# Weakening, Strengthening, and Nasalization; the things that happen to consonants in morphological environments[i] .

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## 1 Introduction

In this paper I will present a phonological account of consonant alternations that are triggered by morphosyntactic or lexical environments. These alternations involve gradient changes in the degree of oral aperture or in the degree of sonority and cannot be explained by referring to the phonological environment. In some cases, these processes not only affect the degree of oral aperture or the degree of sonority, but also the place of articulation. The aim of this paper is twofold. First, I will attempt to provide a unified autosegmental account of morphosyntactically conditioned gradient changes in the manner of articulation and in sonority. The second aim is to provide a phonological account for the interaction between manner of articulation and place of articulation.

Consonant alternations that affect the manner of articulation involve changes along the scale in (1) below:

(1) Changes in the manner of articulation:
long plosive <---> short plosive <---> fricative/approximant <---> zero

Rightward changes are commonly referred to as 'weakening' or 'lenition' and occur, for instance, in Finnish, Irish, and Welsh. Changes in the reverse direction are known as 'strengthening' or 'fortition' and are found in West-Atlantic Fula, and Amerindian Southern Paiute.

Consonant alternations that affect the degree of sonority involve changes along the scales in (2):

(2) Changes in the degree of sonority:
a. voiceless obstruent ---> voiced obstruent ---> nasal sonorant
b. voiceless obstruent ---> prenasal obstruent
c. voiceless obstruent ---> nasal sonorant

In Irish, alternations between voiceless and voiced obstruents occur in the same morphological environments in which voiced stops alternate with nasal stops. In Southern Paiute, we find that voiceless stops alternate with prenasal stops in certain grammatical environments and in Welsh, voiceless aspirated stops alternate with voiceless nasals, while unaspirated stops alternate with voiced nasals.

In sections 1.1 to 1.3 I will present some examples of consonant weakenings, consonant strengthenings, and consonant nasalizations, respectively. The theoretical framework that I will adopt is introduced in section 2. Section 2.1 provides an analysis of consonant weakening processes in Finnish and Irish in this framework and section 2.1.1 is devoted to two types of consonant weakening processes in Welsh. Sections 2.2, and 2.3 provide an analysis of consonant strengthenings and consonant nasalizations, respectively. In section 3 I discuss some anomalies concerning the place of articulation and I will argue in favour of Rice's (1996) model of underspecification of place features to explain these anomalies. Section 4 concludes.

## 1.1 Consonant weakening

In Finnish, a phonetically long oral stop is realised as a phonetically short oral stop in the same morphological environment in which an underlying short stop is realised as an approximant. This process is commonly referred to as 'consonant gradation'. The examples below are from Kiparsky (1992), Skousen (1972), and Vainikka (1988). According to Vainikka (1988), [D] represents a coronal sonorant continuant:

| | | | | |
|---|---|---|---|---|
| (3) | a. | piippu | pp=[p:] | 'pipe' (nom) |
| | b. | piipun | p =[p] | 'pipe' (gen) |
| (4) | a. | tapa | p =[p] | 'custom' (nom) |
| | b. | tavan | v =[w] | 'custom' (gen) |
| (5) | a. | hattu | tt =[t:] | 'hat' (nom) |
| | b. | hatun | t =[t] | 'hat' (gen) |
| (6) | a. | katu | t =[t] | 'street' (nom) |
| | b. | kadun | d =[D] | 'street' (gen) |

The chain-like changes from a phonetically long stop to a short stop and from a short stop to a continuant usually occur after a vowel or sonorant consonant in the onset of a closed syllable. However, there are some suffixes that close a syllable and do not trigger a change in the onset stop:

| | | | | |
|---|---|---|---|---|
| (7) | a. | käte | t =[t] | 'hand' |
| | b. | kätensä | t =[t] | 'his hand' |

From this we may infer that consonant gradation is not conditioned by the phonological environment, but by the morphological environment. The phonological context does not play a role in the gradation process and need not be specified in our account of these alternations. The changes depicted in (3b, 4b, 5b, 6b) occur in exactly the same morphological context and constitute one phonological process. The change from a phonetically long stop to a short stop and from a short stop to an approximant in the same environment is difficult to express in a feature geometric model, because there is no unified set of features which accounts for it. In section 2.1 I will show how a theory which employs so-called 'aperture positions' (which are defined in terms of degrees of oral aperture) enables us to express Finnish consonant gradation as one process.

Another example of a consonant weakening process can be found in Modern Irish. In this language, a word which is pronounced with a short stop in isolation is realised with a fricative after certain function words or to mark a syntactic property (e.g. to indicate the past tense of a verb). In the same environments, a word with an initial labial fricative is realised without an initial consonant. The examples below are from Ní Chiosáin (1991):

| | | | | |
|---|---|---|---|---|
| (8) | a. | páipéar | p =[p] | 'a paper' |
| | b. | mo pháipéar | ph=[f] | 'my paper' |
| (9) | a. | fata | f =[f] | 'a potato' |
| | b. | mo fhata | fh=Ø | 'my potato' |

The change from an underlying stop to a fricative in an environment that cannot be described in phonological terms is also attested in native American Southern Paiute. In this language, certain lexical items trigger a mutation in a consonant-initial suffix. In the examples below from Sapir (1930) the suffix *-pi* is realised with an initial fricative after the lexical items *sappi* 'belly' and *avi* 'shade' (other lexical items may induce other changes, see sections 1.2 and 1.3 below). Whether the fricative that results from this spirantization process is voiceless or voiced depends on the preceding vowel. Fricatives are voiceless after voiceless vowels (indicated below by small caps) and voiced after voiced vowels:

| | | | |
|---|---|---|---|
| (10) | a. | sappɪ + pi ---> sappɪɸi | 'belly' (absolutive) |
| | b. | avi + pi ---> avivi | 'shade' (absolutive) |

The fact that spirantization of stops is not triggered by a preceding vowel in Southern Paiute, but by other non-phonological conditions can be illustrated by the following quotation. According to Press (1979:24): 'a few postpositions in Southern Paiute vary their initial consonant according to whether the noun to

which they are attached is animate or not, regardless of the "phonological shape" of the stem'.

