KUNIYA NASUKAWA
PHILLIP BACKLEY (Eds.)

# Strength Relations in Phonology

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*edited by*

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# Contributors

Phillip Backley
Department of English
Tohoku Gakuin University
Tsuchitoi 1-3-1
Aoba-ku
Sendai 980-8511
Japan
backley@tscc.tohoku-gakuin.ac.jp

Karen Baertsch
Department of Linguistics
Southern Illinois University
at Carbondale
Carbondale
IL 62901-4517
U.S.A.
kbaertsc@siu.edu

Bert Botma
Opleiding Engelse Taal en Cultuur
Universiteit Leiden
P.N. van Eyckhof 4
Postbus 9515
2300 RA Leiden
The Netherlands
e.d.botma@hum.leidenuniv.nl

Stuart Davis
Department of Linguistics
Indiana University
Memorial Hall 331
1021 E. 3rd St.
Bloomington
IN 47405
U.S.A.
davis@indiana.edu

Daniel A. Dinnsen
Department of Linguistics
Indiana University
Memorial Hall East 334
1021 E. Third Street
Bloomington
IN 47405
U.S.A.
dinnsen@indiana.edu

Colin J. Ewen
Opleiding Engelse Taal en Cultuur
Universiteit Leiden
P.N. van Eyckhof 4
Postbus 9515
2300 RA Leiden
The Netherlands
c.j.ewen@hum.leidenuniv.nl

Ashley W. Farris
Department of Psychology
E11 SSH
University of Iowa
Iowa City, IA 52240
ashley-trimble@uiowa.edu

John Harris
Linguistics
University College London
Chandler House
2 Wakefield Street
London WC1N 1PF
UK
john.harris@ucl.ac.uk

Ben Hermans
The Meertens Institute of the Royal Netherlands Academy of Arts and Sciences
Postbus 94264
1090 GG Amsterdam
The Netherlands
ben.hermans@meertens.knaw.nl

Nancy C. Kula
Department of Language and Linguistics
Essex University
Wivenhoe Park
Colchester CO4 3SQ
U.K.
nckula@essex.ac.uk

Lutz Marten
Department of Africa
School of Oriental and African Studies
University of London
Thornhaugh Street
Russell Square
London
WC1H 0XG
U.K.
lm5@soas.ac.uk

Kuniya Nasukawa
Department of English
Tohoku Gakuin University
Tsuchitoi 1-3-1
Aoba-ku
Sendai 980-8511
Japan
nasukawa@tscc.tohoku-gakuin.ac.jp

Eirini Sanoudaki
School of Psychology
University of Wales, Bangor
College Rd Bangor
Gwynedd LL57 2DG
Wales
U.K.
e.sanoudaki@bangor.ac.uk

Hidetoshi Shiraishi
Department of Economics
Sapporo Gakuin University
Bunkyodai 11
Ebetsu
Hokkaido 069-8555
Japan
hide@sgu.ac.jp

Yuko Z. Yoshida
ILC Doshisha University
Kyo-Tanabe City
Kyoto 610-0394
Japan
yuyoshid@mail.doshisha.ac.jp

# Introduction

## *Kuniya Nasukawa and Phillip Backley*

### 1. Introduction

This collection of papers explores the general theme of phonological strength, bringing together current work being carried out in a variety of leading theoretical frameworks. Its aim is to show how different aspects of the phonological grammar can be better explained by referring directly to strength relations.

The contributors take the view that strength differences should be approached from a phonological angle rather than a phonetic one, many of them proposing innovative analyses of language data in which strength relations are understood to reflect structural relations holding between representational units. This marks a significant departure from the widely held view that the strength of a segment derives from its positional context and the physical attributes associated with that context. In this way, the present volume provides a snapshot of current thinking on the broad issue of strength and its influence on phonological systems. The diversity of the language data introduced here gives an indication of how phonological strength serves to unite a whole range of patterns and processes which at first sight appear to have little, if anything, in common.

The papers in this collection were first presented at the workshop *Strength Relations in Phonology*, which was held at Tohoku Gakuin University, Sendai (Japan), in September 2006. They are organized in two parts: those in part I focus on issues of segmental strength, while those in part II are concerned with strength-related phenomena affecting structure above the level of the segment. By dividing the contents of the volume in this way, we do not suggest that segmental strength and prosodic strength should be treated as two independent areas of enquiry. Indeed, the following pages emphasize the extent to which these two manifestations of phonological strength are interrelated; moreover, they highlight the need to develop ways of expressing this interrelatedness in formal terms. So in most cases the ‘segmental’ papers also make crucial reference to prosodic factors, while the ‘prosodic’ papers necessarily incorporate descriptions of segmental patterning. The split between parts I and II therefore reflects a difference in emphasis rather than a difference in type.

The six papers in part I discuss strength-related segmental patterns in a range of languages including English, Dutch, Greek, Nivkh and Sesotho, and consider the implications of these data for different models of phonological knowledge. In the first paper Harris explores final devoicing, presenting strong evidence to challenge the widely held view that this phenomenon represents a case of phonological strengthening. By characterizing speech as a carrier-signal which can be 'modulated by linguistically significant acoustic events', he shows how it becomes possible to treat devoicing in parallel with other domain-final weakening effects. Harris adopts an innovative view of the nature of speech and linguistic information, which allows the notion of strength to be formalized in a simple and appealing way: a strengthening process increases modulation of the carrier signal, while a weakening process such as final devoicing has the opposite effect of reducing the degree of modulation.

Backley and Nasukawa continue the theme of the relation between linguistic information and the speech signal. In particular, they discuss information relating to the location of prosodic boundaries, which they assume have a role to play in word recognition and general language processing. In order to transmit the linguistic information carried by a word's prosodic structure, they argue, it must be expressed in a form that can be physically interpreted – that is, in melodic representation. Using an Element Theory approach, they propose that differences in prosodic strength can be encoded directly in segmental structure through the notion of element headedness: headed expressions are strong, non-headed ones are weak. In this way, melodic headedness reflects the prosodic information that is required for efficient language processing.

Botma also highlights the interrelatedness of melodic and prosodic structure. In his paper he focuses on the transparency effects of nasal harmony using an Element-based Dependency model of segmental structure which represents nasality and voicing as a single category. Botma argues that the transparent system of nasal agreement in Southern Barasano operates at the prosodic level, the harmonic trigger being lexically specified as a property of the syllable. However, he claims that not all transparent systems adhere to this type of lexical specification. For example, nasality in Yuhup exists not only as a syllabic property but also as a segmental property, while in Wãnsöhöt nasality makes no reference to prosodic structure at all, instead behaving only as a segmental property. Botma's insights make a significant contribution to our understanding of the typological variation affecting melodic-prosodic integration.

The paper by Dinnsen and Farris-Trimble brings a shift in context as well as theoretical approach by proposing an Optimality Theory analysis of the ‘prominence paradox’ – a mismatch between child and adult grammars regarding the location of prominent positions: in adult phonologies domain-initial position is typically strong and domain-final weak, whereas in some child phonologies the reverse situation holds. It introduces data from several (late) developing phonologies showing a range of laryngeal, manner and place contrasts supported in domain-final position but neutralized domain-initially. A standard OT treatment of these facts presents a challenge to the Continuity Hypothesis, in addition to introducing a certain amount of stipulation into the grammar. In response, the authors argue for a new family of markedness constraints which assign prominence to different prosodic contexts; a re-ranking of these constraints during acquisition is then held responsible for the developmental switch from final to initial prominence. It is suggested that this re-ranking may be driven by the effects of restructuring taking place in the expanding lexicon during language development.

Data relating to first language acquisition also form the basis of the paper by Sanoudaki, who develops a Strict CVCV analysis of obstruent clusters in Greek. Although clusters which combine stops and fricatives (e.g. [xt]) are present in Modern Greek, more marked stop-stop (e.g. [pt]) and fricative-fricative (e.g. [fθ]) clusters have until recently been associated only with prestige varieties. Now, however, these are also permitted in the Popular dialect, and the author questions how a change from unmarked to marked should be expressed in the grammar, and furthermore, how this change is acquired by first language learners. In the context of Element Theory, Sanoudaki proposes a parameter based on element complexity to control consonantal strength. The default setting of this parameter requires a licensed position to have fewer elements than its licensor, predicting only mixed clusters such as [xt], whereas the marked setting also permits licensor and licensee to be of equal complexity, allowing more marked clusters such as [pt] and [fθ] in addition. The paper discusses experimental data from child language development studies to support the existence of this complexity parameter: as predicted, in early language only mixed clusters are observed (default parameter setting), then in later development the more marked stop-stop and fricative-fricative clusters emerge when the input language triggers a change in parameter setting.

Part I closes with a paper by Shiraishi, who examines the typologically marked process of morpheme-initial weakening in the Nivkh language of Outer Manchuria; in this system, a morpheme-initial stop is spirantised when another morpheme precedes. Previous work has treated this effect as consonant mutation rather than weakening, since weakening is not usually associated with initial position. By contrast, Shiraishi analyses the Nivkh case as a perceptually-motivated process of lenition, adopting an approach to prosodic structure which makes appeal to 'syntagmatic asymmetry' and 'visibility' (HAD-V). Lenition in Nivkh occurs only at the inter-morphological level where, it is argued, an asymmetric dependency relation forms between the heads of morphemes in the same expression; the general pattern is that dominant melody remains intact whereas dependent melody is subject to lenition. The Nivkh facts differ from lenition generally in that more deeply embedded positions are immune to the process; thus spirantisation fails to take place in consonants which are not morpheme-initial.

The five papers in part II focus on strength relations holding between units in prosodic structure, although, as already noted, this inevitably involves making reference to segmental patterns also. In the first paper, Ewen amd Botma examine the syllabic affiliation of postvocalic 'coda' consonants such as *wist*, *field* and *paint*, known as 'rhymal adjuncts' in standard Government Phonology. Although rhymal adjuncts fail to show phonotactic relations with a preceding nucleus, they often show place agreement with the onset of the following syllable. The authors develop an integrated approach to these prosodically-defined dependency/phonotactic relations by syllabifying rhymal adjuncts in the specifier position of the following onset head. In this way, the absence of phonotactic relations alongside the presence of place agreement need not be viewed as an anomaly. Rather, it allows phonotactic constraints to function within a prosodically-defined domain, just like phonotactic restrictions in branching nuclei and onsets. Ewen and Botma then strengthen their proposal by extending the Specifier-Onset configuration to sC clusters and other anomalous consonant sequences.

In the next paper, Kula and Marten employ a Strict CVCV model of representation to discuss differences in positional strength resulting from the interaction between phonological government and licensing. Their approach identifies strong positions as licensed but ungoverned, and weak positions as unlicensed and ungoverned; then a level of intermediate strength is defined for intervocalic positions that are both licensed and governed. The authors argue that domain-initial position is rendered strong by virtue of an empty CV sequence at the left edge of the domain; this serves as the target of government that would otherwise fall on the initial position. By appealing to a parametrically controlled relation of Proper Government, they make the further claim that an initial empty CV is not found in languages which have no true consonant clusters (other than geminates and partial geminates) or which show no vowel-zero alternations. This allows typological predictions to be made for languages with both typological predictions to be made for languages with both sonority-increasing and sonority-decreasing consonant clusters in initial position.

Baertsch and Davis present a quite different approach to the way positional strength is formalised. Adopting a sonority-based view of segmental strength, they propose a ‘split margin’ approach within the framework of Optimality Theory, whereby the difference between strong and weak positions is the result of associating a separate constraint hierarchy to each. The M1 hierarchy gives preference to low sonority consonants such as obstruents and applies to strong consonantal positions, while the M2 hierarchy favours sonorous consonants such as liquids and applies to weak positions. When M1 and M2 positions come together they form either an M1-M2 cluster (e.g. complex onset: *tray*) or an M2-M1 cluster (e.g. coda-onset sequence over a syllable boundary: *curtain*), the former being a (subset) mirror image of the latter. The paper proposes that phonotactic restrictions within clusters are accounted for by the local conjunction of the M1 and M2 constraints into a single hierarchy; furthermore, it shows how this analysis correctly predicts the M1-M2 pattern to be more restrictive than the M2-M1 pattern. Further support for the split margin approach comes from the way changes in the degree of restrictiveness in one type of cluster are paralleled by similar changes in the other cluster type: e.g. complex onsets now emerging in Bambara are accompanied by new heterosyllabic coda-onset sequences through syncope, thereby maintaining the mirror image relation.

In the next paper, Hermans makes the interesting claim that the mora should be treated as a headed constituent that may potentially license a dependent; this renders its role essentially metrical in nature. His argument develops through an analysis of the lexical contrast between two tonal accent patterns in the Limburg dialects, these being distinguished by their moraic structure: the accent1 pattern contains a bimoraic syllable (deriving from an underlyingly long vowel) and accent2 a monomoraic syllable (from a short vowel). This difference is paralleled by a distinction in the way tonal melody is mapped on to the segmental string. Hermans then discusses an accent shift phenomenon in which accent2 words are reinterpreted with accent1 if they contain a voiced consonant followed by an empty nucleus. To account for this effect, it is proposed that the consonant is a dependent of the empty mora head and, following Element Theory, that a voiced consonant is too complex to occupy a dependent slot; as a result, this weak syllable is removed from the foot structure, forcing the remaining strong syllable to become bimoraic and support accent1. The paper proposes an interesting adaptation of Moraic Theory within a Government Phonology approach to syllable structure.

Finally, and also working within the framework of Government Phonology, Yoshida focuses on the strength-based relation between lexical accentuation and the melodic structure of vowels in the Tokyo and Kyoto dialects of Japanese. Like many of the contributors, she employs an Element Theory approach to segmental structure in which headedness relations are assumed to hold between the privative elements. The author argues that headedness in a vocalic expression tends to attract lexical accentuation in both dialects. She claims, however, that the accentual difference between the Tokyo and Kyoto dialects is attributed to the type of element which can be headed. In Tokyo Japanese the |U| element (representing the vowel /u/) is the only one to which headedness cannot be assigned, whereas in Kyoto Japanese a headed |U| is grammatical. Assuming a direct relation between accentuation and melodic headedness, this difference makes /u/ the least likely vowel to be accented in the Tokyo dialect, while the Kyoto dialect allows lexically accented /u/.

Clearly, a volume of this size cannot do justice to a topic as broad as that of phonological strength. Nevertheless, we hope that these papers will convey something of the scope and influence that strength relations appear to have on a range of apparently unrelated phenomena observed in a variety of different languages. This work was partially funded by the Ministry of Education, Culture, Sports, Science and Technology of the Japanese government under grants 18520390 and 19520429.

# Part I

# Segmental strength

# Why final obstruent devoicing is weakening

*John Harris*

## 1. Introduction

There is a long-standing tradition in phonology of regarding the widespread process of final obstruent devoicing as a form of fortition, hardening (*Verhärtung*) or strengthening. The view has deep roots in the philological tradition and continues to be widely held right up to the present day (see for example Iverson and Salmons 2007). There is a less well established view that the process is rather one of lenition or weakening. This analysis is not always explicitly presented as such, but it is implicit in proposals to treat final devoicing in terms of feature deletion and in the claim that it originates in the weakness of auditory-acoustic cues to voice contrasts in final position (cf. Steriade 1997, 2001).

The present paper has two main goals. The first is to show that the available evidence clearly favours the weakening account of final devoicing. The second is to present a unified model of phonological strength that unequivocally classifies final devoicing as weakening.

Of course it all depends on what we mean by strengthening and weakening. Like most scientific generalisations, the notion of strength in phonology is a metaphor. Its initial value flows from the way it allows us to put a name to a set of generalisations that would otherwise go unexpressed. This brings us to the first of the three main reasons I will present for rejecting the strengthening account of devoicing: it subverts important generalisations we can otherwise make about processes that uncontrovertibly do count as weakening, such as debuccalisation and spirantisation. The generalisations concern (i) the phonetic impact of weakening, (ii) the otherwise general tendency for final position to promote weakening and (iii) the way in which final devoicing sometimes interacts directly with weakening processes in the same language.

The other two reasons for rejecting the strengthening account coincide with the two main arguments used to support it. One is based on the observation that obstruent voicing, such as commonly occurs intervocalically, is clearly a weakening process. Since devoicing apparently has the opposite phonetic effect, so the argument goes, it should surely be viewed as strengthening. The other argument takes the form of a claim that devoicing strengthens final obstruents in order to demarcate the right edge of words (Iverson and Salmons 2007).

As I will try to show below, neither of these arguments is particularly convincing. The first is based on a faulty conception of voicing as an entity that remains uniform across different segment types and phonological contexts. The second is based on the questionable assumption that processes with a demarcative function are necessarily strengthening in nature.

If strength is to be more than pure metaphor, we need to establish whether it correlates with any known phonetic property and whether it has any unitary presence in phonological representation. It is widely supposed that strength has a basis in sonority or degree of articulatory aperture. Neither of these definitions provides us with a unified model of strength, let alone with a yardstick for determining whether final devoicing counts as weakening or strengthening.

This paper outlines an alternative definition of phonological strength that unambiguously unifies final devoicing with processes uncontroversially regarded as weakening. The definition is based on the characterisation of speech as carrier signal modulated by linguistically significant acoustic events. The strength of a segment can be defined as the extent to which it modulates the carrier signal. Any process that reduces the extent of a modulation counts as a weakening. Not only does this approach clearly establish final devoicing as a weakening process but it also invites connections with certain word-final processes that are not usually considered to be related to strength.

The first part of the paper discusses evidence showing that final devoicing clearly patterns with well established weakening processes. I will present this evidence at the same time as critiquing two of the main claims for treating devoicing as strengthening: that it is the phonetic opposite of voicing (§3) and that it serves to mark word-final position as strong (§4). The second part of the paper addresses the issue of whether strength has any unitary phonetic basis, starting with reasons for rejecting definitions based on sonority or articulatory aperture (§5). In §6, I outline the unified account of phonological strength that is provided by the modulated-carrier model of speech and show how this unambiguously classifies final devoicing as weakening. I conclude in §7 by considering the broad implications of this account for how we evaluate alternative feature representations of final devoicing. First, however, we need to dispose of one criterion that might have been assumed to help us decide between the strengthening and weakening analyses of final devoicing: neutralisation.

## 2. Neutralisation

Final devoicing has long been held up as a paradigm example of neutralisation. As illustrated by the Dutch examples in (1), a stem-final lexical distinction between voiced and voiceless obstruents is maintained before a suffix vowel but suspended word-finally.

(1) *Dutch*

| | Singular | Plural | |
|---|---|---|---|
| a. | va[*t*] | va[*t*]en | ‘barrel’ |
| | aa[*p*] | a[*p*]en | ‘ape’ |
| | me[*s*] | me[*s*]en | ‘knife’ |
| | | | |
| b. | ba[*t*] | ba[*d*]en | ‘bath’ |
| | dui[*f*] | dui[*v*]en | ‘dove’ |
| | hui[*s*] | hui[*z*]en | ‘house’ |

It might have been tempting to cite this neutralising effect as evidence in favour of a weakening analysis – at least if we follow a tendency in the recent literature to conflate neutralisation with weakening on the one hand and strengthening with contrast maintenance on the other. The tendency finds expression in the use of output constraints that promote fortition and the preservation of distinctions in strong positions (see for example Kirchner 1998; Zoll 2004). However, there are at least two reasons for rejecting neutralisation as a criterion for choosing between strengthening and weakening.

The first reason is that strengthening and contrast preservation should not be conflated. It is certainly true that strong positions can often sustain contrasts that are neutralised elsewhere. It is also true that prominent positions can promote strengthening. But these two characteristics are not intrinsically connected. Strengthening is potentially no less neutralising than weakening, a fact that can be established independently of devoicing. For example, the strengthening process that hardens continuants to plosives after nasals in Sesotho neutralises the continuancy contrast we see when we compare (2a) with (2b) (Doke and Mofokeng 1974):

(2) *Sesotho*

|  |  | ‘vb. me’ |  |
|---|---|---|---|
| a. | *tɧɛta* | *n-tɧɛta* | ‘roll’ |
|  | *pɧɛhɛla* | *m-pɧɛhɛla* | ‘cook for’ |
| b. | *rata* | *n-tɧata* | ‘love’ |
|  | *fa* | *m-pɧa* | ‘give’ |

In any case, there is another reason for not using neutralisation to adjudicate between the strengthening and weakening analyses: an on-going controversy over whether final devoicing is genuinely neutralising in the first place. A series of studies of some of the best known languages with devoicing has discovered small but significant phonetic differences between pairs of consonants that are supposedly merged by the process (e.g. Port and O’Dell 1985; Slowiaczek and Dinnsen 1985; Charles-Luce and Dinnsen 1987; Piroth and Janker 2004; Ernestus and Baayen 2006). The controversy continues partly because listeners in these studies cannot always detect these differences reliably and partly because of methodological concerns that the studies do not always adequately control for potentially contaminating factors such as orthography and pragmatic context. These findings do not call into question the fact that devoicing describes a real process (or collection of processes) with identifiable phonetic effects. In examining these effects below, we can side-step the issue of whether they result in true merger or not.

## 3. The disunity of voice

### 3.1. Final devoicing and intervocalic voicing

We can illustrate the notion that final devoicing and intervocalic voicing produce phonetically opposite outcomes by comparing the Dutch examples in (1) with the Kalenjin examples in (3) (data from Katamba 1989).

(3) *Kalenjin*

| | Progressive | |
|---|---|---|
| *kep* | *kebeːt* | ‘notch’ |
| *nap* | *nabeːt* | ‘sew’ |
| *kuːt* | *kuːteːt* | ‘blow’ |
| *luk* | *lugeːt* | ‘fight’ |

The observation that the outcomes are apparently phonetic opposites lies behind the traditional assumption that the two processes pull in different strength directions: voicing weakens a consonant, so devoicing strengthens it.

The grounds for treating intervocalic obstruent voicing as weakening are pretty well established. In particular, it displays two characteristics that can reasonably be considered symptomatic of weakening. First, whenever it is sensitive to prosodic or morphological domain structure, it typically occurs in what are independently known to be weak or ‘non-prominent’ positions, such as non-initial in the foot or stem. Second, as illustrated by the Basaa examples in (4a), it frequently co-occurs with spirantisation or vocalisation. And these processes can be identified as weakening quite independently of the voicing issue, as illustrated by Tuscan Italian spirantisation in (4b) (see Giannelli and Savoia 1980) and Central American Spanish vocalisation in (4c) (see James Harris 1983).

(4) a. *Basaa*

| | Reversive | Passive | |
|---|---|---|---|
| *kap* | *kewel* | *kewa* | ‘to share’ |
| *tet* | *tiɾil* | *tiɾa* | ‘to pound’ |
| *lok* | *luɣul* | *luɣa* | ‘to lie’ |

b. *Italian*

| Standard | Gorgia Toscana | |
|---|---|---|
| *kapo* | *kaɸo* | ‘head’ |
| *prato* | *praθo* | ‘meadow’ |
| *amiko* | *amixo* | ‘friend’ |

c. *Spanish*

| | | |
|---|---|---|
| Castilian | Cibaeño | |
| pape[*l*] | pape[*y*] | ‘paper’ |
| a[*l*]go | a[*y*]go | ‘something’ |
| ma[*r*] | ma[*y*] | ‘sea’ |
| ca[*r*]ta | ca[*y*]ta | ‘letter’ |

Given the popularity of the strengthening take on devoicing, it is somewhat surprising to note that the process displays essentially the same two ‘weak’ symptoms as intervocalic voicing. First, at least for many purposes, word-final position undoubtedly counts as non-prominent, especially when compared with initial position within, for example, the word or foot. (We should of course not be too hasty in assuming that final position is always weak in this sense, especially in light of Iverson and Salmons’ (2007) claim that devoicing serves to signal word ends by marking them as strong.) Second, devoicing often co-occurs with processes with independently verifiable weakening effects. We will examine evidence of these two characteristics in some detail below. But even a preliminary acknowledgement that intervocalic voicing and final devoicing are similar in these two respects suggests we should review the notion that the outcomes of the two processes are phonetic opposites of one another.

### 3.2. Active versus passive voicing

The assumption that final devoicing produces the opposite outcome to intervocalic voicing is itself based on another, more general assumption: phonetic voicing is phonologically classifiable as [+voice] (or some equivalent category), irrespective of the type of segment or the phonological context it occurs in. Following Itô, Mester and Padgett (1995), let us call this the ‘unity of voice’ principle. Although the assumption may have a certain pedagogical usefulness in introductory phonetics and phonology courses, it is known to be incorrect in certain crucial details. The available evidence points unequivocally to a fundamental disunity of voice. The evidence is of three types, involving differences among (i) segment types, (ii) phonological contexts and (iii) languages. We can briefly review the first two of these right away, before moving on in the next section to a more detailed consideration of the third.

The main segment-type evidence involves the well established distinction between spontaneous and non-spontaneous voicing (cf. Halle and Stevens 1971). The absence of a build-up of intra-oral air pressure in sonorants allows for continuous airflow across the glottis, thereby facilitating spontaneous vocal-fold vibration. In contrast, voicing in obstruents is inhibited by a build-up of oral pressure and can in most circumstances only be maintained by the non-spontaneous activation of some compensatory gesture.

As to the phonological-context evidence, the status of voicing within the class of obstruents themselves varies according to phonological position. And it does so in a way that bears directly on the contextual difference between final devoicing and intervocalic voicing. The inhibitory effect of obstruent stricture on vocal-fold vibration makes itself felt most forcefully at the beginning and end of utterances and words. Intervocalically, however, there is the potential for the spontaneous voicing of the surrounding sonorants to be interpolated passively through the obstruent, especially if it is of reduced duration (Westbury and Keating 1986; Rice and Avery 1989; Kirchner 1998; Iverson and Samuels 2003; Avery and Itsardi 2001; Harris 2003; Jansen 2004).

On the basis of this contextual difference within the obstruent class, we are entitled to conclude that final devoicing and intervocalic voicing are not phonetic opposites at all. Rather they are two sides of the same coin: each moves an obstruent towards a phonetically inert or unmarked state. This suggests that whatever we conclude about the strengthening or weakening status of one of the processes necessarily also holds of the other. Since we have independent reasons to treat the voicing process as weakening, a natural conclusion would be that devoicing must be weakening as well.

### 3.3. Voicing versus aspiration languages

The third reason for rejecting the unity-of-voice assumption concerns differences in the way voice contrasts manifest themselves in individual languages. Convenient as the traditional voiced-voiceless terminology may be for broadly describing languages with a two-way laryngeal contrast, it is quite unhelpful for our present purposes. This is because it glosses over precisely the kind of phonetic detail we need to take account of in deciding whether obstruent devoicing counts as strengthening or weakening. In particular, it abstracts away from the different ways in which the timing of voicing activity can be used to signal laryngeal contrasts in plosives. In doing so, it ignores the major typological distinction between voicing languages and aspiration languages (cf. Jakobson 1949), based primarily on differences in voice onset time in word-initial plosives (as first systematically measured by Lisker and Abramson 1964). For our present purposes, we may class as voicing languages those where a two-way laryngeal contrast in initial plosives takes the form of a distinction between a plain series with zero or near-zero lag-time and a prevoiced series with long lead-time. The corresponding contrast in aspiration languages is realised as a VOT difference between zero lag-time (plain) and long lag-time (aspirated).

Final devoicing occurs both in voicing languages (such as Dutch) and in aspiration languages (such as German). The use of the single term 'devoicing' might be taken to imply a process with the same phonetic effect in both types of language. Let us consider whether this implication is justified or not.

On the face of it, the situation in voicing languages seems pretty straightforward. In languages of this type that lack devoicing (such as French and Hungarian), final voiced plosives are 'post-voiced' in a way that roughly mirrors the prevoicing of initial plosives; that is, there is a significant time lag between the onset of post-vocalic stop closure and the offset of voicing (Flege and Hillenbrand 1987; Jansen 2004). 'Devoicing' in voicing languages (such as occurs in Dutch, Catalan and Russian, for example) can thus be considered an accurate term for the process that excludes post-voiced obstruents from final position. We can thus say that, in voicing languages, it is the plain series of obstruents that survives in final position: obstruents in this position lack the active laryngeal component that characterises the voiced series in initial position.

The corresponding situation in aspiration languages seems less straightforward. What does it mean to say that devoicing can occur in a language that lacks actively voiced obstruents? An often implicit way of justifying the use of the term 'devoicing' to describe languages of this sort is to compare final obstruents with intervocalic counterparts. In standard German, for example, the intervocalic *d* of *Bade* is phonetically voiced, so it seems to make sense to describe the final *t* of *Bad* as devoiced. This is an invidious comparison, however, in light of the fact mentioned above that voicing in intervocalic stops can be spontaneous in nature. In the case of German, there is good reason to view intervocalic *b, d, g* as plain stops that are passively voiced as a result of vocal-fold vibration seeping through from the surrounding vowels (cf. Jessen and Ringen 2002). So the term 'devoicing' is not a particularly felicitous way of describing what happens to obstruents in German-style languages, since there is nothing intrinsically voiced to devoice in the first place.

What sort of obstruents survive in final position in aspiration languages with devoicing? According to the strengthening account of German, they come out as fortis – the term used to describe the aspirated plosives that occur word-initially. In fact, Iverson and Salmons (2006, 2007) explicitly classify the final voiceless plosives as aspirated too. This is consistent with a tradition of using the term 'aspirated' (sometimes qualified by terms such as 'partially' or 'lightly') to describe final voiceless plosives, not just in German but in other languages as well, including Danish, Klamath, Kashmiri, Turkish (see Vaux and Samuels 2005 and the references there) and English (Gimson 1995). However, this description is problematic on at least two counts.

Firstly, the final voiceless obstruents in German are not reported to be significantly different phonetically from devoiced obstruents in voicing languages. If we specify the German series as aspirated, phonetic consistency would demand that we do the same for the corresponding series in voicing languages. In other words, we would have to recognise a type of language in which aspiration is licensed word-finally but not initially. Whether there is any typological precedent for this state of affairs is quite controversial. While most phonologists would deny any such precedent, Vaux and Samuels (2005) argue that aspiration is the unmarked state for final voiceless plosives, including in voicing languages. Of course even if we subscribe to the majority view on this, we could ignore considerations of phonetic consistency and just say that the phonological specification of final voiceless obstruents varies according to whether they occur in aspiration or voicing languages.

Secondly, there is the question of whether it is accurate to describe German final plosives as aspirated in the first place. Although VOT is only one of a wide range of potential cues to voice contrasts (cf. Kingston and Diehl 1994), its long-lag instantiation in initial pre-vocalic plosives is acknowledged to be one of the most robust measures of aspiration (as originally noted by Lisker and Abramson 1964). While VOT is measurably continuous in speech production and the acoustic signal, its behaviour in speech perception and phonological distinctiveness is very clearly categorical. Referring to degrees of aspiration may be a convenient way of describing timing differences in articulation or acoustics, but it is not a valid way of talking about perception or phonology. There is a well-established VOT point (around 35ms) at which listeners' identification of initial plosives tips abruptly from plain to aspirated (see Keating 1984). If a final plosive is to be described as aspirated, it would be reasonable to expect it to display similarly categorical timing behaviour. This is indeed what we find with pre-aspiration (as in some North Germanic and Celtic), where there is a significant time lag between voicing offset and closure onset in final voiceless plosives (Ladefoged and Maddieson 1996). But it is not what we find in German, where Iverson and Salmons (2007) explicitly acknowledge the corresponding series as postaspirated.

In any case, there are circumstances where post-aspiration simply cannot be phonetically expressed as long-lag VOT in final plosives, namely when there is no following vowel for VOT to onset onto. The conditions necessary for long-lag VOT in a word-final plosive are only met when a vowel-initial word follows. In many varieties of northern German this possibility is closed off by *harter Einsatz* – the appearance of a glottal onset in lexically vowel-initial words. However, in those varieties of German where *harter Einsatz* is either variable or not present at all, it is clear that final plosives are not aspirated in this environment (without *harter Einsatz*, the *t* in *schaut aus* 'seems', for example, lacks the long-lag VOT of the *t* in *tauchen* 'dive'). The same is true of voiceless final plosives in English (one of the reasons *taupe oak* is distinct from *toe poke*, for example).

We have to conclude that, when Iverson and Salmons (2007) and Vaux and Samuels (2005) use the term 'aspirated' to describe final plosives in German and other languages, they are identifying some property other than VOT. That property, we may surmise, is the voiceless noise burst accompanying the release of the plosive. The burst consists of a transient followed by a brief interval of high-intensity aperiodic energy (cf. Stevens 2002) – but crucially not by a prolonged interval of lower-intensity aperiodicity of the type that characterises long-lag VOT in word-initial aspirates. The burst might appear particularly noteworthy in final plosives when compared to languages where final voiceless stops are unreleased, either variably (as in many dialects of English) or obligatorily (as in many southeast Asian languages). But all plosives – plain, aspirated or otherwise – are by definition characterised by a release burst. In short, there is no reason for us to describe final voiceless stops in German as anything other than plain and released.

