LENITION IN GAALPU: AN OPTIMALITY THEORETIC ANALYSIS*

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ABSTRACT

Continuant-stop alternations are a common pattern among Australian languages, such as in Yolngu Matha, Mawng and Wubuy. Some of these alternations have been hitherto analysed as lenition (eg. Yolngu), while others have been argued to be hardening processes (eg. Wubuy). Lenition processes of this kind are difficult to account for in various models of phonology, because they are conditioned by a two-sided context. This paper presents an analysis, couched in Optimality Theory, of one such lenition pattern in Gaalpu, a Yolngu variety (Wood 1978). I show that the process can be succinctly analysed in terms of two constraints: a constraint on consonant strength across syllable boundaries, and a constraint against non-continuants in a sonorous context (following Kingston 2008). I argue that this analysis is superior to existing accounts precisely because it is able to capture the role of both the preceding segment and following segment in conditioning lenition. I show in addition that the alternation in Wubuy, previously analysed as hardening (Heath 1984), can also be analysed succinctly using the same hierarchy proposed for the lenition process in Gaalpu.

Keywords: Optimality Theory; Lenition; Hardening; Gaalpu; Wubuy (Nunggubuyu); Yolngu

1. INTRODUCTION

Continuant-stop alternations are a common pattern across Australian languages. Some of these alternations have hitherto been analysed as hardening (eg. Wubuy, Heath 1984; Baker 2009; Murrinh-Patha, Street 1987), while others as lenition (eg. Djambarrpuyngu, Wilkinson 1991; Djapu, Morphy 1983). This paper investigates one such alternation analysed as lenition in Gaalpu, a Yolngu language in Northern Australia (Wood 1978). This is a pervasive process affecting stops that occur between continuants (liquid, semivowel or vowel) at a morpheme boundary. In (1) the stop variant surfaces between a nasal and vowel, and in (2) the semivowel variant surfaces between continuants.

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(1) puɻum + **k**u ‘fruit-Dative’

(2) t̪a:kaj + **w**u ‘taste-Dative’

More generally, assimilation processes such as lenition have traditionally been difficult to account for in Optimality Theory (Prince & Smolensky 2004[1993]). Many analyses of assimilation (eg. Bakovic 2000; McCarthy 2004) fail to account for two-sided contexts such as intervocalic lenition, a very common process. The triggering environment of lenition can of course be one-sided (eg. post-vocalic spirantization in Tiberian Hebrew; see Malone 1993). However, lenition conditioned by two-sided contexts is very common, thus, there needs to be an analysis of lenition that is able to satisfactorily account for the role of a two-sided environment. Proposals for analysing lenition have sought to incorporate phonetic constraints directly (Kirchner 1998, 2001) or indirectly into a phonological constraint hierarchy (Kingston 2008). In this paper, I propose an analysis of lenition couched in Optimality Theory (hereafter OT), following Kingston (2008), that is able to account for two-sided contexts in lenition.

To this end, the organization of this paper is as follows: in §2, I present a brief overview of Gaalpu and its phoneme inventory. §3 describes the lenition process in Gaalpu. I then proceed to adopt a model for analysing lenition following Kingston (2008). In §4, I discuss the problems with some previous formal approaches of analysing lenition. I conclude in §5 by describing the implications of using my analysis with specific emphasis on its ability to account for consonant hardening in other languages, such as Wubuy, as well as lenition. Lastly, I also discuss the difficulties of accounting for the behaviour of the glottal stop in Gaalpu.

2. The Gaalpu Language

Gaalpu is a Dhangu (Eastern) variety of Yolngu, a dialect chain that is a member of the Pama-Nyungan family. It is spoken in North-eastern Arnhem land in the Northern Territory, Australia. Currently, it has approximately 200 speakers (Gordon 2005). Like most Pama-Nyungan languages, Gaalpu is exclusively suffixing in its morphology. Its phoneme inventory is typical of an Australian language, with a 6-place contrast in stops and nasals, a 3-way lateral contrast, and no fricatives.

In the Yolngu languages, considerable attention has been paid to a lenis versus fortis stop distinction in contrastive medial environments. Certainly there is evidence of an active contrast historically, but that opposition has been eliminated synchronically in some varieties due to a lenition rule that weakened lenis stops to their corresponding homorganic semivowel.[1] Various analyses have been adopted to explain this stop contrast, and the opposition has variously been treated as lenis/fortis, voiced/voiceless, singleton/geminate and lax/tense (Wilkinson 1991; Wood 1978; Heath 1980; Morphy 1983). Heath (1980) suggests, at least for Ritharrngu, that this opposition is phonetically manifested by duration, tenseness and voicing. In most varieties this contrast has been lost; yet even in languages with this contrast, it is maintained only in intercontinuant position (eg. Ritharrngu, Heath 1980). The actual phonetic characteristics of this contrast where they do exist are still under investigation (see Butcher 1995).