Stop-fricative alternations are frequently found in intervocalic positions. In Spanish, for instance, the voiced stops /b, d, g/ are realised as the corresponding voiced fricatives [β, ð, ɣ] in between two sonorants, and in certain dialects of American English the voiced stop /d/ is realised as the flap [ɾ] in intervocalic position. In Finnish, Irish, and Southern Paiute, however, the respective consonant changes cannot be attributed to surrounding sounds (although this was the case historically in Irish). I will account for these morphosyntactically or lexically conditioned weakening phenomena in a uniform way in section 2.1.

## 1.2 Consonant strengthening

The reverse of consonant weakening, i.e. consonant strengthening, is also attested, although gradient changes to sounds which are one degree more constricted are hard to find. There no changes from zero to continuant which are not triggered by the phonological environment. This is probably due to the following facts. First, onsetless syllables are rare cross-linguistically as well as within one language. Inserting a continuant at the left edge of the word where, in most instances, there is an underlying onset consonant already would consequently not be a very effective way of marking a morphological process. Second, to insert a continuant at the right edge of a word goes against the general tendency in languages to end a syllable by either a vowel or a non-continuant (i.e. an oral or nasal stop). Considering these facts, it is not surprising that we do not find the option of using an inserted continuant as a morphological or lexical marker in languages.

In contrast, the change from no underlying consonant to the presence of a continuant is frequently found in phonological contexts. In Dutch, for example, an approximant is inserted between two vowels (of which the first one determines the place of articulation of the approximant):

| | | | | | |
|---|---|---|---|---|---|
| (11)a. | piano | pi[j]ano | c. | Inuit | Inu[w]it |
| b. | theater | the[j]ater | d. | boa | bo[w]a |

The change from a continuant to a short plosive is found in morphological environments in West-Atlantic Fula (Arnott 1970, Paradis 1992).The stem *baat* 'needle' does not change its initial consonant in noun class 3, while *weer* 'host' appears with initial *b* in that class and *fow* 'hyena' is realised with initial *p*:

(12)a. baat + el ---> baatel 'needle' (diminutive sg.)
b. weer+ el ---> beerel 'host' (diminutive sg.)
c. fow + el ---> powel 'hyena' (diminutive sg.)

In Southern Paiute, some lexical items cause a suffix-initial short stop to lengthen:

(13) a + pi ---> ap:i 'horn' (absolutive)

The examples given in this section illustrate non-gradient leftward changes along the scale in (1) above. I will now turn to examples of changes along the scales in (2a-c).

## 1.3 Consonant nasalization

Irish has a morphological process know as 'initial nasalization' by which voiceless obstruents become voiced and voiced stops become nasal stops (there are no underlying voiced fricatives in Irish). The data below are from Ní Chiosáin (1991):

(14)a. peann p =[p'] 'pen'
b. a bpeann bp=[b'] 'their pen'

(15)a. fear f =[f'] 'man'
b. leis an bhfear bhf=[v'] 'with the man'

(16)a. bó b =[b] 'cow'
b. ocht mbó mb=[m] 'eight cows'

Another nasalization process is found in Amerindian Southern Paiute. In this language, a lexical item may trigger prenasalization in a stop-initial suffix:

(17) ago + pi ---> ago$^{m}$pi 'tongue' (absolutive)

There are no underlying oral voiced stops or prenasal stops in Southern Paiute. I know of no language in which voiceless stops alternate with prenasal stops in the same morphological context where prenasal stops alternate with nasals. The analysis that I will present in section 2.3 below predicts a system in which such chain-like changes occur. The reason why a language to illustrate this system is difficult to find may be due to two facts. First, languages with underlying

prenasal stops are rare and, second, languages which utilise consonant nasalization as a morphosyntactic process are rare. Together, the two facts explain why we do not find languages in which voiceless stops turn into prenasal stops in the same context in which underlying prenasal stops turn into nasals.

In Welsh, voiceless aspirated stops are realised as voiceless nasals in the same environment in which voiceless unaspirated stops are realised as plain nasal stops (Ball and Müller 1992):

| | | | |
|---|---|---|---|
| (18)a. | cath | c =[$k^h$] | 'cat' |
| b. | fy nghath | ngh=[ŋ] | 'my cat' |
| (19)a. | Fe'm gwelodd Wyn | g =[k] | 'Wyn saw me' |
| b. | Roedd Wyn yn fy ngweld | ng =[ŋ] | 'Wyn was seeing me' |

The examples presented in this section differ from the phonological phenomenon known as 'nasal harmony' in that there is no overt phonological trigger like a nasal consonant or nasal vowel. In most instances, the degree of sonority is increased by lowering of the velum for part of the segment's duration (Southern Paiute) or for the entire duration of the segment (Welsh). Irish displays a chain-wise increase of sonority by (i) voicing voiceless segments and (ii) nasalizing segments which are voiced underlyingly. In section 2.3 I will propose that the processes illustrated in this section always involve the addition of the feature 'Sonorant Voicing' (see Rice 1993).

## 2 Alternations in manner of articulation and autosegmental phonology

The consonant alternations presented in sections 1.1 and 1.2 involve changes in the manner of articulation. In autosegmental phonology, the so-called 'manner features' include [continuant] and [approximant]. These features pose a number of problems for phonological theory.