One of the main contributions of the work of Iverson and Salmons (2007) and Vaux and Samuels (2005), it seems to me, is that it highlights the need to distinguish aspiration from plosive release when describing final oral stops (see Jansen 2004 for further discussion of this point). What is traditionally referred to as final devoicing can suppress aspiration in this position without necessarily also suppressing plosive release. The latter property can of course also be suppressed (as in Thai for example), as part of a set of processes that we might refer to more generally as 'delaryngealisation' (see Honeybone 2005 and the references there). We will return to this point below.

To sum up: the traditional term 'devoicing' describes a situation in which the only type of obstruent permitted in final position is plain. This is true irrespective of the nature of whatever laryngeal contrast may hold in other positions – be it one based on active voicing or one based on aspiration.

It is generally agreed that aspiration, like non-spontaneous voicing, requires the active engagement of an articulatory component that is lacking in plain plosives. The notion that a plain stop is somehow a diminished verison of its aspirated and voiced counterparts might be taken as support for the view that final devoicing is weakening. However, if this conclusion is to have more than intuitive appeal, it needs to follow from a theory that defines a necessary connection between weakening and the lack or loss of components. Before taking up this issue in §6 below, let us consider the other main justification for treating final devoicing as strengthening: the claim that it serves to demarcate the ends of words.

## 4. Positional strength

### 4.1. Devoicing as demarcative strengthening

In presenting their case for viewing final devoicing as strengthening, Iverson and Salmon (2007) subscribe to Blevins' (2006) claim that the process has its origins in the inhibition of vocal-fold vibration commonly observed at the end of utterances. The explanation runs as follows. The high incidence of devoiced obstruents that are both utterance- and word-final provides a basis for learners to overgeneralise the pattern to all word-final obstruents, including those that are utterance-internal. (It is not made clear why the devoicing effect fails to overgeneralise to all segments, including sonorants, which can also be subject to utterance-final voicing decay.) At this point, strengthening by devoicing takes on the function of marking word ends.

In order to be able to evaluate the claim that final devoicing is demarcative strengthening, we need to answer two questions. First, is there evidence, independent of devoicing, that final position promotes segmental strengthening? That is, do we find evidence of consonants' manner or place characteristics being strengthened in this context? Second, is there a necessary connection between demarcative function and strengthening?

### 4.2. Word-final weakness

On the first of these questions, it has to be said right away that the strength enhancing properties Iverson and Salmons (2007) attribute to final position in German cannot be considered a language universal. Word-final position is overwhelmingly acknowledged to be a weak position in the sense that it favours or fails to resist segmental changes (see Beckman 1997 for discussion and references), including weakening and deletion (cf. Escure 1977; Lass and Anderson 1975; Harris 1997).

It is certainly possible to find sporadic examples of individual languages where final position appears to act as a strengthening environment for manner, but even here the evidence is somewhat equivocal. For example, Korean fricatives are hardened to stops word-finally (as described in Kim 1979 for example). However, this has to be off-set against the fact that this is just one consequence of a more general word-final effect that neutralises the Korean three-way laryngeal contrast in plosives, affricates and fricatives under a single lax stop series. And there is good reason to treat this laxing as a simplification or weakening process (as argued by Ahn and Iverson 2003).

By far the more general pattern is for word-final processes that target manner or place to have weakening effects. This point is underlined by the fact that final position often lines up with other positions that are independently acknowledged as weak, in particular internal codas. In the case of manner, this combined environment is the one favoured by some of the weakening processes mentioned above, including liquid vocalisation of the type illustrated by the Cibaeño Spanish examples in (4).

The evidence is even more clear-cut in the case of place. It is difficult to imagine what a place-strengthening process would look like: the spontaneous emergence of place categories not historically attested in other, supposedly weaker positions perhaps? In contrast, it is very clear what place-weakening looks like: debuccalisation. And word-final position is precisely one of the positions that favours debuccalisation of stops and fricatives, as the northern Malay data in (5) illustrate (data from Onn 1980).

(5) *Northern Malay*

| | Stem | Nominalised | |
|---|---|---|---|
| a. | *ʔasaʔ* | *ʔasapan* | ‘smoke’ |
| | *kilaʔ* | *kilatan* | ‘lightning’ |
| | *sepaʔ* | *sepakan* | ‘kick’ |
| b. | *balah* | *balasan* | ‘finish’ |
| | *habeh* | *habisan* | ‘end’ |
| | *negateh* | *negatefan* | ‘negative’ |

The evidence from processes that target manner or place helps establish final position as a typically weak environment. If we tried to maintain that final devoicing simply bucks this trend by acting as demarcative strengthening, we would at the very least expect it not to co-occur with final weakening processes in the same language. However, this expectation is simply not borne out.

Consider the example of southern Catalan, where, as in other dialects of the language, final obstruent devoicing is neutralising; compare (6ai) with (6aii) (see Lloret and Jiménez 2008 for data and discussion). As shown in (6aii), voiced stops are subject to intervocalic spirantisation.

(6) *Southern Catalan*

| | | | | | |
|---|---|---|---|---|---|
| a. | i. | peti[*t*] | ‘small (m.)’ | peti[*t*]a | ‘small (f.)’ |
| | | se[*k*] | ‘dry (m.) | se[*k*]a | ‘dry (f.)’ |
| | ii. | fre[*t*] | ‘cold (m.)’ | fre[*ð*]a | ‘cold (f.)’ |
| | | ce[*k*] | ‘blind (m.)’ | ce[*ɣ*]a | ‘blind (f.)’ |
| b. | i. | peti[*ð*] i dolç | ‘small and sweet’ | | |
| | | se[*ɣ*] i prim | ‘dry and thin’ | | |
| | ii. | fre[*ð*] i fosc | ‘cold and dark’ | | |
| | | ce[*ɣ*] i sord | ‘blind and deaf’ | | |
| c. | i. | va[*k*]a | ‘cow’ | | |
| | | ca[*s*]a | ‘game’ | | |
| | ii. | va[*ɣ*]a | ‘strike’ | | |
| | | ca[*z*]a | ‘house’ | | |

When intervocalic, word-final obstruents in southern Catalan are also subject to voicing and, in the case of stops, spirantisation. When we compare

(6bi) with (6bii), we can see that this voicing shows up on both lexically voiceless and lexically voiced obstruents. The neutralisation here is directly due to final devoicing rather than to voicing itself. This can be established by noting that lexically voiceless obstruents are immune to voicing in word-internal position, where they maintain a contrast with lexically voiced counterparts (compare (6ci) and (6cii)). To put it in derivational terms: word-finally, the neutralised output of devoicing is the input to intervocalic voicing. Final devoicing in southern Catalan thus occupies a place on a trajectory that includes two weakening processes, intervocalic voicing and spirantisation (e.g. *b/p* > *p* > *β*). If devoicing really were demarcative strengthening, then we would have to conclude that the phonology of southern Catalan sends out contradictory signals: word ends are marked as strong by some processes but as weak by others.

We might have retreated to a position where Iverson and Salmons' (2007) account of devoicing as demarcative strengthening applies only to German – or maybe only to aspiration languages (and thus not to Catalan, a voicing language). However, in German too we find clear evidence that word-final position acts as weak for certain processes, including some that are entwined with devoicing. Let us briefly consider a number of examples where final position lines up with one or other of two well-established weak environments – internal codas and unstressed syllables.

The combined environment of word-final position and word-internal coda hosts a range of weakening processes in various dialects of German. For example, it is the site of non-rhoticity (see (7a)) and, in some regional dialects, *l*-vocalisation (see the Austrian German examples in (7b)). In northern German, it is part of the environment where historical *g* is spirantised (see (7c)).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7) | a. | Pfi~~r~~sich | | 'peach' | | | |
| | | Pfe~~r~~d | | 'horse' | | | |
| | | seh~~r~~ | | 'very' | | | |
| | b. | Schulter | Schu[*y*]ter | 'shoulder' | | | |
| | | Gold | Go[*y*]d | 'gold' | | | |
| | | Stuhl | Stu[*y*] | 'chair' | | | |
| | c. | sagen | a[*ɣ*]en | 'say' | sagte | sa[*x*]te | 'said' |
| | | Tage | Ta[*ɣ*]e | 'days' | Tag | Ta[*x*] | 'day' |

Note in (7c) how *g*-spirantisation intersects with devoicing in word-final position, yielding *x* in *Tag*. Let us now examine a more extensive illustration of how devoicing can interact directly with weakening processes in German.

In some varieties of northern German, historically fortis stops undergo voicing and, in the case of coronals, tapping when intervocalic within a foot (see (8a)).[1] The examples in (8b) confirm the contribution of the metrical condition: intervocalic fortis stops resist voicing/tapping when foot-initial. The voiced/tapped stops merge with their historically lenis counterparts (see (8c)), reinforcing the conclusion that the process is one of weakening.

| | | | | |
|---|---|---|---|---|
| (8) | a. | Suppe | Sú[*b*]e | ‘soup’ |
| | | bitte | bí[*ɾ*]e | ‘please’ |
| | | Zucker | Zú[*g*]er | ‘sugar’ |
| | b. | Papier | Pa[*pɧ*]íer | ‘paper’ |
| | | getaucht | ge[*tɧ*]áucht | ‘dived’ |
| | | Paket | Pa[*kɧ*]ét | ‘parcel’ |
| | c. | Grube | Grú[*b*]e | ‘mine’ |
| | | Seide | Séi[*ɾ*]e | ‘silk’ |
| | | Fuge | Fú[*g*]e | ‘seam’ |

In those northern varieties where *harter Einsatz* is only variably present, the other context where stops occur intervocalically is word-final before a vowel-initial word. As noted above, the absence of long-lag VOT from this otherwise favourable environment is one indication that these stops should not be classified as aspirated. This conclusion is bolstered by the fact that dialects with voicing/tapping show it here too, as illustrated in (9).

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[1] My thanks to Ulrike Pohlmann for providing the Schleswig-Holstein German examples given here and for discussing their analysis.

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| (9) | a. | i. | klipp und klar | kli[*b*] und klar | ‘clearly’ |
|  |  |  | hat er | ha[*ɾ*] er | ‘he has’ |
|  |  | ii. | hat Ernst | ha[*ɾ*] Érnst | ‘Ernst has’ |
|  |  |  | ein Schluck auf | ein Schlu[*g*] áuf | ‘a toast to’ |
|  | b. |  | gab ihm | ga[*b*] ihm | ‘gave him’ |
|  |  |  | fand er | fan[*d*] er | ‘he found’ |

Unlike the word-internal context, the word-final manifestation of voicing/tapping occurs regardless of whether the following vowel is unstressed (as in (9ai)) or stressed (as in (9aii)). This is further confirmation that the process is sensitive to foot structure, a point we’ll return to immediately below. As with southern Catalan voicing/spirantisation, word-final voicing/tapping in the relevant German dialects applies to the merged output of devoicing. In the case of final stops, this means that the process affects not only historical *p/t/k* (as in (9a)) but also, as illustrated in (9b), *b/d* (historical *g* is subject to the spirantisation illustrated in (7c)).

For this example to count against the strengthening analysis of final devoicing, it is important to establish that intervocalic position in German only acts as weak under certain prosodic conditions. This is highlighted in (10), which spells out the different foot and word conditions under which an intervocalic stop can occur (in the absence of *harter Einsatz*). (In (10), word boundaries are marked by square brackets and foot boundaries by parentheses; the illustrative stops, here represented by *p*, are underlined.)

(10)

|  | Word | Foot |  |  |  |
|---|---|---|---|---|---|
| a. | Initial | Initial | V[(CV | zwei Pulte | ‘two desks’ |
|  | Internal | Initial | V(CV | Papier | ‘paper’ |
| b. | Internal | Internal | (VCV) | Suppe | ‘soup’ |
|  | Final | Internal | VC]V) | klipp und klar | ‘clearly’ |
|  | Final | Final | VC)]V | schlepp áuf | ‘draw up’ |

The foot- and/or word-initial contexts in (10a) resist voicing/tapping and thus count as strong. The contexts where voicing/tapping does apply, those in (10b), are all non-foot-initial; and it is this property that marks them out as weak. Since word-final position belongs to this non-foot-initial set, we can conclude that it counts as weak for the purposes of both tapping and voicing.

In those northern German dialects that have it, intervocalic voicing/tapping masks the effects of devoicing in one context. But what of the context where devoicing shows up as in other dialects, namely before a consonant or at the end of an utterance? If we were to maintain that devoicing acts as demarcative strengthening in only these last two contexts, we would be faced with the same paradox as we were with southern Catalan: word-final position is weak when a vowel follows but strong when a consonant or pause follows. The phonological delimitation of word ends would have to be assumed to switch on or off according to what follows – not a particularly advantageous property for a demarcative function to have.

### 4.3. Devoicing as demarcative weakening

This last point brings us back to the second of the questions posed at the start of this section: even when we can show that a segmental process has a demarcative function, does that necessarily mean it must be strengthening? Are strong consonants intrinsically better at demarcating domain edges than weak ones?

In the case of domain-initial position, the answer seems to be yes. The phonological evidence is pretty clear: positions that are initial in domains such as the stem, word and foot are frequently observed to promote strengthening processes and to resist weakening processes that target non-initial positions (again see Escure 1977; Lass and Anderson 1975; Harris 1997). This asymmetry chimes with phonetic evidence that talkers typically produce tighter and longer articulatory gestures in initial compared to non-initial positions (cf. Fougeron and Keating 1996; Keating *et al.* 2004). This presumably enhances the perceptual salience of initial positions (cf. Beckman 1997), which from the listener's standpoint is a beneficial result, given the privileged part played by initial segments in word recognition (cf. Nooteboom 1981; Hawkins and Cutler 1988).

However, establishing that strengthening enhances the perceptibility of domain starts does not mean that it is necessarily a good way of demarcating domain ends. If anything, domain-final strengthening would dilute the value of domain-initial strengthening. Moreover, given the prevalence of weakening in domain-final position, we should at least consider the possibility that weakening itself might have a demarcative function. Whatever the basis of this function might be, it cannot be perceptual salience, at least at the position where the weakening occurs. In the case of weakening processes targeting manner or place, there's a clear sense in which weakening processes reduce the perceptual salience of a consonant. In the next section, I will try to make this notion explicit and show how it extends naturally to final devoicing. If weakening is to be viewed as having any kind of demarcative value, it surely lies in how it serves to accentuate the syntagmatic differences between segments in different positions (cf. Harris 2004; Shiraishi 2006, this volume). In excluding strong segments from non-initial positions, weakening increases the extent to which strong segments can be relied on to demarcate initial positions. And the more non-initial positions a given weakening process targets, the greater the reliability of this demarcative function is likely to be.

These remarks on the domain-delimiting potential of weakening are admittedly somewhat speculative. But it seems to me they depict a communicative scenario that is at the very least no less plausible than the one presented by the notion that final devoicing demarcates by strengthening. Moreover, they help clarify the point that there is no intrinsic connection between domain-final segments and increased strength.

With these remarks in mind, let us return to the specifics of final devoicing and consider the demarcative value of aspiration in German. I argued above that it is incorrect to describe final voiceless plosives in German as aspirated. However, suppose for a moment that this description were correct. The distribution of aspiration in German would then have to be stated like this: it occurs at the beginning of a word, or in the onset of a stressed syllable (that is, at the beginning of a foot), or at the end of a word. It should be clear that, with this distribution, aspiration is not going to help the listener tell the beginnings of words from the ends of words.

Once we acknowledge that German final plosives are plain, we are left with a much simpler distribution of aspiration in the language: it occurs only in salient positions that are initial in the word or foot. The demarcative potential of this distribution is clear, its usefulness enhanced by the high frequency with which the left edges of words and feet coincide in German. (The same point can be made about several other Germanic languages, including Danish and English – see Harris 2004.)

## 5. Modelling strength

### 5.1. In search of a unitary basis for strength

The evidence reviewed in the first part of the paper helps establish phonological strength as a unitary phenomenon. The evidence shows that what might otherwise seem like a collection of diverse processes acts in a unified manner when it comes to the environments they occur in, the way they interact with one another and the directionality inherent in their outputs. If strength is to be more than just a label we give to this unitary behaviour, we need to discover whether it correlates with some independently established phonological and/or phonetic unity. For example, does it have a unitary feature representation? Is there some unitary phonetic parameter along which strengthening and weakening processes occur?

Note that asking these questions is not the same as asking what causes weakening and strengthening. It is widely taken for granted that weakening is caused by speaker laziness: that is, speakers undershoot production targets out of a need to minimise the expenditure of articulatory effort. Weakening then becomes phonologised when the results of undershoot become reinterpreted by listeners as targets in their own right. This account may or may not be right, but it has nothing directly to say about the impact weakening has on the segments it targets and whether this impact can be captured in any kind of unitary fashion.

This point is evident in the work of Kirchner, who attributes weakening to the activity of grammar-internal constraints that penalise the expenditure of articulatory effort (1998, 2001). Weakened consonants surface when these laziness constraints outrank competing faithfulness constraints that call for the consonants' segmental integrity to be respected. When Kirchner makes the claim that this provides a unitary model of weakening, it is important to understand that he is referring primarily to the causes of weakening. He is not overtly concerned with the question of whether weakening has a unitary impact on phonological forms. Implicitly, he seems to assume that it does not. This is clear from the fact that the representations he uses to illustrate how the various constraints interact contain collections of features and continuous phonetic parameters that are not related to one another in any particular way.

In this section, we will briefly consider two familiar models of phonological strength, one based on sonority, the other on articulatory aperture. Neither succeeds in providing a unified analysis of strengthening and weakening, and neither offers much insight into the question of whether devoicing counts as one or the other. This is in marked contrast to the much less familiar model of strength I will present in §6.

### 5.2. Strength as articulatory aperture

The first attempt at a unitary phonetic definition of strength we will consider is one that relates it to degree of articulatory stricture and the extent to which this impedes airflow through the vocal tract. The basic idea is that stronger segments have tighter strictures and thus offer greater resistance to airflow. Weakening can then be thought of as articulatory 'opening' (Lass and Anderson 1975): it loosens stricture and thus reduces resistance to airflow.

This definition is best suited to characterising weakening processes that target manner. The progression plosive > fricative > approximant that figures in spirantisation and vocalisation certainly involves opening in this sense. The definition might be extended to weakening processes that target place, but only at a push. Debuccalisation replaces one obstacle to the free passage of air through the vocal tract (caused by a supralaryngeal stricture) by another (glottal stricture). To accommodate debuccalisation, an opening account of strength would thus need to show that a constriction in the oral cavity impedes airflow to a greater extent than one at the glottis. (It is perhaps easier to see how this attempt might succeed with spirant debuccalisation (*s* > *h*) than with stop debuccalisation (*t* > *ʔ*).)

The opening account of weakening cannot, however, be extended to voicing or devoicing processes. The open glottis setting required for voiceless sounds impedes airflow to a lesser extent than the adducted vocal-folds setting required for voiced sounds. This would imply correctly that devoicing weakens obstruents but incorrectly that voicing strengthens them. Lass and Anderson (1975) themselves acknowledge this point, by placing intervocalic voicing on a 'sonorisation' trajectory that is independent of opening.

### 5.3. Strength as sonority

Another approach to strength equates it with sonority: weakening is claimed to render a consonant more sonorous (see for example Lavoie 2001). As with the opening account, this correctly predicts the segment trajectory we find in spirantisation and vocalisation, i.e. plosives > fricatives > approximants.

Extending this account to debuccalisation raises the controversial issue of whether sonority has a unitary phonetic definition or not (for a summary of the relevant literature, see Harris 2006). In what way can an input plosive be said to be less sonorous than an output glottal stop? According to one claim, sonority correlates directly with overall output of acoustic energy: the more sonorous a sound, the greater its amplitude or intensity (see for example Parker 2002 and the references there). The presence of a release burst lends a plosive more intensity than a glottal stop. So under this definition debuccalisation leads to an increase in sonority – the reverse of what happens in spirantisation and vocalisation. This contradiction remains even if we assume that stop debuccalisation always passes through a stage where the plosive first loses its release burst (cf. McCarthy 1988). The first stage (from plosive to unreleased oral stop) still involves a decrease in intensity/sonority, while the second (from unreleased oral to glottal stop) potentially involves no change in intensity at all.

Nor does the sonority account of weakening fare much better when we turn to voicing and devoicing processes. The question of where voiced and voiceless obstruents belong on the sonority hierarchy has never really been settled. (Of course if we take the view, shared by many researchers, that voice is orthogonal to sonority, we immediately relinquish any notion that strength has a unitary basis in sonority.) The problem becomes clear when we try to apply the intensity definition of sonority to oral stops. Does the periodic energy that radiates through the talker's neck during the hold phase of a voiced stop make it more sonorous than a voiceless counterpart? Or does the higher intensity of the aperiodic energy associated with the voiceless stop's release burst make it the more sonorous of the pair? In the light of these indeterminacies, we have to conclude that a sonority-based account of strength-changing processes makes no testable predictions about the directionality of voicing and devoicing.

In any event, there is one glaring empirical flaw in any sonority approach to weakening. Nasals occupy a stage on the hierarchy that is intermediate between obstruents and resonants (liquids and glides). Yet spirantisation and vocalisation routinely bypass a nasal stage when they weaken oral stops to resonants (see Harris 1994).

Neither the aperture-based nor sonority-based accounts allow us to identify a single phonetic dimension that correlates with phonological strength. Before we conclude that we are simply wrong to suppose there is such a single dimension in the first place, let us consider an alternative approach, one based on the carrier-modulation model of speech.

## 6. A modulated-carrier model of strength

### 6.1. Speech as a modulated carrier signal

Speech can be thought of as a carrier signal modulated by acoustic events. The carrier is linguistically void: it allows linguistic messages to be heard. The modulations are linguistically significant: they contain the information that enables messages to be understood. Although this way of conceptualising speech has been around for many years, my own exposure to it comes primarily from the more recent work of Ohala (see especially 1992) and Traunmüller (1994, 2005).

An unmodulated carrier can be characterised as the schwa-like sound that is produced by a neutrally open vocal tract. The carrier thus lacks spectral prominences, reflecting the evenly spaced formant structure of schwa. The carrier is typically (though not necessarily) periodic. Although it contains no linguistic information, it divulges information about the talker's organism, emotional state and location.

The carrier provides a neutral baseline for the modulations, which contain the linguistic content of an utterance. The baseline can be modulated along various acoustic parameters, in particular amplitude, spectral shape, periodicity, duration/timing and fundamental frequency.

Carrier energy and modulation energy are of course not physically separate (for example, they are not separately displayed on spectrograms). Nevertheless, it is clear that listeners are able to tease them apart. That is, listeners winnow linguistic information from speech signals through a process of 'demodulation' (Traunmüller 1994).

The magnitude of a modulation can be measured in terms of the extent to which it deviates from the baseline set by the carrier. This can be expressed as the distance a modulation travels through an acoustic space defined by the parameters mentioned above (Ohala 1992). For example, the *p* in *əpə* modulates the carrier to a significantly greater extent than the *w* in *əwə*. The modulation produced by the plosive follows a relatively long acoustic trajectory that takes in a combination of changes in overall amplitude, spectral shape and periodicity. The modulation produced by the approximant follows a much shorter trajectory that involves little more than a change in spectral shape.

## 6.2. Strength as modulation size

The modulated-carrier model of speech provides us with a straightforwardly unified definition of phonological strength. Strength correlates directly with the magnitude of a modulation: the stronger the consonant, the greater the extent to which it perturbs the carrier signal.

Weakening processes diminish modulations, shortening the acoustic distance a targeted consonant travels from the carrier. We can characterise this overall effect as the loss or suppression of some aspect of the modulation associated with the unweakened consonant. In the case of weakening processes targeting manner or place, the suppressed aspect mainly involves one or more of the parameters of amplitude, spectral shape and periodicity. This idea has been presented in detail elsewhere (Harris and Urua 2001; Harris 2003, 2004), so it will be enough to summarise it briefly here before proceeding to the question most relevant to this paper: what does this account have to say about final devoicing?

As to individual weakening processes that target place or manner, each can be seen to reduce the extent to which a consonant perturbs the carrier. Debuccalisation does this by suppressing the spectral properties that signal place. In the case of spirant debuccalisation (e.g. *s* > *h*), this removes the frequency characteristics of the aperiodic energy associated with the consonant's continuous frication. In the case of stop debuccalisation (e.g. *t* > *ʔ*), the equivalent characteristics of the plosive burst are removed along with formant transitions. Spirantisation (e.g. *b* > *β*) and vocalisation (e.g. *t* > *ɾ*) both suppress the abrupt and sustained drop in amplitude associated with non-continuant consonants.

Each of these processes leaves some aspect of the modulation associated with the affected consonant more or less intact. A debuccalised stop retains its radical amplitude drop. A debuccalised fricative retains its aperiodic energy, albeit with reduced intensity. A spirantised plosive retains the spectral characteristics of the original consonant's release burst. A vocalised non-continuant retains its formant transitions.

The outcome of weakening being allowed to advance as far as deletion is the total suppression of any modulation associated with the original consonant: the consonant has been pushed to the point of total merger with the carrier signal.

### 6.3. Final devoicing and intervocalic voicing as modulation reduction

Now let us consider how processes affecting the voice value of consonants fit into the modulated-carrier picture. In the case of intervocalic voicing, let us start with the simplifying assumption that the main acoustic parameter involved here is periodicity. Later we will need to take into account cues to voice that are based on other parameters, especially duration/timing.

In vowels, periodicity is a property of the carrier signal. It contributes to the audibility of linguistically significant acoustic events caused by modulations along the parameters of spectral shape (vowel quality) and fundamental frequency (tone). Once we acknowledge this separation between carrier and modulation properties in vowels, it is clear that intervocalic obstruent voicing counts as weakening in the sense just outlined (cf. Harris 2003). One way in which an intervocalic voiceless stop modulates the carrier is by introducing a discontinuity in periodicity. Voicing a stop in this position removes this discontinuity, allowing the periodicity of the carrier to seep through the consonant. The slope of the modulation produced by the stop as it interrupts the vowels is flattened still further when voicing co-occurs with spirantisation (as in *p* > *β*). The tendency for the two processes to go hand in hand in this environment can be attributed to the fact that the opening of the consonantal stricture is accompanied by a decrease in duration; these combine to reduce the build-up of intra-oral air pressure, which in turn facilitates spontaneous voicing (see Ohala 1999).

Where does final obstruent devoicing fit into this picture? On the face of it, devoicing an obstruent at any point in the speech stream might seem to magnify the modulation produced by the consonant, since it switches off the periodicity associated with the carrier. However, to draw this conclusion would be to fall into the same trap as the unity-of-voice assumption discussed above.

The modulated-carrier model of speech invites us to think primarily about the listener's experience of the acoustic signal. But, we need also to take into consideration how the listener interprets the intentions of the talker (especially since listeners are of course also normally talkers themselves). The well-founded distinction between spontaneous and non-spontaneous voicing, which – as noted above – is fundamentally inimical to the unity-of-voice assumption, is drawn initially on the basis of how the talker's vocal folds behave under different aerodynamic conditions. We can plausibly assume that the listener implicitly takes this distinction into account when demodulating the speech signal. The listener needs to be able to distinguish between periodicity that is part of the carrier signal and periodicity that represents a linguistically significant modulation. In other words, the listener has to determine when periodicity is being used to deliver the linguistic message and when it forms part of the message itself.

To achieve non-spontaneous voicing, the talker makes an active articulatory gesture with the intention of signalling the voiced term of a contrasting voiced-voiceless pair of obstruents. To recognise this term, the listener must then interpret the resulting periodicity as part of a modulation that contains the talker's intended message.

The fact of successful communication is enough to confirm that this is what listeners actually do. Exactly how they do it, though, remains an open question. Does the articulatory and aerodynamic distinction between spontaneous and non-spontaneous voicing correlate with some verifiable acoustic distinction that listeners can directly rely on in speech recognition? Or, if the two types of voicing are not acoustically distinct, are listeners still able to infer the distinction indirectly on the basis of other information that is locally present in the speech signal (as suggested for example by Stevens 2002 and Kingston *et al.* 2008)? For example, do listeners assign differing significance to periodicity according to whether it co-occurs with other acoustic events that signal the contrast between obstruents and sonorants? This is an empirical issue that, to the best of my knowledge, has yet to be systematically investigated in the speech perception literature.

It is undoubtedly true that voicelessness contributes to the modulation produced by a post-vocalic word-final stop. But that does not alter the fact that voicelessness is the natural or unmarked state for stops in this context. That is, it is an aerodynamically favoured consequence of the oral stricture responsible for a major part of the stop's modulation, namely a radical drop in amplitude.

The high incidence of final devoicing in the world's languages can be taken as a reflection of the essential inertness of voicelessness in stops in this position. In comparison, the various properties that can be used to maintain final laryngeal contrasts can be viewed as being actively deployed by the talker. As is well known, the range of these properties is quite large, and certainly larger than can be comfortably accommodated by a literal reading of 'voice' or even 'laryngeal'. A non-exhaustive selection of the properties that can be utilised to distinguish post-vocalic stops is presented in the form of contrasting pairs in (11) (see Denes 1955; Chen 1970; Raphael 1975; Javkin 1976; Mack 1982; Kohler 1984; Walsh and Parker 1984; Flege and Hillenbrand 1987; Kingston *et al.* 2008 and the references there). Some of the properties can co-occur within the same language, while some are clearly mutually exclusive.

(11) Contrasting ‘laryngeal’ properties in word-final stops

| | |
|---|---|
| Pre-aspiration | No aspiration |
| Glottalisation | No glottalisation |
| Lack of release | Plosive release |
| More intense release burst | Less intense release burst |
| Longer stop closure | Shorter stop closure |
| Faster V-to-C formant transitions | Slower V-to-C formant transitions |
| Rapid voice off-set | Delayed voice off-set |
| Absence of significant low-frequency energy at VC transition | Presence of significant low-frequency energy at VC transition |

Each of these contrasting pairs involves some property that can be viewed as an addition to the basic structure of a plain stop. (It is not relevant to our immediate purposes whether the additional property attaches to the ‘voiced’ or ‘voiceless’ member of a two-way contrast or to some member of a more complex set of contrasts.) Put differently, each property magnifies the modulation produced by a stop relative to that of a plain counterpart. The modulation’s acoustic trajectory is extended by following a route through not just periodicity (as might be implied by a literal reading of VOICE) but also, depending on the particular property, duration/timing, spectral shape, amplitude and fundamental frequency.

In sum, the modulation produced by a voiceless plain stop in word-final position is smaller than those produced by stops featuring modifications of the type listed in (11). Phonological processes that neutralise laryngeal contrasts in final stops under a single plain series thus have the shared effect of diminishing modulations in that position. According to the definition of strength as modulation magnitude, these processes thus count unequivocally as weakening. This definition is not restricted to the classic type of devoicing that neutralises two-way contrasts in voicing languages and aspiration languages. It also covers the whole range of delaryngealisation processes, including those that neutralise three- or four-way contrasts involving more complex combinations of properties such as those in (11).

## 7. Conclusion: implications for feature theory

It is not the purpose of this paper to propose or subscribe to a specific feature representation of final devoicing. Nevertheless, let us briefly consider where the modulated-carrier model of strength stands in relation to the broadly distinguishable approaches to the representation of devoicing that have been adopted in the recent literature.

If we are right in thinking that strength has a unitary phonetic basis, then it would be reasonable to expect it also to have some unitary basis in phonological feature representation. With standard feature models belonging to the SPE tradition, this is certainly not the case. That is hardly surprising, given historical disagreements about what the phonetic basis of strength might be and about which particular processes count as weakening or strengthening in the first place. The contrast with assimilation processes is striking. There is general agreement about what qualifies as assimilation, and since the 1970s there has been more or less general agreement that processes of this type are best captured in terms of feature spreading.

With standard features, there is no unified way of representing strength (which is why some phonologists advocated the introduction of independent 'strength scales' on the model of the sonority hierarchy, cf. Foley 1977). There are at least three alternative ways of representing weakening using standard features: deletion, spreading and the replacement of one value by another. Debuccalisation, for example, can be represented as the deletion of a feature-geometric Place node (cf. McCarthy 1988). Intervocalic spirantisation can be represented as the assimilation of [continuant] from the flanking vowels (cf. James Harris 1969; Mascaró 1984). Vocalisation requires [+consonantal] to be relaced by [–consonantal].

All three of these alternatives have been turned to in the representation of intervocalic voicing and final devoicing. Spreading is utilised in what can be considered the orthodox textbook analysis of intervocalic voicing as the assimilation of [voice] from the surrounding vowels (see for example Carr 1993). Replacement is employed in what is perhaps the most traditional analysis of devoicing: [+voice] > [–voice]. Deletion figures in analyses that treat final devoicing as the suppression or absence of a privative laryngeal feature (although what the specific feature is varies from one account to another, cf. Harris 1994; Lombardi 1995a, 1995b; Jessen and

Ringen 2002). Of these various mechanisms, it should be clear that feature deletion takes us closest to the notion that weakening diminishes the modulation produced by a consonant.