Wood (1978) states that this opposition is present underlyingly in Yolngu generally, but eliminated from the surface in all but the apical set of stops in Gaalpu. Yet, even in the apical set, this lenis/fortis distinction is only maintained in intervocalic position and neutralised elsewhere. I discuss the distribution of apical stops in §3.2 and the examples below show the contrast between [ʈ] and [ɖ].

(3) jaraʈa 'line, row'
(4) jaraɖa 'lightning'

Wood (1978) states that a synchronic lenition rule affects *lenis* peripheral and laminal stops on the surface. However, there is no evidence to suggest that there is a lenis/fortis contrast suffix-initially, the only position where lenition occurs synchronically.[2] Crucially, it seems counterintuitive to posit an underlying contrast when this contrast is never active on the surface. Therefore, I do not make a distinction between lenis and fortis stops, save for the apical series. However, for the sake of categorization and presentation I have left the labels for fortis and lenis stops in Table 1 to capture the active contrast for the apical series. For all other stops, I have attempted to show their non-contrastive nature by overlapping them over the fortis and lenis stop rows. I use the voiceless stop symbol throughout this paper for non-contrastive stops, however both the voiceless (fortis) symbols and voiced symbol are used when referring to contrastive apicals.

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[1] A comparison with varieties that preserve this contrast phonemically such as Ritharrngu (Heath 1980) and Gupapuyngu (see Wood 1978) is illustrative of an active contrast historically in Proto-Yolngu.

[2] Djambarrpuyngu (Wilkinson 1991) seems to have non-leniting stop-initial suffixes which might be regarded as fortis-initial. In Gaalpu, however, this is not the case. All stops that occur between continuants at a morpheme boundary lenite to their corresponding semivowel.

<table>
<tr><th></th><th>bilabial</th><th>lamino-
dental</th><th>apico-
alveolar</th><th>apico-
retroflex</th><th>lamino-
palatal</th><th>dorsal</th></tr>
<tr><td>fortis stop</td><td rowspan="2">p</td><td rowspan="2">t̪</td><td>t</td><td>ʈ</td><td rowspan="2">c</td><td rowspan="2">k</td></tr>
<tr><td>lenis stop</td><td>(d)[3]</td><td>ɖ</td></tr>
<tr><td>nasal</td><td>m</td><td>n̪</td><td>n</td><td>ɳ</td><td>ɲ</td><td>ŋ</td></tr>
<tr><td>laterals</td><td></td><td>l̪</td><td>l</td><td>ɭ</td><td></td><td></td></tr>
<tr><td>tap/trill</td><td></td><td></td><td>r</td><td></td><td></td><td></td></tr>
<tr><td>semivowel</td><td>w</td><td></td><td></td><td>ɻ</td><td>j</td><td>(w)</td></tr>
</table>

Table 1. Phoneme inventory of Gaalpu, following Wood 1978

3. Lenition in Gaalpu

Wood (1978) describes a lenition rule that targets peripheral and laminal stops, leniting them to their corresponding semivowels. This alternation occurs when the preceding segment is a semivowel, liquid or vowel and the following segment is a vowel. I will refer to this class as continuants, following general Australianist practice (Baker 2008). These correspondences are shown in Table 2 below.

w	↔	p
j	↔	t̪
j	↔	c
w	↔	k

Table 2. Continuant/stop correspondences

The lenition rule can be stated simply as (5):

(5) $[-\text{son}] \rightarrow [+\text{cont}] \,/\, [+\text{cont}]+\_[+\text{cont}]$

So a non-sonorant stop becomes a continuant between continuants. Note that lenition only targets laminal and peripheral stops. Apical stops, where a phonemic lenis/fortis contrast is maintained, do not lenite to a corresponding semivowel or flap even though this is a common pattern for apical stops in Australian languages (Dixon 2002). (5) does not account for differences by place of articulation. I discuss the status of apicals

[3] Wood (1978) suggests that there is not sufficient evidence to maintain a contrast between [t] and [d], and gives just one example of [d], in [kuɖudut] 'bird: species of dove'. The status of this contrast, however, is not relevant to the main focus of this paper.

in §3.2. Crucially, this alternation only occurs at a morpheme boundary, and stops appear between continuants morpheme-internally, as in (6).

