirantisation should be blocked in this context, just as in its mirror image, as /ld/ and /dl/ are both partial geminates. However, /dl/ clusters in Spanish are restricted, so far as I am aware, to heteromorphemic contexts involving rather learned words. Thus the spirantisation in [aðlateres] may be an effect of paradigmatic faithfulness with respect to the prefix [að-] (see section 3.1), rather than natural conditioning of /d/ spirantisation in pre-[l] position.

post-nasal position (regardless of homorganicity), as seen in the following forms (16b) from Wembawemba:

(16)	a.	/taka/	takə	'to hit'
		/milpa/	mɪlpə	'to twist'
	b.	/jantin/	jandɪn	'me'
		/panpar/	panbər	'shovel'

1.2.6. NO EXCLUSIVE OCCLUSIVISATION OR DEVOICING OF SINGLETONS. *No occlusivisation or obstruent devoicing process targets singletons to the exclusion of geminates.* This claim, the flip side of geminate resistance to oral reduction and voicing, is originally due to Churma (1988), who refers to these processes more loosely as "strengthening." Thus, one may find languages in which both geminate and singleton obstruents are uniformly realised as stops (that is, all obstruents occlusivise), e.g. Warray, Mayali, and numerous other Australian languages (see Evans 1996); and there are languages in which only geminates occlusivise, e.g. Modern Berber (Schein & Steriade 1986), Luganda (/jj, ww/ - [ɟɟ, gg^w], Clements 1986, Churma 1988), and Malayalam (/rr/ - [tt], Mohanan 1986). But there appears to be no language in which singletons occlusivise to the exclusion of geminates. Similarly, there are languages in which both geminate and singleton obstruents uniformly surface as voiceless (that is, all obstruents devoice), e.g. Delaware (Maddieson 1984); and Ohala 1983 cites Nubian as a case of geminate devoicing:

(17)	<u>Noun stem</u>	<u>Stem + ‘and’</u>	<u>Gloss</u>
	sɛgɛd	sɛgɛttɔn	father
	kadʒ	kattʃɔn	scorpion
	mʊg	mʊkkɔn	dog

(See also the devoicing of the geminate rhotic in Malayalam, noted above). But there appears to be no language in which singletons devoice to the exclusion of geminates.

2. PREVIOUS APPROACHES

2.1. GEMINATE INALTERABILITY PROPOSALS.

2.1.1. THE CLASSIC AUTOSEGMENTAL PROPOSALS. Both Hayes 1986 and Schein & Steriade 1986 attempt to derive geminate inalterability effects largely from general assumptions of the theory of representations of Autosegmental Phonology (e.g. Goldsmith 1976, Clements and Keyser 1983).

```
(18)  a.  True geminate:   X   X     b.  Singleton:  X     c.   Heteromorphemic geminate:   X + X
                            \  /                     |                                      |     |
                           Melody                  Melody                                 Mel. Mel.
```

In particular, "true" geminates (18a) can be distinguished from both singletons (b) and heteromorphemic ("fake") geminates (c), in that true geminates involve *multiple association* of the melody (featural content of the segment) to the segment-timing or prosodic units which dominate it. Hayes attributes inalterability to the following notational convention:

(19) *Linking Constraint*. Association lines in structural descriptions are interpreted as exhaustive.

Thus, a rule such as Tigrinya spirantisation (20a) cannot apply to a geminate, because the structural description of the rule refers to a single association line between the target dorsal consonant and its timing unit, whereas a geminate is associated with two timing units (20b).

```
(20)      Tigrinya spirantisation:   a.  V       C                 b.  C    C
                                         | . - ' |                      \   /
                                     +cont  dors                        dors
```

Schein & Steriade propose a somewhat more narrowly drawn convention:

(21) *Uniform Applicability Condition ("UAC")*. 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 principal difference between the two conventions is that the Linking Constraint blocks rule application when the target or trigger is a geminate; whereas the UAC blocks only when the target is a geminate, by virtue of the "alters the contents" clause. However, both approaches focus upon the *representational* distinction between single and multiple autosegmental association to block certain rules from applying to geminates. Furthermore, both approaches elegantly handle the distinct behaviour of tauto- and heteromorphemic geminates, e.g. in Tigrinya, where the first half of heteromorphemic geminates undergo spirantisation, just like singletons (see section 1.2.2): heteromorphemic geminates are singly linked (18c), just like singletons (b).

Neither approach, however, draws a connection between inalterability and lenition phenomena. Neither approach prohibits rules which specifically target geminates for full or partial spirantisation or voicing. And neither approach draws a connection between inalterability effects and the general markedness of geminate continuant consonants and geminate voiced obstruents, as reflected in segment inventories. Rather, these approaches predict that inalterability effects are tied to what Schein & Steriade call "structure-dependent" rules, which refer to information on both melodic and timing-unit tiers. Such rules necessarily refer to the linkages between these tiers, thus invoking blocking by the Linking Constraint or UAC. Inkelas & Cho 1993, however, demonstrate that this prediction is false. Syllabification processes (whether formalised in terms of rules or constraints, cf. Itô 1986) refer to prosodic and melodic information, and thus should invariably display inalterability effects.[19] Yet in Korean, for example, the rule or constraint which eliminates velar nasals in onset position applies to singletons and geminates alike (e.g. [kaŋ] ('river'), but *[aŋa], *[aŋŋa]). Similarly, geminates are never immune to rules or constraints requiring sonority sequencing within coda and onset clusters: thus in Latin, a coda [kl] cluster is

[19]Indeed, Itô (1986) relies upon the Linking Constraint to account for geminates' immunity to a phonotactic coda place constraint in Japanese and other languages.

ill-formed, whether the [l] is a singleton (e.g. *[akl.ta]) or the first half of a geminate (e.g. *[akl.la]).

Inkelas & Cho further note that the Linking Constraint and UAC do not hold true for "long-distance" (i.e. segmentally non-adjacent) multiple linking, as Hayes (p. 328) acknowledges. For example, tones which are associated to multiple syllables are not typically immune to processes affecting singly-linked tones. Finally, Inkelas & Cho observe that it is frequently possible to formulate rules either as structure-dependent or segmental, so as to place the rule within or outside the purview of the Linking Constraint or UAC; thus, the predictions these approaches make, as to which processes will or will not exhibit geminate inalterability effects, are not as strong as initially meets the eye (as Hayes (p. 344) acknowledges).[20] Indeed, this criticism can be taken considerably further: to the extent that these approaches attempt to constrain possible individual *rules*, without thereby constraining *sound systems*, they are empirically vacuous. Thus, for example, nothing in these approaches rules out "Zigrinya," a hypothetical language with a general post-vocalic spirantisation rule, as in Tigrinya, *plus* a rule specifically spirantizing post-vocalic geminates. Zigrinya thus achieves by a combination of licit rules the same unattested sound pattern which the Linking Constraint and UAC purport to rule out.

2.1.2. GENERALISED INALTERABILITY. In contrast to the foregoing approaches, Inkelas & Cho 1993 challenge the basic assumption that geminate inalterability is a discrete phenomenon. Inkelas & Cho observe that the blocking of phonological rules is by no means confined to geminates. For example, the "opaque" behaviour of certain vowels in harmony processes, and lexical exceptionality, are also examples of rule blocking. They further identify *prespecification* as the generalised blocking mechanism. For example, under their analysis, Latin coda [l] velarisation involves a rule assigning onset [l] a [-back] specification. This rule applies to the geminates,

[20]For example, Schein & Steriade analyze Turkish depalatalisation as changing a coda velar to [+back], thereby invoking the UAC, and correctly accounting for the fact that this depalatalisation does not affect a multiply-linked [-back] specification. However, it is equally possible (and, as Inkelas & Cho argue, more elegant) to express this as a rule delinking a [-back] specification from a coda velar; this delinking rule does not invoke the UAC, since it does not "alter the contents" of the multiply-linked node.

because they are in onset position (it does not matter that they are also in coda position). Other (i.e. coda singleton) laterals undergo a context-free feature-filling rule making laterals [+back]. The onset rule is ordered before the context-free rule, by virtue of the Elsewhere Condition (Anderson 1969, Kiparsky 1973). But the context-free rule is blocked from applying to the geminates (or other onset [l]'s), because they are already specified for [back]. Other prespecifying rules may specifically target geminates: e.g. in Berber, a rule specifies geminate consonants as [-cont], which bleeds an "elsewhere" rule assigning [+cont].

Although their observations are couched in terms of a rule-based framework, Inkelas & Cho's notion of blocking through prespecification anticipates certain aspects of more recent constraint-based frameworks such as Optimality Theory: specifically, highly general phonological processes can be blocked through conflict with a variety of higher-ranked constraints (cf. the discussion of blocking and triggering in Prince & Smolensky 1993, chs. 3-4). For example, Inkelas & Cho's analysis of Latin [l] velarisation can be restated in OT terms as follows:

(22) ONSET L: *[+back,+lateral] in onset   ELSEWHERE L: *[-back,+lateral]

		ONSET L	ELSEWHERE L
☞	al.la		*
	ał.ła	*!	
	al.ta		*!
☞	ał.ta		

Indeed, this idea of generalised blocking, translated into OT as blocking through higher ranking, is employed in my own analysis of Tigre vowel harmony (3).