Privativeness is a basic requirement of any proposal that sets out to treat weakening as feature deletion. Bivalent features intrinsically imply the replacement rather than the deletion of values (for full discussion, see for example van der Hulst 1989 and Harris and Lindsey 1995). With bivalency, replacement can be implemented in one step, by directly rewriting one feature value with its complement. Or it can be implemented in two steps as *faux* deletion – by deleting one value and then having the complement value filled in by some independent 'default' mechanism (the method associated with underspecification theory (see for example Archangeli 1988) and adopted for vowel weakening by Crosswhite (2004) among others).

Implementing authentic deletion with privativity requires each feature to be defined in such a way that deleting it does not necessitate the introduction of some other feature to safeguard the phonetic interpretability of the affected segment. Privative feature models are not always constructed with this design property in mind (although for explicit proposals that it should be rolled out across the entire feature set, see for example Harris and Lindsey 1995; Backley and Takahashi 1998; Nasukawa 2005; Botma 2004; Backley and Nasukawa, this volume). The notion is more often invoked in proposals for specific features, particularly so for those that represent laryngeal contrasts.

Most proposals for privative laryngeal features assume that plain stops are laryngeally unspecified (see Harris 1994; Brockhaus 1995; Lombardi 1995a, 1995b; Iverson and Salmons 1995, 2006; Jessen and Ringen 2002). That is, unlike with underspecification, plain stops are phonetically interpretable without the need for the filling-in of default laryngeal values. Other types of stop are then specified by the presence of additional features that we can think of as moving a stop away from a plain baseline. Deleting these additional features returns a stop to its basic plain state.

Treating weakening as feature deletion in a privative model leads naturally to treating strengthening as feature insertion. This is indeed how Brockhaus (1995) and Iverson and Salmons (for example 2003) analyse final devoicing in German: final obstruents acquire or retain a [spread glottis] feature that is suppressed in certain other positions. However, the validity of this particular use of feature insertion is undermined by the evidence that final devoicing should not be treated as strengthening in the first place.

Taking plain stops as an unspecified baseline implies subscribing to 'laryngeal realism' (Honeybone 2005) – the assumption that laryngeally specified stops have different representations in voicing and aspiration languages (see for example Anderson and Ewen 1987; Harris 1994; Lombardi 1995a, 1995b; Iverson and Salmons 1995, 2003; Jessen 1998; Jessen and Ringen 2002; Avery and Idsardi 2001). Aspirates are represented in terms of a feature such as [spread glottis], [stiff vocal folds], [H] or some equivalent. Actively voiced stops are represented in terms such as [voice], [slack vocal folds] or [L]. This approach was initially tailored to the representation of laryngeal contrasts in prevocalic stops. But there is a largely unresolved issue of how or even whether it is suited to the representation of contrasts in word-final stops.

It is relatively straightforward to say that the marked series in aspiration languages is specified as [spread] (or some such) in initial position, where it is realised as long-lag VOT. Under a weakening analysis of devoicing, this feature is suppressed in final position. But how do we represent the final contrast in aspiration languages without devoicing? Traditional phonemic reasoning would lead us to consider [spread] to be the contrastive feature here too. But this immediately raises a question mark over how the feature should be phonetically defined. Adhering to a strict interpretation of laryngeal realism (and bearing in mind the conclusions reached in §3 above), we would probably want to reserve [spread] in final position for pre-aspirated plosives. We can only extend the feature to other contrastive phonetic properties in this position (such as some of those in (11)) by adopting a rather less literal interpretation of realism. That would allow us to redefine [spread] as a cover feature that encompasses an apparently diverse range of phonetic effects (in which case some more abstract feature label would be more appropriate).

There is of course a radical alternative: to abandon phonemic thinking and allow for laryngeal contrasts in initial and final stops to be specified in terms of different sets of features. According to this ‘hyper-real’ approach, each of the properties in (11) would in principle need to be considered for independent feature status. An untrammelled proliferation of features would be avoided by assuming that sets of acoustically similar properties should be grouped together on the grounds that they present integrated cues to a given laryngeal contrast, in the manner proposed by Stevens and Blumstein (Stevens and Blumstein 1978; Blumstein and Stevens 1980). (One such set might be the ‘low frequency energy’ property proposed for postvocalic ‘voiced’ stops by Kingston *et al.* (2008). This integrates at least three similar acoustic effects which combine to concentrate energy at low frequencies near the onset of stop closure: lowered first formant, lowered fundamental frequency and sustained low-frequency periodicity.)

Pursuing a non-phonemic approach allows us to grant feature status to the release burst property discussed in §3, thereby highlighting its independence from aspiration (see Harris 1990 and Steriade 1993 for rather different proposals along these lines). In this way, we can draw a clear distinction amongst languages with word-final delaryngealisation between those that suppress only aspiration (e.g. German) or voicing (e.g. Catalan) and those that also suppress plosive release (e.g. Thai).

Whichever version of laryngeal realism we choose to run with, it should be clear that this overall approach is in keeping with the notion that features map to modulations of the carrier signal. Each privative laryngeal feature adds some ingredient to an obstruent that magnifies the modulation it produces.

To sum up: deletion analyses of final delaryngealisation in general and devoicing in particular are compatible with the notion that features code modulations of the carrier signal. Delaryngealisation decreases the modulation produced by a final obstruent, and the most direct way of representing this effect in the phonology is by feature deletion. The same goes for intervocalic voicing. Feature deletion transparently records the fact that this process removes a discontinuity in periodicity that the consonant would otherwise impose on the VCV sequence.

In short, feature suppression is the most direct way of capturing the fact that final devoicing, like intervocalic voicing, is a weakening process.

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# Headship as melodic strength

*Phillip Backley and Kuniya Nasukawa*

## 1. Introduction

All languages show lenition effects of one kind or another, either historical or synchronic, which suggests that all language users must have a certain instinctive or subconscious knowledge about strength differences in their own sound system. One of the goals of an explanatory theory of phonology must therefore be to capture these strength relations in a non-arbitrary way.

When addressing the issue of strength, it emerges that we need to refer to two levels of structure: melodic and prosodic. Accordingly, this paper begins by considering the relation between strong prosodic positions and strong melodic expressions. It then goes on to discuss the distinction made in Element Theory (Harris and Lindsey 1995; Backley and Nasukawa 2006; Nasukawa and Backley 2008) between headed and non-headed melodic expressions, and argues that some obstruent categories – aspirates, ejectives, fully voiced stops – must be represented as headed melodic expressions. Finally, it shows how headed expressions function as strong acoustic cues in the speech signal; these cues help listeners to identify prosodic constituents such as feet and words, and thereby facilitate language processing. It will be argued that lexical access is made more efficient by knowing where prosodic domains begin and end, the central claim being that headed melodic expressions assist language users in locating these prosodic boundaries.

## 2. Approaches to strength and lenition

The labels ‘phonological strength’ and ‘lenition’ are both imprecise terms, leading to some varied usage in the literature. Nevertheless, generalisations do emerge from this variation. The common consensus is that lenition – a reduction in strength – may bring about an alternation or a sound change in one or more of the following directions:

A: an increase in sonority along some established sonority scale
B: a decrease in oral occlusion
C: a loss of phonologically marked properties

These effects share the assumption that lenition should be described primarily in segmental terms; in other words, it is assumed that lenition alters melodic structure in some way. This melodic approach to lenition will be described here as the standard view, where a typical description of segmental weakening also includes some mention of the prosodic context where the lenition process takes place. For example, frequent reference is made to the inherently weak positions where lenition is expected to occur, such as intervocalic and word-final. So the standard approach characterises lenition by referring to (i) differences in melodic strength, represented as feature change or feature loss, and also (ii) differences in prosodic or positional strength, which are usually stipulated. Some of the most common lenition processes are listed below (for a comprehensive survey, see Gurevich 2004).

Table 1. *Common lenition processes*

| *Process* | *Examples* | *Effects* |
|---|---|---|
| spirantisation | Tiberian Hebrew (Idsardi 1998): e.g. t→θ<br>*katab* [kaːθáv] ‘write, 3MS.PERF.’<br>Scots Gaelic: e.g. k→x<br>*c*[k]*as* ‘steep’, *glé ch*[x]*as* ‘very steep’ | A, B |
| vocalisation | Estuary English: e.g. l→ʊ<br>*tell* [teʊ] (cf. *telling* [ˈtelɪn])<br>Modern Persian (Hayes 1986a): e.g. v→w<br>[nowruːz] ‘New Year’ (cf. [noviːn] ‘new kind’) | A |
| voicing | developments from Latin: e.g. t→d<br>Latin *vita* ‘life’ → Spanish *vida* ‘life’<br>Shoshone (Shimkin 1949): e.g. p→b<br>*timpin* [tɨmbi] ‘rock’ | A |

| | | |
|---|---|---|
| debuccalisation | Toba Batak (Hayes 1986b): e.g. k→ʔ<br>*hala*[ʔ] *batak* ‘Batak person’ (cf. *hala*[k] ‘person’)<br><br>Coria Spanish: s→h<br>*susto* [suhto] ‘fright’ | B |
| de-aspiration | Proto-Indo-European developments:<br>PIE **dhuer* → Eng. *door*, Dutch *duer*, Gothic *daúr*<br><br>Sanskrit (Joseph and Janda 1988): e.g. $t^h$→t<br>/kaprt$^h$/ [kaprt] ‘penis’ | C |

In this paper, as in the standard approach, we acknowledge that effects relating to phonological strength must be characterised in both melodic and prosodic terms. However, in the alternative approach to be presented here, we suggest that it is neither useful nor desirable to discuss melody or prosody in isolation, since the two are fundamentally linked. Specifically, we argue that strength is essentially a prosodic property, which is then reflected directly in melodic structure. We claim that the distribution of strong and weak sounds has a linguistic function, which is to convey information about prosodic structure. But in order for this information to be transmitted during communication, it must be converted into a form that listeners can perceive and interpret; in other words, it must be expressed in melodic terms and encoded in melodic structure.

Of course, it has been recognised for some time that the realisation of a sound can be sensitive to its prosodic position (Fougeron and Keating 1997; Cho and Keating 2001). Yet this is normally viewed as a purely phonetic effect because it typically involves small, gradient changes in articulation. For example, Keating *et al.* (2004) propose an analysis of domain-initial strengthening on the basis of slight increases in duration and VOT. By contrast, in this paper we argue that such differences in melodic strength are linguistically significant, that they carry important linguistic information for listeners, and that they should therefore be incorporated into the phonology. Below we demonstrate how these melodic strength differences may be formalised in the context of an Element Theory approach to melodic representation.

## 3. Prosodic strength and melodic strength

Let us clarify our own understanding of the term ‘strength’, first from a prosodic angle and then from a melodic point of view.

In describing prosodic strength we refer to a growing body of evidence from the psycholinguistics literature which indicates that listeners rely on the identification of prosodic categories when interpreting speech. Experimental evidence indicates that, in order to recognise words quickly and process language efficiently, listeners give priority to locating the edges of prosodic domains (Cutler and Norris 1988; Jusczyk, Cutler and Redanz 1993). Assuming this is the case, there are two questions that need to be addressed. First, if prosodic categories are important for language processing, how do listeners locate them in running speech? The claim that we develop below is that the constituents of prosodic structure are indicated by the presence of strong prosodic positions; in other words, the positions which are generally considered to be strong are the ones which carry the responsibility for demarcating the edges of prosodic domains. In most cases it is the left edge of a domain which is marked out, and again the psycholinguistics literature offers some explanations for this preference (Marslen-Wilson and Tyler 1980). So, word-initial position is expected to be prosodically stronger than word-final position, for example, and syllable-initial position (i.e. onset) stronger than syllable-final (i.e. coda).

If listeners are assumed to pay particular attention to strong prosodic positions, the second question to be addressed is this: how do listeners identify strong positions? We proceed by assuming that they can distinguish between prosodically strong and weak positions because this information is reflected directly in melodic structure – and ultimately, in the acoustic signal. More precisely, we claim that listeners pay attention to certain cues in the acoustic signal which indicate the presence of a strong position. And in turn, these cues help listeners to locate the edges of prosodic word domains (or, less frequently, of foot or syllable domains). Once again we echo the views expressed in various psycholinguistic studies and assume this is the information that listeners rely on for segmenting utterances into words and then for sharpening the process of lexical access.

So, our own view of prosodic strength relies crucially on recognising a distinction between those positions which lie at the boundaries of prosodic domains (i.e. strong positions) and those which are domain-internal (i.e. weak positions). This distinction does not directly facilitate the communication process, however, for the simple reason that the primary function of prosodic structure is organisational, not interpretative. Its chief roles are to convey information about the relations holding between sounds and to identify higher structural units that may be relevant to the suprasegmental aspects of speech. As an organisational construct, prosodic structure is not usually subject to direct phonetic interpretation; rather, it influences the way in which interpretable material (i.e. melodic structure) is interpreted. Now extending this assumption, we wish to pursue the argument that prosodic strength cannot be described independently of melodic strength. Let us therefore clarify our understanding of melodic strength, and at the same time examine the nature of this key relation between prosody and melody.

It has already been suggested that differences in prosodic strength must be audible in some way – that is, we take it that there are certain acoustic cues present in the speech signal which serve to indicate the presence of a prosodically strong position. Now, because these cues are linguistically significant – that is, they carry important information about linguistic structure – it should be the case that they are expressed formally in phonological representations. Here, we propose that such cues are encoded specifically in segmental structure, and below we illustrate this point using an Element Theory approach to melodic representation (Harris and Lindsey 1995; Backley and Nasukawa 2006). Indeed, it appears that the element-based model is ideally suited to conveying prosodic information of this kind. In comparison, while there may be a way of using traditional distinctive features to encode strength relations in segmental structure, it is not immediately obvious how this should be done.

## 4. Headship in Element Theory

For independent reasons the Element Theory framework makes an important distinction between headed and non-headed melodic expressions, which is explained below. Our claim here is that this headship distinction also reflects differences in prosodic strength: the acoustic cues which indicate strong prosodic positions are those corresponding to headed melodic expressions, while weak positions only contain segments represented by non-headed expressions. The notion we wish to formalise is that melodic headship is one of the strategies that languages use to indicate prosodic strength. This, in turn, assists listeners in locating the prosodic constituent boundaries that help to make language processing more efficient.

So, our central claim is that one of the functions of melodic headship in Element Theory is to express differences in prosodic strength. And in §5–8 below we present evidence from a variety of languages to support this view that melodic strength reflects prosodic strength. The pattern that will emerge is one where headed expressions show a distributional bias towards prosodically strong positions. Clearly, however, the validity of our claim rests largely on whether or not the notion of headedness in melodic structure is a valid one. We therefore proceed with an outline of Element Theory itself and some generalisations concerning the role of headship. Then we go on to demonstrate how the use of headship can be extended in a specific way: we propose that a headed melodic structure is essential to the representation of certain obstruent categories – namely, aspirated stops, ejective stops and fully voiced stops. We claim that these three classes are formalised by the presence of headed |$\underline{\text{H}}$|, headed |$\underline{\text{ʔ}}$|, and headed |$\underline{\text{N}}$| respectively. In describing these categories, we show how the distribution of headed melodic expressions reveals a direct connection with prosodic strength.

Element Theory is a restrictive model of segmental structure in which segments are represented by combinations of features or 'elements' drawn from the six-member set |A I U H N ʔ|. Elements are single-valued units of phonological structure, each standing for a universal property which exhibits active phonological behaviour and which is mapped on to an information-bearing pattern in the speech signal. Although any element can in principle appear in any syllabic position, the set of six elements naturally divides into two groups. The 'resonance' group consists of the three resonance elements |A I U|, which are primarily involved in the description of vowel contrasts. Clearly, this aspect of the theory owes much to earlier work in Dependency Phonology (Anderson and Durand 1986), Particle Phonology (Schane 1984) and other related frameworks. The remaining elements |H N ʔ| comprise the 'laryngeal-source' group and describe the laryngeal and manner properties of consonants. Each element may stand alone in an expression, or, as already indicated, may combine with other elements in either equal or unequal proportions. An unequal combination creates a head-dependent relation between the elements concerned.

The resonance elements |A I U| provide the linguistic code for describing vowels: they create vowel contrasts, they shape vowel systems, and they participate in dynamic phonological processes. Physically, the vowel elements are associated with the peripheral vowels [a i u] – i.e. the three extreme points in the acoustic vowel space; in addition, they stand for the three basic speech signal patterns that are fundamental to vowel systems. In terms of their phonological behaviour, |A I U| are regularly active in dynamic processes such as assimilation, coalescence and diphthongisation, which strengthens the view that these properties have primitive (i.e. element) status. When two or more elements combine, the result is a compound segment. This is a compound in two senses: physically the compound expression is associated with multiple patterns in the speech signal, and phonologically it represents a segment belonging to more than one natural class.

Although |A I U| are chiefly associated with vowel structure, the same elements also contribute ‘place of articulation’ properties in consonant representations. This highlights one of the central assumptions of the Element Theory view – that a single element may have more than one possible interpretation, depending on its context; this allows important cross-category groupings (e.g. front vowels and palatal consonants) to be captured in a non-arbitrary way.

While the resonance elements |A I U| provide place properties in consonants, the laryngeal-source elements |H N ʔ| cover all remaining aspects of consonant structure. Traditionally, these other aspects are described using informal labels relating to ‘manner of articulation’ (stop, fricative, nasal, approximant, etc.) and ‘glottal state’ (voicing, aspiration, etc.). Within Element Theory, however, this division between manner and glottal state is not especially relevant and is therefore not formally expressed. This is due, in part, to the way that elements have different phonetic interpretations across different consonant categories. For example, in §7 we shall see how |N| is responsible for nasality in sonorant consonants and also for contrastive voicing in obstruents. It is also partly due to the way Element Theory carves up the consonant space along the boundaries of linguistic categories, and not according to phonetic classification. For instance, an element-based representation cannot overtly express the fact that sonorants are usually voiced, because their voicing properties do not carry significant linguistic information. In what follows, therefore, we introduce the consonant elements |H N ʔ| by describing their intrinsic phonological properties; these properties do not necessarily correspond to established phonetic categories.

The |H| element is also known by its descriptive label *stiff vocal folds*, and broadly defines the class of obstruents since it is usually present in stops and fricatives. Its typical manifestation is voicelessless, and it functions as the active laryngeal property in English, Swedish and other so-called aspiration languages (see §5). The |ʔ| (or *stop*) element, on the other hand, represents a drop in amplitude of the kind which is present in the spectral profile of oral stops, nasal stops and some laterals. In acoustic terms, |ʔ| corresponds to a momentary ‘empty’ slice in the spectral profile. This is discussed more fully in §6. Finally, the element |N|, also known by its descriptive label *slack vocal folds*, serves the dual function of contributing nasality in nasal stops and obstruent voicing in fully voiced stops. In §7 we describe how these two quite different manifestations of |N| are distinguished phonologically.

The motivation for recognising the elements |H| and |N| derives in part from the arguments which relate to voice onset timing (Backley and Nasukawa 2006). However, Harris (1994: 134) also introduces further evidence for the primary status of these elements.[1] In acoustic terms, the two glottal states stiff vocal folds and slack vocal folds correspond to raised and lowered fundamental frequency, respectively. This, in turn, suggests a parallel with tonal contrasts in vowels. Although this claim requires further investigation, it appears that some phonological processes indicate a correlation between stop aspiration and high tone on a following vowel, as well as between obstruent voicing and a neighbouring low tone vowel (Matisoff 1973). Here we follow this view of laryngeal contrasts, although our discussion will reveal how the basic categories |H| and |N| must be modified in order to accommodate the specific characteristics of aspiration languages and voicing languages.

Almost since its inception, Element Theory has incorporated into its melodic representations some form of head-dependency relation holding between elements in the same expression. This headship relation serves two important purposes: first, it increases the number of possible melodic expressions – and thus, the number of contrasts – that the model can generate; second, it permits a situation in which one element (i.e. the head) dominates all others (i.e. dependents) in an expression, allowing this dominant element to manifest a stronger set of acoustic cues and thus predominate in the physical interpretation of the resulting melodic expression. It is this head-dependent asymmetry that will be shown to play the key role in our formulation of melodic strength.

To illustrate the workings of melodic headship, let us review a standard example involving compound vowels. The vowel element |I| has the effect of increasing the value of F2 in any expression where it is present; in articulatory terms, this broadly translates into vowel frontness. So when |I| occurs alone, its typical interpretation is as a high front vowel [i] – a vowel with high F2 but no other salient linguistic properties. Consider now the element |A|, which is associated with a high F1 value; this suggests an open articulation, and indeed its usual interpretation is as a low vowel such as [a] or [ɑ]. When |I| and |A| combine in the same expression, the result is a blend of – in effect, a compromise between – their respective properties high F2 and high F1. While symmetrical fusion is possible, it is very com-

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[1] The |N| element is referred to as |L| in some sources including Harris (1994).

mon for elements to combine unequally, and in such a case one element is designated the head of the expression. Should |I| predominate as the head of this |<u>I</u> A|[2] combination, then this element makes a greater contribution to the resulting compound: the outcome is a high front vowel (high F2) which has been lowered to [e] through the influence of the dependent element |A|. On the other hand, if |A| acts as the head of a compound |I <u>A</u>|, then the result is [æ] – a low vowel (high F1) onto which vowel fronting from |I| has been superimposed.

In this paper we aim to show how the same principle of melodic headship may also be applied to the representation of consonants. Specifically, we will demonstrate how the three laryngeal-source elements are subject to the same headed versus headless distinction already described for vowels. In §5 we argue that |<u>H</u>| (i.e. |H| as a headed element) represents aspirated stops, while in §6 we show how headed |<u>ʔ</u>| classifies the category of ejective stops. Then §7 discusses the role of headed |<u>N</u>| in identifying the class of fully voiced stops. In conclusion, we will argue that the headed status of aspirated stops, ejective stops and fully voiced stops provides an explanation for why these obstruent categories show a natural affinity for strong prosodic positions.

## 5. Headed |<u>H</u>| in aspirated stops

Most versions of Element Theory recognise two laryngeal-source elements |H| and |N|. The |N| element is assumed to be active in 'full voicing' languages such as Russian and Spanish, and is interpreted as non-spontaneous voicing or even pre-voicing in obstruents. In terms of its phonetic interpretation and also its distributional properties, |N| behaves in a similar way to the privative [voice] feature of Lombardi (1994). In §7 we return to a discussion of |N| in consonant representations.

By contrast, the |H| element appears in 'aspiration' languages like English, German and Korean. Its distribution broadly corresponds to features such as [asp] (Lombardi 1994), [spread glottis] (Iverson and Salmons 1995) and [+tense] (Jessen 1998). The usual interpretation of |H| is voicelessness, but in certain environments |H| can also be interpreted in other ways, such as aspiration on plosives or as vowel shortening before fortis consonants. The Element-based representations in (1) show |H| as a

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[2] In a compound expression, the head element is underlined.

contrastive property in English.[3] Note that aspiration languages like English have lenis stops such as [b̥ d̥], which are produced without voicing. Moreover, lenis stops are phonologically neutral in the sense that they have no active laryngeal/voicing properties. For this reason, (1b) has no |N| element or other property referring to voicing (Backley and Nasukawa 2006).

(1) The contrastive function of |H|
 a. fortis [pʰ] *post, appear…* |ʔ U H|
 b. lenis [b̥] *brief, about…* |ʔ U |

The contrast in (1) oversimplifies the situation, however. A closer look at the laryngeal behaviour of English stops reveals that the simple presence or absence of |H| is insufficient by itself to account for all the laryngeal patterns attested in English. These are given in (2). What we actually find is that the fortis series has the two contextually determined forms in (2ab), while the lenis series shows the alternations in (2cd):

(2) Laryngeal contrasts in *English*

| | *aspirated* | *voiced* | *context* | *examples* |
|---|---|---|---|---|
| a. [pʰ] | yes | no | foot-initial | pass, appear |
| b. [p] | no | no | foot-internal, *s*_ | wrapper, spy |
| c. [b̥] | no | no | foot-initial | best, about |
| d. [b] | no | yes | foot-internal | ruby, cupboard |

The fortis stop in (2a) is aspirated in the archetypal strong environment of foot-initial position, but loses its aspiration in weaker positions such as those described in (2b). Nevertheless, both expressions are voiceless and consequently both should contain |H|. Yet (2a) and (2b) are distinct in terms of their phonetic interpretation and also their distributional patterns; we therefore expect them to have different representations. What the standard Element Theory model lacks, however, is a means of referring to aspiration independently of voicelessness, which seems necessary if we are to succeed in capturing this aspirated/non-aspirated difference. A further complication arises from the apparently alternating behaviour of the lenis stop. In strong

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[3] The representation of labial stops also contains the element |U|, which contributes labial resonance in consonants, and the stop element |ʔ|, which represents the drop in amplitude associated with oral/nasal stops and some laterals. For a brief description, see §4 above. For details see Harris and Lindsey (1995).

positions, the voiceless unaspirated stop [b̥] in (2c) shows physical characteristics that are similar to those of the weakened (i.e. de-aspirated) stop [p] in (2b). The lenis stop [b̥] is also subject to weakening, however, especially in foot-internal contexts where it becomes a fully voiced [b]. As it stands, |H| alone seems quite unable to register this full set of laryngeal patterns.

One possible way of marking a phonological distinction between voicelessness and aspiration is to retain |H| for representing voicelessness but to introduce another laryngeal element uniquely for aspiration. For several reasons, however, this option is best avoided. There is sufficient evidence from dynamic phonological processes to support the assumption that English, like other aspiration languages with a two-way laryngeal distinction, uses only |H| as an active laryngeal property. In fact, |N| is the only other laryngeal element available within the Element Theory framework, and there is no indication that |N| behaves as an active property in English. Furthermore, the introduction of an additional element increases the generative capacity of the model unnecessarily, and also brings about the existence of a new, supposedly natural class of sounds for which there is no obvious empirical support.

On the other hand, it could be argued that the presence/absence of aspiration and full voicing should be a matter for phonetic realisation rather than for phonological representation. After all, in Germanic languages the choices between [pʰ] versus [p] and between [b̥] versus [b] are entirely predictable. We take issue with this suggestion too, and instead follow the line of thinking set out in Harris and Urua (2001), who equate lexical information with linguistic information, whether this information is contrastive or predictable. They argue that representations convey information about the speech signal, this information being manifest in the form of acoustic cues that serve as the input to a listener's auditory-perceptual system. This position clearly departs from the prevailing view that phonological structure encodes facts about articulation. As just indicated, Harris and Urua make a further departure from the standard articulatory-based position by assuming that representational information is not limited to the description of melodic contrasts; it can also include other salient linguistic cues. Expressed in traditional terms, we might say that they recognise no division between phonemic and allophonic differences. This is because some sound properties, despite being non-contrastive, still turn out to have a linguistic role to play, and are therefore highly salient in perceptual terms. As Harris and Urua (2001: 76) note, aspiration may be considered a case in point:

> The high cue potential of certain supposedly redundant properties rests to a large extent on their very predictability. English aspiration is not only paradigmatically informative, acting as the most robust local cue to the ‘voice’ identity of plosives, but it is also syntagmatically informative to the extent that it adheres to the onset of a stressed syllable and thus demarcates the left edge of a foot.

On this basis, we shall assign equal status to the aspiration difference [pʰ]–[p], the fortis/lenis difference [pʰ]–[b̥], and the voicing difference [b̥]–[b]. All are similar in terms of their linguistic significance. We therefore need a way of representing phonologically the four-way laryngeal split shown in (2). Ideally, however, this should be achieved by referring just to |H|, which is the only laryngeal element which is active in the structure of English obstruents. In addition, we would like the resulting representation to reflect the fact that, at least in Germanic languages like English, aspiration and voicelessness are apparently related in the sense that aspiration implies voicelessness (i.e. lenis stops are not usually aspirated). In fact, below we will show how this close relation between the two properties is central to their element-based representations.

The behaviour of its laryngeal properties defines English as an aspiration language; it therefore refers to the presence/absence of |H| in expressing the difference between fortis and lenis stops. This much is clear. But with regard to the difference between aspirated [pʰ] and unaspirated [p], a distinction in terms of melodic structure is not obvious, since both are voiceless and therefore both have |H|. So this is not a question of the presence or absence of an element. Rather, the issue concerns the relative prominence of |H| in the overall expression. In phonetic terms, the laryngeal categories in (2) may be expressed as follows:

(3) Representation of laryngeal categories in *English*

| | *category* | *laryngeal property* | *representation* |
|---|---|---|---|
| a. | [pʰ] (aspirated) | long voicing lag | \|H\| prominent →\|H̲\| |
| b. | [p] (unaspirated) | short/no voicing lag | \|H\| present →\|H\| |
| c. | [b̥] (neutral) | short/no voicing lag | \|H\| present →\|H\| |
| d. | [b] (voiced) | spontaneous voicing | laryngeal inactive →\|  \| |

The voicelessness (i.e. voicing lag) associated with |H| is perceptually more salient in aspirated than unaspirated stops; and we claim that this heightened salience indicates that aspirated stops contain the element |H| in its stronger guise – namely, as headed |H̲|. In other words, voicelessness is exaggerated in aspirated stops owing to the presence of $|\underline{\mathrm{H}}|$. This is consistent with our understanding of headed expressions in general, where the acoustic properties of a head are expected to be stronger and more prominent than when the same element is a dependent.

This dominance relation between elements is reminiscent of other head-dependent asymmetries which have long been recognised, particularly in prosodic structure. In fact, the parallel between prosodic headship and melodic headship seems fairly robust. In prosody, it is common for head status to be reflected in some property of the speech signal; for example, in the head-dependency relation holding between the two nuclei that define a binary foot, it is typical for the head nucleus to be perceptually stronger than the dependent nucleus and acoustically more prominent (cf. strong versus weak units in stress systems). Similarly, in melody we expect the head-dependency relation to have direct phonetic consequences: the head element in a melodic structure makes a greater contribution to the overall acoustic profile of an expression than do other elements. So in the case of aspirated stops, the defining characteristic of voicing lag is reinforced through melodic headship.

It will be recalled that in this paper we are attempting to stress the inseparable nature of melodic strength and prosodic strength. Therefore the next question to arise is this: if headship has the effect of strengthening a melodic expression, how does this relate to prosodic strength? We have already made three claims. First, melodic strength reflects prosodic strength. Second, melodic strength is achieved through headship. And third, prosodically strong positions are those that aid language processing by indicating the location of various prosodic domains. Applying these insights to English, it appears that the relevant prosodic domain is the foot, since aspirated stops (which are headed expressions) are distributed in a way that marks the left edge of a foot domain.[4] We note here that stress in English can also help listeners in the identification of foot domains, since the distribution of stressed syllables is linked directly to foot structure. In fact, a good deal of evidence resulting from psycholinguistic experimentation (Cutler and Norris 1988; Echols, Crowhurst and Childers 1997; Jusczyk, Cutler and Redanz 1993) indicates that users of stress-timed languages rely on stress patterns in order to segment continuous speech into words – which is, of course, needed before lexical retrieval can take place.

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[4] The prosodic word domain also seems to be significant in English, as aspiration is regularly interpreted word-initially even when this position is not foot-initial: e.g. *potato* [pʰəˈtʰeɪtəʊ].

Returning to the matter of representations in Element Theory, let us summarise the argument so far. We have claimed that aspirated stops have a representational structure containing the headed element $|\underline{\mathrm{H}}|$, and further, that headed expressions in general serve the function of conveying information about the location of prosodic domain boundaries. Thus it is unlikely to be a coincidence that aspirated stops in English occur systematically at the left edge of word and foot domains, given that listeners are able to process the incoming speech signal more efficiently when they have this prosodic information at their disposal.

So, there are grounds for assuming that aspirates contain a headed $|\underline{\mathrm{H}}|$. Let us now extend this assumption by making the further claim that not only aspirated stops but all fortis stops lexically contain headed $|\underline{\mathrm{H}}|$; this includes unaspirated fortis stops such as those in (3b). Put simply, we claim that all voiceless stops are potential aspirates. However, this potential aspiration – represented in element terms as a 'strong' or headed expression – can only be realised in prosodically strong positions (Backley and Nasukawa 2006; Vaux and Samuels 2005). Recall that strong positions are those which are rich in linguistic/prosodic information because they mark out the left edge of a prosodic domain. In case this prosodic strength requirement is not met, the result is a weaker or lenited interpretation of the same structure.

Now, the lenition of a segment generally involves some loss of its defining properties: for example, stops can lose their place of articulation, fricatives can lose their audible friction, and vowels can lose their peripheral quality. In Element Theory, a lenited expression occurring in a weak position shows a reduction in the amount of acoustic information it expresses, where a loss of acoustic information typically results from a loss of melodic/structural material from its representation. In many cases, a loss of melodic material amounts to the loss of one or more elements (Harris and Lindsey 1995). In other instances, such as the present case of de-aspiration, however, it can result in a loss of headedness. In fact, if headed expressions are associated with strong positions, then it is only to be expected that a lenition process taking place in weak positions would target and remove the headed status of an expression.