First, McCarthy (1988), among others, observes that the feature [approximant] does not participate in autosegmental processes like spreading or delinking. Incorporating the feature [approximant] into the root node explains why this feature cannot spread or delink on its own. Wetzels (1991) observes that we seldom find that the feature [+continuant] spreads from a fricative to a following stop as in the hypothetical case *aspa* --> *asfa*, or is given up when adjacent to another continuant, as in *afsa* --> *apsa*. Given the theory of autosegmental phonology in which spreading and delinking of features are the basic operations on segmental representations, the behaviour of the feature

[continuant] is unexpected. A possible solution to this problem may be to incorporate this feature in the root node together with the feature [approximant], but this poses other problems, e.g. for the representation of affricates.

Second, Steriade (1993) observes that in a theoretical model which assumes the features [continuant] and [approximant] there is no explanation for the fact that complex segments like pre- and postnasals involve plosives (stops and affricates), rather than continuants (fricatives and approximants).

Third, consonant weakening processes may involve phonetically long plosives which are shortened in the same context in which short plosives are spirantised (Finnish), or short plosives which are spirantised in the same environment in which fricatives are deleted (Irish) and such chain-like changes are difficult to express in a theory which assumes the features [approximant] and [continuant]. Linguists have referred to these changes as 'bizarre, irregular, and quirky phenomena' (Lieber 1987). Many attempts have been made to express such weakening processes as a single generalisation (e.g. Ní Chiosáin 1991, Vainikka 1988), but the result has been analyses in which it has been proposed, for example, that [+continuant] is inserted in the case of a segment that is underlyingly underspecified for that feature, while additional rules ensure that an underlying [+continuant] specification results in deletion of all underlying features. Such rules are indeed highly 'irregular'. As an example of such an approach, I will discuss the autosegmental account of Modern Irish initial lenition proposed by Ní Chiosáin (1991).

Ní Chiosáin (1991) assumes the following underlying representations for Irish consonantal phonemes (palatalization, which is distinctive in Irish, is ignored):

(20) Underlying representations of Irish consonants:

| a. | b. | c. |
|---|---|---|
| /p,t,k,b,d,g/ | /f/ | /h/ |
| [-son,+cons] | [-son,+cons] | [-son] |
| | \| | |
| | [+cont] | |

In environments where lenition does not apply, a redundancy rule inserts the value [-continuant] for stops and [+continuant] for /h/. In environments where lenition applies the value [+continuant] is inserted by the spirantization rule below:

(21) Spirantization

$$[_{Wd}\ \alpha \quad | \quad [\ \ ] \ \text{---} > [+\text{continuant}]$$

The sound /f/ undergoes the spirantization rule vacuously, because it is underlyingly specified as [+continuant], (see 20b). For this case, Ní Chiosáin (1991:51) proposes a default rule 'Total Deletion', which only applies when the spirantization rule applies vacuously. This is theoretically 'suspect'. I will now discuss a theoretical framework which overcomes the problems which a theory with manner features has.

Steriade (1993) proposes to define the nodes to which features may attach in terms of degree of oral aperture. Instead of the feature-geometric notion of root node which may comprise the features [consonantal], [sonorant], and (perhaps) [approximant], Steriade assumes the following aperture positions:

(22)a. A0: complete obstruction in the oral cavity

b. Afric: degree of oral release sufficient to create a turbulent airstream

c. Amax: maximal degree of oral release for consonants

Some consequences of this proposal are, first of all, that the features [approximant] and [continuant] are no longer necessary in phonological representations and that the exceptional status of these features with respect to spreading or delinking processes does not need a special explanation. Second, since non-continuants (stops and affricates) involve two aperture nodes (one for the closure phase and one for the release phase), whereas continuants involve one node (for the release phase), it follows that features like [nasal], [spread glottis], etc. have two positions to associate to in the case of non-continuants and one in the case of continuants. This proposal predicts a four-way contrast among non-continuants and a two-way contrast among continuants:

(23)a. stops:

| aspirated | preaspirated | postaspirated | unaspirated |
|---|---|---|---|
| A0 Amax | A0 Amax | A0 Amax | A0 Amax |
| \ / | \| | \| | |
| [+spr. gl] | [+spr. gl] | [+spr.gl] | |

b. fricatives:

| aspirated | unaspirated |
|---|---|
| Afric | Afric |
| \| | |
| [+spr. gl] | |

Third, Steriade's proposal to represent the manner of articulation by means of aperture positions has interesting consequences for consonant weakening,

consonant strengthening, and consonant nasalization processes, as I will now go on to show in the following sections.

## 2.1 Consonant weakening processes and aperture theory

Languages that distinguish released stops and affricates (e.g. German) and languages that distinguish voiced fricatives and voiced approximants (e.g. Dutch) have a phonological distinction between two degrees of oral release. Steriade (1993) suggests the following segmental representations involving aperture positions for fricated and approximant release:

| | | | | | |
|---|---|---|---|---|---|
| (24) a. | approximant: | Amax | c. | fricative: | Afric |
| b. | released stop: | A0 Amax | d. | affricate: | A0 Afric |

In what follows I will not be concerned with different degrees of release. The idea that I will borrow from Steriade (1993) is that released non-continuants involve two positions in phonological representations, whereas continuants are represented by one position. Stops in utterance-medial positions are generally unreleased and are assumed to carry one position for closure in phonological representations (see 25a). For languages that do not have affricates, nor a phonological distinction between voiced fricatives and voiced approximants, the difference between voiceless fricatives and voiced approximants may be indicated by a feature for voicing under the aperture position for release. The aperture position that characterises fricatives as well as approximants in such languages is given in (25b) and the representation of released stops is given in (25c):

| | | |
|---|---|---|
| (25) a. | unreleased stop (in coda position): | A0 |
| b. | continuant: | Arel |
| c. | released stop (in onset position): | A0 Arel |

One of the consequences of the proposal to represent closure and release in the oral cavity by distinct aperture positions is that it enables us to express consonant weakening as one process, viz. the deletion of an aperture position, as I will illustrate for Finnish first.