But while Inkelas & Cho's approach, particularly in its OT reincarnation, gives us a general mechanism for the blocking of phonological processes, it does not account for the generalisations identified in section 1, which specifically concern geminates and lenition. Inkelas & Cho, acknowledging Churma's (1988) observations along these lines, attempt to draw a connection between geminate inalterability and lenition, as follows. They assume, following Hyman 1985 and Hayes 1989, that (underlying) geminates are linked to moras in underlying representation; whereas other segments must be assigned moras by rule. Moraification rules often impose minimum sonority requirements on coda consonants, e.g. in Hausa, which requires codas to be [+sonorant] (Klingenheben's Law). The geminates escape this condition of the moraification rule, however, because they are already moraified. However, this analysis only extends to cases of *coda* lenition. In Tigrinya and Hebrew, geminate inalterability effects are observed, although lenition occurs in intervocalic onset, as well as coda, position (i.e. post-vocalically). Nor does it appear from the geminate lenition survey above that geminate inalterability is any less universal under post-vocalic or intervocalic lenition than under coda lenition. In their conclusion, however, Inkelas & Cho (1993: 569) explicitly acknowledge the further need for a phonetically based account of certain aspects of geminate inalterability:

> Although they are arbitrary under our analysis, certain of the allophonic alternations involving geminates have a plausible phonetic basis. For example, the fact that voicing is harder to maintain over longer durations might motivate the distribution of [voice] in Berber ... in which singletons but not geminates are voiced.

This is precisely the sort of account which I develop in section 4 below.

2.2. PREVIOUS APPROACHES TO LENITION. The notion that lenition is driven by considerations of articulatory effort is hardly novel. Hock (1991: 80), for example, expresses the naive, but apt, intuitiveness of such an idea:

> Among non-linguists, the perhaps most commonly cited cause for sound change is 'laziness'. While this is a dubious explanation for the great variety of changes that are found in the world's languages, it seems to be singularly appropriate for the class of changes which has been termed **weakening** or **lenition.**

2.2.1 CLASSIC GENERATIVE PHONOLOGY. However, this intuitive explanation has not standardly been incorporated into the formal characterisation of these patterns. Rather, sound patterns have been standardly expressed in terms of language-specific rewrite rules which convert some class of underlying segments into a different class in a particular context; thus, intervocalic spirantisation of oral stops may be expressed as the following rule:

(23) [-nas] - [+cont] / V__V

In the Generative tradition, however, it is further assumed that the formal simplicity of a rule reflects its naturalness, thereby offering some insight as to why phonological phenomena such as lenition are widespread, whereas other conceivable rules are rare, or unattested (Chomsky and Halle 1968, chs. 8,9). By its own standards, then, the classic Generative Phonological formalism exemplified in (23) is inadequate: for an unattested rule, such as intervocalic stop formation, can be expressed with equal formal simplicity:

(24) [-nas] - [-cont] / V__V

A fortiori, this framework does not capture the generalisations concerning geminate inalterability under lenition.

2.2.2. NATURAL PHONOLOGY. The Natural Phonology programme of Stampe (1972) and Donegan & Stampe (1979) attacked the phonetic arbitrariness of classic Generative Phonology. Anticipating much of the orientation of the effort-based approach develop herein, Donegan & Stampe invoked functional principles such as of ease of articulation and ease of perception in their analysis of particular sound patterns, including lenition processes. Unfortunately, the Natural Phonology programme did not develop a restrictive, unified formal characterisation of lenition processes.[21] Rather, the phonetic principles, such as ease of articulation, were merely invoked in the prose as explanation for the ubiquity of particular kinds of phonological processes; the formal statement of the processes themselves is not significantly different from that of classic Generative Phonology. This is not an acceptable result for a scientific research programme: if explanatory principles are left in the realm of unformalised metatheory, their descriptive adequacy cannot be rigorously evaluated, and so they remain mere illusions of explanation.

2.2.3. LENITION AS AUTOSEGMENTAL SPREADING. As an alternative reaction to the arbitrariness of classic Generative Phonology's feature-changing rules, Autosegmental Phonology (Goldsmith 1976) permitted a large class of natural phonological rules, most notably assimilation processes, to be expressed as operations on association lines, such as feature spreading. Within the framework of Autosegmental Phonology, then, an obvious move is to attempt to reduce lenition to autosegmental feature-spreading assimilation. Thus, James Harris (1984) accounts for Spanish spirantisation in terms of a rule that spreads [+continuant] from an adjacent segment (see also Mascaró 1983 and Jacobs and Wetzels 1988; see Selkirk 1980, Mascaró 1987, Cho 1990, Lombardi 1991 for similar treatments of voicing).

Problems with attempts to derive geminate inalterability from the autosegmental theory of representations have already been discussed in section 2.1. In addition, autosegmental approaches to lenition face several immediate and fundamental problems.

2.2.3.1. THE LACK OF A UNIFIED APPROACH. First, certain types of lenition, namely degemination, debuccalisation, and elision, can only be expressed in autosegmental theory as deletion or delinking of phonological material, not as spreading. For example, there is no feature which can be spread onto a consonant to turn it into Ø, nor a feature which turns a geminate into a singleton. Therefore the feature-spreading approach does not permit a unified characterisation of lenition. A unified treatment, however, is motivated, for example, by the lenition pattern of Florentine Italian ((10); see Kirchner 1998, ch. 8): in (roughly) intervocalic position, voiceless stops display increasing lenition, first to fricatives, then to approximants, then to voiced approximants or [h], and finally to Ø, the faster the speech rate or the lower the register. In light of the scalar nature of this lenition, and its sensitivity to the same conditions and contexts

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[21]They do, however, make a number of proposals concerning the *ordering* of lenition processes relative to fortition processes.

(fast/casual speech, flanking vowels) at every step along the scale, these alternations clearly behave as a unified phenomenon. Patterns of increasing reduction in fast/casual speech are likewise reported for German by Kohler (1991). Further motivation for a unified approach is found in patterns such as Malayalam, in which retroflex stops undergo flapping, while stops at the other places of articulation spirantise to voiced approximants, all in the context /[+son,-nas]__V (Mohanan 1986). Similarly, in Yindjibarndi (Wordick, 1982), in intervocalic position, /k/ deletes, while stops at other places of articulation spirantise to glides. Without a unified approach, we must treat each of these structural changes (spirantisation, flapping, deletion) as unrelated phenomena, missing the generalisation that these are all manifestations of reduction of consonant constriction degree, occurring in the same context, across all places of articulation, in each of these languages. Nor could we account for the striking fact that these different patterns of reduction happen to be conditioned by substantially the same context in Florentine, Malayalam, and Yindjibarndi (i.e. roughly intervocalic position; or more precisely, a two-sided context requiring some threshold of openness of the flanking segments).

2.2.3.2. TWO-SIDED LENITION CONTEXTS. Second, this approach predicts that lenition may occur *whenever* a consonant is preceded (or followed) by any segment bearing a lenitional feature value ([+cont], [+voi], [+son], etc.), with equal likelihood. In particular, the feature-spreading approach fails to give a natural account of two-sided lenition contexts such as intervocalic position: it suffices to spread the relevant feature from *either* adjacent vowel, and so the role of the other vowel in conditioning the lenition is unexplained. As Flemming (1995: 116) has observed, this problem constitutes a general flaw of the autosegmental formalism: assimilations, which typically appear to have some basis in the phonetic tendency to coarticulate gestures, are treated as feature-spreading. But in many cases, this coarticulation results in a categorical alternation only when the coarticulation is two-sided. Flemming gives the example of Cantonese vowel fronting, which occurs between two coronal consonants; the coarticulation in this case involves tongue body fronting. I regard intervocalic lenition as a kind of coarticulation involving the jaw/articulator ensemble: it is the opening gestures of the flanking vowels which exert pressure for a more open realisation of the intervening consonant (see Kirchner 1998, ch. 6; de Jong et al. 1992). Banner-Inouye (1995) attempts to address this problem with respect to intervocalic flapping, by proposing that flaps are represented as tripartite contour segments, i.e. [[+cont][-cont][+cont]]. With this representation, intervocalic flapping can be captured as spreading of [+cont], from both adjacent vowels. But this contour-segment treatment does not extend to intervocalic spirantisation or voicing, as it is untenable to posit contour representations for simple fricatives and voiced obstruents. Nor can this approach offer a unified account of intervocalic flapping and flapping in other contexts, e.g. word-final flapping of /ɖ/ in Gujarati (Cardona 1965).