To illustrate how and when this process of de-aspiration takes place, consider again the relevant English data:

(4) Laryngeal contrasts in *English*

| | | *aspirated* | *voiced* | *context* | *examples* |
|---|---|---|---|---|---|
| a. | [pʰ] | yes | no | foot-initial | pass, appear |
| b. | [p] | no | no | foot-internal, *s*_ | wrapper, spy |
| c. | [b̥] | no | no | foot-initial | best, about |
| d. | [b] | no | yes | foot-internal | ruby, cupboard |

The expression |ʔ U H̲| in (4a) is interpreted in full – i.e. without any loss of acoustic or linguistic information – because it appears in foot-initial position. But in weaker positions like foot-internal and word-final, headedness and the aspiration associated with headedness no longer has any prosodic function to perform, so it drops. Accordingly, aspiration is lost but voicelessness (as non-headed |H|) remains. Retaining |H| means that this lenited form potentially overlaps with the lenis stop in (4c), although the distribution of each remains distinct. However, the form in (4d) indicates that even lenis stops are susceptible to weakening in foot-internal position. In this case the lenition process targets the laryngeal specification |H|; and once |H| is suppressed, its associated property 'short/no voicing lag' is also removed from the expression, thereby allowing spontaneous voicing to be heard.

To conclude this section, consider the distribution of stop categories in Swedish. This is another aspiration language, and therefore we assume that |H| is active as a laryngeal property in Swedish, as it is in English. We also analyse Swedish aspiration as we did for English, where aspirated stops are represented by headed structures containing |H̲|. The distribution of aspirated stops in Swedish seems to support this analysis, because once again it appears to be prosodically conditioned. In the case of Swedish, however, it is the beginning of the word domain that supports aspirated stops, while in intervocalic and final positions the headed expression loses its headed status and is interpreted as fortis unaspirated (Ringen and Helgason 2004; Petrova *et al.* 2006):

(5) Laryngeal properties in *Swedish*

| | | | | |
|---|---|---|---|---|
| a. | [pʰ]acka | 'pack' | \|ʔ U H̲\| | word-initial |
| b. | kö[p]a | 'buy' | \|ʔ U H\| | word-medial |
| c. | kö[p]-te | 'bought' | \|ʔ U H\| | obstruent cluster |

The forms in (5) show an alternation between aspirated and non-aspirated which is similar to the one observed in English. In Swedish, however, word-initial is the only prosodically strong position where aspiration (from headed |H̲|) can be interpreted, as in (5a). Elsewhere the fortis stop remains fortis (as indicated by the presence of |H|) but loses aspiration. In fact we do find some degree of phonetic variation in the interpretation of this lenited expression, which is unaspirated for some speakers but slightly pre-aspirated for others.

## 6. Headed |ʔ̲| in ejective stops

In the preceding section we highlighted a relation between prosodically strong positions and melodically headed expressions involving a headed |H̲|. But to determine whether this relation is part of a more general pattern, we need to examine other headed expressions and observe their behaviour with respect to prosodic structure too. Here we focus on the distribution of expressions containing a headed |ʔ̲|, then in §7 we turn to the behaviour of structures with headed |N̲|.

The element written as |ʔ| is dubbed the 'stop' element because it represents the drop in amplitude which is present in the spectral profile of oral stops, nasal stops and some laterals. Now, if |H| can contribute to an expression as either a head or a non-head, like we have just seen in §5, then we expect the same to be true of |ʔ|. And similarly, we expect the difference between |ʔ| and |ʔ̲| to carry some linguistic significance. Taking these points into account, we follow recent proposals (Backley and Nasukawa 2006; Bellem 2004) and argue that in a structure containing a headed |ʔ̲| the relevant acoustic cue – namely, a sharp decrease in amplitude – dominates the expression. Headedness renders the amplitude drop more sudden, perhaps longer, and perceptually more salient. In phonological terms, this suggests a suitable representation for the series of ejective stops[5] found in many languages of Eastern and Southern Africa as well as the Americas.

It may be felt that this offers too straightforward a solution to the representation of ejectives, and that the relatively rare status of ejectives is not compatible with this level of formal simplicity. In fact, ejectives are more common cross-linguistically than is generally acknowledged – around 15% of languages make a contrast between plain and ejective stops; this fact gives ejectives a relatively unmarked status as a consonant category.

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[5] Although more phonological evidence is needed, it may be that (pre-)glottalised stops are also represented by structures containing a headed |ʔ̲|. Like ejectives, their acoustic profile is dominated by their occlusion properties.

As such, it seems entirely appropriate that the relatively simple structure |ʔ̲| should be used to represent this relatively unexceptional class of sounds, and we therefore maintain that languages with an ejective series of stops employ a headed |ʔ̲| in their melodic structure. Additionally, and in line with the previous discussion of aspiration and voicelessness, our proposal for the interpretation of headed |ʔ̲| has the advantage of capturing an implicational relationship between ejectives and plain stops, such that the description of an ejective stop (containing enhanced or headed |ʔ̲|) subsumes the description of a plain oral stop (with |ʔ|), but not vice versa.

Extending the analysis of |ʔ̲| to the behaviour of ejectives in other languages, let us consider the case of Korean. This language has a set of fortis stops usually labelled ‘tense’, which we claim to be the interpretation of |ʔ̲|-headed expressions. This tense series belongs to the well-documented three-way laryngeal split among voiceless stops in Korean: lenis (or lax) vs. fortis (or tense) vs. aspirated. Various sources (e.g. Kagaya 1974; Cho and Keating 2001) argue that the fortis and aspirated sets are marked by their own positive laryngeal properties, which, in the above sources, are mainly described in articulatory terms. Importantly, these marked laryngeal properties are assumed to be absent from the lenis series. It therefore seems appropriate to have this asymmetry reflected in the phonology by referring to the difference between headed and non-headed expressions. We propose the following structural distinctions:

(6) Laryngeal distinctions in *Korean*

<table>
<tr><th colspan="3"><em>category</em></th><th colspan="2"><em>description</em></th><th colspan="2"><em>examples</em></th></tr>
<tr><td>a.</td><td>[p]</td><td>(lenis)</td><td>light aspiration</td><td>|ʔ U H|</td><td>[paŋ]</td><td>‘room’</td></tr>
<tr><td>b.</td><td>[p’][6]</td><td>(fortis)</td><td>glottal reinforcement</td><td>|ʔ̲ U H|</td><td>[p’aŋ]</td><td>‘bread’</td></tr>
<tr><td>c.</td><td>[pʰ]</td><td>(aspirated)</td><td>heavy aspiration</td><td>|ʔ U H̲|</td><td>[pʰaŋ]</td><td>‘bang’</td></tr>
</table>

Just as in English and Swedish, the presence of headed expressions in Korean is conditioned by prosodic structure. Word-initial position behaves as prosodically strong, informationally rich and perceptually significant, as reflected in the way it supports the maximal three-way laryngeal contrast shown in (6). Predictably, these neutralise to a lenis stop in standard weak

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[6] The literature sometimes refers to the fortis series as ‘glottalised’, which is in fact a more appropriate label to use here. Moreover, this description is backed up by studies of the physical properties of these stops (Hirose, Lee and Ushijima 1974; Dart 1987).

positions such as the syllable coda, word-finally, and before another obstruent. The literature does show some variation in the precise phonetic interpretation of these neutralised stops, with reports describing a range of realisations from ‘unreleased’ through ‘weakly released’ to ‘released with a brief burst.’ However, we do not see this variation as bearing any linguistic importance. Rather, each possible interpretation suggests the absence of any predominant laryngeal specification, which we assume corresponds to the non-headed structure |ʔ U H| given in (6) for the lenis series. This neutralised structure contains the melodic content common to all three stop categories, but without any headedness relation. Of course, headedness is removed from these weak positions because it is precisely in these positions that headedness ceases to have any prosodic marking function to carry out.

One final point should be mentioned about osbtruent weakening in Korean – namely, that lenis stops are phonetically voiced between vowels (e.g. *papo* [pabo] ‘fool’). Yet in all other respects, the phonology of Korean gives no indication that voicing is an active property in the obstruent system of this language. For this reason it would be a costly move, from the standpoint of any restrictive theory, to introduce a marked voicing feature at this point. One solution would be to treat this effect as nothing more than a case of spontaneous voicing; this is the kind of voicing that obstruents regularly undergo in intervocalic contexts, as observed in many unrelated languages. Alternatively, a phonological explanation does present itself if we assume that the neutralised structure |ʔ U H| undergoes further lenition to |ʔ U|, resulting in suppression of the element |H|. (It will be recalled that lenition within Element Theory involves the loss of some structural material from a segment’s representation, this material being either headedness or an element itself.) The effect of losing the voicelessness of |H| is that we remove the only property that offers any resistance to the natural and spontaneous voicing that characterises sonorant expressions, where ‘sonorant’ includes vowels, glides, approximants, nasals – in fact, any expression without |H| in its element structure.

It was noted earlier that ‘ejective’ is by no means uncommon as a phonological category. At the same time, however, ejective stops typically show a limited distribution: while functioning as contrastive sounds in syllable onsets, they have a tendency to be excluded from (i.e. neutralised in) syllable codas. This is true for a number of languages of the Americas such as Klamath, Cuzco Quechua, Maidu, Navajo and Dakota (Rimrott 2003). Significantly, this same distributional property is also seen in other laryngealised classes such as aspirated stops – a situation that is unsurprising if ejectives and aspirates are indeed united as a set by their headed melodic structures.

To close this section, let us consider the behaviour of ejective stops in (Cuzco) Quechua. In this language too, there are clear indications that ejectives are associated with strong prosodic positions. And by maintaining the assumption that ejectives are represented using a headed melodic structure (containing |ʔ̲|), this language further supports the proposal that information concerning the location of prosodically strong positions can be conveyed through melodic headedness. Like Korean, Quechua makes a lexical distinction between three series of stops (Parker 1997; Rimrott 2003):

(7) Laryngeal distinctions in (Cuzco) *Quechua*

| | | | |
|---|---|---|---|
| a. voiceless | [p t tʃ k q] | [tanta] | ‘collection’ |
| b. aspirated | [pʰ tʰ tʃʰ kʰ qʰ] | [tʰanta] | ‘old, used up’ |
| c. glottalised/ejective | [p’ t’ tʃ’ k’ q’] | [t’anta] | ‘bread’ |

As already mentioned, the three-way contrast in (7) operates only in syllable onsets. Specifically, the appearance of aspirated and ejective stops is limited to onset position, so that in the syllable coda all laryngeal distinctions are neutralised and only the voiceless stop can appear: for example, [maqt’a] ‘young man’ but *[maq’ta]. Further prosodic restrictions also apply to the headed expressions in (7b) and (7c). For instance, if a word contains a stop which is aspirated or glottalised, this will always be the first (onset) stop of the word: for example, [p’atay] ‘to bite’ but *[pat’ay]. In many cases this restriction has the effect of marking the left edge of a word domain as a strong position, as already observed in (5) for Swedish.[7]

Additionally, aspirated and glottalised stops appear in roots but never in suffixes (Quechua has no prefixes); on the assumption that morphological concatenation involves an asymmetric head-dependency relation with the root as the head, this again reflects the way these headed melodic structures are naturally drawn to strong prosodic units. And Quechua is not an isolated case. Among other affixing languages, we regularly see a full set of lexical contrasts and suprasegmental properties being supported in roots while only a subset of these is maintained in affixes. Yet what seldom oc-

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[7] The presence of an aspirated or ejective stop does not provide an entirely reliable way of identifying the beginning of a word domain, since a word-initial onset may contain a continuant consonant that cannot contain either of the laryngeal specifications |H| or |ʔ̲|: for example, [hayk’a] ‘how many?’.

curs is the reverse situation in which the full contrastive set belongs exclusively to affixes. In Japanese, for instance, lexical pitch accent is specified on verbal and adjectival roots but not on their suffixes. And in the Bantu language Chichewa (Mtenje 1985), which has a standard 5-vowel system, lexical mid vowels can appear in roots but not in suffixes. Element Theory (Harris and Moto 1994) provides a straightforward explanation for the Chichewa pattern based on the distinction between [e o] as compound expressions (containing two elements each) and [i u a] as simplex expressions (containing a single element each): the relative complexity of [e o] requires them to be licensed by a prosodically strong position associated with a root form, while those weaker positions associated with a dependent suffix form are able to license only simpler structures involving a single element. In Chichewa, then, melodic strength (in the form of segmental complexity) mirrors an asymmetry in prosodic strength as established by the head-dependent relation holding between a root and its suffix.

So, the evidence from Japanese and Chichewa indicates a difference in prosodic strength between roots and affixes, which is further supported by the facts of Quechua. In this language we have noted how ejective stops, which contain a headed |ʔ| in their melodic representation, are distributed in a way that shows a clear bias towards prosodically strong positions. This, in turn, lends support to the central claim of this paper, that prosodic strength is directly reflected in melodic strength, so that any headed melodic structure will have a natural tendency to be interpreted in stronger rather than weaker positions. We have now shown this to be the case for expressions containing headed |H| and |ʔ|; and in the following section we demonstrate how the same can be said for segments containing a headed |N| in their representation.

## 7. Headed |N| in voiced obstruents

Now consider one further series of obstruents for which a headed element structure has been proposed. In line with the theme of this paper, we again expect the distribution of these headed expressions to reflect prosodic strength relations.

According to standard versions of Element Theory, the laryngeal-source element |L| identifies the set of voiced obstruents in 'full voicing' languages such as Japanese, Russian, Spanish and French. These all maintain a two-way contrast between true voicing (i.e. long voicing lead) and neutral voicing (i.e. no voicing lag), which strongly suggests that the element |H| is not involved in laryngeal-source contrasts. Using Japanese as an example, (8) illustrates the contrastive function of |L| in obstruents:

(8) Laryngeal distinctions in *Japanese*
[p] neutral (no voicing lag) |ʔ U | [paɴ] ‘bread’
[b] fully voiced (long voicing lead) |ʔ U L| [baɴ] ‘evening’

For some time, however, there has been a movement within Element Theory towards abandoning |L| from melodic representations. For example, Cabrera-Abreu (2000) has proposed that |L| be removed from the representation of intonation patterns. Her arguments are based on the observation that low tone (= |L| in nuclear position) does not behave like a true phonological category, but rather, should be assigned by default to those prosodic boundaries that have no associated high tone |H|. This idea is in line with the wider goal of generative restrictiveness and with the general preference for reducing the overall size of the element set.

The obvious question then arises as to how, in the absence of the element |L|, fully voiced obstruents are to be represented. Nasukawa (1995, 2005) offers convincing evidence to support a merger of voicing and nasality under a single element |N| (formerly referred to as the ‘nasal’ element). One key advantage of this move is that it reflects the strong cross-linguistic correlation between nasality and voiced obstruents. This relation becomes apparent from the observation of the nasal-voice correlation in nasal harmony, as well as from processes such as postnasal voicing assimilation, the prenasalisation of voiced obstruents and voiced velar obstruent nasalisation. By taking voicing lead to be the salient acoustic cue provided by |N|, and by employing headedness as we have already done for |H| and |ʔ|, then the three-way laryngeal division in (9) is able to incorporate both voicing and nasality within the scope of a single element:

(9) Degrees of voicing lead
[p] neutral (no/short voicing lag) | | (= laryngeal unspecified)
[m] nasal (short voicing lead) |N| (= |N| present in signal)
[b] fully voiced (long voicing lead) |$\underline{\text{N}}$| (= |N| prominent in signal)

Once more, the structural difference between a headed and a non-headed expression reflects the relative strength of the acoustic cue provided by the element in question; in the present case it is the |N| element, and its primary acoustic cue is voicing lead. In (9) the absence of |N| is interpreted as neutral voicing, which represents the default laryngeal state. Then if |N| is present in its non-headed form, it is interpreted as nasality. But if the same element is headed and therefore prominent in the acoustic signal, it is interpreted as full obstruent voicing.

Nasukawa (2005: 26) provides evidence to support the choice of assigning head status to voicing rather than to nasality. First, an implicational universal exists between the two properties:

(10) Typology of nasal and long voicing lead

| | *nasal* | *long lead* |
|---|---|---|
| Quileute | ✗ | ✗ |
| Finnish, English | ✓ | ✗ |
| (none) | ✗ | ✓ |
| Dutch, French, Thai | ✓ | ✓ |

As (10) shows, we never find a language which has no nasals but which does have plosives with long-lead voicing. In other words, the presence of long-lead voicing implies the presence of nasal. This implicational universal is reflected in the headship relation, such that the existence of a headed element (here, |N̲|/voicing) implies the existence of its non-headed counterpart (here, |N|/nasality). Second, there is the question of universality. Almost all languages exploit nasality as a contrastive property, whereas long lead voicing is parametrically controlled. The optional status of voicing is reflected in the similarly optional status of headedness: in some languages |N| is permitted to act as the head of an expression, while in others this is not a structural possibility. Third, Element Theory assumes there is a difference in complexity between nasality and voicing – when an element exists as a head, this adds to its structural complexity. And in the analysis of prenasalisation and velar nasalisation (Nasukawa 1999), nasality is shown to be less complex than voicing, since the latter is often suppressed in weak intervocalic contexts and nasality is interpreted in its place. This occurs in several Bantu languages, as well as in some Western Indonesian languages and dialects of Japanese. As we have demonstrated throughout this paper, and as Harris (1994, 1997) has discussed in detail, segmental structure is typically less complex in weak positions than in strong positions.

Having motivated the representation of nasality as |N| and voicing as |N̲|, let us close this section by analysing data from a dialect of Japanese in order to demonstrate the three degrees of voicing lead described in (9). The Northern Tohoku dialect of Japanese (henceforth NTJ) in (11) provides a useful illustration, as its laryngeal system displays positional alternations involving the distribution of headedness. This is similar to the headship alternation that we have already noted for |H̲| and |ʔ̲|. In NTJ we observe how the distribution of headed |N̲| is sensitive to prosodic strength, where the relevant prosodic domain is the foot:

(11) Laryngeal properties in *Northern Tohoku Japanese*

| | | | | | | |
|---|---|---|---|---|---|---|
| a. | [b] | fully voiced | foot-initial | [biɴ] | ‘bottle’ | \|ʔ U H N̲\| |
| b. | [$^{\mathrm{m}}$b] | prenasalised | foot-internal | [sa$^{\mathrm{m}}$bi] | ‘rust’ | \|ʔ U H N\| |
| c. | [p] | neutral | foot-initial | [petto] | ‘pet’ | \|ʔ U H \| |
| | | | foot-internal | [papa] | ‘daddy’ | \|ʔ U H \| |

Because foot-initial position is prosodically strong in NTJ, the form in (11a) allows the fully voiced [b] to appear. This is the interpretation of a headed melodic structure containing |N̲|. In contrast, the form in (11b) shows the same expression in a weak intervocalic position, interpreted as the prenasalised stop [$^{\mathrm{m}}$b]. Following a similar line of argument as above, this suggests that [$^{\mathrm{m}}$b] is a lenited form of [b], which is expressed phonologically by the change in headship status from headed to non-headed. So once more, headedness is retained and interpreted by a prosodically strong position, because it is fulfils its role of marking out the edge of a prosodic domain. But when no such boundary is present (e.g. in foot-internal position), headedness is lost and a weaker form of the stop is interpreted. As expected, the neutral stop in (11c) shows no alternation of headedness according to its position, because it is lexically non-headed and has no laryngeal specification. Although singleton [p] has no place in the native lexicon of Japanese, this pattern does emerge in loanwords (e.g. [petto] ‘pet’, [pea] ‘pair’) and mimetic words (e.g. [papa] ‘daddy’, [potapota] ‘dribbling’).

## 8. Further examples of melody-prosody interaction

Finally, we end this study of the relation between prosodic and melodic strength by considering data from Thai and Bengali. These two systems provide further support for the claim that the location of prosodic domain boundaries is indicated by the presence of headed melodic structures. Thai and Bengali have been chosen because each has more than one stop series requiring a headed representation, and in both cases the headed series show similar behaviour in serving as prosodic markers.

Thai displays the three-way laryngeal-source contrast shown in (12). Following our earlier analysis, we assume here that headed |$\underline{\text{H}}$| and headed |$\underline{\text{N}}$| are both active in the phonology of this system:

(12) Laryngeal-source contrasts in *Thai*

| | *category* | | *example* | |
|---|---|---|---|---|
| [p] | voiceless unaspirated | \|ʔ U H \| | [paa] | 'forest' |
| [pʰ] | voiceless aspirated | \|ʔ U $\underline{\text{H}}$ \| | [pʰaa] | 'cut, slit' |
| [b] | voiced | \|ʔ U H $\underline{\text{N}}$\| | [baa] | 'shoulder' |

The word-initial stops in (12) are interpreted in their full lexical form, as they occur in a prosodically strong position. Like the analyses given above for |$\underline{\text{H}}$| in English, |$\underline{\text{ʔ}}$| in Korean and |$\underline{\text{N}}$| in Japanese, the element structure and headedness of the stop remain intact when the segment in question has the function of marking out the left (strong) edge of the prosodic domain.

While this three-way contrast is maintained word-initially, only stops from the voiceless unaspirated series may appear in other positions. In fact, owing to the morphological characteristics of Thai, any consonant which is not word-initial is typically word-final – an archetypal weak position. The failure of aspirated and voiced stops to appear word-finally results in laryngeal neutralisation (Abramson 1972), as shown in (13):

(13) Domain-final neutralisation in Thai

| | | | | | |
|---|---|---|---|---|---|
| [kop] | 'mat rush' | [p] | = | \|ʔ U H\| | *[kopʰ], *[kob] |
| [kot] | 'push' | [t] | = | \|ʔ R H\|[8] | *[kotʰ], *[kod] |
| [kok] | 'flog' | [k] | = | \|ʔ @ H\| | *[kokʰ], *[kog] |

As already observed, an expression occurring in a weak position has no prosodic function to perform; and to reflect this, we expect some loss of linguistic information from that expression. In §5–7 we showed how this was brought about by suppressing some of the melodic material in the segment's representation; the target was typically melodic headedness, since a headed expression was taken as a clear indicator of prosodic strength, not weakness. The same is true of Thai, where headed |$\underline{\text{N}}$| is suppressed entirely at the right edge of a prosodic domain, thereby disallowing voiced stops, and |$\underline{\text{H}}$| loses its headed status. The remaining

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[8] Here we follow the Element Theory tradition of employing |R| to represent coronal resonance and @ to represent velar. For an alternative view of resonance elements in consonants, see Nasukawa and Backley (2008).

non-headed |H| is associated with the audible release phase of the neutralised forms [p t k].

As a final illustration of the correlation between melodic and prosodic strength, consider the system of laryngeal-source contrasts patterns in Bengali (Indo-Aryan). The stop system of Bengali is unusual in typological terms – though typical of its own language group – in that it supports a four-way laryngeal-source distinction in stops:

(14) Laryngeal distinctions in *Bengali*

| | *category* | | *examples* | |
|---|---|---|---|---|
| [p] | voiceless unaspirated | \|ʔ U H \| | [pandita] | 'wise' |
| [p$^h$] | voiceless aspirated | \|ʔ U H̲ \| | [p$^h$arasā] | 'fair, clear' |
| [b] | voiced unaspirated | \|ʔ U H N̲\| | [barga] | 'tribe, species' |
| [b$^h$] | breathy voiced | \|ʔ U H̲ N̲\| | [b$^h$asma] | 'ashes' |

The examples in (14) indicate that the full set of laryngeal contrasts is supported in the inherently strong word-initial position; this is true not just for the labial stops shown but for the stop system as a whole, including the dental, retroflex, palato-alveolar and velar series. The first three laryngeal categories in (14) are structurally identical to those given in (12) for Thai. What distinguishes Bengali is the way it also allows the headed elements |H̲| and |N̲| to be interpreted in the same consonant expression, creating a 'breathy voiced' or 'voiced aspirated' category. As the latter term suggests, this category combines the full voicing properties of |N̲| with the aspiration properties of |H̲| within a single melodic expression.

So, voiced aspirates like [b$^h$] contain two headed elements |N̲| and |H̲|, rather than just a single head.[9] On the one hand, double headedness appears to give such expressions a relatively marked status in consonant inventories. And on the other hand, given our proposal that headedness increases a segment's melodic strength, it renders these expressions particularly strong and suggests that they should show a particular affinity with prosodically strong positions. Conversely, when a voiced aspirate appears in a weak position we predict that it should be especially prone to lenition; we further predict that a lenition process will target the very source of the expression's melodic strength, namely its headed elements. As (15) shows, this is what happens in Bengali (data from Kenstowicz 1994: 193–194):

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[9] Further investigation is needed on the question of whether an expression containing two headed elements is grammatical or not. Here, however, the data suggest that this is a structural possibility in some languages.

(15) Effects of morphological concatenation in *Bengali*

| | | | | | | |
|---|---|---|---|---|---|---|
| [pɔt$^h$] | ‘road’ | + | [dæk$^h$a] | ‘seeing’ | → | pɔd-dæk$^h$a |
| [mač] | ‘fish’ | + | [d$^h$ɔra] | ‘catching’ | → | maǰ-d$^h$ɔra |
| [pãč] | ‘five’ | + | [gun] | ‘times’ | → | pãǰ-gun |
| [lab$^h$] | ‘profit’ | + | [kɔra] | ‘making’ | → | lap-kɔra |
| [šat] | ‘seven’ | + | [b$^h$ali] | ‘brothers’ | → | šad-b$^h$ali |
| [lob$^h$] | ‘greed’ | + | [t$^h$aka] | ‘remaining’ | → | lop-t$^h$aka |
| [mɔd] | ‘alcohol’ | + | [k$^h$aoa] | ‘drinking’ | → | mɔt-k$^h$aoa |

The morphologically complex forms (rightmost) contain medial CC sequences in which the second consonant position supports a full set of laryngeal contrasts whereas the first supports none. However, this difference makes sense once we take into account the unequal prosodic status of the two respective positions. The second consonant occupies a strong position – the domain-initial position of the latter morpheme – which allows any headed expression (containing |N̲| or |H̲| or both) to be interpreted in full (e.g. [šad-**b$^h$**ali]). In contrast, the first consonant in the CC sequence occupies the weak domain-final position marking the end of the first morpheme, and it is in this position that we find the four-way laryngeal contrast neutralised to a voiceless unaspirated stop (e.g. [la**p**-kɔra]). In fact, this choice of a voiceless unaspirated stop as the neutralising form is expected, on the basis that this is the only category in (14) not represented by a headed melodic expression. In this way, Bengali provides further evidence in support of the connection between strong/weak prosodic positions and headed/non-headed melodic expressions.[10]

## 9. Summary

This paper has examined the notion of phonological strength from both the prosodic and melodic angles, and has highlighted some important ways in which these two are closely linked. In fact, the connection between prosodic strength and melodic strength appears to be so strong that one cannot be fully explained without reference to the other.

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[10] An independent process of regressive voicing assimilation is also operating in (15), resulting in forms such as [maǰ-d$^h$ɔra] (*[mač-d$^h$ɔra]). As expected, the source of |N̲|-assimilation is the strong (second) consonant position in the CC sequence.

By adopting an Element Theory approach to segmental structure we have been able to exploit one of the characteristics of this model – melodic headship – in our formal definition of melodic strength. An element whose acoustic properties dominate an expression is deemed the head of that expression, and we have argued that having a melodic head contributes to an expression's melodic strength: the presence of a head element renders the whole expression acoustically more prominent and perceptually more salient. Furthermore, we have claimed that the distribution of headed expressions is sensitive to prosodic strength. Although the general literature makes frequent reference to strong and weak prosodic positions, it has shown little interest in explaining why this distinction exists. In this paper, however, we have developed a definition of prosodic strength in which a strong position is one that assists language processing by indicating to listeners the location of a prosodic (typically foot or word) domain. It draws attention to the (usually, left) edge of the domain by making this position sound perceptually more prominent, where perceptual prominence is achieved by allowing a strong (i.e. headed) melodic structure to be interpreted in that position.

To demonstrate the intrinsic relation between melodic and prosodic strength, we first argued that aspirated stops, ejective stops and fully voiced stops all require headed structures in their respective melodic representations. We then considered data from a range of languages which showed how these headed structures are naturally interpreted in strong prosodic positions. Conversely, when the same expressions appear in weak environments we observe alternation effects whereby they lose their headed status. This loss of headedness operates as a means of redressing the balance between the strength of the melodic structure and the strength of the position where that structure is interpreted. In the future we would like to extend the scope of this study by examining whether a similar melody-prosody relation controls the distribution of vowel expressions too.

## Acknowledgements

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# Transparency in nasal harmony and the limits of reductionism

*Bert Botma*

## 1. Introduction

The phenomenon of nasal harmony, in which nasality surfaces as a property of not just one segment but of a string of segments, has proved a fruitful testing ground for theories of segmental structure. This is due not only to the rich typology of nasal harmony systems, but also because the study of nasal harmony brings together a number of important issues in segmental phonology, e.g. the status of non-local assimilation, the relevance of prosodic units such as the syllable, the nature of phonological features and the relative abstractness of phonological representations.

Since the 1990s a number of representational approaches have been advanced to account for the various nasal harmony patterns that are found in languages of the world (see e.g. Piggott 1992, 1996; Nasukawa 1995, 1997, 2005; Piggott and van der Hulst 1997; Ploch 1999; Botma 2004; Botma and Smith 2007). What unites these approaches is that they take a reductionist stance as to the content and the structure of phonological representations. The aim of this paper is to review three reductionist claims that have been advanced in these approaches, against the backdrop of the element-based dependency model of Botma (2004). These claims are stated in (1):

(1) a. The representation of nasalisation and obstruent voicing in terms of a single element.
    b. The location of harmonic nasality at the level of the syllable in languages where voiceless obstruents are transparent.
    c. The recognition of an underlying category of 'sonorant stops' in languages where nasals are in complementary distribution with voiced oral stops.

As we will see, these claims make crucial reference to the concept of head-dependency relations (for a general discussion of this concept, see Ewen 1995). Such relations are asymmetric, in that one element, i.e. the 'head', is stronger, or more prominent, than the other, i.e. the 'dependent'. Head-dependency relations can therefore be viewed as a general instantiation of phonological ‘strength’.

Two types of head-dependency relations are of importance in this paper. First, in respect of (1a), the element-based dependency approach relies on the context-sensitive interpretation of a small number of elements. One of these is |L|, which denotes sonorancy, voicing or nasalisation, depending on its position in the phonological structure (see Ploch 1999; Nasukawa 2005 for related approaches). If |L| occurs as head, the segment is identified as a sonorant. If it occurs as dependent, the segment is voiced or nasalised, depending on the type of head to which |L| is associated. This account is in principle more restrictive than a traditional feature-based account, which requires at least three features, viz. [sonorant], [voice] and [nasal].

Second, in respect of (1b), Botma (2004) argues that the transparency of voiceless obstruents, which is a property of some nasal harmony systems, is captured if nasalisation operates at the syllabic level (see also Piggott and van der Hulst 1997; Nasukawa 2005). This makes it possible to express the harmony as nucleus-to-nucleus spreading, which automatically accounts for the fact that intervening voiceless obstruents are skipped. Here, too, we are dealing with a manifestation of relative strength: an element associated to the head position of a syllable, i.e. the nucleus, has greater autosegmental scope than an element associated to a non-head position such as the onset.

As to (1c), Botma claims that the context-sensitive interpretation of |L| offers a straightforward account of the nasal harmony pattern in languages like Tuyuca and Southern Barasano. This pattern is characterised by the transparency of voiceless obstruents and by a complementary distribution between nasals and voiced oral stops. Following Piggott (1992), Botma argues that in this pattern the harmonic targets are restricted to sonorants. This analysis implies that Tuyuca and Southern Barasano lack underlying nasals. Nasals in these languages are instead derived from voiced stops, which function as sonorants. Furthermore, if nasality is uniquely specified at the level of the syllable, which, according to Piggott and van der Hulst, is the case for Southern Barasano, (1c) is a corollary of (1b).

In this paper I evaluate the claims in (1) against the harmony pattern of Yuhup, a Makú language of Amazonia. As we will see, the Yuhup pattern suggests that the context-sensitive interpretation of |L| can be maintained, but that modifications are required in respect of the underlying status of nasals and of the prosodic level at which nasal harmony operates. More specifically, we will see that nasality in Yuhup cannot be reduced to a syllable-level property, but must be specified on both the syllabic and the segmental levels. This suggests, therefore, that there are limits to a reductionist, syllabic approach to transparent nasal harmony systems. Rather, the possibility of such an approach must be determined on a language-specific basis.

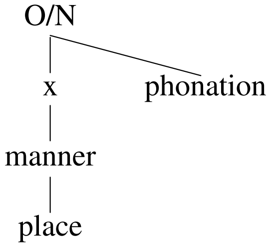
The paper is organised as follows. First, in §2, I outline the main tenets of the element-based dependency approach, paying particular attention to the claim that nasalisation and voicing are both represented by the element |L|. Next, in §3, I focus on nasal harmony systems that involve obstruent transparency. I discuss the status of the voiced oral stop series that arguably underlies the nasals in these systems (§3.1), and examine the extent to which harmonic nasality can be viewed as a property of the syllable (§3.2). This sets the stage for an analysis of Yuhup, which I present in §4. In §5, I discuss the implications of the Yuhup system for the status of syllable nasalisation. §6 concludes.