(6) paɻka ‘upper arm/armlet/sleeve’

Amery (1985) states that the basic syllable structure in Yolngu languages is CV(C)(C). Moreover, suffixes, though not word-minimal, must meet the syllable template of the language. This means that in Gaalpu the segmental target for lenition will necessarily be followed by a vowel. The following vowel’s role in conditioning lenition synchronically then is not testable since there are no situations in which we get an alternating suffix characterised by a single stop.[4] Historically, lenition occurred with word-medial lenis stops. Crucially, this only occurred in inter-continuant position. Word-initial and word-final stops did not lenite. The following examples (from Wood 1978: 72) are illustrative of this cognate relationship between Gupapuygnu, a language with a synchronic contrast, and Gaalpu:

	Gupapuyngu[5]	Gaalpu	
(7)	ɻa**ɟ**al	ɻa**j**al	‘clean sand’
(8)	car**b**aɻ**b**aɻ	car**w**aɻ**w**aɻ	‘long and thin’

Thus, Gaalpu had an unambiguous two-sided environment for lenition historically. Synchronically, it is still plausible that the conditioning environment is necessarily two-sided. Yet for the reasons outlined above, this is not a certainty. For the rest of this paper then, I pursue an analysis that assumes a two-sided conditioning environment for lenition. This is further developed in §3.1.

Examples of synchronic lenition in Gaalpu are shown below. The first member of each pair shows the stop alternant and the second the semivowel one.

From Wood (1978: 72):

(9) wa:jin + puj → [wa:jin**p**uj] ‘animal-Associative’

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[4] In the related varieties of Djapu and Djambarrpuyngu, there is a vowel deletion rule that affects suffixes when affixed onto a vowel-final (see Chong 2011 for a discussion of the difficulties this poses for a theoretical analysis in OT). This is a reflex of sociolectal differences within the Dhuwal/Dhuwala language. It is unclear whether or not this is the case as well in Gaalpu. It is assumed that this does not occur in Gaalpu, pending further investigation.

[5] The lenis/fortis contrast is maintained in Gupapuyngu. Thus I have represented this contrast using both the voiced (lenis) and voiceless (fortis) stop symbols where necessary.

(10)	kaɳa + puj	→	[kaɳa**w**uj]	‘salt water-Associative’
(11)	puːɻum + ku	→	[puːɻum**k**u]	‘fruit-Dative’
(12)	t̪akaj + ku	→	[t̪akaj**w**u]	‘the top-Dative’

Since Gaalpu is a suffixing language, lenition can only target suffix-initial stops. In this position, peripheral and laminal consonants are neutralised for the feature [continuant]. The contrast between stops and homorganic semivowel, however, is maintained word-initially and word-medially as we see in (13) and (14). The status of apical stops is different to that of peripheral and laminal stops, and their distribution is discussed in § 3.2.

(13)	**w**alŋa	alive, living
(14)	**k**alŋa	paper money, skin, bark (from Zorc 1996)

3.1 Analysing Lenition in Gaalpu

My analysis of lenition in Gaalpu is couched in OT (Prince & Smolensky 2004[1993]). Specifically, I adopt a proposal discussed in Kingston (2008). In brief, Kingston discusses the phonetic motivation behind lenition. He suggests that lenition occurs to increase the intensity of a particular stream of speech. In particular, lenition reduces the extent to which target consonants disrupt the sonority of a stream of speech to convey the continuity of a particular prosodic constituent. Crucially, while accepting that there are phonetic motivations for a markedness constraint, Kingston (2008) argues that the phonetic component and the phonological component of the grammar should be kept separate, contra Kirchner's (1998, 2001) approach.[6,7] He posits a markedness constraint that prohibits [-continuant] segments from occurring in particular segmental contexts. This constraint refers to a hierarchy of markedness constraints whose ranking follows that of the sonority scale: *Voiceless Stop / X_Y ≫ *Voiced Stop/X_Y ≫ … *Semivowel/X_Y, where X and Y specify lower limits in sonority value for conditioning segments.

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[6] Kirchner (1998, 2001) conceptualises lenition as essentially a manifestation of "gestural reduction" (1998: 6). He proposes an effort minimization constraint, which he terms Lazy. For a discussion of the empirical problems with such an approach, see Kingston (2008) and Kaplan (2010).

[7] The reasons for which one might want to keep phonetic and phonological components separate is beyond the scope of this paper. I refer the reader to Kingston (2008) for supporting arguments.

In Gaalpu, stops lenite following a liquid, semivowel or vowel and preceding a vowel. In order to account for the facts about lenition in Gaalpu, I propose a markedness constraint based on Kingston (2008) using the feature [sonorant] instead of [continuant]. This markedness constraint is formulated below:

(15) *[-SON]/[+SON]_[+SON]: Assign one violation mark for every segment with the feature [-sonorant] that falls in between two sonorants.

(15) is a generalised surface constraint and I will refer to this as Sonority Preservation (SONPRES) in the rest of this paper.