2.2.4. LENITION AS LOSS OF PHONOLOGICAL MATERIAL. Given the observation that certain types of lenition must be treated as deletion of phonological material, perhaps a deletional approach can be extended to lenition generally. This approach is adopted by John Harris (1990), within the framework of Government Phonology (Kaye, Lowenstamm, and Vergnaud 1985).[22] In Government Phonology, all features are privative. Thus, for example, voicing lenition can be expressed as the loss of a h˚ element (corresponding to [-voice] in conventional feature inventories), and spirantisation is the loss of a ʔ˚ (= [-continuant]) element. This approach thus permits voicing and spirantisation lenition to be treated in a uniform manner with the more obviously deletional lenition processes, such as consonant elision, degemination, and debuccalisation. To account for the frequent conditioning of lenition by coda position, Harris further posits a "Complexity Condition," which requires a "governed" position to be of lesser “complexity” (i.e. number of elements, which is directly related to "strength") than its governor, in this case the following onset. Consequently, a coda consonant which is underlyingly governed by a less complex (weaker) onset may jettison one or more elements/features to avoid a Complexity Condition violation. Similarly, the nucleus of a governed (unstressed) syllable must have a less

[22]Cf. Grijzenhout's (1995) similar attempt to characterise of Celtic consonant mutations as deletion of aperture nodes (Steriade 1993a).

complex onset than that of its governor (the nucleus of an adjacent stressed syllable); this may then induce lenition of the onset of the unstressed syllable.

However, this approach presents a number of significant empirical problems. First, the privative representation of voicelessness is incompatible with the widely attested phenomenon of word-final devoicing. In Harris' feature system, such a rule must be expressed as the insertion of a h˚ element: not only is such feature insertion formally arbitrary; it occurs in coda position, where Harris predicts feature *deletion.* But without this assumption, Harris' unified approach to lenition collapses. Moreover, the Complexity Condition incorrectly predicts that lenition of the onset of one syllable can be sensitive to the complexity of the onset of an adjacent syllable (the nucleus of an unstressed syllable must have a simpler onset than that of a stressed syllable). We would therefore expect to find lenition patterns such as C - +cont /$[\_\_V]_{\sigma}[CCV]_{\sigma}$: to my knowledge, such patterns are completely unattested. Nor is it clear how Harris' notion of onset lenition as relative strength of nucleus government translates into an intervocalic environment for lenition (although Harris asserts that it does): apparently under Harris' definition of government, a closed as well as an open syllable can govern a following syllable, in which case the onset of the following syllable is a lenition environment by Harris' definition, although it is not intervocalic. Finally, and most importantly for present purposes, the deletion approach affords no insight into geminate inalterability under lenition. That is, nothing intrinsic to Harris' approach blocks the deletion rules from applying to geminates as well as singletons.

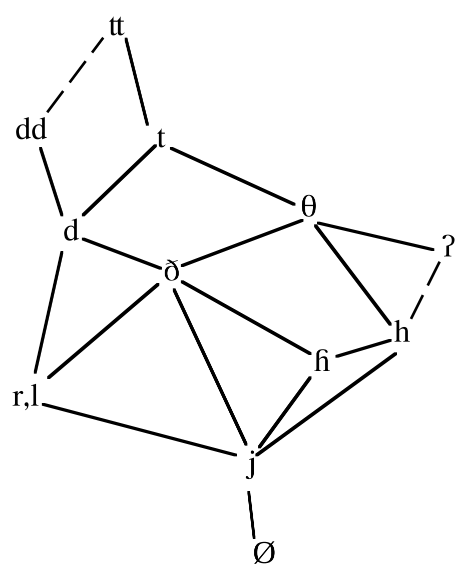
2.2.5. LENITION AS SCALAR PROMOTION. Lenition patterns such as that of Florentine Italian (increasingly drastic lenition in lower registers), make the scalar nature of lenition readily apparent; so also does the fact that lenition often involves a diachronic gradual "erosion" of highly constricted consonants, such as stops, into more reduced consonants, ultimately culminating in elision.[23] It is therefore desirable for the theory to be able to refer to a scale of consonant "strength"; and an obvious move is to attempt to reduce this scale to the other phonological scale countenanced in the standard theory, viz. the sonority scale, used in syllabification theory (e.g. Steriade 1982, Clements 1990) -- namely, by characterizing lenition as promotion along the sonority scale.

But although this notion of sonority-promotion has often been tentatively suggested as an approach to lenition (e.g. Foley 1977, Churma 1988, Clements 1990, Hock 1991, Ní Chiosáin 1991, Elmedlaoui 1993, Lavoie 1996), this proposal has rarely been fleshed out in explicit analyses of actual sound patterns. A closer examination of the proposal reveals significant problems. First, the fit between the sonority scale and the strength scale is not particularly compelling:

(25) a. <u>Sonority scale</u> (Dell & Elmedlaoui 1985)

stops
⇑
voiceless fricatives
⇑
voiced fricatives
⇑
nasals
⇑
liquids
⇑
high vowels/glides
⇑
low vowels

b. <u>Strength scale</u> (Hock 1991):



(“Lenition” corresponds to any downward path in the lattice in (25); the dotted lines represent possible (in Hock’s view) but unattested lenitions.) The weak end of Hock’s scale is occupied by Ø; but it is impossible to speak of a deleted segment as having any sonority at all, let alone being maximally sonorous. Conversely, at the strong end of the scale lie the geminate stops; but there is no evidence that these behave as less sonorous than singletons for phonotactic purposes; indeed,

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[23] Cf. Theo Vennemann's frequently repeated dictum (cited in Hyman 1975: 165), "A segment X is said to be weaker

they typically do not pattern as single segments at all, but as clusters. Furthermore, if we take the sonority scale seriously as a characterisation of lenition, we would expect that fricatives can lenite to nasals; yet such alternations are unattested. Moreover, vowel reduction, which would appear to be the vocalic counterpart of consonant lenition,[24] typically involves *raising* (and centralisation), e.g. a - ə. But the higher the vowel, the *less* sonorous it is; thus vowel reduction appears to involve sonority *demotion* rather than the expected promotion.

Plausibly, the mismatches between the two scales reflect the perceptual vs. articulatory bases of the sonority and strength scales, respectively. The scale evidenced in syllabification presumably has to do with the contexts in which particular sounds are sufficiently audible (in brief, low sonority sounds are most audible when adjacent to high sonority sounds, due to the transitional cues, see Kawasaki 1982; Steriade 1993; Wright 1996); whereas the scale evidenced in lenition typology, I argue, has to do with the relative effort costs of achieving constriction or opening gestures. Of course, these overlap to some extent -- typically, the less constricted a segment, the greater its acoustic energy -- but this is not to say the scales can be safely equated.

Finally, the sonority scale suffers from the same lack of an explicit, unified phonetic characterisation (see Kawasaki 1982) that has plagued the "strength" scale of lenition theory (see Bauer 1988). Thus, even if it were successful, the strategy of unifying the two scales at best amounts to debt consolidation, not payment in full. It is, of course, conceivable that lenition involves some abstract scale of "strength," which bears no straightforward relation to any phonetic dimension, which is perhaps distinct from “sonority” as used in syllabification, and which may even vary from language to language. Lenition then is characterisable in terms of an operation of promotion on this scale. Such a position is explicitly adopted by Foley (1977). However, this view of the "strength" scale does not appear to offer anything more than a bare restatement of the facts: class X may lenite to class Y, class Y to class Z, etc. Moreover, in the context of rule-based frameworks, which attempt to characterise possible sound systems in terms of a maximally

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than a segment Y if Y goes through an X stage on its way to zero.”

restrictive set of operations (such as Autosegmental Phonology's operations on association lines), the introduction of promotion operations constitutes a serious weakening of the theory. Finally, the promotion operation says nothing about the contexts and conditions under which lenition occurs; hence it can afford no characterisation insightfully linking the structural changes of lenition with the environments in which they naturally occur.

2.2.5. AN ARTICULATORY PHONOLOGY APPROACH. The framework of Articulatory Phonology (e.g. Browman & Goldstein 1990, 1992) represents lexical items as "scores" of articulatory gestures, and attempts to analyze phonological processes (particularly the highly productive, phrasal, casual-speech processes which are standardly treated as part of "phonetics") in terms of a relatively restricted set of operations on these otherwise invariant gestural scores, principally modification of intergestural timing, and, more importantly for our purposes, gestural reduction. A unified characterisation of lenition is therefore trivial in this framework: lenition equals gestural reduction.