## 2. Element-based dependency

In representational approaches to segment-internal structure there are two strategies that can be labelled 'reductionist'. The first involves a reduction in the number of features or elements, e.g. by means of underspecification or monovalency (for a general discussion, see e.g. Ewen and van der Hulst 2001). The second involves a reduction in the types of possible structures. Perhaps the clearest examples of this are approaches that use head-dependency relations, such as dependency phonology (e.g. Anderson and Ewen 1987), radical CV phonology (van der Hulst 1995), head-driven phonology (van der Hulst and Ritter 1999), as well as certain versions of element theory (Botma 2004; Botma and Smith 2006, 2007). Indeed, the distinction between heads and dependents makes it possible to reduce the number of features, since one and the same feature can be assigned a different interpretation depending on whether it occurs as head or dependent.

The context-sensitive interpretation of elements figures prominently in the approach of Botma (2004), which combines insights from dependency phonology (see especially Anderson and Ewen 1987) and element theory (Harris and Lindsey 1995). Botma assumes the segmental structure in (2), where O and N are onset and nucleus respectively. (Unless otherwise noted, consonants are dominated by onsets and vowels by nuclei.)

(2)



In (2) the manner and place components together form what may be termed the segmental ‘core’. This expresses the observation that it is unmarked for a segment to be specified for manner and place, but marked to be specified for phonation. Following Kehrein (2002), the phonation component forms a dependent of a subsyllabic constituent rather than of an individual segment, as is traditionally assumed (see also Botma 2003; Kehrein and Golston 2004). This predicts that a subsyllabic constituent can have at most one laryngeal contrast. The implementation of this contrast is language-specific. A contrastively aspirated /p/, for example, can be realised as either pre- or postaspirated; however, (2) predicts that no language contrasts /p$^h$/ with /$^h$p/, at least not in the same syllabic position.

Element-based dependency uses a subset of the elements of element theory, the ‘amplitude drop’ element |ʔ|, the ‘high-tone’ element |H| and the ‘low-tone’ element |L|. |ʔ,H,L| represent the manner and laryngeal aspects of segments.[1] As manner elements, they have the following articulatory and acoustic correlates.

(3)

| | | *Articulatory interpretation* | *Acoustic interpretation* |
|---|---|---|---|
| ʔ | : | complete closure | energy reduction |
| H | : | close approximation | aperiodicity |
| L | : | open approximation | periodicity |

The articulatory correlates of |ʔ,H,L| correspond to the traditional three-way manner distinction in terms of the degree of oral stricture. In the absence of place |ʔ,H,L| have an ‘autonomous’ interpretation: |ʔ| denotes [ʔ], |H| [h] and |L| a ‘placeless’ vowel, typically [ə]. In combination with place, |ʔ,H,L| denote plosive, sibilant and vocalic manner respectively. This is motivated

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[1] As their names suggest, |H| and |L| also denote high and low tone respectively. In this paper I will not be concerned with tone.

by the observation that plosives, sibilants and vowels are the unmarked segmental instantiations of the properties associated with |ʔ,H,L|.[2]

|  |  |  |  |  |
|---|---|---|---|---|
| (4) | ʔ | : | plosive | (unmarked stop type) |
|  | H | : | sibilant | (unmarked fricative type) |
|  | L | : | vowel | (unmarked sonorant type) |

Consider the structures in (5), where I assume that the place elements |A,I,U| denote velar, coronal and labial place in consonants, and lowness, frontness and roundness in vowels respectively (for a similar treatment of place, see van de Weijer 1996 and references therein).

|  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| (5) | a. | O | b. | O | c. | O | d. | N |
|  |  | \| |  | \| |  | \| |  | \| |
|  |  | x |  | x |  | x |  | x |
|  |  | \| |  | \| |  | \| |  | \| |
|  |  | ʔ |  | H |  | L |  | L |
|  |  | \| |  | \| |  | \| |  | \| |
|  |  | A |  | I |  | U |  | U |
|  |  | /k/ |  | /s/ |  | /w/ |  | /u/ |

In (5cd) the difference between a vocalic and a consonantal realisation depends on whether the |L| is dominated by an onset or a nucleus.

|ʔ,H,L| can also enter into dominance relations, giving ‘complex’ manner types. In this paper I restrict my attention to the manner type in which |L| dominates |ʔ|. This structure involves a combination of sonorancy and stopness; the resulting segment type is a ‘sonorant stop’, as in the example in (6).

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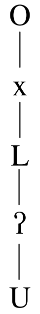
[2] For arguments that sibilants are the unmarked fricative type, see Anderson and Ewen (1987) and Smith (2000).

(6)



[m~b~$^{m}$b~b$^{m}$]

The dominance relation in (6) is motivated by the interaction between manner and prosodic interpretation on the one hand, and manner and place on the other. Sonorant stops function as sonorants for the purposes of prosodic interpretation. Therefore, their sonority is expected to be visible to processes that are prosodically conditioned (such as the type of nasal harmony that is discussed in §3). The 'dominated' |ʔ| in the manner component indicates that sonorant stops have available the same range of place distinctions as obstruent stops, i.e. plosives. This is corroborated by typological evidence: in the UPSID database (cf. Maddieson 1984), the range of place contrasts in nasals (the typical realisation of a sonorant stop) generally matches that of plosives.

The realisation of sonorant stops is variable. It ranges between a nasal, a voiced oral consonant and a nasal contour, i.e. a pre- or post-nasalised stop. This variability is in part a matter of free variation and is in part dependent on the phonological system of the language in question. Sonorant stops are typically realised as nasals, presumably because the acoustic signature of nasals offers perceptually the most salient compromise between sonorancy and stopness.[3]

An example of a language in which the realisation of sonorant stops is variable is Rotokas, a Papuan language of New Guinea. Firchow and Firchow (1969) describe two dialects. 'Rotokas A' contrasts voiceless stops and nasals. 'Rotokas B' has a surface contrast between voiceless stops and a series of consonants that is realised as voiced, with variable continuancy and nasality.

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[3] Nasals, on the other hand, are not always represented as 'bare' sonorant stops. In languages where nasals are phonologically active, e.g. because they trigger voicing or nasalisation, they are represented as sonorant stops with an additional dependent |L|. For discussion of this, see Botma (2004).

| (7) | *Rotokas A* | | | *Rotokas B* | | |
|---|---|---|---|---|---|---|
| | p | t | k | p | t | k |
| | m | n | ŋ | b~β~m | d~r~l~n | ɡ~ɣ~ŋ |

Firchow and Firchow (1969: 274) note that nasal realisations in Rotokas B are “rarely heard except when a native speaker is trying to imitate a foreigner’s attempt at speaking Rotokas”. Following Rice (1993), I analyse the voiced consonants in (7) as sonorant stops, and assume that their variable realisations in Rotokas B represent different phonetic options. According to this account Rotokas B is marked because it lacks a surface contrast between oral and nasal stops.[4] However, like most, perhaps all, languages it contrasts a series of obstruent stops with a series of sonorant stops.

In other languages the realisation of sonorant stops is determined by the phonological system. This is the case in languages where nasals alternate with voiced oral stops. An example is Cama, a Kwa language of the Ivory Coast, where voiced ‘lenis’ stops are realised as nasals in the context of a following nasalised vowel (Stewart 1973; Botma and Smith 2006). Botma and Smith treat the alternating segments as non-nasalised sonorant stops, i.e. as structures of the kind in (6), and derive the nasal allophones by means of vowel nasalisation. The sonorant status of the voiced lenis stops of Kwa is corroborated by their realisation, which is ‘non-explosive’ (cf. Clements and Osu 2002), and by their behaviour (cf. Clements 2000).

Other examples of languages in which the realisation of sonorant stops is conditioned by phonological factors are Tuyuca and Southern Barasano – languages where nasals are in complementary distribution with voiced oral stops. I consider these languages in more detail in §3.

## 2.1. The representation of laryngeal structure

In element-based dependency |ʔ,H,L| represent not only the manner but also the laryngeal properties of segments.[5] The former occupy the head

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[4] Rotokas is one of a handful of languages in UPSID that lack nasals; apparently, Maddieson’s data have been taken from Rotokas B.

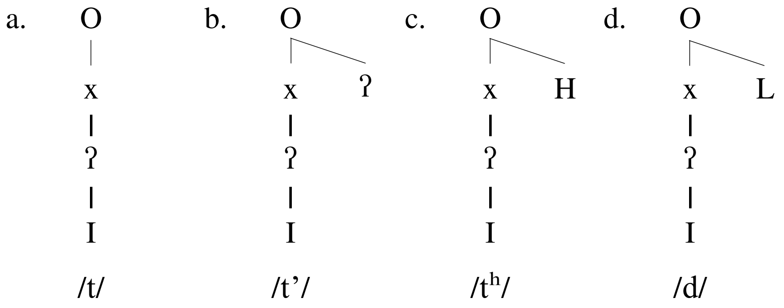
[5] Much of the discussion in §2.1 and §2.2 recapitulates that of Botma and Smith (2007: 37–40).

manner component, the latter the dependent phonation component. As laryngeal elements, |ʔ,H,L| have the following interpretation.

(8) ʔ : glottal constriction
H : glottal widening
L : voice/nasalisation

Thus, (9a) represents a coronal stop [t], containing a manner component |ʔ| dominating |I|. (9b–d) represent more marked options. (9b) has a dependent |ʔ|, and denotes a coronal stop with glottal constriction; a frequent realisation is [t']. (9c) has a dependent |H|, and is typically realised as [tʰ]. The coronal stop with dependent |L| in (9d) denotes voiced [d].

(9)



The maximally restrictive hypothesis is that the phonation component is limited to at most a single element. This would be in line with the idea that heads permit greater complexity than dependents (see e.g. Dresher and van der Hulst 1995). Whether this can be maintained is of course an empirical issue, but will not be discussed here (though see §4).

The structures in (9) show that the interpretation of elements is context-sensitive. A case in point is |L|. The presence of |L| in the manner component identifies a segment as a sonorant.[6] The interpretation of |L| as a phonation element is variable: |L| denotes nasalisation if there is also an |L| in the manner head, and voicing if there is no |L| in the manner head. These possibilities are illustrated in (10).

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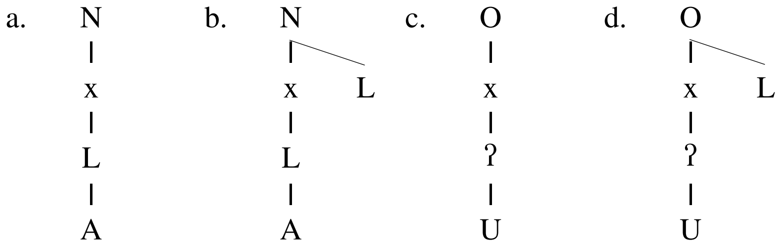
[6] A reviewer points out that |L| as a manner element is arguably redundant. This is not a move that I wish to make, for two reasons. First, in complex structures such as that of a sonorant stop the presence of |L| is contrastive with its absence. Second, manner elements do not just have a contrastive function, but they also determine the phonetic interpretation of laryngeal and place elements.

(10)



/a/ /ã/ /p/ /b/

(10a) represents the low vowel /a/; its manner component consists of |L|, which is dominated by the nucleus and itself dominates |A|. In (10b), nasalised /ã/ has an additional dependent |L|, which is interpreted as nasalisation because the manner head also contains an |L|. (10c) represents /p/. (10d), which represents /b/, has an additional dependent |L| that denotes voicing, since there is no |L| in the manner head. The interpretation of dependent |L| thus embodies the claim that nasalisation and voicing are in complementary distribution (for a similar claim, see Nasukawa 1995, 1997, 2005; Ploch 1999). In element-based dependency this is expressed by treating nasalisation on a structural par with laryngeal articulations.

## 2.2. The dual interpretation of dependent |L|

The interpretation of dependent |L| as voicing and nasalisation represents a shift away from the phonetic concreteness of elements. Nevertheless, there are a number of arguments in favour of such an approach. One is that it is restrictive, since it obviates the need for cooccurrence restrictions between sonorancy and voicing, and obstruency and nasalisation. Cross-linguistic evidence shows that languages have neither distinctively voiced sonorants nor distinctively nasalised obstruents.[7]

The dual interpretation of dependent |L| also permits an interpretation of post-nasal voicing, whereby a voiceless stop is realised as voiced under the influence of a preceding nasal. Post-nasal voicing can be represented as in

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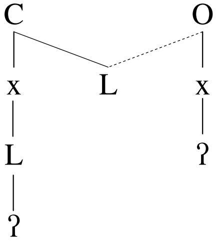
[7] This implies that nasal contours, which are potentially contrastive, are clusters; Downing (2005) offers an account along these lines. The nasal harmony systems discussed below have pre- and postnasalised stops, but these occur as the surface realisation of underlyingly simplex stops, and behave as sonorants.

(11), where |L| spreads from the plosive in the coda (C) to the nasal in the onset, where it is interpreted as voicing.[8]

(11)



Nasals in languages with post-nasal voicing are therefore phonologically ‘active’; I assume that such nasals are represented as sonorant stops with dependent nasalisation, as in (11).

Further support for the dual interpretation of dependent |L| comes from processes that trigger either nasalisation or voicing, depending on whether the target is an obstruent or a sonorant. An example of such a process is found in Navajo. Rice (1993) notes that the Navajo perfective is signalled by voicing of stem-final fricatives (12a) and by nasalisation of stem-final vowels (12b) (see also Botma 2004; Botma and Smith 2007).

| | | | | |
|---|---|---|---|---|
| (12) | a. | IMPERF | PERF | |
| | | -ʔaaɬ | -ʔaal | ‘chew’ |
| | | -ʔaaʃ | -ʔaaʒ | ‘few go’ |
| | | -loos | -looz | ‘lead’ |
| | b. | IMPERF | PERF | |
| | | -bi | -bĩ | ‘swim’ |
| | | -ʔa | -ʔã | classifier (small object) |
| | | -ka | -kã | classifier (contained object) |

These surface manifestations can be straightforwardly accounted for if the perfective morpheme is analysed as |L|, which is linked to the dependent position of the stem-final segment.

The evidence reviewed above suggests that there are good grounds to assume that nasalisation and voicing are represented by a single element,

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[8] The mirror image of this process appears to be unattested; apparently, |L| can spread from a sonorant to an obstruent, but not vice versa. This asymmetry requires further research.

viz. dependent |L|. In §3 we will see that this assumption is also supported by nasal harmony systems in which voiceless obstruents are transparent.

## 3. Properties of transparent nasal harmony systems

Typological research has shown that nasal harmony systems may vary in a number of respects (see Schourup 1973; Piggott 1988, 1992; Pulleyblank 1989; Walker 1998), including those in (13).

(13) *Parameters of nasal harmony*

  a. Trigger of nasalisation
  b. Domain of nasalisation
  c. Direction of nasalisation
  d. Target range of nasalisation
  e. Behaviour of non-targets

In (13d), the ‘target range’ refers to the range of segments that is compatible with nasalisation. In (13e), the ‘non-targets’ are those segments that are incompatible with nasalisation; these either block harmony or are transparent to it.

The extent to which the parameters in (13) are independent depends on one’s assumptions. For instance, if in some language nasality is limited to segments within a particular syllable, then an account which treats nasality as an underlying property of that syllable arguably collapses all parameters in (13). This reductionist approach has been applied to languages in which non-targets are transparent (see Piggott and van der Hulst 1997; Botma 2004; Nasukawa 2005). Consider for example the following data from Tuyuca, an Eastern Tucanoan language of Colombia (from Walker 1998).

| | | | | | | |
|---|---|---|---|---|---|---|
| (14) | a. | w̃ãã | ‘to illuminate’ | b. | mĩpĩ | ‘badger’ |
| | | h̃õõ | ‘there’ | | nĩtĩ | ‘coal’ |
| | | ẽmõ | ‘howler monkey’ | | tĩŋõ | ‘Yapara rapids’ |
| | | w̃ĩnõ | ‘wind’ | | ɲõsõ | ‘bird’ |

The harmonic forms in (14a), which contain sonorants and laryngeals only, surface as nasalised throughout.[9] Those in (14b) show that nasalisation is not always distributed across a contiguous string of segments, since voiceless obstruents are apparently skipped. This ‘long-distance’ pattern is by and large limited to South America, where it occurs in a number of Tucanoan, Tupi, Chibchan and Makú-Puinave languages.[10] I will refer to languages that display this pattern as ‘transparent systems’.

Transparent systems exhibit considerably less variation in the target range than systems in which non-targets block nasalisation. In the former only voiceless obstruents are transparent; all other segments are predictably harmonic. Below, I focus in more detail on two other properties which have been attributed to transparent systems: the presence of an underlying series of sonorant stops (§3.1) and the location of harmonic nasality at the level of the syllable (§3.2).

## 3.1. On the status of sonorant stops

One property of transparent systems is that they display a complementary distribution between a series of voiced oral stops and a series of nasals. The former occur in ‘oral words’, the latter in ‘nasal words’. This is illustrated by the following Tuyuca (near-)minimal pairs.

| | | | | | | |
|---|---|---|---|---|---|---|
| (15) | a. | *Oral words* | | b. | *Nasal words* | |
| | | bipi | ‘swollen’ | | mĩpĩ | ‘badger’ (cf. 14b) |
| | | diti | ‘to lose’ | | nĩtĩ | ‘coal’ (cf. 14b) |
| | | sɨge | ‘follow’ | | tĩŋõ | ‘Yapara rapids’ (cf. 14b) |
| | | oso | ‘bat’ | | ɲõsõ | ‘bird’ (cf. 14b) |
| | | pee | ‘to bend’ | | pẽẽ | ‘to prepare soup’ |
| | | sia | ‘to tie’ | | sĩã | ‘to kill’ |

This suggests that voiced oral stops and nasals share a single underlying representation. Different interpretations have been offered as to the nature

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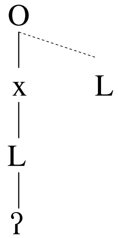
[9] I ignore the issue of nasalised laryngeals; for discussion of this, see Walker and Pullum (1999) and Botma (2004).

[10] A non-Amazonian example is Moba Yoruba, where, according to Archangeli and Pulleyblank (2007), both voiced and voiceless stops are transparent. This suggests that the voiced stops in this language pattern as obstruents and involve simple stop structures with a dependent |L|, i.e. as in (10d).

of this representation. According to one view, transparent systems involve nasalisation of all voiced segment types, such that sonorants are nasalised and voiced stops are turned into nasals (see e.g. Pulleyblank 1989; Noske 1995; Walker 1998). The problem with this approach is that it is stipulative, since it is unclear why voicing and nasalisation should have this affinity.

Alternatively, it has been suggested that this type of harmony is limited to sonorants (see e.g. Piggott 1992; Rice 1993; Botma 2004). This implies that the voiced oral stops in transparent systems function as sonorants. A strong argument for this position is that it permits a uniform account of the harmony process.[11] In element-based dependency, the generalisation is that nasalisation, i.e. dependent |L|, associates to all |L|-headed segments in the harmonic domain. This includes voiced oral stops, which are 'bare' sonorant stops underlyingly. As is shown in (16), association of dependent |L| to such stops yields a nasalised sonorant stop, i.e. a nasal.

(16)



This interpretation is similar to the feature-based analyses of Piggott (1992) and Rice (1993), where [nasal] associates to segments specified for SV, which replaces the traditional feature [sonorant]. However, an account in terms of |L| is arguably more restrictive, since it requires no more than a single element.

A second argument for positing an underlying class of sonorant stops is typological. As was noted in §2, most, and perhaps all, languages have an underlying contrast between obstruent and sonorant stops, with the latter typically realised as nasals. In transparent systems, however, the distribu-

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[11] Some transparent systems such as Tuyuca lack alternating stop-initial suffixes (e.g. [-pa~-pã], [-ba~-mã]). Barnes (1996) concludes from this that both the voiceless and voiced stops are obstruents, since this permits the generalisation that harmony in suffixes targets sonorants only (see also Walker 1998). It has also been proposed that this root–suffix asymmetry results from two distinct harmony systems (Botma 2004). Such a distinction would seem to be required in any case; compare e.g. the pattern of root–suffix interaction in Tucano, as discussed in Piggott and van der Hulst (1997).

tion of nasals is predictable, given that their nasal aspect is supplied by the context. This means that if the basic oral variants are taken to be obstruents, then transparent systems would lack an underlying contrast between obstruent and sonorant stops – a highly marked state of affairs.

The above considerations suggest that the underlying stop contrast in transparent systems is identical to that proposed for Rotokas in §2. It is interesting to observe in this respect that like Rotokas, many transparent systems display variability in the realisation of sonorant stops. For instance, Smith and Smith (1971) note that in Southern Barasano prenasalisation of voiced oral stops is obligatory word-initially and optional word-internally, as is shown by the 'oral words' in (17).

| | | | |
|---|---|---|---|
| (17) | $^{n}$diro | 'grasshopper' | (*diro) |
| | wa$^{m}$ba ~ waba | 'come!' | (*wã$^{m}$ba) |
| | $^{m}$ba$^{ŋ}$go ~ $^{m}$bago | 'eater' | (*$^{m}$bã$^{ŋ}$go) |
| | ta$^{m}$boti ~ taboti | 'grass' | (*tã$^{m}$boti) |

Different interpretations of this phenomenon have been offered in the literature. Noske (1995: 153), who is concerned with a similar phenomenon in Tucano, a language closely related to Southern Barasano, accounts for this kind of nasalisation by a spreading rule. On the other hand, Piggott (1992: 48) claims that "the nasal property of…prenasalised stops is epiphenomenal; it is directly derivable from the articulatory adjustments required to realise spontaneous voicing". The latter position is supported by the observation that the contours in (17) do not trigger nasalisation themselves; compare the impossibility of forms like *[wã$^{m}$ba].

Both Noske and Piggott observe that prenasalisation is predictable, but while Noske accounts for it in terms of a phonological process, Piggott shifts the explanatory burden to the phonetics. The difference between the two accounts is not entirely trivial. If it turns out that there are languages in which contours trigger nasalisation themselves, then Piggott's account is in trouble, while in Noske's account such nasalisation can in principle be ordered to apply after the creation of the contour. As we will see in §4, Yuhup seems to be such a language – though I will argue that the nasalising effect of contours in Yuhup is in fact only apparent.

## 3.2. Syllable nasalisation

A further property of transparent systems is that in fully harmonic words it is impossible to determine the direction of nasal spread. However, not all transparent systems have as their harmonic domain entire words. For instance, the description of Southern Barasano in Smith and Smith (1971) shows that the language has ‘oral’ words (18a), ‘nasal’ words (18b) and ‘disharmonic’ words (18c).

| | | | | | | |
|---|---|---|---|---|---|---|
| (18) | a. | *Oral words* | | b. | *Nasal words* | |
| | | wariaro | ‘pathway’ | | kãmõkã | ‘rattle’ |
| | | kahe | ‘eye’ | | mãsã | ‘people’ |
| | | ekare | ‘to feed’ | | mãnõ | ‘none’ |
| | | isia | ‘buttocks’ | | w̃ãtĩ | ‘demon’ |

| | | |
|---|---|---|
| c. | *Disharmonic words* | |
| | tu$^{n}$diamĩ | ‘he returns’ |
| | rimã | ‘poison’ |
| | romĩõ | ‘woman’ |
| | hiãmõkõnõ | ‘ten’ |

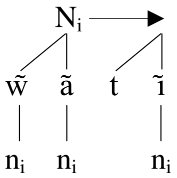
In the forms in (18c) it is possible to determine the direction of nasalisation. For instance, the form [hiãmõkõnõ] suggests that nasality is a lexical property of the vowel /ã/, from which it spreads rightwards, skipping any intervening obstruents. However, matters are complicated by the observation that any sonorant consonant directly preceding the leftmost nasalised vowel is also realised as nasalised, as is shown by the remaining forms in (18bc).

Piggott and van der Hulst (1997) conjecture that the Southern Barasano pattern receives a unified account if nasality is an underlying property of the leftmost syllable in the harmonic domain. Progressive harmony can then be analysed as a local process, i.e. as involving nasal spreading at the level of syllable heads; to this extent, Piggott and van der Hulst claim, this type of nasal harmony involves the same formal mechanism as vowel harmony. Thus, Piggott and van der Hulst assume that in a harmonic form like [w̃ãtĩ], nasality spreads from the first to the second vowel, skipping /t/. The same process is responsible for the second nasalised vowel in e.g. [mãnõ], although here the intervening consonant is also nasalised. Piggott and van der Hulst (1997: 102) claim that syllable-level nasality can also account for this:

> It is a fundamental principle of linguistic structure that the properties of the head of a construction are simultaneously the properties of the entire construction. Consequently, when [nasal] is associated with the head or nucleus of the syllable, it is automatically a feature of the syllable itself. It should, therefore, be realised on all the segments in the syllable that can be nasal bearing.

This leads them to the following account for the form [w̃ãtĩ]: harmonic nasality, represented by $N_i$, is underlyingly associated to the head of the first syllable, from which it spreads to the head of the second syllable. The nasalisation of the initial /w/, on the other hand, is an automatic result of the nasality of the following syllable head. This yields the surface form in (19), where all nasalised segments are specified for $n_i$, i.e. the phonetic instantiation of $N_i$ (cf. Piggott and van der Hulst 1997: 102).

(19)

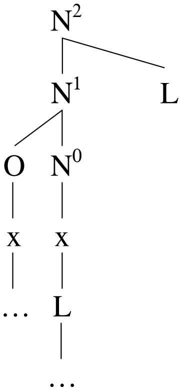


The surface distribution of nasality in (19) creates the impression that the harmony process is non-local. However, this is only apparent, since nasal spreading operates on the level of syllable heads, where it is local.

Piggott and van der Hulst's account faces a number of problems; the reader is referred to Nasukawa (2005: 121–123) for a detailed discussion of these. For the purposes of this paper, one problem is that Piggott and van der Hulst allow for the possibility of nasalised obstruents, so that they need an explanation for the transparency of the /t/ in [w̃ãtĩ]. To this end Piggott and van der Hulst argue that the feature [nasal] occupies a different structural position in sonorants and obstruents; [nasal] is a 'head' feature in sonorants and a 'dependent' feature in obstruents. This allows them to say that syllable nasalisation targets all segments in which [nasal] can occur as head. Unfortunately, however, Piggott and van der Hulst do not discuss the internal structure of nasalised segments in any detail, nor do they consider the relation between [nasal] and other features. For instance, it is unclear whether there is any further motivation for the different positions of [nasal], or in what way [nasal] can be said to be contrastive in obstruents.

To this extent at least, the element-based approach is arguably superior. Consider (20), where, following Levin (1985) and the tradition in dependency phonology (see e.g. Anderson and Ewen 1987; Ewen and Botma, this volume), I assume that the syllabic level corresponds to the $N^1$-projection of the nucleus $N^0$. Harmonic nasality, expressed by |L|, is a sister of this projection; the maximal projection $N^2$ serves to incorporate this |L|.[12]

(20)



One advantage of this approach is that it makes the prediction that syllable-level |L|-harmony will always involve nasalisation, and never voicing. The reason is that syllable heads are projections of nuclei; given that nuclei dominate sonorants, and that dependent |L| in sonorants denotes nasalisation, syllabic specifications of |L| will never be interpreted as voicing. This approach thus predicts the possibility of long-distance nasalisation, while ruling out the possibility of long-distance voicing (for discussion of this asymmetry, see Botma and Smith 2007). Consider in this light the representation of the surface form [w̃ãtĩ] in (21), where, in line with Piggott and van der Hulst, the $L_i$-specifications represent the phonetic instantiation of harmonic nasality.

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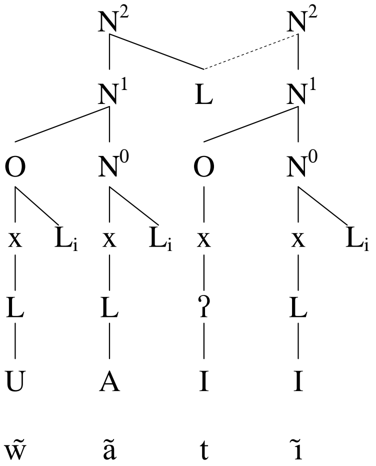
[12] Since Southern Barasano lacks codas, I assume that it lacks a nuclear projection equivalent to the level of the rhyme.

(21)



In (21) dependent |L| is an underlying property of the nuclear projection of the first syllable. As a result, all sonorants in the word surface as nasalised, as is indicated by their association with $L_i$. Notice, however, that since |L| can also be linked to obstruents, its association in transparent systems must be restricted to the class of sonorants. Botma (2004) invokes the following principle for this, which is based on a similar principle proposed by Piggott and van der Hulst.[13]

(22) *Principle of Consistent Interpretation*

In a domain $N^n$, where $N^n$ is a projection of $N^0$ and specified for a dependent element X, X is implemented on structures of the same type as $N^0$ only.

In this way, syllable heads regulate not only the propagation of nasality, but also its implementation in non-nuclear positions. However, the problem is that both Piggott and van der Hulst and Botma fail to make explicit what is meant by the 'implementation' or 'inheritance' of nasality. Specifically, the question is whether nasalisation of non-nuclear segments must be accorded phonological status, as has been assumed so far, or whether it forms part of the phonetic implementation component. The latter position is argued for by Nasukawa (2005).

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[13] Piggott and van der Hulst propose a principle of 'consistent dependency relations', forcing inherited features to manifest the same dependency relation. Thus, if harmonic nasality is a 'head' feature, all occurrences of nasality in the harmonic domain must also be 'head' features, i.e. be associated to sonorants.

As was already noted, an attractive aspect of syllable nasalisation is that it makes transparent nasal harmony similar to vowel harmony. However, as Nasukawa points out, vowel harmony does not display the kind of syllable-internal element sharing that transparent systems appear to display. This leads him to suggest that sonorant nasalisation should not be accounted for by the phonology, but by phonetic interpolation (see Cohn 1990 for a general discussion of this notion). If we adopt this view, then the surface representation of e.g. [w̃ãr̃ĩ] would contain only a single, doubly-linked specification of dependent |L| on the syllabic level.

One advantage of this analysis is that it obviates the need for a principle of the kind in (22). The assumption that harmonic forms contain a multiply-linked |L| at the syllabic level allows us to say that interpolation targets intervening consonants insofar as these are *phonetically* compatible with nasality. In this way, the complementary *phonological* interpretation of |L| as voicing never enters into the picture. From a phonetic viewpoint it is not unthinkable that fricatives, whose phonological representation rules out nasalisation, display a degree of nasal airflow when they occur in a nasal span. But an interpolation account does not commit us to the position that nasalised fricatives are a phonological segment type.

Interpolation also provides a natural account of the variable outcome of consonant nasalisation in harmonic domains. For instance, Omamor (1979) notes that in Isekiri, a Bantu language of Nigeria, nasalised /j/ is variably realised as [j̃] and [ɲ]. This variation does not appear to be conditioned by the phonology – but it is not unexpected if the nasality of the consonant is a transitional effect.

An interpolation account has an additional advantage. As Botma and Smith (2007) note, locating dependent |L| at the syllabic level extends the approach to laryngeal contrasts of Kehrein (2002) to include higher-level prosodic units such as the syllable. The parallel with Kehrein's approach should be interpreted with care, however. First of all, while some languages have syllable-level nasality, there do not appear to be any languages with syllable-level voicing, aspiration or glottalisation. Second, if the parallel with Kehrein's approach is to be maintained, the structure in (20) would predict that nasality, when contrastive at the level of the syllable, cannot at the same time be contrastive in smaller domains. As we will see in §4, this prediction is not borne out by the pattern of harmony in Yuhup. This pattern suggests that nasality is an underlying property of both the syllabic and the segmental levels. Notice that this cannot be expressed if all segmental occurrences of |L| are 'inherited' from a syllabic specification.

## 4. Nasal harmony in Yuhup

Yuhup is an endangered Makú language spoken by a seminomadic group of some 400 people, distributed among ten small villages in the west of the Amazonas province of Brazil and across the border in Colombia. My discussion of Yuhup is based on Lopes and Parker (1999), which contains data from the Brazilian dialect.[14] Lopes and Parker (1999: 324) note that their examples have been kept to an "absolute minimum [owing to] the sensitive political issues which arise in conjunction with studying indigenous groups in Brazil". The description of the Colombian dialect of Yuhup in Ospina-Bozzi (2002) is much more comprehensive, but, unfortunately, this dialect does not display the type of nasalisation that is at issue here.

Consider first the data in (23), which show that Yuhup has oral and nasal roots.

| | | | | | | |
|---|---|---|---|---|---|---|
| (23) | a. | *Oral roots* | | b. | *Nasal roots* | |
| | | ke | 'wing' | | nĩ | 'stay' |
| | | paːjh | 'rock' | | pãːj̃ɦ̃ | 'paternal uncle' |
| | | hoːd$^{n}$ | 'hole' | | ɦ̃õːn | 'to vomit' |
| | | $^{n}$doːg$^{ŋ}$ | 'fruit sp.' | | nãːŋ | 'grease' |

These examples illustrate two properties of transparent systems discussed in §3, viz. the nasalisation of all segments except voiceless obstruents and the complementary distribution of voiced oral stops and nasals. In Yuhup the former are realised as prenasalised stops root-initially and as post-nasalised stops root-finally. Since Yuhup roots are generally monosyllabic, they do not provide any evidence for nucleus-to-nucleus spreading; however, as we will see shortly, voiceless obstruents are skipped in root-suffix combinations.