(16) SONPRES: Assign one violation mark for every segment with the feature [-sonorant] that falls in between two sonorants.

The markedness constrainT SONPRES dominates a faithfulness constraint IDENT-IO[SON] (McCarthy & Prince 1995):

(17) IDENT-IO[SON]: Assign one violation mark for every change in the value of the feature [sonorant] between the input and the output. (Hereafter IDENT[SON])

Additionally, we also need a parameterised IDENT constraint (McCarthy & Prince 1995) to capture the fact that [-sonorant] segments do occur between sonorants word-internally, as in (6), since lenition only targets suffix-initial stops synchronically. Alternations in the root are prohibited. This constraint is presented below:

(18) IDENT-IO[SON]-ROOT: Assign one violation mark for every change in the value of the feature [sonorant] in the *root* between the input and the output. (Hereafter IDENT-ROOT)

IDENT-ROOT must necessarily dominate SONPRES, since if not we would expect to see lenition of intersonorant stops stem-internally.

Furthermore, we need to account for the fact that stops do not lenite following nasals, segments which are specified as [+sonorant]. A well motivated constraint (19) appeals to the Syllable Contact Law (Murray and Vennemann 1983). This constraint is a general one in many Australian languages (Hamilton 1996) since we do not generally find clusters of [-cont][+cont] segments.

(19) Syllable Contact Law (SCL): The preference for a syllabic structure *A*$*B*, where *A* and *B* are marginal segments and *a* and *b* are the consonantal strength values of *A* and *B* respectively, increases with the value of *b* minus *a*. (Murray & Venneman 1983: 520)

In Gaalpu, semivowels and liquids (and vowels) are grouped together as one class for the purposes of conditioning lenition. I have assigned them an overall strength value of *W*. Nasals and stops have the overall strength value *S*. This grouping also corresponds to a natural class distinction between [+continuant] segments with value *W* and [-continuant] segments with value *S*.

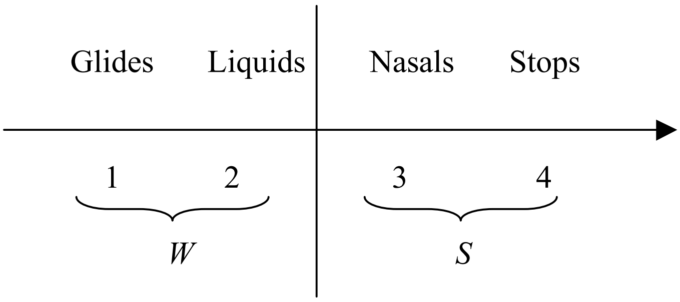

Figure 1: Consonant strength scale in Gaalpu

With this in mind, I propose the following constraint that appeals to SCL:

(20) SCL: For a heterosyllabic sequence of *A*$*B*, where *b* is the consonantal strength of *B* and *a* is the consonantal strength for *A*, assign one violation mark for every segment, *B*, whose consonantal strength is lower than that of A (ie. $*b < a$) where the values of *a* and *b* are either *W* or *S* (where $S > W$).

A stop that lenites to its corresponding semivowel following a nasal violates SCL. Crucially, sequences of *WS* (such as liquid-stop) do not violate this constraint, though they do violate SonPres. SCL is necessarily ranked above SonPres since it is apparently unviolated in the lexicon of Gaalpu, as well as in derived forms. (21) illustrates SCL's interaction in the constraint hierarchy.

(21) Illustration of SCL

	/wa:jin + puj/	SCL	SONPRES	IDENT[SON]
☛a.	wa:jinpuj		*	
b.	wa:jinwuj	*!		*

Candidate (b) contains the semivowel variant of the associative suffix since it lenites to satisfy SONPRES, but crucially this violates higher ranked SCL. As an outcome, we get (a), the faithful candidate, as the correct output.

Another possible way in which SONPRES and SCL could be satisfied is by deletion of the target segment or by epenthesis of some non-continuant consonant – epenthesis of a vowel will not solve the issue. Therefore, we also need to make a brief account of the ranking of faithfulness constraints MAX-IO and DEP-IO-C (McCarthy & Prince 1995).

(22) MAX-IO: Assign one violation mark for every segment that is deleted between input and output. (Hereafter MAX)

(23) Dep-IO-C: Assign one violation mark for every consonant segment that is inserted between input and output. (Hereafter DEP-C)

Neither of these processes occurs, so presumably they are undominated constraints in the hierarchy. Their relative rank, however, cannot be determined. Furthermore, it is not clear how these faithfulness constraints should be ranked against IDENT-ROOT. For present purposes, I have assumed that IDENT-ROOT is ranked above SCL and is unranked with reference to MAX and DEP-C. Hence we have the following constraint hierarchy:

(24) MAX, DEP-C, IDENT-ROOT ≫ SCL ≫ SONPRES ≫ IDENT[SON]

I present a summary tableau in (25):

(25) Summary Tableau

	wa:jin+puj	MAX	DEP-C	IDENT-ROOT	SCL	SONPRES	IDENT[SON]
☛a.	wa:jinpuj					*	
b.	wa:jinwuj				*!		*
c.	wa:jinuj	*!					
d.	wa:jintpuj		*!				