Finnish has the following consonant inventory:

(26) *Finnish consonantal phonemes*

| | Labial | Dental | Palatovelar | Laryngeal |
|---|---|---|---|---|
| stops | p | t | k | |
| fricatives | | s | | h |
| nasals | m | n | ŋ | |
| approximants | w | l/r | j | |

In the case of released stops, the aperture position for closure is lost under gradation and what remains is the aperture position for release which characterises an approximant:

(27) t a p a+n ---> t a [w] a n ('custom')

$A_0$ $A_{max}$ $A_{max}$

The same process affects phonetically long stops. These segments are usually referred to as 'geminates' and can be analysed as a sequence of an unreleased stop in coda position followed by a homorganic released stop in onset position. The result of gradation, i.e. deletion of A0, is a A0 Amax sequence, which characterises a phonetically short stop:

(28) l a p p u+n ---> l a [p] u n ('paper')

$A_0$ $A_0$ $A_{max}$ $A_0$ $A_{max}$

To sum up, (29) schematically represents the analysis of Finnish gradation that I propose in this paper:

(29) Finnish Consonant Gradation as deletion of $A_0$:

long stop ---> short stop; short stop ---> approximant

$A_0$ $A_0$ $A_{max}$ ---> $A_0$ $A_{max}$ $A_0$ $A_{max}$ ---> $A_{max}$

I will now argue that the same analysis accounts for Irish initial lenition. In (30) I present the relevant part of the phonological representation forIrish obstruents. Palatalization is ignored and I will not be concerned with the strident fricative (for a phonological account of the behaviour of /s/ in Irish, see Grijzenhout 1995). There are no underlying affricates, voiced fricatives, or glides in Irish and for this reason I will use Arel rather than Afric and Amax in the representations below:

(30) a. /p,t,k,b,d,g/ b. /f/
$A_0$ $A_{rel}$ $A_{rel}$

The stem-initial lenition process illustrated in examples (8b) and (9b) can be analysed as deletion of a stem-initial aperture position as illustrated below:

(31) Modern Irish Initial Lenition as deletion of the initial Aperture Position:

| initial stop | ---> | fricative; | initial fricative | ---> | zero |
|---|---|---|---|---|---|
| # $A_0$ $A_{rel}$ | ---> | $A_{rel}$ | # $A_{rel}$ | ---> | Ø |

Welsh has a similar process of stem-initial consonant weakening and I will argue next that these also involve deletion of one aperture position. Welsh has a contrast between aspirated and unaspirated plosives and for this reason I will discuss the phonological representation of aspiration first.

### 2.1.1 Aspiration and aperture theory

In this section I will illustrate Steriade's (1994) account of word-initial aspiration in Huautla Mazateco, an Otomanguean language of Oaxaca, Mexico, and discuss the consequences for an account of word-initial aspiration and stem-initial lenition in Modern Welsh.

Huautla Mazateco has a complex pattern of onset consonants including pre- and postglottalised plosives, pre- and postaspirated plosives, prenasalised plosives and prenasalised aspirated plosives. In the present section, we concentrate on aspiration. Steriade (1994:219) presents the following consonant inventory:

(32) *Mazateco consonantal phonemes*

| labial | alveolar | strident | postalveolar | retroflex | velar | laryngeal |
|---|---|---|---|---|---|---|
| b | t | ts | tʃ | tʂ | k | ʔ |
| | | s | ʃ | ʂ | | |
| m | n | | ɲ | | | |
| | l | | y | | | h |

In onset position of Mazateco words, we find single consonants, but no consonant clusters. In word-initial positions, oral stops and affricates may be preaspirated, while nasal stops may be partly devoiced:

| | | | |
|---|---|---|---|
| (33) a. | hti | ht =[$^{h}$t] | 'fish' |
| b. | htse | hts=[$^{h}$ts] | 'a sore' |
| c. | hno | hn =[n̥n] | 'corn' |

The segment /h/ involves maximal aperture for consonants in the oral cavity, no place of articulation, and a spread glottis. Steriade (1994) therefore represents laryngeal /h/ as an $A_{max}$ position with the feature [spread] for aspiration:

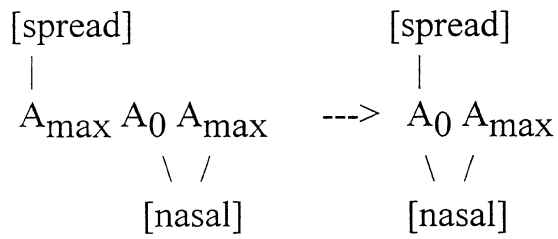
(34) /h/: $A_{max}$
|
[spread]

This segment may appear on its own in Mazateco. For reasons beyond the scope of the present paper, Steriade (1994:233-234) argues that onsets with preaspiration are generated by a merger process of the aperture position for /h/ and the aperture position for closure of the onset stop. This is compatible with the fact that aspiration is phonetically realised as simultaneous with at least the first half of the stop closure:

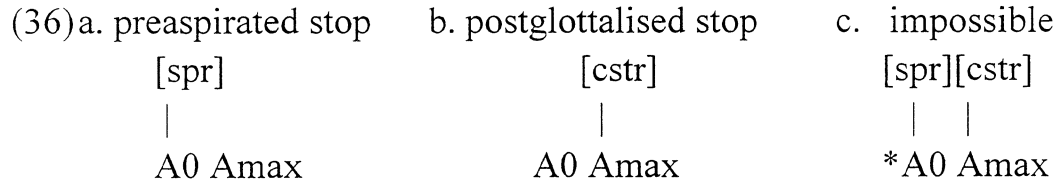
(35) a. Merger deriving preaspirated oral stops in onsets:

[spread] [spread]
| |
$A_{max}\ A_0\ A_{max}$ ---> $A_0\ A_{max}$

b. Merger deriving partially devoiced nasal stops in onsets:




In Mazateco, consonants are available landing sites for the features of aspiration and glottalisation, but the restriction seems to be that the one feature excludes the other. Onset consonants may be preaspirated or postaspirated and preglottalised or postglottalised, but not, for instance, preaspirated-postglottalised. In Steriade's framework this follows from the fact that aspirated and glottalised onset consonants are monosegmental and only one laryngeal feature is allowed per segment (below [spr] and [cstr] stand for the features for spread and constricted glottis, respectively):




The analysis of Huautla Mazateco aspiration finds independent support from Welsh, as will be shown next.