2.2.5.1. ACCOUNT OF GEMINATE LENITION GENERALISATIONS. Furthermore, one can readily construct an Articulatory-Phonology account of the geminate lenition generalisations (at least with respect to oral constriction). If we take a position-vs.-time curve for a long oral closure gesture (26), and simply reduce the magnitude of the gesture, without otherwise modifying the "shape" of the curve, the immediate result is shortening of the closure duration (b); and further reduction, to the point of spirantisation, entails shortening (c) as well.[25]

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[24] That is, like lenition, it occurs more readily the faster the speech rate and the lower the register, and is commonly blocked in stressed syllables, see Crosswhite 1999.
[25] The portion of the curve above "closed" position corresponds to *compression* of the active articulator against the passive; while the portion below corresponds to *displacement* of the active articulator.

(26)

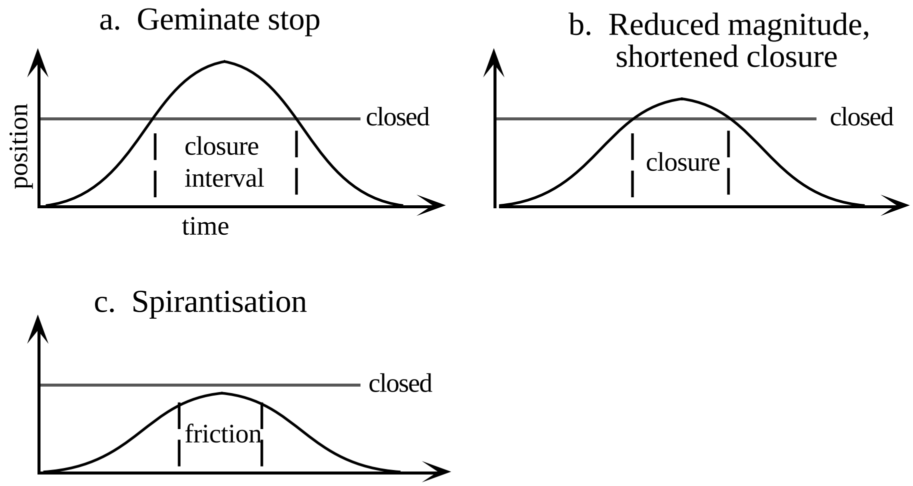
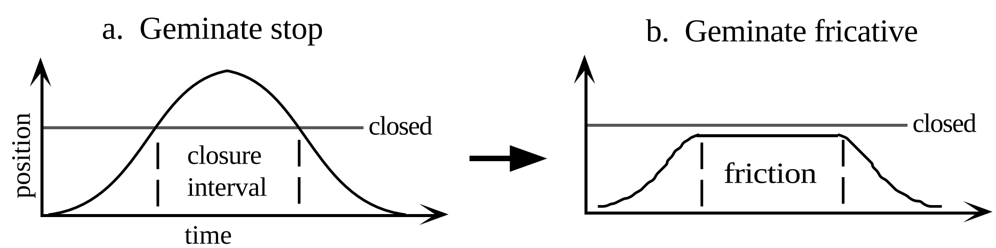


Figure 1

In order for this Articulatory Phonology-inspired account to go through, however, it must be the case that lenition processes are strictly operations of reduction. Further modifications of the input gesture must be universally prohibited, otherwise nothing prevents further modification of the shape of the displacement curve, as in (27), resulting in a geminate fricative.

(27)



2.2.5.2. LENITION IS *NOT* MERE GESTURAL REDUCTION. But lenition processes can in fact involve modifications of the original gestures, beyond mere reduction. For example, Romero (1996) observes, from electromagnetic articulometry data on Andalusian Spanish lenition, that gradient reduction of constriction *degree* is accompanied by modification of the constriction *location* target: the reduced labials tend to be more retracted (closer to labiodental) and the reduced dentals tend to be more advanced (closer to interdental) than the corresponding stops (p. 62). Giannelli & Savoia's (1979) description of Florentine Italian lenition likewise casts doubt on the characterisation of lenition as simple gestural reduction. Specifically, they report that in careless (*trascurato*) speech, /ɡ/ debuccalises to [ɦ] (i.e. "voiced h").[26]

(28) gamba / la ɦamba 'leg / the leg'
grattare / e si ɦratta 'to scratch / (s)he scratches'

That is, the dorsal closure gesture of the /ɡ/ is replaced, in this debuccalisation process, by a (weak) glottal abduction gesture. However, there is no reason to suppose that this glottal abduction gesture is present in the original gestural plan for the voiced stop; indeed, glottal abduction would be inimical to voicing of this contrastively voiced stop. Simple gestural reduction, therefore, cannot derive [ɦ] from /ɡ/. Rather, it would appear that the [ɦ] serves as a *perceptual* vestige of the input voiced stop. Moreover, if any process is to be viewed as part of the synchronic speech production system which Articulatory Phonology seeks to model, it is this Florentine lenition process: the variation is sensitive to speech rate and register; it applies without lexical exceptions, in phrasal domains as well as within lexical items; and it constitutes part of a more general pattern of scalar lenition.

Additionally, in the London and Fife dialects of English (John Harris 1990) /t/ debuccalises to [ʔ], in intervocalic and final position. That is, loss of the coronal closure gesture (and glottal abduction gesture) is compensated for by insertion of a glottal *constriction* gesture. Though it might be suggested that the final /t/'s are already glottalised in the input in this case (since coda glottalisation of /t/ is well attested, for example in American English), there is no reason to suppose that the input /t/'s have any glottal constriction component in *intervocalic* position. A further case of intervocalic stop debuccalisation to [ʔ], in this case targeting /k/, is found in West Tarangan (Nivens 1992). It appears from Lavoie's (1996) survey (p. 291), however, that fricatives (including voiced fricatives, which should have no significant glottal abduction) debuccalise exclusively to [h].

[26] Note that Giannelli & Savoia's transcription of the consonants is extremely narrow (distinguishing, for example, three different degrees of constriction in continuant consonants; and distinctions between ordinary [h], a somewhat

Table 5. Fricative debuccalisation outcomes.

Language	Reference	Debuccalisation pattern
Miami (Illinois)	Costa 1991	s,x,θ,ʃ,tʃ,ç > h /__-voi stop
Latin American Spanish	Lipski 1984	s - h /V__V and /__# in polysyllabic words
Proto-Greek	Sommerstein 1973	s > h /__V
Middle Chinese	Pulleyblank 1984	x > h (context unclear)
Páez	Gerdel 1985	x - h /V__V
Navaho	Kari 1976	x - h non-initially
Babine	Story 1984	x > h stem-finally
Canelakraho	Popjes & Popjes 1986	j,x > h initially
Pipil	Campbell 1985	w - h word-finally and /__C

Plainly, what is being preserved in these debuccalisation cases is not the *gestural* component of the input stop or fricative, but one of its acoustic/auditory properties, i.e. an interval of silence or noise (or in some cases, a mere consonantal interval). Moreover, in Kanakuru (Newman 1974), Lama (Ourso & Ulrich 1990), Limbu (van Driem 1987), Uzbek (Sjoberg 1963), and Warndarang (Heath 1980), bilabial stops reduce to the labiovelar glide, [w]: that is, as the bilabial gesture reduces, the resulting glide is perceptually enhanced by insertion of a dorsal raising/backing gesture.[27] In Nkore-Kiga (Taylor 1985), /b/ reduces to a labiodental approximant, [ʋ], a modification of the constriction location target of the underlying gesture (cf. Romero's similar finding for Andalusian Spanish, above). Finally, in Warndarang (Heath 1980), /k/ reduces to [w], neutralizing with the reduced labial: in this case, the velar glide resulting from reduction of the underlying /k/ is enhanced by insertion of a labial rounding gesture.

Thus, it is not correct to assume that lenition processes are strictly characterised as gestural reduction; rather, such reductions are commonly accompanied by gestural insertion or modification, presumably for purposes of perceptual enhancement of the lenited output. Therefore, the Articulatory Phonology framework appears to be too restrictive; but if the framework is enriched to permit further modification of reduced gestures, then nothing prevents the

weaker voiceless variant [ḥ], and this voiced [ɦ]); moreover, these transcriptions are reported to be based on spectrographic analysis.

[27]See Stevens, Keyser & Kawasaki (1986) on the acoustic basis for viewing the combination of tongue-body

transformation of an input geminate stop gesture into an output geminate fricative, and the Articulatory Phonology account of the geminate lenition generalisations collapses. What is missing from this account, I contend, is a distinction between gestural modifications which result in a net reduction in effort and gestural modifications which result in a net increase in effort. That is, lenition is more accurately characterised as *substitution of a less effortful set of gestures*, subject to requirements that the output be sufficiently perceptually similar to the input, and sufficiently perceptually distinct from other forms, as formalised in section 3 below.