This constraint ranking enables us to describe the stop-continuant alternations in Gaalpu and many other Australian languages succinctly and elegantly.

3.1.2 KINGSTON'S PROPOSAL

Kingston's original constraints refer to a hierarchy of markedness constraints whose ranking follows that of the sonority scale: *VOICELESS STOP / X_Y ≫ *VOICED STOP/X_Y ≫ … *SEMIVOWEL/X_Y, where X and Y specify lower limits in sonority value for conditioning segments. Specifically, the feature [-continuant] is banned in a particular segmental context. In the case of Gaalpu, X is any segment that is as sonorous as or more sonorous than a liquid (L) and Y is anything as sonorous as a vowel (V). The L_V context certainly accounts for many of the facts about lenition in Gaalpu. In this section, I consider briefly Kingston's original proposal and suggest why my analysis is better capable of accounting for lenition in Gaalpu

The proposal here differs from Kingston's original proposal in two ways: (i) it prohibits [-sonorant] segments instead of [-continuant] segments from appearing in a particular segmental context, and (ii) the flanking environments are not defined in terms of lower limits in sonority value.

(i) is motivated by the fact that a constraint using the feature [continuant] predicts that stops would potentially lenite to fricatives when they do not (since alternations are structure-preserving). It also predicts that nasals lenite when they do notMoreover, if lenition serves to increase the intensity of a stream of speech, as Kingston (2008) suggests, then it seems that continuancy (the degree of stricture in the vocal tract) is not the best reflection of intensity. Instead, acoustic intensity is often the phonetic correlate sonority (Parker 2002).[8]

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[8] I thank an anonymous reviewer for pointing this out to me.

Indeed if we consider Kingston's original constraints:

(26) *[-CONTINUANT]/L_V: Assign one violation mark for every segment specified as [-continuant] that follows a segment equal to or more than the sonority of a liquid and that precedes a vowel.

(27) IDENT[CONTINUANT]: Assign one violation mark for every change in the value for the feature [continuant] between the input and the output.

So far our analysis has only dealt with stop-initial suffixes. There are a number of suffixes which are nasal-initial. Thus, surface forms of nasal-suffixes in the environments in which we would expect lenition would violate *[-CONTINUANT]/L_V.[9] An illustration of the problem is shown below with the accusative suffix /-n̪a/:

(28) Lenition of suffix-initial nasal (Unattested optimal candidate indicated by ☠)

	/puɻwu + n̪a/ 'flower-Accusative'	*[-CONTINUANT]/L_V	IDENT[CONTINUANT]
☛a.	puɻwun̪a	*!	
☠b.	puɻwuj̃a		*

Using *[-CONTINUANT]/L_V predicts that candidate (b) would be the optimal output. While candidate (a) is the desired output, (b) is favoured because it does not violate the higher ranked *[-CONTINUANT]/L_V, which (a) does. So the markedness constraint using the feature [continuant] favours the wrong candidate.[10]

Using the feature [sonorant] remedies this situation. By using the constraint ranking in (24), we are able to capture this pattern. The sole caveat is that we are forced to use the constraint IDENT[CONTINUANT] to break the tie between candidates as we see in (29).

(29) Correct output using SONPRES

[9] I will not show the interaction of MAX and DEP-C with these constraints since I have argued that they are undominated and are not pertinent to my purpose in this section.

[10] The alternative would be to posit a universal markedness constraint against the lenition of nasals.

	/ puɻwu + n̪a /	SONPRES	IDENT[SON]	IDENT[CONTINUANT]
☛a.	puɻwun̪a			
b.	puɻwuj̃a			*!

Neither candidate is favoured by SONPRES and neither candidates violate the faithfulness constraint IDENT[SON]. IDENT[CONTINUANT] is needed to break the tie between candidates (a) and (b). Presumably this constraint is low-ranked, since it is not needed in the other interactions shown so far. It must necessarily be ranked below SONPRES since if not we would expect that lenition is always blocked from occurring. Its relative ranking with respect to IDENT[SON], however, cannot be determined.