According to Ball & Jones (1984), the voicing contrast on Welsh plosives is phonetically realised as the presence or absence of aspiration. The fricatives exhibit a contrast in length. All speakers use length of frication as a distinguishing feature between what is usually notated as /f,θ/ and /v,ð/, respectively, while some also utilise an amount of voicing for the fricatives /v/ and /ð/ although they are still not fully voiced. To better represent the distinction in length, I will use /f:/ and /θ:/ for the phonetically long fricatives and /f/ and /θ/ for their shorter counterparts. The following table presents an inventory of Welsh consonants that may occur in word-initial non-mutation environments:[ii]

(37) *Modern Welsh initial consonants*

| | labial | dental | strident | velar |
|---|---|---|---|---|
| stops | $p^h$, p | $t^h$, t | | $k^h$, k |
| fricatives | f:, f | θ:, θ | s | |
| nasals | m | n | | |
| liquids | | t̻, l, r̻, r | | |

As in Irish, word-initial consonants in Welsh may be weakened in certain morphological or syntactic environments. Even though the attested consonant alternations are different from Modern Irish, I will maintain that the phonological process is the same, viz. lenition entails the deletion of an initial aperture position.

In Welsh lenition environments, aspirated plosives are realised as unaspirated plosives (38b), unaspirated plosives as fricatives (39b), fricatives are not affected, and devoiced sonorants are fully voiced (40b). The following examples are from Willis (1986):

| | | | | |
|---|---|---|---|---|
| (38) a. | pen | p =[$p^h$] | 'head' |
| b. | ei ben | b =[p] | 'his head' |
| (39) a. | brawd | b =[p] | 'brother' |
| b. | ei frawd | f =[f] | 'his brother' |
| (40) a. | llong | ll=[ɬ] | 'ship' |
| b. | ei long | l =[l] | 'his ship' |

With Steriade (1994), I assume that aspiration for plosives and devoicing of sonorants is carried by a separate aperture position for laryngeal release. In non-lenition environments the aperture position for laryngeal release merges with the aperture position for closure of the onset stop or the aperture position for sonorants, as illustrated for Mazateco aspirated onset stops in (35a).

In accordance with the analysis of consonant weakening processes in Finnish and Irish, I will analyse Welsh stem-initial lenition as deletion of an aperture position. In lenition environments, the initial aperture position is deleted in a segment characterised by more than one aperture position and this may be the aperture position for laryngeal release. Contrary to Irish, fricatives are not affected in Welsh due to the fact that an onset consonant is obligatory in Welsh. The consequence is that an aperture position for release cannot be deleted and must remain to fill the onset position: [iii]

(41) Welsh initial lenition as deletion of an initial A-position:

a. aspirated plosive ---> unaspirated plosive

[spread]
|
$A_{rel}$ $A_0$ $A_{rel}$ ---> $A_0$ $A_{rel}$

b. unaspirated plosive ---> phonetically short fricative

$A_0$ $A_{rel}$ ---> $A_{rel}$

c. fricative unaffected (to fill the onset-position)

$A_{rel}$

d. devoiced sonorant ---> fully voiced sonorant

[spread]
|
$A_{rel}$ $A_{rel}$ ---> $A_{rel}$
| |
[lateral] [lateral]

What emerges from this discussion is that lenition in Welsh and Irish is basically the same process, but, since the underlying representations are different in both languages, the outcome of the lenition process has different phonetic results. [iv]

This concludes the discussion of the phonological analysis of consonant weakening processes. In all the cases that we have come across, consonant weakening involves deletion of an aperture node. As independent support for the theory, I discuss the analysis of consonant strengthening processes in the following section.

## 2.2 Consonant strengthening processes and aperture theory

In section 1.2 it was illustrated that Fula approximants turn into voiced stops in the same environment in which voiceless fricatives turn into voiceless stops. This process is difficult to account for in a autosegmental theory. We may, for instance, suggest that the process involves the introduction of the feature value [-continuant] or the deletion of the feature value [+continuant], but that would leave unexplained why the approximant loses its sonorant status. In the theory proposed here, voiceless fricatives are characterised by one position for voiceless release and approximants are represented as one position for voiced

release. Following Rice (1993) and in anticipation of the discussion on sonority in section 2.3, I will use the feature SV (sonorant voicing) to indicate voicing of obstruents and sonorants. The change from stem-initial continuant to released stop in certain noun classes in Fula can be analysed as the insertion of an aperture position for closure:

(42) Fula Strengthening as insertion of initial A0:

a. voiceless continuant ---> voiceless stop (e.g. f---> p)
Arel A0 Arel

b. voiced continuant ---> voiced stop (e.g. w ---> b)
Arel A0 Arel
| |
SV SV

I propose the same analysis for Southern Paiute lengthening of short plosives (see example 13):

(43) Southern Paiute Gemination as insertion of initial $A_0$:

short stop ---> phonetically long stop (e.g. p ---> p:)
$A_0$ $A_{rel}$ ---> $A_0$ $A_0$ $A_{rel}$

All consonant weakening processes manifest themselves as a decrease of consonantal stricture and consonant strengthening processes manifest themselves as an increase of consonantal stricture. The theory developed on independent grounds in Steriade (1993) seems particularly suited to capture this fact, i.e. a decrease of stricture is analysed as the loss of an aperture position and an increase of stricture is analysed as insertion of an aperture position. I will now consider an analysis of consonant nasalizations in this framework.