Yuhup has a contrast between plain, laryngealised and aspirated vowels. The latter two are realised as [V̰ʔV̰] and [VhV] respectively, which creates phonetically disyllabic forms of the kind in (24).

| | | | | | |
|---|---|---|---|---|---|
| (24) | a. | tʃḭʔḭːb$^{m}$ | 'foot' | b. | kõ̰ʔõ̰ːm | 'potato sp.' |
| | | wɔhɔːt | 'striped mullet' | | õɦ̃õːp | 'to sleep' |

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[14] Other descriptions of this dialect can be found in del Vigna and Lopes (1987), del Vigna (1991) and Lopes (1995), but I have been unable to obtain these sources.

Lopes and Parker observe that these forms behave phonologically as single syllables: the vowels flanking the laryngeal articulations are invariably identical, and [ʔ h] are the only intervocalic consonants that occur in morpheme-internal context. Treating [ʔ h] as a phonological property of the nucleus explains their predictable occurrence in this context.

The domain of nasal harmony in Yuhup is limited to roots and certain root-suffix combinations. The forms in (25), which consist of combinations of oral and nasal roots, show that underlyingly oral roots resist nasalisation.

| | | | |
|---|---|---|---|
| (25) | oral-oral | tə-ᵐbəːgᵑ | ‘eye’ |
| | oral-nasal | haj-mæ̰̃ʔæ̰̃h̃ | ‘boa constrictor’ |
| | nasal-oral | mũn-teːgᵑ | ‘palm sp.’ |
| | nasal-nasal | mĩh̃-nãːw̃ | ‘paca rodent’ |

Based on such forms, Lopes and Parker treat nasality as a morpheme-level autosegment [nasal], which docks with its corresponding morpheme and spreads iteratively, in a left-to-right fashion, to all root-internal targets. It seems equally possible to analyse the harmony as being syllable-bound, since Lopes and Parker (1999: 325) assert that “each morpheme consists of one, and only one, syllable and, conversely, each syllable can be assumed to correspond to a distinct morpheme”. While this brings Yuhup in line with the transparent systems discussed in §3, it is important to observe that Yuhup harmony is sensitive to the morphological structure of words. This is not only because the language lacks disharmonic roots, but also because nucleus-to-nucleus nasalisation is restricted to certain root-suffix combinations; it is to the latter issue that I turn now.

Support for syllable nasalisation in Yuhup comes from the behaviour of alternating suffixes, i.e. suffixes which have oral and nasalised allomorphs depending on the presence of harmonic nasality in the root.[15] An example is the progressive suffix /-ih/, which is realised as [-ih] after oral roots (26a) and as [-ĩh̃] after nasal roots (26b).

| | | | | | | |
|---|---|---|---|---|---|---|
| (26) | a. | ᵐbiːʔ-ih | ‘working’ | b. | ũːm-ĩh̃ | ‘killing’ |
| | | ⁿdo̰ʔo̰ːh-ih | ‘getting married’ | | pãːh̃-ĩh̃ | ‘hearing’ |
| | | ʃaːw-ih | ‘shouting’ | | õh̃õːp-ĩh̃ | ‘sleeping’ |

---

[15] Lopes and Parker (1999) observe that most Yuhup suffixes are alternating. This suggests that suffixation and compounding take place at different strata, since roots are never alternating.

The form [õh̃õːp-ĩh̃] shows that root-final obstruents are transparent. This suggests an analysis in which nasality is underlyingly linked to the root's syllable head, from which it spreads to that of the suffix. The nasalisation of the surrounding consonants can then be viewed as the effect of phonetic interpolation, along the lines suggested in §3.2. An additional, theory-internal argument for syllable nasalisation concerns the observation that the root vowel in [õh̃õːp-ĩh̃] is aspirated. The assumption that dependent phonation is limited to a single element (see §2.1) forces us to treat aspiration as a property of $N^0$, and nasalisation as a property of the maximal projection of $N^0$, i.e. $N^2$.

The data considered so far suggest that Yuhup is a typical transparent system. However, what makes Yuhup special is the effect that a root-final postnasalised stop has on a following alternating suffix. The forms in (27) show that /-ih/ surfaces as nasalised when it follows a postnasalised stop.

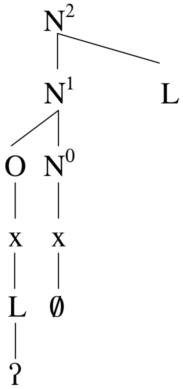
| | | |
|---|---|---|
| (27) | təːdⁿ-ĩh̃ | 'beating' |
| | əːgᵑ-ĩh̃ | 'drinking' |

This is unexpected if, as was suggested in §3.1, the nasality of contours is a phonetic effect.

One way to account for the pattern in (27) would be to assume that the nasality of Yuhup contours is phonologically relevant, i.e. to attribute [-ĩh̃] to the nasalising effect of the postnasalised stop. This analysis is problematic, however. If postnasalised stops are derived from underlying sonorant stops, nasalisation of /-ih/ would have to take place after the creation of the contour. This account is unattractive not only because it relies on rule ordering, but also because the pattern of nasalisation in alternating suffixes has lexical characteristics; for the purposes of nasal harmony, /-ih/ forms a domain with the preceding root. Postnasalisation, on the other hand, would appear to be postlexical. An analysis in terms of underlying postnasalised stops is similarly unattractive, since it requires the stipulation that these stops are limited to root-final position. In addition, if the nasal portion of a postnasalised stop is phonologically active, it is unclear why nasality does not surface as a property of the entire word, giving *[tə̃ːn-ĩh̃] and *[ə̃ːŋ-ĩh̃]. This suggests, then, that the nasality of postnasalised stops does not have phonological status, and that the origin of suffix nasalisation lies elsewhere.

Let us next see whether the facts in (27) are amenable to an account in terms of syllable nasalisation. This is not the case if root-final consonants occupy the coda position of a CVC syllable, since then we would expect such syllables to surface as fully nasalised. Another possibility would be to assume that root-final consonants occupy the onset position of an empty-headed syllable, and that such syllables, like 'normal' syllables, can be specified for nasality (see Botma 2005). The final syllable of the roots in (27) would then have the following structure, where 'Ø' denotes an empty position.[16]

(28)



The idea behind this analysis is that in the absence of a syllable head, the consistent interpretation principle prohibits syllable nasalisation from being realised. Consistent interpretation requires that nasality be implemented on segments of the same type as the syllable head – but since the syllable in (28) is headless, no nasalisation can take place. Therefore, its onset will be phonologically oral and phonetically a nasal contour. The nasal realisation of the following alternating suffix can then be attributed to its incorporation in the empty-headed syllable; once this syllable has acquired a head, nasality is free to be implemented on the segmental level, giving [-ĩɦ̃].

Closer inspection reveals that this account is untenable. For one thing, it still fails to account for the surface distribution of nasality in forms like [təːdⁿ-ĩɦ̃]. If the nasalised suffix allomorph results from syllable nasalisation, then it remains unclear why the root-final onset sonorant has not been targeted. A further problem is that this account fails to explain why we find suffix nasalisation in the case of root-final sonorant stops only. If we admit the possibility of final empty-headed syllables, then nothing would rule out nasalisation after e.g. root-final voiceless stops, as in the hypothetical form

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[16] Another argument for this structure is that we find the same range of consonants in morpheme-final and morpheme-initial position.

*[wit-ĩh̃]. The absence of such forms suggests that the nasal harmony in the forms in (27) cannot be attributed to the effect of syllable nasalisation.

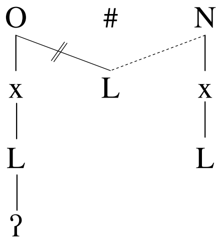
This leaves us with the possibility that suffix nasalisation is triggered by nasal consonants. This account would imply that the nasal contours in oral roots are underlyingly nasalised rather than bare sonorant stops – i.e., that they are nasals. The forms in (23ab) would then be derived as follows.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (29) | a. | *Nasal roots* | | | b. | *Oral roots* | | |
| | | /nĩ/ | → | [nĩ] | | /ke/ | → | [ke] |
| | | /pãjh/ | → | [pãːj̃h̃] | | /pajh/ | → | [paːjh] |
| | | /hõn/ | → | [h̃õːn] | | /hon/ | → | [hoːd$^{n}$] |
| | | /nãŋ/ | → | [nãːŋ] | | /noŋ/ | → | [$^{n}$doːg$^{ŋ}$] |

In (29) nasals are retained in the context of a neighbouring nasalised vowel (29a) and undergo denasalisation elsewhere (29b).

According to this analysis, Yuhup differs from a language like Southern Barasano in that it has both syllable nasalisation and underlying nasals. The former involves the presence of |L| as a syllabic dependent, while the latter involves the presence of |L| as a segmental (or more precisely, subsyllabic) dependent of sonorant stops. It is important to note that these specifications are not independent. The examples in (29b) show that denasalisation occurs whenever the neighbouring root vowel is oral, i.e. when there is no syllable nasalisation. This suggests that a dependent |L| in non-nuclear position is sanctioned only if a dependent |L| is simultaneously present in a nuclear projection. Crucially, however, we cannot interpret this to mean that underlying nasality is a property of the syllable level alone. The reason for this is that denasalisation of a root-final nasal does not always involve the loss of its dependent |L|. This is shown by the forms in (27), where the source of vowel nasalisation in the suffix allomorph [-ĩh̃] stems from the preceding root-final nasal, which is itself denasalised. Consider (30), where N and C$^{N}$ represent the nasal and the postnasalised stop respectively.

(30)



/…N#V…/ → [$\mathrm{C}^{\mathrm{N}}$Ṽ]

In terms of optimality theory, we may think of this spreading-and-delinking as a ‘faithfulness’ effect. Spreading of |L| can be attributed to the effect of a Max-type constraint, while delinking would involve the violation of an Ident-type constraint. The latter is dominated by a constraint that regulates the distribution of nasality in roots. This constraint must ensure that surface nasals in Yuhup occur only when their nasality is ‘shared’ with a nasalised vowel, which, crucially, must be part of the same root. Below, I will sketch one possible optimality-theoretic account of this scenario.

The forms in (27) are unfortunately the only examples of nasal-induced harmony cited in Lopes and Parker (1999). However, additional support for underlying nasals comes from the pattern of allomorphy that is displayed by the locative suffix (Loc). Some examples are given in (31).

(31)

| | Root | | Root-Loc | |
|---|---|---|---|---|
| a. | tiw | ‘path’ | ti:w-wit | ‘on the path’ |
| b. | j̃ãm | ‘village’ | j̃ã:m-mãt | ‘in the village’ |
| c. | jud$^{n}$ | ‘clothes’ | ju:d$^{n}$-nũt | ‘on the clothes’ |

Lopes and Parker take the underlying representation of the locative suffix to be /-CVt/, where C and V are copies of the final consonant and vowel of the root respectively. Of particular relevance is the form in (31c), which shows that a root-final postnasalised stop is copied as a plain nasal, with a following nasalised vowel copy. This pattern is difficult to account for if nasals are derived; but if the root-final stop is a nasal underlyingly, then the presence of the nasal copy is what would be expected. In that case, denasalisation is forced, again, by the absence of syllable-level nasality in the root, while nasalisation of the vowel copy in the suffix is forced by the required sharing of nasality with the preceding suffix nasal.

Reasons of space preclude a detailed optimality-theoretic account of the Yuhup harmony pattern. A follow-up to the analysis proposed above would be to assume two correspondence constraints that militate against the loss of nasality in onsets and nuclei, e.g. IDENT-ONSET and IDENT-NUCLEUS. Building on the notion of ‘sharing’ introduced above, we could then say that these two constraints interact with a third constraint which requires nasality, when present, to be shared by an onset and a following nucleus – e.g. SHARE-NASAL. If root-final consonants are analysed as onsets, then the ranking IDENT-NUCLEUS >> SHARE-NASAL >> IDENT-ONSET accounts for the observation that the presence of nasality in onsets depends on that in nuclei, but not vice versa. I leave the details of such an analysis for future research. Further research is also needed to determine in which respect(s) the harmony pattern of the Colombian dialect of Yuhup differs from the Brazilian dialect discussed here.

## 5. Discussion

The Yuhup data, though scant, indicate that the underlying specification of nasality in transparent systems cannot always be reduced to the syllabic level. This requires us to rethink the motivation for syllable nasalisation. As was argued in §3.2, the first, and most compelling, argument for syllable nasalisation is that it permits an account of obstruent transparency in terms of nucleus-to-nucleus spreading, and thus a local interpretation of harmonic vowel nasalisation. The second argument – the observation that transparent systems display nasalisation of tautosyllabic sonorants – is less compelling. For one thing, there are, as we have seen, good grounds to treat consonant nasalisation in languages with nucleus-to-nucleus spreading as the result of interpolation. In addition, the Yuhup data indicate that syllable-internal nasalisation is not only sometimes violated (cf. [təːd$^{n}$-ĩh̃], for example), but also that nasality in transparent systems is not necessarily a syllabic property. Rather than syllable-level nasality, the Yuhup facts suggest a local, subsyllabic sharing relationship between onset and nucleus, as shown in (31) above.

To illustrate this last point, I consider briefly the nasal harmony pattern of Wãnsöhöt, a Puinave language of Brazil, as discussed by Girón (2004). Root-initially, Wãnsöhöt displays the familiar complementary distribution between voiced stops and nasals: the former precede oral vowels (32a), the latter nasalised vowels (32b). Voiceless stops precede both oral and nasalised vowels.

| | | | | | | |
|---|---|---|---|---|---|---|
| (32) | a. | [ᵐboʔ] | ‘agouti sp.’ | b. | [mũn] | ‘palm fruit sp.’ |
| | | [ⁿdet] | ‘limpet’ | | [nõm] | ‘road below’ |
| | | [kɵt] | ‘star’ | | [tãt] | ‘shotgun’ |

On their own, these facts might suggest an analysis in terms of syllable-level nasality and underlying sonorant stops. However, the problem is that nasals in Wãnsöhöt occur not only before a nasalised vowel, but also root-finally, where they follow both nasalised (33a) and oral vowels (33b).

| | | | | | | |
|---|---|---|---|---|---|---|
| (33) | a. | [saww̃ãn] | ‘cotton’ | b. | [ⁿdem] | ‘yesterday’ |
| | | [sũm] | ‘worm sp.’ | | [ⁿden] | ‘woman’ |
| | | [kãn] | ‘hammock’ | | [ʝam] | ‘yam’ |

The only way in which the nasals in (33b) could be due to syllable nasalisation would be if they occupied the onset position of an empty-headed, nasalised syllable. But, as for Yuhup, such an account is flawed, because it incorrectly predicts the possibility of forms like [ⁿdew̃] and [ⁿdek], where the syllables containing [w̃] and [k] are nasalised.[17]

Girón notes that if Wãnsöhöt is analysed as having underlyingly voiced non-nasal stops, there is no uniform way in which surface nasals can be derived. This suggests, then, that Wãnsöhöt, like Yuhup, has underlying nasals. Nasals in Wãnsöhöt are regularly denasalised root-initially, and, in some cases at least, root-finally preceding the plural suffix /-ot/. This suffix generally surfaces as nasalised following a root-final nasal (34a), but sometimes triggers denasalisation, in which case root-final /m/ and /n/ surface as [b] and [ɾ] respectively (34b). A handful of words exhibits variation (34c).

| | | Sg | Pl | |
|---|---|---|---|---|
| (34) | a. | ʝotdan | ʝotdanõt | ‘tiger’ |
| | | kan | kanõt | ‘hammock’ (33a) |
| | b. | bikan | bikaɾot | ‘mite sp.’ |
| | | sawãn | sawãɾot | ‘cotton’ (33a) |
| | | ɟoikam | ɟoikabot | ‘avocado’ |

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[17] Suppose we found consistent nasalisation of suffix vowels after oral roots, e.g. /kɤt-ot/ → [kɤtõt]. This would be an argument for positing a root-final empty-headed nasalised syllable. However, no such nasalisation occurs in Wãnsöhöt, nor, as far as I am aware, in any other language.

| | | | |
|---|---|---|---|
| c. | ʝam | ʝamõt ~ ʝabot | ‘yam’ (33b) |
| | ɟukon | ɟukonõt ~ ɟukoɾot | ‘spear’ |

Girón accounts for the cases in (34bc) in terms of a lexical denasalisation process that applies to a restricted class of roots, which seems a reasonable assumption. The regular cases in (34a) involve onset-induced nasalisation of the following vowel. This is different from root-internal domains, where nasal sharing in onset-nucleus spans is enforced by the nasalised vowel. In both domains the surface result is a nasalised syllable – though notice that neither involves syllable-level nasality.

A more general problem with a syllable-based account is that Wãnsöhöt does not display nucleus-to-nucleus spreading. Indeed, Girón (2004: 94–95) explicitly states that the only domain in which nasalisation is active is in onset-nucleus spans. To this extent, Wãnsöhöt is similar to languages like Secoya (Johnson and Peeke 1962) and Gbe (Capo 1981). Unlike Wãnsöhöt, Secoya and Gbe do not allow codas, so that the surface domain of nasality in these languages is coextensive with the syllable. However, in the absence of nucleus-to-nucleus spreading this observation alone is insufficient to conclude that nasality is a syllable-level property.

## 6. Summary and conclusion

I started out this paper by stating three reductionist claims which have been made in recent representational approaches to nasal harmony. These claims are repeated in (35):

(35) a. The representation of nasalisation and obstruent voicing in terms of a single element.
b. The location of harmonic nasality at the level of the syllable in languages where voiceless obstruents are transparent.
c. The recognition of an underlying category of ‘sonorant stops’ in languages where nasals are in complementary distribution with voiced oral stops.

In element-based dependency, (35ab) are manifestations of a phonological strength relation, formalised in terms of a subsyllabic and a syllabic head–dependency relation respectively. The data considered in this paper suggest that (35a), viz. the dual interpretation of dependent |L| as nasalisation and voice, can be maintained, provided we make certain ancillary assumptions concerning the phonetic interpretation mechanism in transparent systems. In this respect, an account in terms of interpolation appears to be preferable to a phonological account, e.g. one in which the interpretation of harmonic |L| is constrained by a principle of 'consistent interpretation'. More generally, I have argued that syllable-internal nasalisation of consonants does not provide compelling evidence for syllable-level nasality, and that the location of nasality at the syllabic level in a language is warranted only if this language has nucleus-to-nucleus spreading.

Evidence from languages like Southern Barasano suggests that (35c) is a corollary of (35b). A language in which nasality is uniquely specified at the syllabic level lacks underlying nasals; an analysis of the nasal underliers as sonorant stops then permits a uniform account of the nasalisation process. However, we have seen that not all transparent systems allow this kind of reductionism. The distribution of nasality in Yuhup suggests that nasality must be specified on both the syllabic and the subsyllabic levels, while the distribution of nasality in Wãnsöhöt suggests that it is a subsyllabic property. The nasal harmony systems of these languages thus corroborate the view that syllable-level nasalisation should be restricted to languages with nucleus-to-nucleus spreading.

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# Developmental shifts in phonological strength relations

*Daniel A. Dinnsen and Ashley W. Farris-Trimble*

## 1. Introduction

This paper presents evidence from young children's developing phonologies that would seem to be at odds with widely held assumptions about the relative strength of phonological contexts in fully developed languages. More specifically, the evidence suggests that children in the early stages of acquisition can and do merge multiple contrasts across different feature classes in presumably strong contexts (e.g. word-initially) while maintaining those same distinctions in other presumably weak contexts. This disparity is especially problematic for theories that make strong universal claims of continuity between developing and fully developed languages and incorporate learnability considerations for the assessment of explanatory adequacy. We offer a solution to this problem that appeals to a developmental shift in prominence and is cast in terms of the general framework of optimality theory (e.g. Prince and Smolensky 1993/2004).

It is generally acknowledged among phonologists that different positions within the word often behave differently depending on the relative strength of that context. For example, contexts such as the initial position of the syllable, foot, and word have been found cross-linguistically to favor the preservation of phonological contrasts and resist neutralization processes (e.g. Beckman 1998; Lombardi 1999; de Lacy 2002; Smith 2002). Those contexts are judged to be strong, perceptually salient, or prominent. While other contexts can also support phonological contrasts, they are considered to be weaker because they are more vulnerable to neutralization processes that merge underlying distinctions. Some of those weaker contexts include syllable-final, word-final, and foot-medial positions. This dichotomy of strong and weak contexts has several consequences. First, it explains why, for example, so many languages have phonological processes that neutralize voice, place, and manner contrasts only in word-final or syllable-final contexts or why in some languages there might be prohibitions against place features in codas or against coda consonants altogether, or why in heterosyllabic consonant clusters, it is usually the onset consonant that triggers regressive assimilation (rather than the coda that triggers progressive assimilation). This contextual dichotomy is suggestive of the tendency or implicational universal in (1):

(1) Strength/contrast implicational relationship
The occurrence of a contrast in a weak context implies its occurrence in a strong context, but not vice versa.

Following from this implicational generalization are the typological predictions in (2) concerning the presence/absence of a contrast in different contexts:

(2) Typological predictions

There are languages in which a particular feature
a. fails to contrast in any context (strong or weak),
b. contrasts only in a strong context, or
c. contrasts in all contexts (strong and weak).

But, there are no languages in which
d. a contrast is maintained only in a weak context.

These predictions have largely been borne out by investigations of fully developed languages. Even the few apparent exceptions (e.g. Parker 2001; Steriade 2001) end up supporting an asymmetrical typology in which one of the logical possibilities does not occur. Consider, for example, Steriade's (2001) claim that the preferred (strong, perceptually salient) context for maintaining an apical contrast between plain and retroflex consonants is in postvocalic position. She has observed that there are three basic types of languages relevant to this particular contrast, namely (a) those that maintain an apical contrast in both post- and prevocalic contexts (e.g. Djinang), (b) those that maintain the contrast in postvocalic, but not prevocalic contexts (e.g. Murinbata and Miriwung), and (c) those that maintain the contrast in neither post- nor prevocalic contexts (e.g. English). Importantly, no language has yet been identified that maintains an apical contrast prevocalically without also maintaining that contrast postvocalically. Thus, while the details of the typology for an apical contrast may differ from most other contrasts, the same contextual asymmetry still holds such that the occurrence of a contrast in a certain context (i.e. a presumably weak context) implies its occurrence in other (stronger) contexts, but not vice versa. Consequently, the typology in (2) would accurately describe the facts about apical contrasts, provided that the strength of a context is relativized to certain specific featural contrasts.

The more serious problem for contextual strength relations, at least as we see it, is that some children's developing phonologies provide evidence of precisely what does not occur in fully developed languages. More specifically, Dinnsen and Farris-Trimble (2008) have shown that some children merge a single voice, place, or manner contrast in word-initial position while maintaining that same contrast in the presumably weaker postvocalic context. That empirical finding poses a number of theoretical challenges, which are further compounded by the findings to be presented in this paper.

The theoretical problem is this. On the one hand, the facts from both developing and fully developed languages when taken together would seem to completely undermine any sense of contextual strength since all contexts appear to be equally vulnerable to phonological mergers, and no context can be singled out as preferred for preserving a phonological contrast. All of the logical possibilities seem to occur. This does, however, treat as accidental the otherwise well established contextual asymmetry that has been observed in fully developed languages. On the other hand, contextual strength may be a valid, legitimate construct that is instantiated one way in fully developed languages and a different way in developing phonologies. The problem with this is the challenge it poses for the continuity hypothesis (Pinker 1984), which maintains that the grammars of developing and fully developed languages are constructed from the same building blocks and are governed by the same grammatical principles.[1] We thus might have expected developing and fully developed phonologies to deal with phonological strength in the same way. This problem is especially acute for the framework of optimality theory (e.g. Prince and Smolensky 1993/2004), which employs a finite set of universal constraints as one of the central constructs for the expression of all significant generalizations. The

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[1] Naturally, theories that do not sanction external evidence from development for the evaluation of its claims may not be troubled by this disparity. Aside from the disparity focused on in this paper, there are admittedly a number of other well established differences between developing and fully developed languages that continue to challenge claims of continuity. See, for example, the phenomenon of consonant harmony in child phonology (described briefly in §2.2, §2.3 and §4.5), which is unattested in fully developed languages. Nevertheless, we will attempt to comply with the requirement of continuity in this paper because of the more rigorous test that it imposes.

assumption is that the constraints are the same for both children and adults and that different language-specific rankings of those constraints should converge on the same common typology of possible grammars. The challenge then is to reconcile the apparent disparity in phonological strength that occurs across developing and fully developed phonologies.

We attempt here to resolve these various problems in a way that acknowledges the significant role of contextual strength relations while also abiding by the continuity hypothesis. Our contention is that the strength of a phonological context changes with development. In the early stages, the grammar assigns strength or prominence to final position by default. This will be reconciled with seemingly contradictory phenomena in §2.4 and §4.4. In later stages of development and in fully developed languages, prominence shifts to initial position. We hypothesize that the shift is triggered, in part, by the lexical restructuring that occurs in response to increases in the size of the lexicon as more and more words are added to the child's vocabulary. Our solution is modeled in optimality theoretic terms, but its general insights should extend to other frameworks as well. Our proposal introduces a new set of conflicting universal markedness constraints. These new constraints assign or license prominence in different prosodic contexts. The ranking of those prominence-assigning constraints determines which contexts are strong. The default ranking leads to final prominence, and the reverse ranking results in initial prominence. The change in ranking is triggered in part by changes in the lexicon. The consequence is that continuity can be preserved across developing and fully developed phonologies with differences being attributed to language-specific rankings of universal constraints.

This paper is organized as follows. In §2, we expand on our previous findings by presenting several new case studies of young children who are acquiring English. Each child was selected to illustrate the merger of multiple contrasts, all of which are restricted to a single, presumably strong context, namely word-initial position. Each child also preserved those same contrasts in other contexts, especially in the presumably weak context of word-final position. One of the novel contributions of this paper is its focus on multiple mergers in the same context in a given child's phonology. This is important and goes beyond our earlier work because it shows that the contextual restriction is a property of the child's larger phonological system and not just a peculiarity of a single process or featural contrast. These cases also serve to further instantiate the typological anomaly, which finds contrasts being merged in what is otherwise considered a strong context while also being preserved in a presumably weak context. In §3, we summarize our earlier optimality theoretic solution to this general problem and show how that proposal also accounts for multiple mergers within a given phonology. This is achieved by illustrating the account for one of the case studies reported here. §4 considers independent evidence supporting our hypotheses along with a discussion of some unresolved issues. Finally, §5 concludes the chapter with a brief summary.

## 2. The typological problem: word-initial mergers and final contrast

The case studies presented in this section exemplify the typological problem posed by some children's developing phonologies. Each child will be shown to exhibit multiple independent phonological processes merging two (or more) contrasts in word-initial position while maintaining those contrasts elsewhere within the word. The data were drawn from the Developmental Phonology Archive at Indiana University. For a fuller description of the Archive; participant characteristics; the methodologies for data elicitation, transcription, and analysis; and for some recent results, see Dinnsen and Gierut (2008). In brief, the Archive includes data on nearly 300 children with phonological delays between the ages 3;0 (years; months) and 7;0. All of the children are typically developing in every respect, except for evidence of a phonological delay. They scored within normal limits on all standardized tests of hearing, oral-motor mechanism and functioning, non-verbal intelligence, receptive vocabulary, and expressive and receptive language. However, they scored at or below the fifth percentile on the *Goldman-Fristoe Test of Articulation* (Goldman and Fristoe 1986). A comprehensive speech sample was elicited from each child in a spontaneous picture-naming task. Pictures were carefully selected to depict objects and actions known to children of this age and to sample all phonemes of English in initial, medial, and final position. The audio recordings of the children's speech were phonetically transcribed by a trained listener with 10% of all productions retranscribed for reliability purposes by an independent judge. The overall mean consonant-to-consonant reliability measure was 90% or better.

Our focus on children with phonological delays may strike some as odd, especially given our interest in unifying accounts of developing and fully developed phonologies. For example, it might be thought that delayed phonologies are inherently aberrant and thus not relevant to the evaluation of typological claims. It should, however, be kept in mind that the only discernable problem for these children was a delay in their phonologies. This determination was, moreover, arrived at based on extensive testing.

These children's error patterns thus resemble those of younger, typically developing children. For a fuller discussion of this general issue, see Dinnsen and Gierut (2008), and for examples of typically developing children who exhibit similar error patterns with the same restrictions, see Dinnsen and Farris-Trimble (2008).

## 2.1. Voice and manner contrasts merged/preserved

The data in (3) are from Child 209 (age 3;5) and are representative of two highly systematic error patterns restricted to word-initial position. One error pattern merges the distinction between voiced and voiceless obstruents by voicing the initial consonant (3a). While the English laryngeal distinction is often referred to in terms of the feature [voice], convincing arguments have been made for the alternative view that the distinction in English is one of aspiration associated with the feature [spread glottis] (e.g. Iverson and Salmons 1995). We will, nevertheless, use the term 'voice' here simply because that is what appears in much of the acquisition literature and is how the children's outputs are typically transcribed. Note that target voiced stops remain voiced (3b). The forms in (3c) show that the laryngeal contrast is preserved postvocalically.

Another independent error pattern replaces word-initial fricatives with a stop. The data in (3d) illustrate this Stopping error pattern. Note that a voiced coronal stop is the substitute for a coronal fricative, and that a voiced labial stop is the substitute for a labial fricative. While voice and manner distinctions are merged in word-initial position, place of articulation is preserved for these sounds. The forms in (3e) establish that stops and fricatives contrast postvocalically.

(3) Child 209 (age 3;5)

a. Initial voiceless stops are voiced

| | | | |
|---|---|---|---|
| [baɪ] | 'pie' | [bɪd] | 'pig' |
| [dɪʊ] | 'tear' | [diθ] | 'tooth' |

b. Initial voiced stops retain voicing

| | | | |
|---|---|---|---|
| [but] | 'boot' | [bait] | 'bite' |
| [dʌn] | 'done' | [dɪʊ] | 'deer' |

c. Voice contrast is preserved postvocalically

| | | | |
|---|---|---|---|
| [doʊp̚] | ‘soap’ | [roʊb] | ‘robe’ |
| [dʌt̚] | ‘cut’ | [bʌd] | ‘bed’ |

d. Initial fricatives are replaced by stops

| | | | |
|---|---|---|---|
| [baɪjʊ] | ‘fire’ | [bɑd] | ‘frog’ |
| [dæntə] | ‘Santa’ | [dʌni] | ‘sunny’ |

e. Stops and fricatives contrast postvocalically

| | | | |
|---|---|---|---|
| [doʊp̚] | ‘soap’ | [naɪf] | ‘knife’ |
| [roʊb] | ‘robe’ | [doʊv] | ‘stove’ |
| [but] | ‘boot’ | [maʊθ] | ‘mouse’ |
| [mʌd] | ‘mud’ | [bʌð] | ‘buzz’ |

A conventional rule-based account of these phenomena might employ two independent rules, each of which would be restricted to apply exclusively in word-initial position. However, when the same restriction is repeated in different rules in a given grammar (as in the case of Child 209), it would appear that a generalization is being missed. The missed generalization in this instance is that word-initial position is behaving as a weak context with regard to voice and manner distinctions while other positions are behaving as strong contexts for the same features.[2]

## 2.2. Place and manner contrasts merged/preserved

Child 142 (age 4;3) provides evidence of two other independent error patterns that are restricted to word-initial position. One error pattern replaces word-initial affricates with simple alveolar stops (deaffrication), and the other replaces word-initial alveolar stops with a dorsal consonant when a dorsal occurs later in the word (consonant harmony). The relevant data are given in (4).

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[2] This should not be taken to mean that all other featural distinctions were also merged in initial position. For an account of selective mergers, see the discussion of the various restrictions on Child 142’s consonant harmony error pattern in §3.2.