2.2.6. A NON-EFFORT-BASED OT APPROACH. Finally, let us consider an approach to lenition which avails itself of Optimality Theoretic (Prince & Smolensky 1993) conflict among violable constraints, but without referring directly to the phonetic notion of articulatory effort, as in my proposal. Such a treatment is Jacobs' (1994) account of Gallo-Romance spirantisation and voicing. Jacob's approach, like that developed in section 4 below, relies upon domination of faithfulness constraints (PARSE(cont), PARSE(voi)) by a set of lenition-inducing constraints. Unfortunately, these lenition-inducing constraints simply stipulate that the specifications [-voice] and [-cont] are disfavored in "lenition environments," which Jacobs equates, on an ad hoc basis, with post-vocalic position.

We can, however, readily construct a more general, unified approach, in which lenition is attributed to a scalar REDUCE constraint, favoring reduction of constriction degree (e.g. approximant < fricative < stop), but without explicitly referring to effort minimisation. Furthermore, the blocking of lenition in geminates could be attributed to a miscellany of constraints, independently motivated by the markedness of geminate continuant consonants and voiced geminate obstruents (see section 1.2.1), such as *[+cont,-cons]/geminates, *[+voi,-son]/geminates, *NASAL + FRICATIVE CLUSTERS, etc.

However, under rankings in which REDUCE dominates one of the markedness constraints, the generalisation embodied by the markedness constraint evaporates:

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raising/backing and lip rounding as mutually enhancing.

(29)

	REDUCE	*[+cont,-cons]/geminates
pp	**!	
☞ ϕϕ	*	*

The markedness constraints must therefore be stipulated, under this approach, to be inviolable. However, this inviolability cannot be maintained across the board: as shown in (30), if the markedness constraint universally dominates the relevant faithfulness constraints (IDENT(cont), IDENT(voi) in the more recent terminology of correspondence theory, McCarthy & Prince 1995), surface /ϕϕ/ is universally ruled out, thus incorrectly ruling out *contrastively* voiced or continuant geminates:

(30)

Input: /ϕϕ/	*[+cont,-cons]/geminates	IDENT(cont)
☞ pp		*
ϕϕ	*!	

Thus, the inviolability of these particular geminate markedness constraints holds true only under lenition. The ranking conditions, therefore, simply restate the generalisations: the approach does not permit them to be derived from more general considerations.[28]

2.7. ASSESSMENT. None of the foregoing approaches affords a sufficiently restrictive, unified characterisation of lenition processes. The phenomenon of geminate inalterability, and other aspects of lenition typology, I contend, reflect, *inter alia*, considerations of articulatory effort. Consequently, no account which ignores these considerations can achieve descriptive adequacy, except by stipulation.

[28] An anonymous reviewer that geminate inalterability might alternatively be attributed to the intrinsic ranking IDENT(manner features)/geminates » IDENT(manner features). Such a treatment would capture an implicational statement such as "if a geminate consonant lenites, then so does the corresponding singleton." The lenition-inducing constraint could be ranked above both, leniting geminates and singletons together; between the two, leniting the singleton but not the geminate; or below both, leniting neither; but no ranking permits the geminate to lenite to the exclusion of the singleton. However, I have shown in section 1 that geminate inalterability under lenition is

3. AN EFFORT-BASED APPROACH TO LENITION

3.1. LENITION AS EFFORT REDUCTION. The core proposal of this article is that lenition patterns are expressed in terms of Optimality Theoretic conflicts between a scalar effort minimisation constraint, LAZY, on the one hand (which generally favors reduction of articulatory gestures, ideally to Ø), and on the other hand a set of lenition-blocking constraints, including "faithfulness" constraints (favoring preservation of underlying specifications). Thus, spirantisation, for example, is analyzed in terms of rankings where LAZY dominates faithfulness to continuancy (31); under the opposite ranking (b), spirantisation is blocked:

(31)

a.

	/b/	LAZY	IDENT(cont)
	b	**!	
☞	β	*	*

b.

	/b/	IDENT(cont)	LAZY
☞	b		**
	β	*!	*

To be more explicit, I assume that the notion of effort to which LAZY refers can be equated with the biomechanical energy required to achieve some set of articulatory gestures, or more precisely, a mental estimate of the neuromuscular analog of this energy. It seems plausible that speakers are capable of extrapolating from past experience of articulatory feedback, to compute an estimate of the activation levels required for a given gesture. Formally, then, I assume that effort cost is computed for each candidate representation, as part of the candidate generating function, GEN. The assignment of greater LAZY violation marks to the stop in (31) reflects the inference that, all else being equal, the stop requires more energy than the fricative due to the greater articulatory displacement in the former (assuming that the consonant in question is preceded or followed by a more open vocal tract position). As in Optimality Theory generally, the absolute number of violation marks for any candidate is formally irrelevant: what matters is the relative gravity of

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considerably stronger than this implicational statement: geminates *never* undergo particular kinds of lenition; and the positional faithfulness account cannot address this.

violations among the set of candidates within the tableau, see Prince & Smolensky 1993, ch. 5.

The connection between effort reduction and *voicing* lenition is not as immediately apparent. However, the oral constriction gesture in voiceless obstruents is typically of greater magnitude (i.e. longer constriction, and greater compression) than in voiced obstruents, cf. the traditional notion that voiceless stops are "fortis," i.e. involving greater muscular force, and voiced stops "lenis" (see generally Ladefoged & Maddieson 1996, chapter 3). Presumably, the more fortis gesture facilitates the maintenance of an occlusion (or partial constriction, in the case of fricatives) notwithstanding the greater oral pressure behind the constriction in voiceless obstruents. For languages in which this is the case, voicing lenition therefore conforms to the general characterisation of lenition given above: that is, temporal/spatial gestural reduction for purposes of effort minimisation. Thus there appears to be a sound phonetic basis for the traditional classification of medial voicing processes as a species of lenition.[29]

3.2. LENITION-BLOCKING CONSTRAINTS. Following McCarthy and Prince 1995, I posit a segmental faithfulness constraint MAX (all input segments have correspondents in the output, i.e. don't delete), and a set of featural faithfulness constraints of the form IDENT(F) (corresponding segments in the input and output have the same value for F, i.e. don't change the value of F).[30] Thus, spirantisation, for example, is analyzed in terms of rankings where LAZY dominates IDENT(cont):

[29] Furthermore, Westbury & Keating 1986 suggest that, due to aerodynamic conditions, in utterance-medial position when preceded by a voiced sonorant, obstruents of normal duration (typically 50-80 msec) undergo *passive voicing*, unless they are devoiced by active abduction (or constriction) of the glottis.[29] If this is correct, voicing in this context would thus afford an effort savings, independent of the oral constriction gesture, simply because the devoicing gesture necessarily involves more effort than no gesture at all; but see Boersma 1998, casting doubt on a number of assumptions of Westbury & Keating’s aerodynamic model.

[30] McCarthy and Prince's anti-epenthesis constraint, DEP, is also assumed, though it will play no role in the present analyses.

(32)

	/b/	MAX	IDENT(son)	LAZY	IDENT(cont)
	b			***!	
☞	β			**	*
	w, β̞		*!	*	
	Ø	*!			

Further lenition, to an approximant or Ø, is blocked by other faithfulness constraints, namely MAX and IDENT(son).

Note that lenitional *chain shifts,* e.g. tt - t - d (e.g. Gallo-Romance, Bourciez & Bourciez 1967), can be handled in terms of the general treatment of chain shifts proposed in Kirchner 1996, i.e. local conjunction of faithfulness constraints. The Gallo-Romance chain shift follows, for example, from the ranking MAX-μ&IDENT(voi) » LAZY » MAX-μ, IDENT(voi).

Restriction of lenition to particular contexts can be obtained through context-sensitive IDENT constraints, an enrichment motivated in Jun 1995, Steriade 1993, 1996, and Beckman 1997, and grounded in the phonetic observation that many distinctions are perceptually more salient, or more crucial to lexical access, in particular contexts, such as word-initial, onset, and stressed position. Intuitively speaking, there is greater impetus to lenite in contexts where expenditure of effort results in relatively little perceptual payoff. Thus, coda lenition (e.g. Hausa) can be captured as follows: IDENT(cont/onset) outranks the more general IDENT(cont) constraint; and LAZY falls between these:

(33)

		IDENT(cont /onset)	LAZY	IDENT(cont)	IDENT(son)
	abda -> ab.da		**!		
☞	abda -> aw.da		*	*	*
☞	aba -> a.ba		**		
	aba -> a.wa	*!	*	*	*

Blocking of lenition in other perceptually prominent positions, e.g. word-initial and stressed positions, can similarly be attributed to context-sensitive faithfulness constraints: IDENT(F/#__), IDENT(F/stressed), etc.[31]

Note, however, that for cases of *complementary distribution*, e.g. no word-initial fricatives, and no non-initial stops, the use of faithfulness constraints as lenition-blockers is insufficient.