## 2.3 Consonant nasalization processes and aperture theory

In standard phonological representations, voicing of obstruents is expressed by the feature [voice] and the "spontaneous voicing" (Chomsky and Halle 1968) which characterises voicing of sonorants is expressed by the feature [sonorant]. Rice (1993) shows that in languages in which voicing of obstruents and voicing of sonorants is not distinctive, we capture more generalisations if the two features are replaced by one phonological feature 'Spontaneous Voicing' or 'Sonorant Voice' (abbreviated as SV). I what follows I will adopt her proposal for the languages under discussion here.

Consider first Southern Paiute Prenasalization which turns suffix-initial oral stops into prenasal stops after certain lexical items. I will analyse this process as one of SV-association to the stem-initial segment as below:

(44) Southern Paiute Nasalization:

| voiceless stop | ---> | prenasal |
|---|---|---|
| A0 Arel | | A0 Arel |
| | | \| |
| | | SV |

When there is a complete obstruction in the oral tract (represented by A0), the air which passes the vibrating vocal cords (represented by SV) cannot escape through the oral cavity and has to be released through the nasal cavity. For this reason, a representation of A0 which dominates SV always indicates nasality. A sequence of A0 Arel where SV is associated to A0, represents nasality followed by oral release, i.e. this is the representation of a prenasal.

The same process of SV-association applies to Irish stem-initial nasalization. In this language there is a preference for association to Arel rather than to A0 (in Grijzenhout 1995 I argue that this is a cross-linguistic tendency). When there is a choice, the prefix SV will associate to an Arel position in Irish rather than to an A0 position:

(45) Modern Irish Initial Nasalization; the case of voiceless obstruents:

| voiceless stop | ---> | voiced stop; | voiceless fricative | ---> | voiced fricative |
|---|---|---|---|---|---|
| A0 Arel | | A0 Arel | Arel | | Arel |
| | | \| | | | \| |
| | | SV | | | SV |

Nasal consonants are more sonorant than voiced obstruents and this may be expressed in phonological representations by multiple association of SV to two aperture positions. In morphological contexts in which the prefix SV is associated to the aperture position for release in the case of voiceless obstruents, it is associated to the other position in the case of voiced obstruents in Irish:

(46) Modern Irish Initial Nasalization; the case of voiced stops:

| voiced stop | ---> | nasal stop |
|---|---|---|
| A0 Arel | | A0 Arel |
| \| | | \ / |
| SV | | SV |

Welsh initial nasalization differs from the Irish case in that SV is associated to both positions:

(47) Welsh Initial Nasalization:

| aspirated stop ---> voiceless nasal; | | unaspirated stop ---> voiced nasal | |
|---|---|---|---|
| [spr] | [spr] | | |
| \| | \| | | |
| A0 Arel | A0 Arel | A0 Arel | A0 Arel |
| | \ / | | \ / |
| | SV | | SV |

To conclude, (48) summarises the analysis of consonant weakenings, consonant strengthenings, and consonant nasalizations, respectively:

(48) Consonant Weakening: deletion of Aperture Position

| | |
|---|---|
| Southern Paiute Spirantization: | delete A0 |
| Modern Irish Lenition: | delete A0, else Arel |
| American English Flapping: | delete Arel |

Consonant Strengthening: insertion of Aperture Position

| | |
|---|---|
| Fula strengthening, Southern Paiute gemination: | insert A0 |
| Intervocalic glide insertion: | insert Arel |

Nasalization: Association of SV to Aperture Position:

| | |
|---|---|
| Southern Paiute and Fula Nasalization: | associate SV to A0 |
| Modern Irish Nasalization: | associate SV to Arel or A0 |
| Modern Welsh Nasalization: | associate SV to A0 and Arel |

There are some residual questions concerning the place of articulation. For instance, in Finnish and Welsh, unaspirated labial and coronal short stops alternate with labial and coronal continuants, respectively (see 3a-6a for Finnish and 38a-39b for Welsh), but velar stops exhibit different alternations:

(49) Finnish velar stop gradation:

| | | | | |
|---|---|---|---|---|
| a. | kurki | ---> kurjen | j =[y] | 'stork' |
| b. | luku | ---> luvun | v =[w] | 'chapter' |
| c. | suka | ---> suan | | 'brush' |

(50) Welsh lenition of the velar stop:

| | | | | |
|---|---|---|---|---|
| a. | gardd | ---> ardd | g= [k] | 'garden' |
| b. | glas | ---> las | g= [k] | 'blue' |

In Irish, labial and velar stops correspond to labial and velar fricatives in lenition environments, but the coronal voiceless stop alternates with the laryngeal fricative and the coronal voiced stop alternates with the dorsal voiced fricative in lenition environments.

(51) Irish lenition of the coronal stops:

| | | | |
|---|---|---|---|
| a. | teach | t =[t'] | 'a house' |
| b. | mo theach | th=[h'] | 'my house' |
| c. | dúnaimid | d =[d] | 'we close' |
| d. | dhúnamar | dh=[ɣ] | 'we closed' |

These are not the only examples of the deviant behaviour of velar stops and coronal stops in phonological processes. I will present a few additional examples in section 3 and present a plausible solution to the coronal and velar asymmetries in section 3.1.