The second way in which this proposal differs from Kingston's is that the segmental context in (26) is modified in favour of a more general surface constraint. This reflects the desire for constraints to be as general as possible. Moreover, if the alternation were driven just by one constraint alone, we lose the potential for accounting for the descriptive generalization that the SCL is a general phonotactic constraint in the lexicon of Australian Aboriginal languages (see Hamilton 1996; Baker 2008). Motivating the blocking of lenition using SCL allows us to account for the fact that syllabic margins obey the same kind of phonotactic constraint across the board.[11]

3.2 THE APICAL QUESTION

In Gaalpu, peripheral and laminal stops lenite, whereas apical stops categorically do not. There are two possible ways to explain this observation: (1) that there is some lenition-blocking constraint that prohibits apical stops from leniting or (2) that this observation falls out directly from the distribution of apical stops. In this section, I discuss why it is unnecessary to posit a lenition-blocking constraint for the apical series of stops. I argue that this particular phonological pattern is explained by distributional and phonotactic reasons alone.

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[11] An anonymous reviewer suggested that an alternative explanation for the appearace of stops following nasals is due to the cross-linguistic dispreference for post-nasal continuants (eg. Zsiga et al 2006). Of course, a constraint such as *NS (Zsiga et al 2006), which bans post-nasal continuants, does account for the blocking of lenition after nasals. However, it is not clear what this buys us in terms of a principled motivation for the pattern. SCL has the advantage of being a phonotactic constraint that has been well-motivated in Australian languages generally (Hamilton 1996). Moreover, it allows us to form a natural class between stops and nasals on the one hand, and liquids and glides on the other.

Wood (1978) does not discuss explicitly whether there are apical-stop-initial suffixes in Gaalpu. Looking at more substantial work on related varieties such as Djambarrpuyngu (Wilkinson 1991) and Dhuwaya (Amery 1985), it seems clear that there are no apical-stop-initial suffixes that would be subject to a lenition rule. Further Zorc's (1996) pan-Yolngu dictionary confirms this with only one entry of an apical-stop-initial suffix, /-tu/, which is an allomorph of the ergative suffix /t̪u-/ due to phonological assimilation to the preceding environment. Even this marginal example is restricted to what Amery (1985) calls Developmental Dhuwaya, a children's variety of the language. This pattern is not an accidental fact, because apicals are phonotactically marked in onsets in Australian languages (Dixon 1980; Hamilton 1996).[12]

Given these facts, it seems superfluous to posit an ad hoc constraint that blocks lenition of apical stops since this generalization falls out directly from distributional patterns and phonotactic restrictions in Gaalpu. Apical stops just do not occur in suffix-initial position, the only position that is the target of lenition.

4. Previous Analyses of Lenition

Analyses of assimilation processes have previously been couched in Autosegmental Phonology (Goldsmith 1979). Many of these insights have also been transferred to analyses couched in OT (eg. McCarthy 2004). In the following sections, I briefly describe these two broad approaches and discuss the problems associated with them.

4.1 Lenition in Autosegmental Phonology

Assimilation processes have traditionally been accounted for in Autosegmental Phonology (Goldsmith 1979) through feature spreading. Lenition, an example of assimilation, can thus be analysed as the spreading of the feature [+cont] to an adjacent target segment (eg. Mascaro 1984 on Spanish). There are, however, a number of problems with such an approach. Firstly, if we are to consider phenomena such as debuccalization or elision examples of lenition as Kirchner (1998, 2001) suggests, then lenition as feature spreading is problematic since the only way to express these processes is through delinking or deletion of phonological material. In order to describe these phenomena we would have to propose a separate analysis thereby missing a major generalization – that these processes are all examples of lenition.

[12] For an extensive discussion of phonotactics in Australian languages see Hamilton (1996).

Secondly, following Kirchner (1998, 2001), feature spreading can only explain the role of one flanking segment in conditioning lenition. As Lavoie (2001) notes, canonical examples of lenition occur either between vowels or between continuants; that is, they occur word-medially. She argues that word-final alternations are not lenition per se but rather are a result of the Coda Condition (Ito 1988). Feature spreading predicts that lenition triggered unilaterally should be just as common as lenition triggered by both flanking contexts. But as Lavoie (2001) suggests, lenition triggered by two-sided contexts is more common. More importantly, feature-spreading analyses cannot explain the role of the following vowel in intervocalic lenition, implying that the following context is redundant when, in fact, it is crucial.

4.2 ASSIMILATION IN OT

Classic OT accounts of assimilation processes have been similarly problematic. A number of constraints have been proposed to account for assimilation, namely local AGREE, ALIGN and McCarthy's (2004) Spans theory. Below, I briefly discuss the limitations of using AGREE and ALIGN in relation to analysing lenition.