(34)

		IDENT(cont/#__)	LAZY	IDENT(cont)
☞	a. #ka -> #ka		**	
	#ka -> #xa	*!	*	*
	b. #aka -> #aka		**!	
☞	#aka -> #axa		*	*
	c. #xa -> #ka	***!**	******	*****
☞	**#xa -> #xa**		*****	
	d. #axa -> #aka		**!	*
☞	#axa -> #axa		*	

If, as in (34), some word-initial obstruent is underlyingly [+cont] (and the OT tenet of Richness of the Base (Prince & Smolensky 1993, ch. 9) prevents us from excluding such an input), both faithfulness and LAZY favor the fricative candidate; thus it is impossible to rule out word-initial fricatives. An additional class of lenition-blocking constraints is required: these must not only block lenition, but actively *induce fortition*, e.g. requiring word-initial obstruents to be realised as stops (*[+cont,-son]/#__). It seems plausible that these fortition constraints are, like the context-sensitive faithfulness constraints, grounded in perceptual considerations. For example, the release burst of a stop contains salient place of articulation cues (e.g. Wright 1996); thus, by militating in favor of consonants with a release burst, this constraint can be viewed as enhancing the

[31]Restriction of lenition to particular *places* of articulation may similarly be obtained in terms of place-specific faithfulness constraints, e.g. {IDENT(cont/lab), IDENT(cont/cor)} » LAZY » IDENT(cont/dors) results in spirantisation of dorsal consonants exclusively. Alternatively, such patterns may be obtained by allowing place-specific LAZY constraints: the ranking {LAZY_{cor}, LAZY_{lab}} » IDENT(cont) » LAZY_{dors} yields the same pattern. Both approaches seem equally ad hoc, as is the typology: there do not appear to be any valid cross-linguistic generalisations (e.g. “if coronals lenite, then so do labials”) concerning place of articulation and lenition (cf. Kirchner 1998; pace Foley 1977). In any case, the choice between place-specific faithfulness and place-specific LAZY approaches is extraneous to our present concerns, therefore I will not pursue it.

perceptibility of the consonant; and the allocation of more robust cues to word-initial position may be viewed as reflecting the greater importance of word-initial consonants in lexical access (see Flemming 1995 for a more general treatment of perceptual enhancement in phonology). However, precise formulation of the fortition constraints is largely extraneous to our present concerns: rather, the focus is on general results of interaction between LAZY and lenition-blocking constraints, whether these are of the faithfulness or the fortition families.

In sum, the structural changes occurring in a given language (with respect to lenition) depend upon which of the lenition-blocking constraints are ranked below LAZY: if IDENT(voi), then voicing; if IDENT(sonorant), then reduction to a sonorant (e.g. a glide or flap); if IDENT(place features), then debuccalisation; if MAX, then elision; if MAX-MORA, then degemination; if no faithfulness constraint, then no lenition at all. *Thus, lenition receives a unified characterisation, in terms of the ranking schema LAZY » faithfulness/fortition.* For a more in-depth exposition of this approach to lenition, including accounts of lenition in intervocalic position, and sensitivity of lenition phenomena to speech rate and register, see Kirchner 1998.

3.3. THE LARGER PROGRAMME. This general constraint system is motivated not merely by lenition typology: essentially the same set of constraints is deployed by Jun (1995) to account for place assimilation in consonant clusters. Jun demonstrates, through analysis of air pressure data, that casual speech gradient assimilation (e.g. /fon bʊk/ - [fombʊk]), attributed by Browman & Goldstein (1990) to gestural overlap, in fact involves gestural reduction of C_1, to the point where the percept of C_1's place of articulation is lost. Local assimilations, then, emerge as a special case of lenition, where gestural reduction is accompanied by temporal extension of the gesture of C_2, in order to preserve other underlying properties of the target segment, such as non-continuancy. Categorical "phonological" assimilations can be analyzed in the same terms, where the reduction of the C_1 gesture is total.

(35) /atka/	MAX	IDENT(cont)	LAZY	IDENT(cor)
atka			****!	
☞ akka			***	*
ahka		*!	**	*
aka	*!	*	*	*

It can readily be seen from this tableau that, with higher ranking of LAZY, the manner as well as the place of the underlying /t/ would be lost, resulting in debuccalisation or elision, i.e. lenition *tout court*.

More generally, the effort-based proposal sketched above may be viewed as part of an emerging research programme, which weds the substance of functional phonetic explanation with the formalism of OT constraint interaction, in order to achieve more deeply explanatory accounts of phonological phenomena. This goal appears, to varying degrees, in such recent works as Steriade 1993, 1996; Kaun 1994; Flemming 1995, 1997; Jun 1995; Silverman 1995; Myers 1996; Pater 1996; Beckman 1997; Gafos 1997; Hayes 1997; Kirchner 1997; MacEachern 1997; Boersma 1998; and Gordon (in progress).[32] Furthermore, the approach continues a line of research on phonetic explanation in phonology, associated with phoneticians such as Ohala (1981, 1983); Lindblom (1983, 1990); Browman & Goldstein (1990, 1992); and Kohler (1991).

Since appeals to functional explanation have historically been received with skepticism by many phonologists, it is perhaps helpful to address explicitly some potential objections regarding the effort-based approach to lenition, and to phonetically based OT (see, e.g., Hyman 1999; Hale & Reiss, forthcoming). It has sometimes been claimed, for example, that phonetic factors are mere tendencies, too "fuzzy" to be useful in formal phonological analyses of particular languages (Lass 1980, Anderson 1981). Moreover, phonetic principles refer to concrete, continuous representations, with gestures and formant frequencies and the like; whereas it is commonly assumed that phonological representations are more abstract, reflecting only potentially contrastive, categorical distinctions (e.g. Keating 1984, Lombardi 1991). Finally, even highly "natural"

[32] To some extent, this orientation was anticipated in the (pre-OT) Grounded Phonology programme of Archangeli & Pulleyblank 1994.

processes may have phonetically arbitrary aspects to their behaviour; therefore it would appear that any attempt to reduce them to phonetics is misguided.

However, the fact that languages differ in the extent to which they adhere to particular phonetic principles is not, as e.g. Lass 1980 assumes, an indication of the formal inutility of such principles, but rather a basic prediction of OT's core assumptions: constraint violability and language-specific ranking (cf. McCarthy and Prince's (1994) discussion of the "fallacy of perfection"). The representational issue is addressed at length in Kirchner 1997; to summarise the argument, the contrastiveness and categorical behaviour of particular features within a sound system can be captured, within the OT framework, in terms of constraint ranking, particular with respect to faithfulness constraints; therefore phonological representations may be as phonetically concrete as the theory of phonetic implementation may require. Finally, the fact that some single phonetic principle does not explain the totality of some phonological process is not a bar to its insightful deployment, as e.g. Anderson 1981, and Hyman 1999 assume. Rather, OT presupposes that sound patterns arise from *interactions* of principles. That is, the claim advanced here is not that phonological patterns can be *reduced* to phonetics, but rather that these patterns can arise from the *interaction* of phonetic considerations with other cognitive factors.

4. GEMINATES AND LENITION

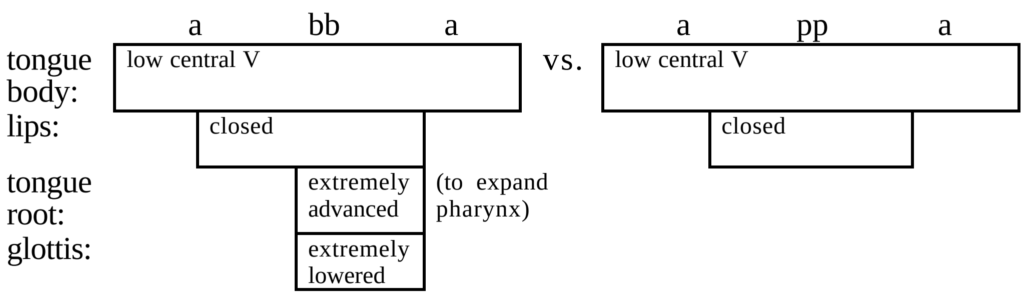
4.1. EFFORT IN GEMINATES.

My account of geminate inalterability under lenition is predicated on two phonetic inferences concerning effort cost:

(36) a. More effort is required to produce a voiced geminate obstruent than a voiceless geminate.
b. More effort is required to produce a geminate continuant consonant than a geminate stop.

4.1.1. VOICING. The first of these inferences derives from Ohala’s (1983) well-established observation that oral constriction is antagonistic to voicing; and the longer the constriction, the greater the antagonism. When the vocal tract is closely constricted, as in an obstruent, the oral cavity quickly fills up with air; the flow of air from the lungs up through the glottis then has nowhere to go; hence the flow stops, and voicing dies off. Voicing can, however, be extended during an obstruent by various oral-cavity-expansion gestures, e.g. pharynx expansion and larynx lowering (Rothenberg 1969), to make room “upstairs” for the airflow.[33] To sustain voicing for the duration of a geminate, typically over 150 msec., significant cavity expansion gestures are required (such as the dramatic pharynx expansion and larynx lowering indicated in (37)).