## 3 Asymmetries and coronal consonants

The first often cited example illustrating the special status of coronal consonants concerns the fact that a segment may be coronal in neutral environments, but take the place of articulation of a following or a preceding consonant:

(52) English: only nasal alveolar stops in coda position undergo place assimilation

a. iN + adequate ---> inadequate
b. iN + possible ---> impossible
c. iN + complete ---> i[ŋ]complete

(53) Korean: oral and nasal alveolar stops in coda position undergo place assimilation

| | | | |
|---|---|---|---|
| a. | ət-ko | [ək.ko] | 'get and' |
| b. | kət$^{h}$-poli | [kəp.pori] | 'kind of barley' |
| c. | sinpal | [simbal] | 'shoes' |
| d. | nun-mul | [nummul] | 'tear' |
| e. | son-kalak | [soŋgarak] | 'finger' |

(54) Dutch: oral coronal stops in onset position of the diminutive morpheme assimilates in place of articulation to a preceding nasal stop

| | | | | |
|---|---|---|---|---|
| a. | zoon | + Tje | ---> zoontje | 'son' |
| b. | zoom | + Tje | ---> zoompje | 'border' |
| c. | koni[ŋ] | + Tje | ---> koni[ŋ]kje | 'king' |

The second example of the special status of coronals is that in some (mostly West African) languages spreading of vocalic place features takes place across coronal consonants, but not across consonants with other places of articulation.

Third, in languages with an epenthetic stop, the inserted consonant is a coronal stop rather than a labial or velar stop. The following example is from Axininca Campa:

(55) /i-N-koma-ako-aa-i-ro/ ---> [iŋkomatakotaatiro]
'he will paddle for it again'

Fourth, there are distribution facts which show that coronals are 'special'. For instance:

| | | |
|---|---|---|
| (56) a. | Koyukon and Finnish: | /m/ and /n/ occur, but *only* coronal /n/ is found in rhymes |
| b. | Kissi: | /m/, /n/, and /ŋ/ occur, but coronal /n/ is *not* found in rhymes |

However, similar distribution facts indicate that velars are 'special' too:

| | | |
|---|---|---|
| (57) a. | Japanese: | /m/, /n/, and /ŋ/ occur, but *only* velar /ŋ/ is found in rhymes |
| b. | English and German: | /m/, /n/, and /ŋ/ occur, but /ŋ/ is *not* found in onsets |

In the following section I will discuss a model which accounts for these facts.

### 3.1 Coronals and velars as the result of a place node with no dependants

Paradis and Prunet (1991:3), among others, state that 'the special status of coronals lies in the fact that they lack specifications for place features in underlying representations'. In a recent paper, Rice (1996) elaborates on this proposal. She argues that coronals as well as velars may result from a C(onsonantal)-Place node with no dependent. Failure to fill in a feature will result in a representation which is phonetically interpreted as a velar consonant (58a). Default fill-in of the unmarked place feature Coronal creates a coronal consonant (58b) and assimilation to an adjacent node will create a labial, coronal, or velar consonant (58c):

(58) a.

| underlying | no default | surface velar |
|---|---|---|
| Root | | Root |
| \| | | \| |
| C-Place | | C-Place |

b.

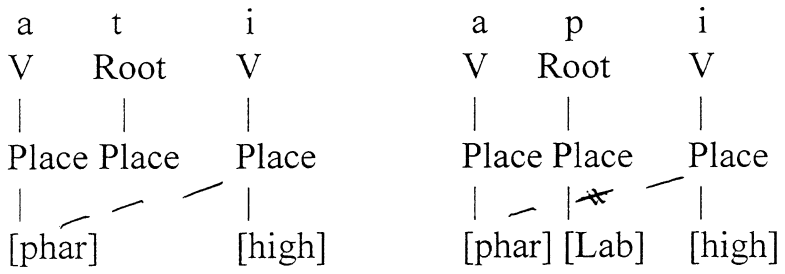
| underlying | default | surface coronal |
|---|---|---|
| Root | ---> | Root |
| \| | | \| |
| C-Place | | C-Place |
| | | \| |
| | | Coronal |

c.

| underlying | | assimilation | surface labial | |
|---|---|---|---|---|
| Root | Root | ---> | Root | Root |
| \| | \| | | \| | \| |
| C-Place | C-Place | | C-Place | C-Place |
| | \| | | \ | \| |
| | Labial | | | Labial |

According to Rice (1996), this approach correctly predicts that assimilation may affect velar and coronal consonants. Transparency of coronal (*and* velar) consonants follows from the fact that these segments lack a place specification in languages where these segments are transparent to the spreading of vocalic place features as in the following hypothetical examples:

(59)




Epenthesis of coronals follows from syllabification positing the simplest possible structure (a bare root node). Spell-out of Coronal is by default. Because coronals and velars may be unspecified for place of articulation, Rice (1996) predicts languages which have epenthetic coronal consonants and languages which have epenthetic velar consonants.

A possible account under Rice's proposal for underspecified place of articulation of the distribution asymmetries concerning nasals is as follows:

(60) a. Koyukon and Finnish: /n/ may occur in the rhyme because it is unspecified for place, i.e. rhymes do not need (independent) place

b. Kissi: /n/ may not occur in rhyme because it is unspecified for place, i.e. rhymes need place specifications

c. Japanese: /ŋ/ may occur in rhyme because it is unspecified for place (see 60a)

d. English and German: /ŋ/ may not occur in onset because it is unspecified for place, i.e. onsets require place of articulation.

I will now consider the consequences of Rice's proposal for consonant weakening processes. The facts that we have to account for can be summarised as below:

(61) a. Finnish Gradation: k: ---> k; k ---> y/w/0

b. Welsh Lenition: k ---> k; k ---> 0

c. Irish Lenition: t (d) ---> h (ɣ)

For Finnish and Welsh, I follow Rice (1996) in her proposal that velar consonants may be underlyingly underspecified for place features. When default coronal insertion fails to apply, the underspecified segment is interpreted as a velar consonant:

(62) Finnish and Welsh:

| labial stop | coronal stop | velar stop |
|---|---|---|
| $A_0$ $A_{max}$ | $A_0$ $A_{max}$ | $A_0$ $A_{max}$ |
| \ / | \ / | \ / |
| C-Place | C-Place | C-place |
| \| | \| | |
| Labial | Coronal | |

The examples that Rice mentions to support her proposal for an underspecified C-place node, all involve stops. I claim here that this is not an accident. Complete obstruction in the oral cavity implies that there is a place of obstruction, i.e. 'closure implies place'. In a theory of aperture positions, this means that where there is an A0 position there is a place of articulation. Representations with an empty C-place node under A0 either (i) trigger default coronal insertion, (ii) or are phonetically interpreted as velar stops, or (iii) get their place specification from an adjacent consonant (in most languages this consonant is an oral or nasal stop, i.e. a segment with an A0 node).