Local AGREE (eg. Bakovic 2000) requires that adjacent segments have the same value for a particular feature. So if a segment has a feature value [αF] then the segment immediately preceding or following it must also bear the feature value [αF]. Applied to lenition, an analysis using AGREE is straightforward for lenition triggered by a one-sided context. But if lenition is crucially triggered by *both* flanking segments, such as in intervocalic lenition, then AGREE is incapable of explaining the role of the other flanking segment.

Similarly, analyses of assimilation using ALIGN pose the same problems (eg. Kirchner 1993). ALIGN ensures that a particular feature spreads to adjacent segments in one direction exhaustively. The crucial drawback is just that: it only spreads from one segment to another in *one direction*. So there is no way for ALIGN to ensure that both flanking vowels are involved in conditioning the lenition of a target segment in intervocalic lenition.

Recall that the analysis so far has taken the line that both the preceding [+cont] segment and the following vowel play a role in conditioning lenition in Gaalpu. Therefore, if we are pursuing an analysis of Gaalpu lenition in which both flanking segments do matter, a satisfactory analysis must account for this two-sided context.

Like feature spreading in Autosegmental Phonology, both AGREE and ALIGN are only capable of describing the role of one flanking segment and are therefore unable to provide us with an insightful analysis of the pattern in Gaalpu. If canonical examples of lenition occur in between continuants, then analyses that only account for the role of one flanking segment make the wrong predictions.

5. IMPLICATIONS

In this section, I discuss how the analysis of lenition presented in this paper can be extended to analysing the reverse process, hardening, in Wubuy. This is an interesting result and suggests that both Wubuy and Gaalpu share a number of phonotactic constraints on surface forms. Following this, I briefly discuss the behaviour of the glottal stop and the difficulty in accounting for its transparency in phonological processes.

5.1 HARDENING PROCESSES

An important implication of adopting the analysis presented in this paper is that we are able to explain hardening processes described in other Australian languages. In this section, I briefly illustrate an analysis using the constraint hierarchy in (29), referring specifically to hardening in Wubuy (a.k.a. Nunggubuyu, Heath 1984; Baker 2009). Wubuy, like Gaalpu, evinces a set of alternating continuants and stops at morpheme boundaries.

w_2	↔	p
l̻	↔	t̻
r	↔	t
ɻ	↔	ʈ
j	↔	c
w_1	↔	k

Table 3. Wubuy consonant alternations, following Heath 1984

The alternation pattern that we see in Wubuy is similar in many respects to the pattern in Gaalpu. In Wubuy, however, the apical series do have corresponding tap and semivowel variants, and the lamino-dental stop alternates with a lamino-dental lateral instead of the palatal approximant as in Gaalpu. The stops surface after a stop or nasal and the continuants appear after semivowels, liquids and vowels as in Gaalpu. Heath

(1984) suggests that while lenition of stops occurred historically, synchronically the continuant should be taken as the underlying representation, so the alternations that we see are really examples of consonant hardening[13]. He points to the fact that there is another set of stems with consistent initial stop and no alternations. Differences aside, the crucial similarity between the alternations in Gaalpu and Wubuy is that the conditioning environments for the stop alternants and continuant alternants are the same. Furthermore, the suffix-initial consonant is also neutralised for the feature [continuant], as in Gaalpu, since there are no suffixes with underlying stops.[14] Positing a separate constraint hierarchy for lenition processes and hardening processes would thus miss these generalizations. In (30), I show how our constraint hierarchy in (24) predicts the correct outcome for the hardening pattern.

(30) Hardening of underlying continuant

	a-l̪aaɲ-ɾuc 'on the chin'	SCL	SONPRES	IDENT[SON]
☛a.	al̪aaɲtuc		*	*
b.	al̪aaɲɾuc	*!		

In (30), candidate (a) with the stop variant violates SONPRES and IDENT[SON], but crucially (b), which has the semivowel variant, violates higher-ranked SCL. Therefore, the optimal candidate is (a). In (31) we see how our constraint hierarchy easily predicts the correct candidate when hardening does not occur.

(31) No hardening following a vowel

	a-l̪akuɭa-ɾuc 'on the lip'	SCL	SONPRES	IDENT[SON]
☛a.	al̪akuɭaɾuc			
b.	al̪akuɭatuc		*!	*

Candidate (a), which contains the semivowel variant, is the faithful candidate. It is easily selected by the grammar as optimal since it does not violate any constraints, whereas (b) violates both SONPRES and IDENT[SON].

[13] Note, however, that while hardening in this instance is an assimilation process, it typically involves strengthening in stressed position such as in Ngalakan (Baker 2008).

[14] Like Gaalpu, Wubuy maintains the contrast between stop and continuant word-initially and within morphemes. Since Wubuy is a prefixing and suffixing language, continuant-initial stems also show alternations. This is, however, complicated by the fact that there are a series of stop-initial stems that do not show alternations at all, even in environments where we would expect the semivowel variant to occur. I do not discuss how we should account for this presently, since it is beyond the scope of this paper, see Chong (2011) for a discussion.