(4) Child 142 (age 4;3)

a. Word-initial affricates replaced by alveolar stops (deaffrication)

| | | | |
|---|---|---|---|
| [tɪn] | ‘chin’ | [dʌmp] | ‘jump’ |
| [tu] | ‘chew’ | [dip] | ‘jeep’ |
| [tɪp] | ‘chip’ | [dɛt] | ‘jet’ |

b. Affricates retained postvocalically

| | | | |
|---|---|---|---|
| [wɔts] | ‘watch’ | [bwɪːdz] | ‘bridge’ |
| [pits] | ‘peach’ | [bædz] | ‘badge’ |
| [pʌntsɪn] | ‘punching’ | [oʊwɪndzi] | ‘orange-i’ |

c. Word-initial alveolar stops assimilate to the place of a following dorsal consonant (consonant harmony)

| | | | |
|---|---|---|---|
| [gʌks] | ‘ducks’ | [gʌki] | ‘duckie’ |
| [gɔg] | ‘dog’ | [gɔgi] | ‘doggie’ |
| [kaɪgoʊ] | ‘tiger’ | [kɪkɪt] | ‘ticket’ |

d. Fricatives occur word-initially

| | | | |
|---|---|---|---|
| [sæni] | ‘Santa’ | [sʌn] | ‘sun’ |
| [soʊp] | ‘soap’ | [sup] | ‘soup’ |
| [sɔk] | ‘sock’ | [sɪk] | ‘sick’ |

e. Word-initial affricates deaffricate and assimilate to the place of a following dorsal

| | | | |
|---|---|---|---|
| [kik] | ‘cheek’ | [kɪkɪn] | ‘chicken’ |
| [kɔk] | ‘chalk’ | [g̥ækət̚] | ‘jacket’ |

f. Alveolars and dorsals contrast word-initially and postvocalically in nonassimilatory contexts

| | | | |
|---|---|---|---|
| [tʌb] | ‘tub’ | [kʌp] | ‘cup’ |
| [toʊᵊz] | ‘toes’ | [koʊm] | ‘comb’ |
| [sʊt] | ‘foot’ | [bʊk] | ‘book’ |
| [but] | ‘boot’ | [wɔk] | ‘rock’ |

g. Progressive consonant harmony blocked

| | | | |
|---|---|---|---|
| [koʊt] | ‘coat’ | [kʌt] | ‘cut’ |
| [skeɪt] | ‘skate’ | [pɑkɛt] | ‘pocket’ |

The forms in (4a) illustrate the deaffrication error pattern in word-initial position, while those in (4b) show that (alveolar) affricates could occur in postvocalic contexts. The contrast between affricates and stops is thus merged in favor of simple stops in one well-defined context, namely in word-initial position. The deaffrication error pattern with its restriction to word-initial position is a common phenomenon in children's early phonologies (Smit 1993).

The merger of the place distinction in word-initial position is illustrated by the consonant harmony error pattern in (4c). Word-initial alveolar stops are replaced by a dorsal consonant when a dorsal follows later in the word. This error pattern is a typical instantiation of a regressive place assimilation process as described in many other children's phonologies (e.g. Pater and Werle 2003 and references therein). While consonant harmony is a common process in developing phonologies, it is acknowledged to be rare or non-occurring in fully developed systems due to the nonlocal domain of the assimilation. This disparity is considered further in §4.5.

This consonant harmony error pattern exhibits several properties that are germane to the main point of this paper. First, this assimilatory process is triggered exclusively by dorsal consonants when they occur in postvocalic (weak) contexts. Note too that word-initial alveolar stops are the only targets of assimilation. The contexts for triggers and targets are just the opposite of what is expected of assimilatory processes in fully developed languages.

The forms in (4d) show that word-initial fricatives are immune to consonant harmony. That is, alveolar fricatives can occur in initial position without modification in both assimilatory and non-assimilatory contexts. The contrast between stops and fricatives is thus preserved in that context.

Deaffrication and consonant harmony also interact, as can be seen in (4e). That is, both processes are applicable when a word-initial affricate is followed by a dorsal consonant. Under those circumstances, the word-initial affricate deaffricates and also assimilates to the place of the following dorsal. It is also important to keep in mind that these two processes are independently necessary. That is, there are some words where deaffrication alone is applicable (4a), and there are other words where only consonant harmony is applicable (4c). In these situations, then, each process applies without any potential interference from the other. However, if an affricate assimilates, it also deaffricates.

While the place contrast between coronals and dorsals is merged in word-initial position due to consonant harmony, that contrast is preserved in postvocalic contexts (even when a dorsal occurs initially) and in word-initial position when the assimilatory trigger is not evident. This is shown in (4f).

The merger of both place and manner distinctions in a presumably strong context and the preservation of those distinctions in weak contexts run counter to standard expectations about contextual strength, at least in fully developed languages. The consonant harmony error pattern exhibits the further anomaly that a presumably strong context is giving way to a weak context as a result of assimilation.

### 2.3. Multiple voice, place, and manner distinctions merged/preserved

The data in (5) are from Child 5T (age 4;3) and exemplify a number of common processes, all of which merge particular distinctions exclusively in word-initial position (Gierut 1985). This child combines all of the processes described in the above two case studies plus one other, but does so in a way that yields different results.

(5) Child 5T (age 4;3)

a. Consonant harmony

| | | | |
|---|---|---|---|
| [gʌk] | ‘duck’ | [gɔʷg] | ‘dog’ |
| [gɔgi] | ‘doggie’ | | |

b. Postvocalic place contrast

| | | | |
|---|---|---|---|
| [bæk] | ‘back’ | [bæt] | ‘fat’ |
| [wɔk] | ‘rock’ | [dʌt] | ‘cut’ |

c. Word-initial deaffrication and postvocalic affricates

| | | | |
|---|---|---|---|
| [dɪp] | ‘chip’ | [wɔtʃ] | ‘watch’ |
| [diːʒ] | ‘cheese’ | [bitʃ] | ‘peach’ |
| [dɛli] | ‘jelly’ | [bɪdʒ] | ‘bridge’ |
| [dʌmp] | ‘jump’ | [bædʒ] | ‘badge’ |

d. Word-initial velar fronting and postvocalic velars

| | | | |
|---|---|---|---|
| [dɔlɪŋ] | ‘calling’ | [bʊk] | ‘book’ |
| [dæːtʃ] | ‘crash’ | [wɔki] | ‘rocky’ |
| [dʌbs̪] | ‘glove’ | [bɪg] | ‘pig’ |
| [dæːhapə] | ‘grasshopper’ | [bæg] | ‘bag’ |

e. Word-initial stopping and postvocalic fricatives

| | | | |
|---|---|---|---|
| [dʌn] | ‘sun’ | [dɛs] | ‘dress’ |
| [doʊp] | ‘soap’ | [dus̪] | ‘juice’ |
| [dʌboʊ] | ‘shovel’ | [bʊʃ] | ‘push’ |
| [dæmbu] | ‘shampoo’ | [wɔʃɪŋ] | ‘washing’ |
| [du] | ‘zoo’ | [bʌð] | ‘buzz’ |
| [dibʌ] | ‘zebra’ | [nɔɪð] | ‘noise’ |

f. Word-initial voicing and postvocalic voice contrast

| | | | |
|---|---|---|---|
| [bʊʃ] | ‘push’ | [doʊp] | ‘soap’ |
| [dʊtθ] | ‘shirt’ | [bɪgi] | ‘piggy’ |
| [dʌb] | ‘tub’ | [dʌt] | ‘cut’ |
| [bɛðoʊ] | ‘feather’ | [bɔːdə] | ‘father’ |

g. Derived alveolar stops immune to consonant harmony

| | | | |
|---|---|---|---|
| [dɔwk] | ‘chalk’ | [dɪkɨn] | ‘chicken’ |
| [dɔki] | ‘sock-i’ | [dɪgi] | ‘ziggy’ |

The forms in (5a) reflect the basic consonant harmony error pattern, which replaces a word-initial alveolar stop with a dorsal when a dorsal consonant follows later in the word. Once again, the target of assimilation must be restricted to the presumably strong context of word-initial position with the trigger being restricted to a presumably weak postvocalic context. The forms in (5b) show that place is indeed contrastive postvocalically. The remaining data illustrate other independent processes that merge word-initial voice, place, and manner distinctions in favor of alveolar stops. For example, deaffrication is exemplified in (5c), velar fronting in (5d), stopping in (5e), and voicing in (5f). Those same data sets show that these error patterns do not affect postvocalic affricates, dorsals, fricatives, and voiceless consonants, respectively. Interestingly, the data in (5g) reveal that consonant harmony does not operate on alveolar stops that are derived from sources other than target alveolar stops. In a rule-based account of these phenomena, consonant harmony would be ordered before all of the other processes in a counterfeeding relation. More importantly, five rules would be required, all of which would have to be crucially restricted to merge contrasts exclusively in word-initial position.

## 2.4. Initial consonant omission and postvocalic consonant retention

It is commonly observed in many fully developed languages that coda consonants are prohibited, resulting in open syllables. It is well known that the presence of coda consonants in a language implies the presence of open syllables in that language, but not vice versa. We might thus expect the marked character of coda consonants to render them vulnerable to deletion, and they certainly are in many children's early speech development. The fact then that final consonant omission is a common error pattern in developing phonologies is entirely consistent with the principles governing fully developed languages. We will return to this point in §4.4. It is also equally well known for fully developed languages that onsetless syllables are marked relative to syllables with onsets. We thus would not expect a child to delete a word-initial consonant to yield a more marked onsetless syllable. However, this is exactly what has been observed in several children's phonologies (Dinnsen and Farris-Trimble 2008 and references therein). We take up here another similar case study involving Child 4 (age 4;2), who omitted initial consonants. The data in (6) exemplify the loss of word-initial consonants and the retention of those same consonants in postvocalic position.

(6) Child 4 (age 4;2)

a. Word-initial consonants omitted

| | | | |
|---|---|---|---|
| [up] | 'soup' | [if] | 'leaf' |
| [æmpu] | 'shampoo' | [ʌn] | 'gun' |
| [u] | 'zoo' | | |

b. Postvocalic consonants retained

| | | | |
|---|---|---|---|
| [aɪs] | 'ice' | [eɪoʊl] | 'jail' |
| [æʃ] | 'crash' | [ɪgi] | 'ziggy' |
| [iz] | 'cheese' | | |

This process of initial consonant omission represents a wholesale merger of many distinctions in a context that might have been thought to resist neutralization. The preservation of postvocalic consonants in itself may not be surprising, but when consonants are preserved in presumably weak contexts, we should expect them to also occur in the perceptually salient context of word-initial position. Admittedly, the process of initial consonant omission is less commonly occurring than the other error patterns discussed in this paper, possibly due to the greater pressure from the target language for syllables to have onsets.

All of the case studies cited here were selected to illustrate the merger of multiple distinctions in word-initial position along with the preservation of those distinctions postvocalically. While these cases came from children with phonological delays, it is important to note that these are not isolated cases and many of the same error patterns and their associated contextual restrictions have also been observed to occur in the early phonologies of children with typical development, although those other reported cases may have focused on the merger/preservation of a single distinction in a given child's phonology (e.g. Dinnsen and Farris-Trimble 2008). The added dimension that is provided by the cases in this paper is that they reveal the contextual restriction to be a pervasive property of the child's grammar – cross-cutting several phonological processes. The problem is, however, that the contexts for these mergers and contrasts are just the opposite of what is observed in later stages of development and in fully developed languages. In the next section we take up the solution to this problem and illustrate its implementation with one of the case studies above.

## 3. The solution: conflicting prominence-assigning constraints

A solution to the general problem posed by the data in §2 has been put forward in our account of similar phenomena from typical and delayed phonological acquisition (Dinnsen and Farris-Trimble 2008). We recapitulate below some of the essentials of that account and relate it directly to the cases of multiple contextual mergers in §2.

### 3.1. Contextual mergers in optimality theory

Let us first briefly review how optimality theory deals with contextual mergers in fully developed languages. Two alternative approaches making essentially the same typological predictions have been advanced. One approach relies on a positional faithfulness constraint to preserve a contrast in a prominent context (e.g. Beckman 1998; Lombardi 1999). Under that approach, what serves as a prominent context is stipulated and may be specific to the property to be preserved. The positional faithfulness constraint would be ranked above a general antagonistic markedness constraint that bans some marked structure. That ranking ensures that a contrast is preserved in a prominent context. At the same time, the merger of the contrast in nonprominent contexts would be achieved by ranking the general markedness constraint above a context-free version of the faithfulness constraint. German serves as a standard example of a language that maintains a voice contrast in onsets while merging that contrast in codas. The prominence of onsets and their resistance to mergers with regard to laryngeal features is captured by stipulating the contextual restriction to onsets in the definition of a laryngeal faithfulness constraint (e.g. ID-ONSET[laryngeal]). By ranking the general markedness constraint *LARYNGEAL below the positional faithfulness constraint, the [voice] feature would be preserved in onsets but banned in all other contexts. The following schema serves to illustrate a standard account of the contextual merger of the voice contrast in fully developed languages:

(7) Positional faithfulness and contextual neutralization
ID-ONSET[laryngeal] >> *LARYNGEAL >> ID[laryngeal]

The alternative approach for dealing with contextual mergers relies instead on a highly ranked markedness constraint that is formulated to ban a marked property in a specific context, i.e. one that is nonprominent or weak. For example, the alternative markedness constraint relevant to the merger of the voice contrast in codas, *VOICED-CODA, simply bans voiced obstruents in codas (e.g. Kager 1999). By ranking ID[laryngeal] between *VOICED-CODA and the context-free version of that constraint, *LARYNGEAL, a contrast is permitted to occur in a prominent onset context but not in the weak coda context. The schema for this alternative approach would entail the following constraints and ranking:

(8) Contextually conditioned markedness and context-free faithfulness
*VOICED-CODA >> ID[laryngeal] >> *LARYNGEAL

No matter which approach (or combination of approaches) one adopts, the assumption about constraints is that they are generally asymmetric in their substantive formulation.[3] That is, if some constraint bans a feature in

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[3] There are some exceptions to this general claim motivated by typological considerations. For example, while the markedness constraint NOCODA (Prince and Smolensky 1993/2004) bans closed syllables, a conflicting markedness constraint FINAL-C (McCarthy 1993) demands that a word-final syllable be closed. It is, however, important to note that these constraints conflict only in absolute word-final position. The asymmetric character of markedness constraints is also chal-

codas, the expectation is that there should be no complementary constraint that is specifically formulated to ban that same feature in the context of onsets. Similarly, if some positional faithfulness constraint demands featural identity between corresponding input and output segments in the prominent context of onsets, no positional faithfulness constraint relating to the same feature would be restricted to the complementary context of codas. The asymmetrical character of many constraints under either approach has the desirable consequence of limiting the typology of possible languages.

Both of these general approaches fail to account for the developmental facts from the prior section. One possible solution might be to give up the asymmetric character of constraints and postulate the existence of additional constraints from the same family with the stipulation of opposite or complementary contextual restrictions. For example, children's acquisition of the voice contrast first in codas and the associated merger of that contrast in word-initial position might seem to require a highly ranked faithfulness constraint stipulating the preservation of the voice contrast in codas while allowing it to be merged in word-initial position due to a lower-ranked markedness constraint. The hypothetical constraint that is called for might be ID-CODA[laryngeal], but that constraint is the complement of what is needed for fully developed languages, namely ID-ONSET[laryngeal], and is otherwise unattested. The same issue arises with regard to constraints involving place and manner contrasts. We could, of course, expand the constraint set to include constraints defined on complementary contexts, but the permutable rankings of these constraints would predict a wider range of variation than has been observed in fully developed languages. This constitutes a serious drawback for this approach.

The facts of fully developed and developing phonologies leave little doubt about the need for contextual restrictions of some kind in the substantive formulation of constraints. The real issue is whether those restrictions need to be stipulated, as has been assumed, and whether the restrictions are the same for developing and fully developed languages. In the next section, we sketch our solution, which derives prominence and retains a universal constraint set that is the same for children and adults.

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lenged by constraints making the same demand in complementary contexts. For example, while ONSET (Prince and Smolensky 1993/2004) bans onsetless syllables, FINAL-C requires that a syllable be closed word-finally. Importantly, there is no constraint that specifically demands that syllables be onsetless.

### 3.2. Prominence-assigning constraints

The main element of our solution introduces a new set of competing markedness constraints that has the effect of deriving prominence (rather than stipulating it in different constraints). Under this proposal, what serves as a prominent context is derived from the ranking of competing universal markedness constraints given in (9). These markedness constraints are similar to markedness constraints that assign syllable structure. That is, neither syllable structure nor prominence is specified in the input, and both are in one sense derived by constraint interaction. These constraints assign or license prominence in certain prosodic domains. For example, one such markedness constraint from the INITIALPROM family holds at the level of the syllable and would assign prominence to syllable onsets (and only that subsyllabic constituent); the other competing markedness constraint from the FINALPROM family would assign prominence to the complementary subsyllabic constituent, namely rhymes. A candidate incurs a violation of these constraints if it fails to have prominence in the licensed context or if it includes prominence in a context that does not license prominence. Ranking these constraints relative to one another is necessary to resolve the conflict that would arise when prominence occurs in different contexts within the word. By resolving the conflict between these constraints, the desired asymmetries can be achieved.

(9) Prominence-assigning markedness constraints

| | |
|---|---|
| INITIALPROM: | The initial constituent of a syllable, foot, or prosodic word must be prominent |
| FINALPROM: | The final constituent of a syllable, foot, or prosodic word must be prominent |
| Default ranking: | FINALPROM >> INITIALPROM |

Depending on how these markedness constraints are ranked, one or the other context, but not both, would be realized phonetically with prominence. It is assumed that no more than one constituent of a particular prosodic domain can be prominent. This is similar to the restriction that a foot can have no more than one head, and every foot must have a head. We further assume, for reasons to be discussed below, that the default ranking of these markedness constraints results in rhymes being prominent in the initial state.[4] Clearly, the ranking of these two prominence-assigning markedness

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[4] Because the prominence-assigning constraints conflict, they must be ranked. This is not unlike what must be assumed about other markedness constraints that con-

constraints must change over time if the well established prominence of onsets in fully developed languages is to be accounted for. We hypothesize that one possible explanation for the reranking of prominence-assigning constraints may be in response to increases in the size of the lexicon and the need to differentiate words in more densely packed lexical neighborhoods. This hypothesis accords with the widely held developmental perspective that the lexicon undergoes a restructuring that leads to more elaborate, detailed representations (e.g. Walley, Metsala, and Garlock 2003). Additionally, some psycholinguistic studies have documented a developmental shift in the prominence of subsyllabic structures with the early salience of rhymes giving way to more enhanced onsets (see §4.1 for some highlights from relevant studies and Munson and Babel 2005 for a more thorough review).

Given that the lexicon under normal circumstances does not get smaller as time goes on, no fact would ever motivate a further reranking of the prominence-assigning constraints. Consequently, once onsets have become prominent due to the first reranking of the prominence-assigning markedness constraints, the ranking of these constraints essentially becomes fixed with onsets remaining prominent in fully developed languages.

With the prominence-assigning markedness constraints determining what is prominent, positional faithfulness constraints can then take advantage of that licensed prominence at any stage of development by simply specifying that the faithfulness constraint holds only in a prominent context. We will be formulating our solution in terms of positional faithfulness, but it could as well be recast in contextual markedness terms.[5]

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flict (e.g. constraints that align feet to the left or right edge of a word or that specify the foot type as trochaic/iambic). The default ranking of the prominence-assigning constraints is a separate empirical issue, which is one of the focal points of this paper. In any event, the ranking of the prominence-assigning constraints does not compromise in any way the presumed default ranking of markedness over faithfulness in the initial state. The prominence-assigning constraints conflict only with one another and do not conflict with any faithfulness constraints.

[5] A contextual markedness alternative to positional faithfulness would rely on the prominence-assigning markedness constraints in much the same way. The difference would be that a context-sensitive markedness constraint would incorporate prominence by specifying that some feature is banned in the non-prominent part of a syllable, foot, or prosodic word. A context-free version of that markedness constraint would also be necessary to ban that same feature in all contexts. By ranking a context-free faithfulness constraint between these two markedness constraints, a contrast would be preserved in prominent contexts and merged in non-prominent contexts.

The formulation of positional faithfulness constraints can in turn be constrained or simplified in that the prominence of a specific context would not need to be stipulated; instead, the constraint would simply specify that it is sensitive to prominence at some higher prosodic level (e.g. the syllable, foot, or word). The ranking of the prominence-assigning constraints would determine whether, for example, it is the onset or the coda of a syllable that is rendered prominent.

The following serves as a generic account of the contextual mergers described in §2. The constraints in (10) are defined in general terms, but they can be instantiated with any of the relevant voice, place, or manner features. Similarly, the prominence-assigning constraint INITIALPROM in (9) above should be interpreted as referring to a family of constraints holding at the level of the syllable, foot, or word. This constraint assigns prominence to the initial constituent of a prosodic category (e.g. either the onset of a syllable, the initial syllable of a foot, or the initial foot of a word).[6] The other family of prominence-assigning constraints, FINALPROM, in (9) refers to the complementary class of constituents in a given prosodic domain (e.g. the syllable rhyme, the final syllable of a foot, or the final foot of a word).

(10) Generic constraints

a. Faithfulness

| | |
|---|---|
| ID-PROM[feature]: | Corresponding segments in prominent contexts must have identical voice, place, or manner features |
| ID[feature]: | Corresponding segments must have identical voice, place, or manner features |

b. Segmental/featural markedness

| | |
|---|---|
| *FEATURE: | Voice, place, or manner features are banned |

Let us now see how our proposal can be applied to the case of Child 142, who merges certain place and manner contrasts word-initially, but maintains those contrasts elsewhere within the word. The full set of constraints that we will be employing in this case is given in (11).

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[6] While we have formulated the prominence-assigning constraints in terms of prosodic categories, it might ultimately be more appropriate to align prominence with edges of prosodic, grammatical, or lexical categories. Because these various domains largely overlap in our data, additional research is needed to disambiguate the different predictions that would follow from these alternative formulations.

(11) Constraints and ranking

a. Markedness
AGREE: Stops with different place features are banned within the word
*AFFR: Affricates are banned
INITIALPROM: The initial constituent of a syllable, foot, or prosodic word must be prominent
FINALPROM: The final constituent of a syllable, foot, or prosodic word must be prominent

b. Faithfulness
ID-PROM[manner]: Corresponding segments in prominent contexts must have identical manner features
ID-PROM[place]: Corresponding segments in prominent contexts must have identical place features
ID[coronal]: Corresponding segments must be identical in terms of the feature [coronal]
ID[manner]: Corresponding segments must have identical manner features

c. Ranking:
FINALPROM, ID-PROM[place], ID-PROM[manner] >>
INITIALPROM, AGREE, *AFFR >> ID[manner], ID[coronal]

In accord with assumptions about the initial state and the default ranking of constraints (Smolensky 1996), it is assumed that error patterns arise from the dominance of certain markedness constraints over antagonistic faithfulness constraints. Deaffrication and consonant harmony involve changes in manner and/or place features, suggesting that the faithfulness constraints ID[manner] and ID[coronal] are dominated by antagonistic markedness constraints. Beginning with deaffrication, we saw that the contrast between word-initial affricates and simple alveolar stops is neutralized in favor of the simple alveolar stop. The markedness constraint *AFFR banning affricates would compel a change to a less marked stop if that constraint dominated ID[manner]. For expository purposes, we will consider stops, fricatives, and affricates to differ in manner, even though different features and geometric structures are ultimately involved in their representations. Thus, any change from an affricate to a simple alveolar stop will be considered to violate ID[manner]. The tableau in (12) illustrates the ranking necessary to account for this one aspect of the error pattern.

(12) Deaffrication

| /tʃu/ ‘chew’ | *AFFR | ID[manner] |
|---|---|---|
| a. tʃu | *! | |
| b. ☞ tu | | * |

We are assuming here that this child’s input representations are target-appropriate. This is in accord with “Richness of the Base” (Prince and Smolensky 1993/2004), which precludes language-specific (or child-specific) restrictions on input representations. However, even if the input representation for this word were assumed to be identical to the occurring errored output representation, as might follow from lexicon optimization (Prince and Smolensky 1993/2004), it is essential that the constraint hierarchy can guarantee the selection of the attested output. By ranking *AFFR over ID[manner], candidate a with an affricate incurs a fatal violation of the markedness constraint and is ruled out in favor of candidate b no matter which of the alternatives is assumed to be the input representation.

In order to account for the preservation of affricates in words such as [pits] ‘peach’, a positional faithfulness constraint is needed that preserves manner in postvocalic contexts. That constraint must also be ranked above the antagonistic markedness constraint *AFFR. This is where we can begin to illustrate the role of the prominence-assigning constraints. Specifically, by appealing to the default ranking of FINALPROM over INITIALPROM, the entire rhyme of a syllable (including specifically the coda consonant) will be rendered prominent. The prominence of that coda establishes it as the proper domain for the positional faithfulness constraint ID-PROM[manner]. The tableaux in (13) show how the manner contrast is preserved postvocalically in ‘peach’ and merged word-initially in ‘chew’. The different possible locations for prominence in the candidate set are indicated by enclosing the prominent segments in parentheses.

It should be kept in mind that freedom of analysis allows candidates to differ solely by their prominence.[7] Notice, for example, that candidates a and b are segmentally identical in each tableau, as are c, d, and e, but they differ in the location and presence of prominence, and their well-

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[7] This is similar to the assumption that is often made regarding different syllabic parses of segmentally identical candidates.

formedness is evaluated differently by the prominence-assigning constraints. Those candidates with initial prominence (a and c) and those with no prominence (e) are assigned fatal violations by FinalProm and are eliminated from the competition. The positional faithfulness constraint takes advantage of the prominence assigned to the rhyme to rule out candidate d in the tableau for ‘peach’ and prevent deaffrication in that context.

(13) Manner contrast preserved postvocalically and merged word-initially

| /tʃu/ ‘chew’ | Final Prom | ID-Prom [manner] | Initial Prom | *Affr | ID[manner] |
|---|---|---|---|---|---|
| a. (tʃ)u | *! | | | * | |
| b. tʃ(u) | | | * | *! | |
| c. (t)u | *! | * | | | * |
| d. ☞ t(u) | | | * | | * |
| e. tu | *! | | * | | * |

| /pitʃ/ ‘peach’ | Final Prom | ID-Prom [manner] | Initial Prom | *Affr | ID[manner] |
|---|---|---|---|---|---|
| a. (p)its | *! | | | * | |
| b. ☞ p(its) | | | * | * | |
| c. (p)it | *! | | | | * |
| d. p(it) | | *! | * | | * |
| e. pit | *! | | * | | * |

Moving now to this child’s consonant harmony error pattern, note that a change in a place feature is involved, namely the change from an alveolar stop to a dorsal when followed by a dorsal consonant. Alveolars are the only place of articulation vulnerable to change; labial and dorsal stops are never realized unfaithfully as a result of consonant harmony or any other process. We thus assume, independent of any assigned prominence, that one or more undominated context-free faithfulness constraints preserve underlying input labial and dorsal place in all contexts (e.g. de Lacy 2002). These constraints will not be mentioned further, but they contribute to the explanation for why dorsals (but not coronals) trigger consonant harmony and why labials are not targets of consonant harmony. The contextually conditioned markedness constraint Agree compels consonant harmony by banning alveolar stops when a different place feature occurs within the word, provided that this constraint also dominates the antagonistic faithfulness constraint ID[coronal]. Notice that AGREE assigns a fatal violation mark to the faithful candidate with this ranking.

(14) Consonant harmony

| /dɔg/ 'dog' | AGREE | ID[coronal] |
|---|---|---|
| a. dɔg | *! | |
| b. ☞ gɔg | | * |

The above account does not yet explain the regressive versus progressive character of consonant harmony. Consider, for example, words such as [koʊt] 'coat', which do not undergo consonant harmony and are realized faithfully by this child. In the absence of any other constraints, the final alveolar stop of the faithful candidate would cause a fatal violation of AGREE, incorrectly predicting progressive consonant harmony as well as regressive consonant harmony. By appealing to the default ranking of the prominence-assigning constraints (as required for the facts about the manner contrast for this child) and by ranking the positionally restricted faithfulness constraint ID-PROM[place] above AGREE, place features in final prosodic constituents will always be preserved. This point is illustrated in the tableaux in (15).

(15) Progressive consonant harmony blocked

| /koʊt/ 'coat' | FINAL PROM | ID-PROM [place] | INITIAL PROM | AGREE | ID[coronal] |
|---|---|---|---|---|---|
| a. (k)oʊt | *! | | | * | |
| b. ☞ k(oʊt) | | | * | * | |
| c. (k)ouk | *! | | | | * |
| d. k(ouk) | | *! | * | | * |

| /dɔg/ 'dog' | FINAL PROM | ID-PROM [place] | INITIAL PROM | AGREE | ID[coronal] |
|---|---|---|---|---|---|
| a. (d)ɔg | *! | | | * | |
| b. d(ɔg) | | | * | *! | |
| c. (g)ɔg | *! | * | | | * |
| d. ☞ g(ɔg) | | | * | | * |
| e. (d)ɔd | *! | | | | * |
| f. d(ɔd) | | *! | * | | * |

Notice in particular that ID-Prom[place] eliminates candidate f due to changes in the place features of prominent codas.

It is a simple matter now to see how the account works for words where deaffrication and consonant harmony interact. The tableau in (16) considers the realization of a word such as ‘cheek’, adopting the combined set of constraints and ranking from above. Due to space limitations, we have excluded from the tableau the two low-ranked faithfulness constraints ID[coronal] and ID[manner] because their violations are not crucial. Undominated FinalProm assigns fatal violation marks to all candidates in which the rhyme (especially the coda consonant) is not prominent. Given that onsets cannot be prominent, the positional faithfulness constraints will not be able to preserve the place or manner of the word-initial affricate. The markedness constraint Agree will thus eliminate the faithful candidate with an initial affricate and the unassimilated candidate with a word-initial simple alveolar stop. Any candidate like f in which the final consonant assimilates to the place of the initial consonant will be eliminated by undominated ID-Prom[place]. Candidate h thus survives as optimal.

(16) Interaction of deaffrication and consonant harmony

| /tʃik/ ‘cheek’ | Final Prom | ID-Prom [place] | ID-Prom [manner] | Initial Prom | Agree | *Affr |
|---|---|---|---|---|---|---|
| a. (tʃ)ik | *! | | | | * | * |
| b. tʃ(ik) | | | | * | *! | * |
| c. (t)ik | *! | | * | | * | |
| d. t(ik) | | | | * | *! | |
| e. (t)it | *! | | * | | | |
| f. t(it) | | *! | | * | | |
| g. (k)ik | *! | * | * | | | |
| h. ☞ k(ik) | | | | * | | |

While this case and the others from §2 involved multiple mergers in the same context, one and the same set of prominence-assigning constraints was employed to designate final prosodic constituents as prominent. All of the mergers were sanctioned in nonprominent (initial) contexts, and all contrasts were preserved due to positional faithfulness constraints that were sensitive to prominence. Those faithfulness constraints are exactly the same positional faithfulness constraints employed in fully developed languages, but their implementation is different due to the particular ranking of the prominence-assigning constraints.

The above account is a particular instantiation of what would be required generally for the cases presented in §2.[8] This even extends to the somewhat unusual error pattern of initial consonant omission (Child 4, §2.4). For example, instead of featural faithfulness constraints being involved in that case, the deletion of whole segments implicates the violation of the low-ranked anti-deletion constraint MAX. Notice that MAX is not restricted by context. Context-free markedness constraints banning various classes of sounds must be ranked above MAX to compel deletion. The preservation of consonants in postvocalic contexts can come about from undominated FINALPROM and an anti-deletion constraint that is sensitive to prominence, namely MAXPROM. This positional faithfulness constraint prohibits deletion in the prominent part of a syllable, foot, or prosodic word. In this particular instance the prominent part of the syllable is the rhyme. By ranking MAXPROM over the markedness constraints, consonants will be preserved in the more prominent postvocalic context, but will be deleted word-initially because that context was not assigned prominence by undominated FINALPROM.

The consequence is that all of the typologically problematic cases in §2 can be fit within the general schema in (17).

(17) Schema for cases in §2
FINALPROM, ID-PROM[feature] >> INITIALPROM, *FEATURE
>> ID[feature]

We have argued elsewhere (Dinnsen and Farris-Trimble 2008) that this schema represents an early intermediate stage of development. More specifically, it fits within a plausible developmental trajectory. Earlier stages of development would be consistent with the default ranking of markedness over (prominence-sensitive) faithfulness. FINALPROM would, of course, outrank INITIALPROM at that earlier point as well. The empirical consequence is that one or more contrasts would be merged in all contexts. This is typical of children who completely exclude certain sounds from their inventories. The early intermediate stage of development that we have been focusing on in this paper derives from that earlier stage by the simple demotion of one or more markedness constraints below the prominence-sensitive faithfulness constraint. A later intermediate stage of development

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[8] The counterfeeding interactions observed in the case of Child 5T in §2.3 require special mechanisms to handle the associated opacity effects. For a discussion of the problems that opacity effects pose for optimality theory and for some possible solutions, see Dinnsen (2008).

is identical to the schema in (17) above, except that FINALPROM is demoted below INITIALPROM. Such a stage of development begins to look more like fully developed languages, where contrasts are preserved word-initially but merged postvocalically. The end-state stage of development results from the demotion of markedness below faithfulness, yielding contrasts in all contexts.

The following section highlights some independent support for our hypotheses and considers some issues that arise from those proposals.