(37)



These cavity expansion gestures necessarily involve some additional effort cost, above and beyond what is required for the corresponding devoiced geminate.

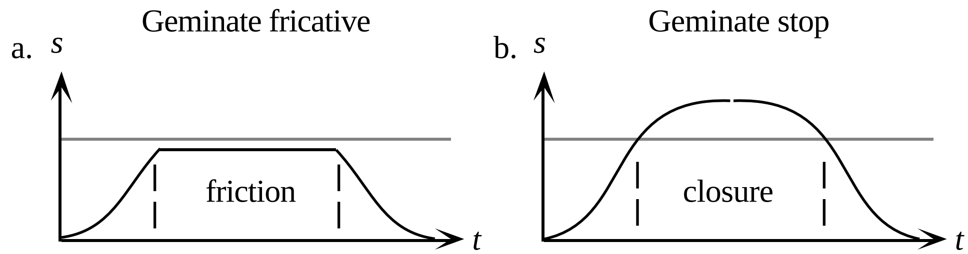
Note, however, that *partial* geminates present none of these devoicing problems. For the air is vented during the nasal or lateral portion of a partial fricative, preventing significant build-up of oral pressure (Pater 1996). Indeed, Hayes & Stivers 1997 suggest that the velic raising that occurs toward the end of a nasal + stop cluster actually facilitates voicing, by expanding the oral cavity during the oral portion of the cluster.

4.1.2. SPIRANTISATION. The second inference is not so clearly established. It seems plausible, however, that some additional effort cost is associated with the precision involved in

[33]The other principal strategy of avoiding passive devoicing, "nasal leak," carries a perceptual cost: risking confusion of the stop with a nasal consonant.

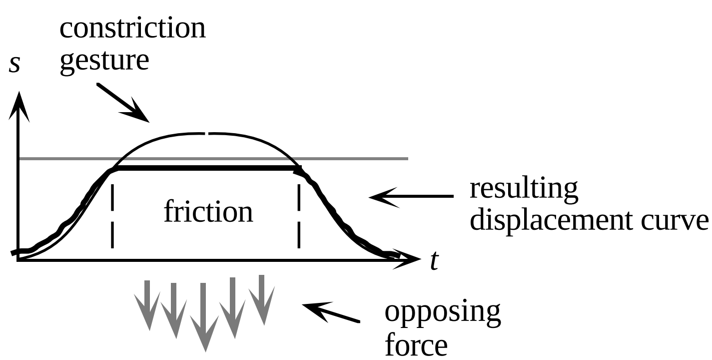
maintaining a steady-state partial constriction for a prolonged interval (38a), as compared to a geminate stop (b).

(38)



That is, in order to achieve such prolonged partial constriction, the upward momentum of the active articulator must be arrested by an active opposing force, i.e. isometric tension.

(39)



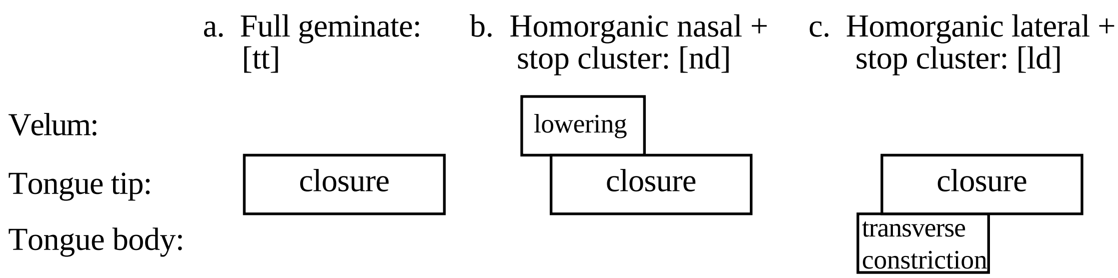
According to this line of reasoning, the total energy required for the constriction gesture plus the opposing gesture is greater than that of the geminate stop. For similar reasons, half-spirantisation of a geminate stop also increases its effort cost.[34] It is beyond the scope of this article to establish the articulatory assumptions on which these effort inferences are based (see Kirchner 1998, ch. 3-5, however, for a mass-spring model of consonant constriction under which these assumptions are borne out). Rather, my objective here is to explore the implications of these inferences

[34] Note, however, that the "problem" in the half-spirantised gesture necessitating isometric tension is the steady-state constriction of the fricative. If the lenited portion of the geminate does not involve a steady-state constriction (e.g. the glide + homoganic stop clusters of Maxakalí, see section 1.2), we can obtain this result simply by slowing down the transition into the closure.

(provisionally assuming them to be correct) for the effort-based approach to lenition outlined in section 3.

Finally, note that the foregoing inferences concerning spirantisation and half-spirantisation of geminate stops apply equally to partial geminates. For the effort relations above refer to oral constriction gestures; and, as schematised in (40), the oral constriction of a partial geminate is equivalent to that of a full geminate.

(40)



4.2. A FORMAL ACCOUNT OF THE GEMINATE LENITION GENERALISATIONS

4.2.1. NO ORALLY REDUCED GEMINATES, ETC. Recall that geminate continuants are more effortful than geminate stops (section 4.1.2). Now, no ranking of IDENT(cont) and LAZY allows an input stop (geminate or otherwise) to map to an output geminate continuant, since the latter candidate fares worse than a geminate stop with respect to both constraints.

(41)

	ap(p)a	LAZY	IDENT(cont)
☞	appa	*	
	aɸɸa	**	*

An input geminate stop can only yield a spirantised output if the output degeminates as well.

(42)	ap(p)a	LAZY	IDENT(cont)	IDENT(length)
	appa	**!		
	aɸɸa	***!	*	
☞	aɸa	*	*	*

Likewise, because of the effort relations *{Geminate fricative, Half-spirantised stop}* > *{Geminate stop, Partial geminate}* (section 4.1.2), neither full nor partial geminates can undergo spirantisation or half-spirantisation (modulo the heteromorphemic geminate case considered in section 5 below).

(43)		LAZY	IDENT(cont)
☞	appa -> appa	*	
	appa -> aɸpa	**	*
☞	ampa -> ampa	*	
	ampa -> amɸa	**	*
	ampa -> aw̃ɸa	**	*

In sum, since reduction of oral constriction in geminate stops increases the effort cost, due to the increased isometric tension involved (see section 4.1.2), oral reduction of geminates is ruled out universally, and the NO ORALLY REDUCED GEMINATES, NO HALF-SPIRANTISATION, and NO REDUCTION OF PARTIAL GEMINATES generalisations are captured.

4.2.2. VOICING. By precisely the same reasoning (see section 4.1.1), voicing of geminate obstruents is prohibited, and the NO VOICING OF GEMINATES generalisation is captured.

(44)		LAZY	IDENT(voi)
☞	appa -> appa	*	
	appa -> abba	**	*

4.2.3. OCCLUSIVISATION, DEVOICING. In singletons, occlusivisation processes must be attributed to fortition constraints. If such a constraint is active in some grammar, it must outrank IDENT(cont) and LAZY.)[35]

(45)

	Input: ϕ	*[+cont] / K	IDENT(cont)	LAZY
☞	p in context K		*	**
	ϕ in K	*!		*

By section 3.1.2, *Geminate continuant* $>_{effort}$ *Geminate stop*, therefore LAZY never favors the fricative geminate. And since the fortition constraint must outrank IDENT(cont), the only constraint which potentially blocks occlusivisation, it follows that the geminate must occlusivise as well.

(46)

	Input: ϕϕ	*[+cont] / K	IDENT(cont)	LAZY
☞	pp in context K		*	*
	ϕϕ in K	*!		**

(LAZY is split off from the rest of the tableau above to indicate that its ranking relative to the other constraints does not affect the result here.) By the same reasoning (see section 4.1.1), the same result obtains for geminate devoicing.

(47)

	Input: bb	*[+voi] / K	IDENT(voi)	LAZY
☞	pp in context K		*	*
	bb in K	*!		**

Consequently, the NO EXCLUSIVE OCCLUSIVISATION OR DEVOICING OF SINGLETONS generalisation is captured. In contrast, occlusivisation or devoicing of *geminates* (e.g. Berber,

[35]Note that this account of the occlusivisation and devoicing generalisations is contingent on the absence from the constraint set of positional faithfulness constraints such as IDENT(cont)/geminates or IDENT(voi)/geminates.

Schein & Steriade 1986) obtains under any ranking in which LAZY or the relevant fortition constraint dominates IDENT(cont) or IDENT(voi), respectively.