(30) and (31) show that the posited constraint hierarchy makes the correct predictions for output forms, even though the underlying form is the continuant variant. The analysis presented in this paper is thus capable of describing *both* lenition and hardening processes using the same constraint hierarchy.[15] Therefore, we are able to capture the generalization that the surface patterns, whatever the direction of change, generally conform to the same set of markedness constraints, that is, SCL and SONPRES.

5.3 THE GLOTTAL STOP

The analysis so far accounts for the data presented in Wood (1978) on Gaalpu. While it is extendable to other varieties of Yolngu such as Djambarrpuyngu (Wilkinson 1991), it is unable to account for the non-local nature of lenition following a glottal stop in these other varieties. In this section, I briefly outline the issues surrounding an account of the glottal stop's behaviour and suggest that this warrants further investigation.

It is not entirely clear how the glottal stop interacts with the lenition process in Gaalpu. Wood (1978) does not explicitly discuss the behaviour of the glottal stop in relation to the lenition process. In closely related languages, such as Djapu (Morphy 1983) and Djambarrpuyngu (Wilkinson 1991), it seems that it does not participate in the conditioning of lenition. In particular, its presence has no effect on the stop-continuant alternations in these languages. Examples of these alternations from Djambarrpuyngu (Wilkinson 1991) are shown below: [16]

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[15] Note that the constraint SONPRES is not strictly speaking crucial in explaining the hardening pattern. Admittedly, a constraint hierarchy such as SCL ≫ IDENT[SON] is sufficient. But as such, we miss the generalization that both hardening and lenition pattern similarly on the surface. Stop variants occur after [-cont] segments and semivowel variants occur after [+cont] segments. From this we can conclude that they conform to the same kinds of markedness constraints. Therefore, even though SONPRES does not seem necessary to describe the hardening pattern, it is necessary if we want to capture the observation that regardless of direction, these processes both conform to similar markedness constraints.

[16] Wood (1978) does not explicitly discuss the behaviour of the glottal stop in relation to lenition processes. He does describe its interaction with a vowel deletion rule (p. 96). Similarly, the conditioning factor for the application of this rule is not the glottal but the segment preceding the glottal. My assumption about the behaviour of the glottal stop is taken from Wilkinson's (1991) extended discussion of it in Djambarrpuyngu. Further description of the glottal stop's behaviour in Gaalpu specifically is very much needed.

(32)	kuɭkuʔ-ju	fish-ERG
(33)	kuɭku-ju	many-ERG
(34)	warakanʔ-ku	animal-DAT
(35)	ɻaŋan-ku	paper-bark-DAT

This presents us with an interesting case of a non-local process. As Wilkinson (1991) points out for Djambarrpuyngu, it is the segment preceding the glottal stop that effectively determines which suffix variant appears on the surface. If the glottal stop is a segment as we have assumed in this paper, then we need an account of its transparency in the lenition process. If the glottal stop is specified for either of the features [continuant] or [sonorant], the analysis presented would fail to correctly predict the attested surface alternations (see Chong 2011 for an illustration of the different results). Therefore, it is possible that my analysis as it stands is wrong in predicting that lenition does not occur following glottal-final roots in Gaalpu.

The issue here is not one of representation. In fact, the glottal stop has been assumed to be maximally underspecified (Harvey 1991) in Australian languages. Rather, the problem is to do with OT's ability to account for non-local processes of this sort, where the conditioning factor for a particular alternation is not a contiguous segment (see Rose & Walker 2004 for a discussion of this). Even if we assume that the glottal stop is a maximally underspecified segment, it still begs the question of how to account for it with the OT framework. A satisfactory analysis of the glottal stop's behaviour needs to be able to account for its transparency to the lenition process in these languages. That is, it plays no role in conditioning lenition; crucially the conditioning segment is the segment that precedes the glottal stop. How exactly to account for this non-local process in OT should be the subject of future investigations.

6. Conclusion

Lenition in Gaalpu is a productive process that affects stop-initial suffixes. In this paper, I have illustrated a possible analysis of this phenomenon in Gaalpu. I have argued for the use of the feature [sonorant] instead of [continuant] to formulate the lenition-triggering markedness constraint, SonPres. I have shown how the ranking of this constraint with respect to SCL predicts the correct output for lenition. A particular strength of the analysis is its ability to explain the role of both sides of a two-sided context in conditioning lenition. Additionally, we are able to describe hardening processes in Wubuy using the same constraint hierarchy. I concluded by discussing problematic behaviour of the glottal stop, suggesting that this is clearly an area in which more investigation is required.

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