In contrast, release in the oral cavity does not imply a place of articulation. Representations with an empty C-place node which lack an A0 position do therefore not trigger default coronal insertion and may not be phonetically interpretable. Consider in this respect that when the epenthetic consonant is a stop (e.g. example 56 for Axininca Campa), the coronal default rule applies, but when the epenthetic consonant is a continuant (e.g. examples 11a-d for Dutch), the place of articulation depends on the surrounding vowels and if no place of articulation is assigned to the continuant in question, it is not realised (as in, e.g., Dutch *chaos* [xa:ɔs] without a glide after the vowel *a*).

When the segments in (62) undergo Finnish consonant gradation (i.e. the loss of an A0-position) the representations in (63) result. In examples (49a) and (49b), the vowel which follows the resulting Amax position supplies a place feature for that position, but in (49c) the vowel*a* does not supply a place feature and the Amax position is not phonetically interpreted.

(63) Finnish:

| labial glide | coronal glide | not interpretable |
|---|---|---|
| $A_{max}$ | $A_{max}$ | $A_{max}$ |
| \| | \| | \| |
| C-Place | C-Place | C-Place |
| \| | \| | |
| Labial | Coronal | |

The representations that result from Welsh initial lenition are given in (64):

(64) Welsh:

| labial fricative | coronal fricative | not interpretable |
|---|---|---|
| $A_{rel}$ | $A_{rel}$ | $A_{rel}$ |
| \| | \| | \| |
| C-Place | C-Place | C-Place |
| \| | \| | |
| Labial | Coronal | |

In Irish, coronal stops are unspecified for place of articulation. In non-lenition environments the feature Coronal is added by default:

(65) Irish /t/ and /d/: $A_0$ $A_{rel}$ default: $A_0$ $A_{rel}$

\ / \ /

C-Place C-Place

|

Coronal

Under lenition, the initial aperture position for closure is deleted and what remains in Irish is an aperture position for consonantal release without place specifications. Without vocal cord vibration this results in the sound /h/ and with vocal cord vibration the phonetic interpretation is that of a velar voiced fricative:

(66) Irish /h/: $A_{rel}$ Irish / γ /: $A_{rel}$

| | / \|

C-Place [voice] C-Place

A consequence of the claim that coronal default insertion only takes place with A0-positions is that surface coronal stops may alternate with velar continuants, but surface velar stops may not alternate with coronal continuants. This prediction seems to be empirically correct.

To summarise the discussion above, (67) schematically represents the effects of consonant weakening of segments underspecified for place:

(67)

| | | default Coronal | weakened counterpart | place of articulation of weakened counterpart |
|---|---|---|---|---|
| Finnish | /k/ | no | Amax | specification for place from vowel, or deleted |
| Welsh | /k/ | no | Arel | specification for place from vowel, or deleted |
| Irish | /t/ | yes | Arel | laryngeal interpretation |
| | /d/ | yes | Arel-[voice] | velar interpretation |

## 4 Conclusion

The things that happen to consonants in morphological environments are (i) weakening (loss of A-position), (ii) strengthening (addition of A-position), and (iii) nasalization (SV affixation). The chain-like changes in (1) and (2a) of the introduction can be schematically represented as follows:

(68) Changes in the manner of articulation

| long plosive | <---> | short plosive | <---> | fricative/approximant | <---> | zero |
|---|---|---|---|---|---|---|
| A0 A0 Arel | | A0 Arel | | Arel | | Ø |

(69) Changes in the manner of voicing

| voiceless consonant | ---> | prenasalized/voiced consonant | ---> | nasal stop |
|---|---|---|---|---|
| A0 Arel | | A0 Arel, or A0 Arel | | A0 Arel |
| | | \| | | \ / |
| | | SV | | SV |

As a result of consonant weakening, there may be a change of place of articulation for short stops which are underlyingly unspecified for a place feature. Stops which undergo weakening and a change in their place articulation are either coronal or velar short stops. After weakening they are (i) realised as continuants without an oral place of articulation (i.e. as a laryngeal continuant), or (ii) they are realised as a continuant which shares its place of articulation with an adjacent vowel, or (iii) they are deleted. To explain this distribution I have argued that the feature Coronal may be added as a default feature in the case of stops, but not in the case of continuants.

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In non-mutated contexts, word-initial /θ:, f, θ, l ,r/ are restricted to borrowings (Ball and Müller 1992:78-80).

It is possible that the phonetically long voiceless fricatives /f:/ and /θ:/ are also characterised by the aperture position for laryngeal release which merges with the aperture position for release of the fricative in non-mutation environments. This implies that under lenition they undergo the same process of deletion of the initial aperture position as plosives and sonorants and are realised as the corresponding short fricatives /f/ and /θ/. There is no data available to me that either supports or contradicts this assumption and I therefore leave it open for future research.

Another consonant weakening process in Welsh, known as 'spirantization', turns stem-initial voiceless aspirated stops into voiceless fricatives under certain morphological conditions. I propose here that this process is best analysed as deletion of two stem-initial aperture positions, i.e. the aperture positions for laryngeal release and closure, respectively. Spirantization in Welsh does not apply to unaspirated stops, because deletion of two aperture positions would result in deletion of unaspirated segments and, hence, in an ill-formed empty onset.