4.2.4. INVENTORY ASYMMETRIES. As shown in the previous section, to obtain surface geminate continuants or voiced geminate obstruents, IDENT(cont) or IDENT(voi) must dominate LAZY, and any applicable fortition constraints (otherwise occlusivisation or devoicing will occur):

(48)

		IDENT(cont)	IDENT(voi)	LAZY	*+cont	*+voi
	ϕϕ -> pp	*!		*		
☞	ϕϕ -> ϕϕ			**	*	
	bb -> pp		*!	*		
☞	bb -> bb			**		*

But under this ranking, an input geminate stop, or voiceless geminate obstruent, surfaces unchanged (and such inputs must be allowed, by the OT tenet of Richness of the Base):

(49)

		IDENT(cont)	IDENT(voi)	LAZY$_X$	*+cont	*+voi
☞	pp -> pp			*		
	pp -> ϕϕ	*!		**	*	
	pp -> bb		*!	**		*

Consequently, the INVENTORY ASYMMETRIES generalisation is captured.

5. HETEROMORPHEMIC GEMINATES

5.1. "FAKE" GEMINATES VS. PARADIGMATIC FAITHFULNESS. In section 4, the effort-based approach appears to rule out half-spirantisation of geminates. Yet in the discussion of Tigrinya in section 1.2.2, we have seen that half-spirantisation is indeed possible, provided that the geminates are heteromorphemic. The Tigrinya facts were taken by Hayes 1986 as precluding any sort of phonetically-based account of geminate inalterability. If inalterability is attributed to phonetic considerations, how, then, could heteromorphemic and tautomorphemic geminates (which are typically phonetically indistinguishable) behave differently from one another? The answer lies in OT's capacity for interaction between purely articulatory constraints such as LAZY and constraints which do refer to morphological affiliation.

Specifically, a class of paradigmatic faithfulness constraints (also called output-output faithfulness, uniform exponence, paradigm uniformity, and allomorphy minimisation constraints) has been motivated by such phenomena as base-reduplicant correspondance, base-derivative correspondance in truncation patterns, and cyclicity effects, see Benua 1995, 1997; Flemming 1995; Kenstowicz 1995; McCarthy and Prince 1995; Steriade 1996; Burzio 1997. These constraints are formally similar to the input-output faithfulness constraints employed above, but the comparison is between two morphologically related surface forms, typically a base and its derivative. Unlike input-output faithfulness, these paradigmatic constraints can enforce identity between output and base with respect to *phonologically derived surface properties of the base*, including lenition.

The Tigrinya pattern of half-spirantisation of heteromorphemic geminates now follows from the ranking in (50):

(50)

	Input: /mɨrak-ka/ (base = [mɨrax])	IDENT(BASE/DERIVATIVE, cont)	LAZY	IDENT(I/O, cont)
	mɨrakka	*!	*	
☞	mɨraxka		**	*

That is, spirantisation occurs in [mɨraxka] not because it serves the goal of effort minimisation (in fact, it fares worse on this score than the competing candidate [mɨrakka]), but because it promotes similarity between the output and its base, [mɨrax], in which spirantisation *is* motivated by LAZY. If, however, IDENT(BASE/DERIVATIVE, cont) is subordinated to LAZY, heteromorphemic geminates will be inalterable under spirantisation, just like tautomorphemic geminates, as we find Tiberian Hebrew. Finally, in tautomorphemic geminates, paradigmatic concerns do not enter the picture (there can be no separate base containing a spirantised singleton), and so half-spirantisation is ruled out under any ranking, as discussed in section 4.2.

5.2. HETEROMORPHEMIC DERIVED GEMINATES. A remaining issue concerns the behaviour of heteromorphemic geminates which are *derived* by assimilation. These derived geminates never undergo half-spirantisation (Guerssel 1977); that is, they do not pattern with other heteromorphemic geminates, but with the "true" (monomorphemic) geminates, in being systematically inalterable under spirantisation. For example, in Tigrinya, /jɨ-t-kəfət/ ('open-passive-jussive') surfaces as [jɨkkəfət], not [jɨxkəfət] (Kenstowicz 1982). This generalisation was adduced by Steriade (1982), Hayes (1986), and Schein & Steriade (1986) as confirmation of the autosegmental true/fake geminate distinction. The reasoning is that the assimilation process, expressed in the autosegmental framework as a feature-spreading operation, gives rise to a multiply linked structure (51a), identical to an underlying true geminate (b), rather than the fake geminate (c).

```
(51)   a. C     C          b. C   C          c. C    C
          ǂ  \  |              \ /              |    |
          t     k               k               k    k
```

Therefore, the derived geminate is correctly predicted to be inalterable under spirantisation, due to the UAC or the Linking Constraint, as is the underlying true geminate.

In theory-neutral terms, the question is why a heteromorphemic, heterorganic cluster such as /t + k/ can partially spirantise to [θk], or undergo place assimilation (yielding [kk]), but not both (i.e. [xk]). In the case of Tigrinya, a language-specific solution happens to be available: only dorsal consonants spirantise; thus, the 'passive' prefix /-t-/ surfaces as [-cont] in all output forms. Therefore, /t+k/ - [xk] violates the undominated constraint IDENT(O/O, cont), losing to [kk]. However, this result is dependent on the absence of coronal spirantisation in Tigrinya. In this discussion, in the interest of obtaining a more general account of Guerssel's generalisation, I instead consider a hypothetical variant of Tigrinya, with coronal spirantisation.

Plausibly, an alternative account of Guerssel's generalisation follows from Jun’s (1995) treatment of place assimilation in consonant clusters (discussed in section 3.3 above), in which assimilation is driven by effort minimisation, parallel to the effort-based treatment of lenition presented herein. Let us assume that a half-spirantised geminate is more effortful than a non-homorganic fricative + stop cluster, which in turn is more effortful than a geminate stop. That is, [xk] $>_{\text{effort}}$ [θk] $>_{\text{effort}}$ [kk] (again, see Kirchner 1998, ch. 5 for a mass-spring model supporting these inferences). Now, assuming there are paradigmatically related forms with surface [θ], the possible outputs are either [θk] (52a) or [kk] ((52b), the correct result for Tigrinya), depending on the ranking of output-output faithfulness to continuancy (specifically, comparing the derived form with other members of the affixal paradigm) relative to LAZY:[36]

(52)

a.

	Input: /jɨ-t-kəfət/ (/-t-/ related to surface [θ] in other outputs)	IDENT(Affixal paradigm/D, cont)	LAZY
☞	jɨθkəfəθ		**
	jɨkkəfəθ	*!	*
	jɨxkəfəθ		***!

b.

	Input: /jɨ-t-kəfət/ (/-t-/ related to surface [θ] in other outputs)	LAZY	IDENT(Affixal paradigm/D, cont)
	jɨθkəfəθ	**!	
☞	jɨkkəfəθ	*	*
	jɨxkəfəθ	**!*	

But no ranking of the relevant constraints permits the half-spirantised geminate, [xk], to emerge as the winner. More generally, since the place-assimilated partially-spirantised candidate incurs a higher effort cost than the unassimilated or unspirantised candidate, the partially-spirantised derived geminate cannot as emerge as the winner. This result thus falls out from Jun’s (1995) treatment of place assimilation in consonant clusters: such assimilation is simply (effort-driven) lenition of C_1 coupled with compensatory extension of the gesture of C_2 (see the discussion of Jun's treatment as it relates to the effort-based approach to lenition in Chapter 1 section 3.3.4).[37]

It is thus possible to account for the distinct inalterability behaviour under lenition of heteromorphemic geminates, underlying and derived, within a phonetically-based approach, and without resorting to a representational distinction between true and fake geminates.

6. CONCLUSION

We have seen that the phenomenon of geminate inalterability, to the extent that it does not reduce to some kind of language-specific generalised blocking effect, holds true only under lenition processes, and holds true inviolably -- a generalisation which none of the previous approaches to geminate inalterability were able to capture. By reducing geminate inalterability, in its inviolable aspect, to considerations of effort minimisation (i.e. LAZY, as it interacts with other well-motivated classes of Optimality Theoretic constraints, such as faithfulness), the effort-based approach to lenition achieves a greater depth of explanation, as well as better empirical coverage, than previous accounts of this class of phenomena.

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[36]PRES(place features) » LAZY is also sufficient to block an assimilated output.

[37]A further alternation in Tigrinya, previously adduced in support of the true/fake geminate distinction, involves the 3d. sg. pronominal suffixes -o and -a (masc. and fem. respectively), which induce gemination of the stem-final consonant, e.g. [jɨbarɨx] ('bless-jussive'), but [jɨbarɨkko]. I suggest, however, that the distinct behavior of -ka vs. geminating -o and -a can equally be handled in terms of a Class II vs. Class I affix distinction. As Benua (1997) has proposed, Class I affixes correspond to lower-ranked versions of B/D faithfulness constraints. In Tigrinya, the selection of the geminate stop candidate [jɨbarɨkko] over the partially spirantised candidate [jɨbarɨxko] now follows from ranking LAZY above PRES(B/D(CLASS I)/cont). However, [mɨraxka] still defeats [mɨrakka], because PRES(B/D(CLASS II)/cont) » LAZY.

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