## 4. Discussion

### 4.1. Psycholinguistic support

The facts considered thus far have largely involved conventional linguistic evidence regarding children's synchronic grammars. However, two recent psycholinguistic studies are especially relevant to our proposals about the early prominence of rhymes and the reranking of prominence-assigning markedness constraints. Both studies provide external evidence of a developmental shift in the prominence of children's subsyllabic structures. In the first study, Brooks and MacWhinney (2000) report results from two experiments that were designed to test the effects of interfering primes in different age groups. They compared the effects of auditorily presented words with onset prime and rhyme prime in a picture-naming task. Thirty participants in four age groups (5 years, 7 years, 9+ years, and college undergraduates) were divided into two groups. Participants were asked to name a picture after being presented auditorily with a stimulus word which was either identical to the picture, phonologically related, phonologically unrelated, or neutral. Of the phonologically related words, half of the participants received words that shared an onset with the picture word and half received words that shared a rhyme with the picture word. The 5-year-old children's picture naming was faster when they were presented with a rhyme prime word than with an onset prime word. Seven-year-old children showed equal facility for the two sets of words, while older children's and adults' productions were better facilitated by onset prime words. Brooks and MacWhinney conclude that there is a developmental change in speech production strategies – as children grow older, they restructure their lexicons in order to facilitate incremental production. As a default, though, young children's productions are most strongly influenced by the rhyme.

In another series of experiments, Coady and Aslin (2004) performed nonword repetition tasks with two groups of twelve children, ages 2;6 and 3;6. Both groups of children more accurately repeated 2- and 3-syllable nonwords that contained high frequency phonemes than they did nonwords that contained low frequency phonemes. However, in a second study, Coady and Aslin found that only the older set of children more accurately repeated nonwords in which the frequency difference occurred only in syllable onsets. The younger children showed no difference in accuracy in these words. Coady and Aslin concluded that while all the children were sensitive to the relative frequency of segments, only the older children were sensitive to more fine-grained frequency differences in onset position.

We take the findings of a developmental shift in the prominence of subsyllabic structures to reflect our proposed reranking of the prominence-assigning constraints and to be supportive of our claim that the default is for rhymes to be prominent in the early stages of acquisition.

### 4.2. Other evidence for the prominence of rhymes

Acquisition researchers have long recognized the perceptual salience of final position for young children (e.g. Slobin 1973; Echols and Newport 1992). Another piece of evidence for the default prominence of rhymes relates to the fact that vowels tend to be produced more accurately than onset consonants in the early stages of acquisition (e.g. Pollock and Keiser 1990; Otomo and Stoel-Gammon 1992; Pollock and Berni 2003).

There is also some evidence that the prominence of rhymes persists for some phenomena, even after there has been a general shift of prominence to onsets for other phenomena. This is exemplified by onset structures that are dependent on an aspect of rhyme structure. That is, on the basis of cross-linguistic and developmental evidence, it has been observed that the occurrence of certain onset clusters in a language depends on the occurrence of complex (branching) rhymes in that language (e.g. Lleó and Prinz 1996; Baertsch 2002; Kirk and Demuth 2003; Kehoe and Hilaire-Debove 2004; Levelt and van de Vijver 2004). A promising optimality theoretic proposal for capturing this dependency is embodied in the 'split margin hierarchy' (Baertsch 2002; Baertsch and Davis this volume). Under this proposal, the occurrence of an onset stop+liquid cluster depends on the occurrence of a coda liquid consonant. The developmental prediction would also be that a stop+liquid cluster cannot be acquired without first having acquired a coda liquid consonant. For an overview and critique of the split margin hierarchy as it relates to acquisition, see Barlow and Gierut

(2008). Independent of the theoretical account that one might adopt, the persistent dependency of onsets on rhymes can be seen as a possible remnant of the early developmental prominence of rhymes. That is, the early prominence of rhymes predicts that marked structures should arise first in rhymes and only later in onsets.

### 4.3. Lexical restructuring and richness of the base

Our proposal about the reranking of the prominence-assigning constraints was tied, in part, to the widely held view among acquisition researchers that children's lexical representations and the organization of their lexicons undergo a restructuring in the early stages (Charles-Luce and Luce 1990; Metsala and Walley 1998; Storkel 2002; Walley, Metsala, and Garlock 2003). The general assumption has been that children begin with more holistic, syllable-sized representations. Those representations are presumed to be coarsely coded, underspecified, or otherwise unanalyzable. As new words are added to the lexicon and more and more words need to be differentiated, representations begin to restructure, becoming more elaborated or more fully specified. This developmental perspective might seem at odds with a basic tenet of optimality theory, namely richness of the base. The assumption of optimality theory is that input representations are universal and are thus the same for children and adults. Children's underlying representations should not be subject to change – contrary to what has typically been assumed by acquisition researchers. These seemingly incompatible positions can, however, be reconciled within optimality theory without violating richness of the base. That is, even during the earliest stages of acquisition, highly elaborate, adult-like, unchanging input representations can be adopted, if the markedness constraints that militate against structure outrank the faithfulness constraints. This is assumed to be the default ranking of constraints, and it mimics what would appear to be simple, underspecified representations. Over time, as markedness constraints are demoted on the basis of positive evidence, more elaborate representations are permitted to surface, revealing the rich base. Under this view, then, it is not the representations per se that change, but rather the constraint hierarchy. In this way, changes in the constraint hierarchy can be equated with apparent lexical restructuring. Consequently, when we talk about the reranking of the prominence-assigning constraints being triggered by lexical restructuring, this should more properly be interpreted to mean that the prominence-assigning constraints rerank in response to increases in the size of the lexicon, which in turn brings on other changes in the constraint hierarchy to yield the effect of lexical restructuring.

Our conjecture about the role of vocabulary size is supported by a recent study by Smith, McGregor, and Demille (2006). They collected spontaneous language samples from three groups of typically developing children: 2-year-olds with average-sized vocabularies (approximately 330 words), age-matched peers with precocious vocabularies (approximately 590 words), and older children (age 2;6) with average-sized vocabularies (approximately 562 words). Phonological performance was measured in a variety of ways, including the number of different consonants that were targeted, the number of different consonants produced correctly, and the percentage of consonants produced correctly. The lexically precocious 2-year-olds were found to be similar to their older vocabulary mates on most measures of phonological performance, and both of these groups were generally superior to the 2-year-olds with smaller lexicons. These findings offer some support for a hypothesized relationship between lexicon size and phonological performance, and suggest that 2-year-olds' phonological development is more closely related to size of the lexicon than to chronological age.

### 4.4. Prominent rhymes and final consonant omission

One of our central claims is that rhymes are rendered prominent in the initial state as a result of the default ranking of the prominence-assigning constraints. This might, however, seem at odds with the fact that many children in the early stages of acquisition omit coda consonants. Why would a child omit coda consonants if rhymes were truly prominent? This is reconciled by appealing to the independent and freely permutable markedness constraint NoCoda, which bans coda consonants. When NoCoda is ranked above the antagonistic faithfulness constraint, Max, which militates against deletion, coda consonants would be omitted, even if FinalProm were ranked above InitialProm. It is important to keep in mind that the prominence-assigning constraints conflict with one another, but they do not conflict with other segmental/featural markedness or faithfulness constraints. There is thus no antagonism between the prominence of rhymes and the presence/absence of coda consonants. The situation we are entertaining here is analogous to the initial state where FinalProm outranks InitialProm and markedness dominates faithfulness. On the other hand, when NoCoda is demoted below Max, coda consonants would be preserved independent of the ranking of the prominence-assigning constraints. Importantly, the early demotion of NoCoda during the stages when rhymes are prominent should result in the emergence of segmental contrasts first in rhymes. It is, of course, possible that NoCoda could be demoted late in the course of acquisition – after many segmental contrasts had already been established in onsets. In such a situation, it might mistakenly appear that our predictions were not supported because rhymes would lag behind onsets in the order and number of acquired contrasts. However, to properly evaluate our hypothesized developmental trajectory, it is important to identify a child who has demoted NoCoda early in the course of acquisition – before onsets and codas compete for featural contrasts.

## 4.5. Some unresolved issues

While our proposals solve certain problems, they also raise other questions and point to some promising areas in need of further research. For example, our proposal about the reranking of the prominence-assigning constraints raises questions about the nature of the evidence needed to trigger the reranking. We speculated that the reranking might be triggered by increases in the size of the lexicon. More psycholinguistic research is also called for to determine whether there is a developmental shift in the prominence of other prosodic constituents beyond the onset and rhyme. These questions highlight the need for more studies that are specifically designed to focus on the interaction between children's error patterns and the structure and organization of their lexicons.

Another issue that arises is whether some contexts are invariably prominent for certain featural contrasts. As we have formulated our proposal, the prominence-assigning constraints are freely permutable, at least to a certain extent, predicting that complementary contexts can be prominent either at different stages of development or in different children. However, returning to Steriade's (2001) claims about the salience of postvocalic contexts for apical contrasts, it would appear that the prominence of that context may not change for that contrast (although she presented no developmental data on this point). If it were to turn out that certain contexts are invariably prominent for certain contrasts, it may be desirable to distinguish those from others that are vulnerable to a shift in prominence. This might be done by postulating positional faithfulness constraints that are restricted to those specific invariant features and contexts.

As a further test of this prediction, it will be important to determine whether there are cases where a child might, for example, merge one contrast in initial position and merge a different contrast in final position. If such cases were found, it would be necessary to modify our proposal. One possible approach to this question might be to reformulate the prominence-assigning constraints with each relativized to specific features. It is unclear at present whether such an elaboration is necessary or desirable.

The prominence paradox is just one of several known disparities between developing and fully developed languages. Our proposal for dealing with this disparity may hold promise for resolving others. For example, one routinely cited difference relates to the phenomenon of long-distance consonant harmony commonly observed in developing (but not fully developed) phonologies (cf. Child 142 in §2.2 and Child 5T in §2.3). The widely held assumption is that assimilation is local with the trigger and target being adjacent (NíChiosáin and Padgett 2001). The nonlocal character of children's consonant harmony processes challenges this assumption. Feature geometry with its hierarchical organization of features and autonomous tiers offers a structural means for characterizing limits on assimilatory processes. However, standard conceptions of feature geometry (e.g. Clements and Hume 1995) only reinforce the disparity by integrating consonant and vowel features into a single geometry with vowel features as dependents of consonant place features. Such a configuration is intended to allow phonetically nonadjacent vowels to participate in harmony processes. More specifically, the assimilating vowel features are assumed to be on their own tier and would not incur line-crossing violations with intervening consonants. Those same geometries preclude place assimilation among nonadjacent consonants because the assimilating consonant features would incur a line-crossing violation with the intervening vowel.

To get around this problem, some have suggested that children's geometries may be simpler than those of adults, being configured with consonant and vowel features on entirely independent segregated tiers (e.g. McDonough and Myers 1991; Macken 1992). Such a proposal would allow phonetically nonadjacent consonants to be autosegmentally adjacent on the consonant tier and thus vulnerable to assimilation. This proposal would at least be consistent with standard locality expectations. Continuity considerations and richness of the base would, however, argue against any claims that children's geometries are inherently different from those of adults.

A possible alternative (similar to our solution to the prominence paradox) might be to postulate two competing markedness constraints that license particular geometric configurations in output candidates. For a discussion of how this might be done, see Dinnsen and Farris-Trimble (2008).

## 5. Conclusion

Our main purpose here was to show that children's error patterns are often restricted to word-initial position, merging a range of contrasts in that context, while maintaining those contrasts elsewhere within the word. The contextual restrictions on these processes are quite different from those observed for phonological processes in fully developed languages. Word-initial position is generally presumed to be a strong, prominent context that resists mergers in fully developed languages; other contexts are weaker and are thus vulnerable to mergers. This discrepancy between developing and fully developed languages represents what we have termed the 'prominence paradox' and would seem to undermine any claims of continuity (e.g. Pinker 1984). A theory such as optimality theory with its strong universal claims is especially challenged to reconcile the discrepancy between these developmental facts and those of fully developed languages.

Our solution introduced a new set of prominence-assigning markedness constraints that conflict with one another. One instance of this family (INITIALPROM) assigns or licenses prominence in the initial constituent of a syllable, foot, or prosodic word. The other, conflicting instance of this family (FINALPROM) assigns prominence to the complementary final constituent of those same prosodic categories. The ranking of these constraints determines which prosodic constituents are realized phonetically with prominence and thus likely to preserve contrasts. It was proposed that the default is for FINALPROM to be ranked over INITIALPROM. That ranking accounts for the early prominence of rhymes and final position and the emergence of many contrasts in those contexts. The reverse ranking of these constraints accounts for the prominence of onsets and initial position in fully developed languages. One likely trigger for the reranking of the prominence-assigning constraints was hypothesized to be a change in the size and organization of the lexicon in accord with experimental results revealing a developmental shift in the prominence of prosodic structures. Other factors as well may be responsible for reranking the prominence-assigning constraints, e.g. treatment that focuses the child's attention on word-initial position. With prominence determined from the ranking of the prominence-assigning constraints, the other positional faithfulness (or contextual markedness) constraints that depend on prominence can take advantage of that licensed prominence to preserve (or neutralize) a contrast.

One result of our proposal is that the constraint set can remain the same for developing and fully developed languages. As has been standard within optimality theory, the difference between these linguistic systems resides in the ranking of the constraints. Consequently, one of the most striking differences between developing and fully developed languages (vis-à-vis the prominence paradox) has in large part been obviated. The difference simply arises when developing phonologies rely on the default ranking of the universal prominence-assigning constraints, and fully developed languages rely on the reverse ranking of those constraints.

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# Strength relations and first language acquisition

*Eirini Sanoudaki*

## 1. Introduction

In this paper, I discuss the acquisition of clusters of voiceless stops (*pt/kt*) and voiceless fricatives (*fθ/xθ*) in Greek. These clusters are closely linked to sociolinguistic questions, since until recently they were not allowed in popular Greek, but only in a high superimposed variety. Popular Greek only allowed dissimilar (fricative-stop) clusters instead.

Building on the analysis of Seigneur-Froli (2003, 2004, 2006) in CVCV theory, I propose a complexity parameter that can capture the historical evolution of these clusters and can make predictions regarding their acquisition. The parameter is based on the assumption that the first member of these clusters occupies a weaker position in comparison with the second member. The chapter proceeds as follows. §2 presents the evolution of the clusters and the proposed analysis, including a complexity parameter. The ensuing predictions are tested with an acquisition experiment reported in §3. §4 is an initial investigation of possible triggers for the diachronic change in the setting of the proposed parameter. A short conclusion follows.

## 2. Historical and theoretical background

### 2.1. Greek Diglossia

The linguistic situation in Greece for centuries has been that of Diglossia (Ferguson 1959). This is a situation in which two linguistic varieties coexist within a country-state: one of them is a superimposed variety, usually the vehicle of literature. It is learned through formal education and is used for formal written and spoken purposes.

Greek throughout history has had two varieties, a low one, used as everyday language, and a high one, used in literature and often supported by authority (Horrocks 1997). In 1830, when Greece became an independent state, the language that became the official language of the new nation was Katharevusa, a ‘purified demotic’, with some elements of the popular language and resuscitated forms and elements of ancient Greek. Katharevusa was a constructed language that nobody spoke consistently (Browning 1983). It was used in literature, education and for official purposes, and became more and more remote from the comprehension of the average Greek.

This situation continued until 1974, when Demotic became the official language. Since 1974 the language spoken in Greece has been a mixture of the popular language and Katharevusa in many respects (Mackridge 1985). Moreover, in some cases (structures and words), two possibilities have coexisted, one of Demotic origin and one of Katharevusa origin, which serves as a social marker for the speaker (Kazazis 1992). The choice of features of one over the other indicates stylistic preferences and also marks the linguistic register and the social class and background of the speaker (Trudgill 1983).

## 2.2. The clusters

The fricative-fricative and stop-stop clusters constitute an example of such language mixture. In modern Greek, there are fricative-fricative clusters (*fθ, xθ* e.g. *ixθiopolˈio* 'fishmonger's'), stop-stop clusters (*pt, kt* e.g. *perˈiptero* 'kiosk') and fricative-stop clusters (*ft, xt,* e.g. *ftˈino* 'spit'). However, some words have two forms: one that contains a fricative-stop sequence, and one that contains a corresponding stop-stop (1a) or fricative-fricative (1b) sequence. In these cases, the speaker's choice is dependent on sociolinguistic factors, and the fricative-fricative/stop-stop sequences have been argued to be linked to higher register (Tserdanelis 2001).

(1) a. stop-stop

| | |
|---|---|
| *ktˈena ~ xtˈena* | 'comb' |
| *eptˈa ~ eftˈa* | 'seven' |
| *oktˈo ~ oxtˈo* | 'eight' |

b. fricative-fricative

| | |
|---|---|
| *xθes ~ xtes* | 'yesterday' |
| *fθinˈos ~ ftinˈos* | 'cheap' |
| *anˈixθika ~ anˈixtika* | 'open, PASS. PAST.1ST SG' |

The dissimilar (fricative-stop) forms originate in Demotic, while the similar (fricative-fricative and stop-stop) forms come from Katharevusa. The use of Katharevusa in education and later in mass media was the cause of the introduction of the similar clusters into standard Greek.

The clusters of Demotic origin have been analysed as the output of manner dissimilation, which was part of a series of changes that led from ancient to modern Greek (Browning 1983; Horrocks 1997). These changes involved:

(2) a. spirantisation of aspirated and voiced stops
b. progressive manner dissimilation of voiceless fricatives (hardening)
c. regressive manner dissimilation of voiceless stops (spirantisation)

Ancient Greek contained three series of stops: aspirated stops (*$p^h$, $t^h$, $k^h$*), voiced stops (*b,d,g*) and voiceless stops (*p,t,k*). Process (2a), spirantisation, was context free and turned the former two series of stops into fricatives.

(3) a. Aspirated stops

| | |
|---|---|
| *$k^ht^h$es > xθes* | ‘yesterday’ |
| *ˈo$k^ht^h$ee > ˈoxθi* | ‘shore’ |

b. Voiced stops

| | |
|---|---|
| *ˈogdoos > ˈoγðoos* | ‘eighth’ |

Processes (2b) and (2c), dissimilation, affected clusters of the (new) series of voiceless fricatives (4a), and clusters of voiceless stops (4b) respectively.

(4) a. Fricatives

| | |
|---|---|
| *xθes > xtes* | ‘yesterday’ |
| *fθˈano > ftˈano* | ‘arrive, 1$^{ST}$ SG’ |
| *ˈoxθi > ˈoxti* | ‘shore’ |

b. Stops

| | |
|---|---|
| *eptˈa > eftˈa* | ‘seven’ |
| *ˈektos > ˈextos* | ‘sixth’ |

According to this view, these historical rules resulted in most Greek dialects having fricative-stop clusters (Joseph and Philippaki-Warburton 1987; Newton 1972). Then the older forms (similar clusters) were re-introduced by Katharevusa (Malikouti-Drachman 1987).

There is disagreement among researchers whether dissimilation rules are active synchronically (as optional rules) (Pagoni 1993) or not (Malikouti-Drachman 1987). Seigneur-Froli (2006) argues that the rule is not synchronic, on the basis of the existence of forms that do not exhibit variation (e.g. *ˈapteros* [**ˈafteros*] 'wingless') and of minimal pairs (*fθˈino* 'decline', *ftˈino* 'spit'). Such forms constitute evidence that the phonological system of (modern) Greek allows both cluster types lexically.

Seigneur-Froli (2003, 2004, 2006) proposes an analysis of dissimilation as positional lenition in CVCV theory (Lowenstamm 1996; Scheer 2004), following, specifically, the Coda Mirror theory (Ségéral and Scheer 2001), for good reasons. The sheer existence of obstruent-obstruent clusters in word initial position is problematic for traditional syllabic theories,[1] let alone the fact that they behave – in terms of strength – like their word-medial counterparts, since they follow identical lenition patterns. But for CVCV theory the two events are expected and fall under a single explanation. For the details of the mechanism the reader is referred to the work mentioned above. For our purposes, it suffices to say that in this phonological approach, structure and segmental strength are effects of the combined action of government and licensing (Ségéral and Scheer 2001). Specifically, licensing strengthens the segmental expression of its target, while government weakens the segmental expression of its target. A well known phenomenon in Romance languages is that a (word-internal) post-consonantal position is strong, while a (word-internal) pre-consonantal position is relatively weaker. For instance, Latin post-consonantal *p* is preserved in French (talpa > taupe [top] 'mole'), while pre-consonantal *p* is not (rupta > route [ʁut] 'road'). The CVCV analysis of this asymmetry is that the former (post-consonantal) position is strong because it is licensed (5a), while the latter (pre-consonantal) position is weak because it is not licensed (5b).

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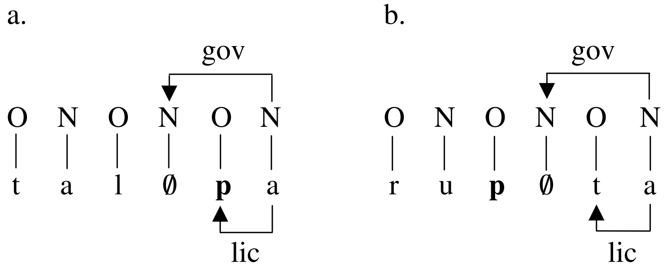
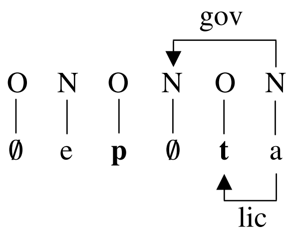
[1] For attempts to accommodate these clusters in other frameworks, see e.g. Steriade (1982), Pagoni (1993) and Pagoni-Tetlow (1998) for an analysis in standard government phonology.

(5)



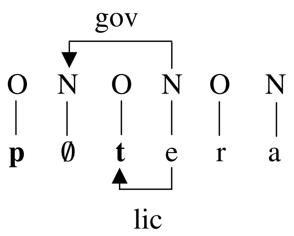
Seigneur-Froli (2003, 2004, 2006) argues that cluster dissimilation in Greek is part of the same phenomenon. Word-medial pre-consonantal stops became fricatives (*e*___p___*t*ˈ*a* > *e*___f___*t*ˈ*a*) because they are in an unlicensed position (6). This contrasts with the licensed (strong) post-consonantal position in the same example, where the stop was preserved (*ep*___t___ˈ*a* > *ef*___t___ˈ*a*).

(6)



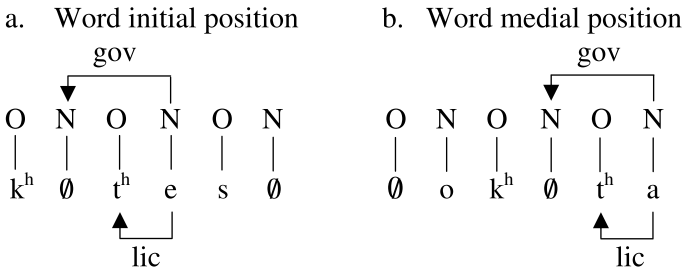
Word-initial preconsonantal stops in Greek are also weak because they are in an unlicensed position (7), like their word-medial counterparts. Word-initial pre-consonantal stops also became fricatives (___p___*ter*ˈ*o* > ___f___*ter*ˈ*o*). The stops following them, being in a licensed (strong) position, were preserved (*p*___t___*er*ˈ*o* > *f*___t___*er*ˈ*o*) like word-medial post-consonantal stops.

(7)



As far as the evolution of clusters of aspirated stops is concerned, Seigneur-Froli (2003) argues that their development into fricative-stop clusters was not preceded by the alleged intermediate step of fricative-fricative clusters – cf. (3). Using evidence of comparative and orthographic nature, she challenges the interpretation of Egyptian and Latin transcriptions of Greek and argues against the existence of a fricative-fricative stage in the development of these clusters; *xt* originates in *$k^ht^h$*, without an intermediate step *xθ*.[2] The analysis she proposes for clusters of aspirated stops is similar to her analysis of clusters of (unaspirated) stops mentioned above: the first (aspirated) stop, being in an unlicensed, weak position, lost stopness (***$k^h$***$t^h$*es* > ***xtes*** 'yesterday'), in contrast to the second stop, which, being in a strong, licensed position, retained stopness ($k^h$***$t^h$****es* > ***x**tes* 'yesterday'). The analysis holds for both word-initial (8a) and word-medial (8b) clusters.

(8)


a. Word initial position
b. Word medial position

How is loss of stopness represented? Following government phonology research on monovalent elements[3] (see e.g. Harris 1990), stopness is represented by a stop element, which differentiates stops from fricatives (9).

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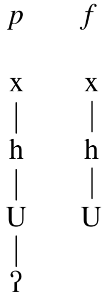
[2] Notice that, according to this view, Katharevusa introduced *novel* clusters (*fθ, xθ*) to the language, instead of re-introducing older forms.

[3] Government phonology (and CVCV as its development), as well as Dependency and Particle Phonology, do not use binary (or multi-valued) features in the representations of segments, but rely instead on monovalent objects. Complexity can thus be seen as the number of primes a segment is composed of (Harris 1990). I provide no list of primes, since there is no consensus as to which these primes are. Some contributions to the debate can be found in Harris (1990, 1994), Harris and Lindsey (1995), Kaye (2001), Rennison (1999), Scheer (1999), Szigetvári (1994).

(9)



The elemental make-up of the sounds in (9) is taken from Pagoni's (1993) analysis of Greek consonants. It involves the place element |U|, along with the noise element |h| and the stop/occlusion element. Following Pagoni (1993), I assume that in Greek a voiceless stop consists of a stop element, a noise and a place element, while the corresponding fricative lacks the stop element. However, the exact representation of these consonants is not crucial for our discussion. Despite the fact that there are numerous proposals for the internal composition of consonants in terms of elements (see footnote 3), several government phonology and CVCV analyses would agree on the statement that a fricative is the lenited version of the corresponding stop, via the loss of some kind of stop element.

### 2.3. The proposal: a complexity parameter

CVCV theory provides us with the tools to determine which positions are strong or weak, and consequently where we should expect to find lenition or fortition diachronically, and where it would be impossible for them to happen. However, the question of what changes in the speaker's grammar when such processes occur is left open.

Following Lightfoot (1991, 1999) in connecting language change to changes in parameter settings, I argue for the existence of a parameter that was responsible for the historical change. The parameter is based on the distinction between a pre-consonantal and a post-consonantal position: recall that in CVCV theory the former position is unlicensed while the latter is licensed. The parameter has the following two settings:

(10) Complexity Parameter
Setting (a):
If A is a licensed position and B an adjacent unlicensed one, and $\alpha$ is the number of elements in A and $\beta$ the number of elements in B, then $\beta$ must be smaller than $\alpha$.[4]

Setting (b):
If A is a licensed position and B an adjacent unlicensed one, and $\alpha$ is the number of elements in A and $\beta$ the number of elements in B, then $\beta$ must be smaller than or the same as $\alpha$.

And more formally:

(11) Setting (a): $\beta < \alpha$
Setting (b): $\beta \leq \alpha$

Before proceeding to a discussion of the parameter, let us briefly see how the parameter relates to the clusters we are examining. In a word like *eft'a*, for instance, *f* is unlicensed and *t* is licensed. *f* contains a smaller number of elements than *t* (see below). As a result, the cluster is allowed under both parameter settings. In contrast, in the word *ept'a* the unlicensed and licensed positions, occupied by *p* and *t* respectively, have the same number of elements. Therefore, the cluster is allowed under Setting (b) only.

The proposed parameter follows the spirit of the complexity condition (Harris 1990). From the early days of government phonology it was argued that some positions are disadvantaged compared to others, in terms of elemental content (see also Kaye, Lowenstamm and Vergnaud 1990). The number of elements that these positions are allowed to contain cannot be higher than that allowed in some other, more privileged positions. In the same spirit, the theory of licensing inheritance was developed (Harris 1997) according to which a position inherits licensing potential from its licensor. According to this system, licensing determines syllable structure, and part of its effects is that the lower down the licensing hierarchy a position is, the fewer elements it is allowed to contain. Different versions of the complexity condition or licensing inheritance have been used in Backley

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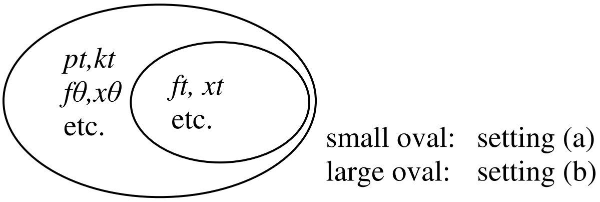
[4] Note that the parameter does not need to involve counting as it can be structured using a stack system of the type used in some parsing models – e.g. Miller and Fox (1994), Shieber (1983).

(1995), Nasukawa (1995, 2005), Pagoni (1993), Rice (1992), Takahashi (1993, 2004), amongst others.

The parameter in (10) is a direct translation of the complexity condition into CVCV theory, with the addition of binarity: a language may allow an unlicensed position to have as many elements as the licensed one,[5] or enforce a tighter restriction, demanding that it have fewer elements.[6]

The default setting for the parameter would need to be Setting (a). This follows from learnability requirements. Specifically, the possible forms allowed under Setting (a) are a proper subset of the possible forms allowed under Setting (b). This is because forms with a smaller number of elements in the unlicensed position would satisfy both settings, while forms with the same number of elements in licensed and unlicensed positions can only exist under Setting (b).

(12) A subset relation



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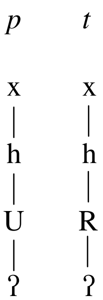
[5] A more complete examination of the Greek consonantal system might reveal that the marked setting of the parameter has to be further relaxed, allowing a higher number of elements in the unlicensed position. This is suggested by the existence of stop-fricative sequences: *ts, ks, ps*. However, several analyses assume a contour segment structure for stop-fricative sequences, at least for *ts* (see Pagoni 1993 and references therein). Note, also that all of these sequences have *s* as their second member; sequences like **pθ*, **kf* are not allowed in Greek. If the parameter is relaxed, so that any segment type is allowed in either position, clusters such as *pθ* and *kf* would only be accidental gaps. I leave this question for further research.

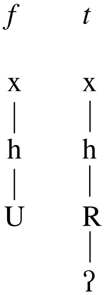
[6] Because structure and strength in CVCV theory depend on a *combination* of government and licensing, a complete parametric system will include both of these forces. However, the proposed parameter is sufficient for our purposes, since the two positions we are examining are only differentiated by the absence versus presence of licensing. Moreover, the parameter could be more fine-grained, to include even tighter restrictions on the number of elements, and should be studied in conjunction with licensing constraints (Charette and Göksel 1996; Kula 2005), which impose restrictions on the possible combinations of elements within a segment. These are issues for further research.

Let us now see how the complexity parameter can describe the diachronic evolution of the Greek clusters. As we saw in §2.2, Ancient Greek contained clusters of voiceless stops such as *pt.* These clusters would have the same number of elements in the unlicensed and the licensed position.

(13)


In the representation above, *p* (in the pre-consonantal unlicensed position) contains three elements, right next to a licensed position, occupied by *t*, which also contains three elements. This indicates that the complexity parameter was set to the marked setting (10b), allowing for an unlicensed position to have the same number of elements as the licensed one.

Compare this with the forms that arose with the dissimilation, as that was described earlier.

(14)


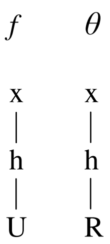
With the loss of stopness, the new forms had fewer elements in the unlicensed position than in the licensed one. The forms with the same number of elements were no longer generated by the grammar. This corresponds to a move from the marked setting (10b) to the unmarked setting (10a).

Moreover, clusters of aspirated stops followed a similar development, in a cascade effect manner. Rule (2a) involves spirantisation of voiceless aspirated stops. This is attested in the case of singletons.

(15) *o*$t^{h}$ˈ*oni* > *oθ*ˈ*oni*
$t^{h}$ˈ*elo* > *θ*ˈ*elo*

However, in the case of clusters of aspirated stops, spirantisation would create clusters of fricatives, a sequence that would be illegal under the new parameter setting. A cluster like *fθ,* for example, would contain the same number of elements in the two positions, licensed and unlicensed one, contrary to the requirements of the parameter.

(16)



Since the resulting cluster would be illegal, the end result would have to be modified in order to conform to the new parameter setting, having a greater number of elements in the licensed position. This meant that instead of *fθ* the cluster arising from $p^{h}t^{h}$ was *ft*.

(17) $p^{h}t^{h}$ > (**fθ*) > *ft*

The evolution proposed here is in line with the evidence presented against the traditionally assumed existence of the intermediate step *fθ* (Seigneur-Froli 2003).[7] Finally, the evolution of voiced stops at first glance appears to violate the new parameter setting. Voiced stops also underwent spirantisation (2a). The resulting clusters of voiced fricatives (3b) would appear to violate the parameter setting by having the same number of elements in the two positions (just like clusters of voiceless stops or

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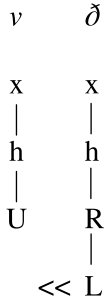
[7] Note that the complexity parameter would also be consistent with a scenario whereby an intermediate step containing clusters of voiceless fricatives was attested. If spirantisation had taken place before the parameter change, then we should be able to find evidence for an intermediate step *fθ*.

fricatives would, as we saw above). However, this is not the case. The difference between voiceless and voiced consonants in Greek is the voice element |L| (Pagoni 1993).[8] In clusters of voiced fricatives, this element originates in the licensed position and spreads to the unlicensed one (see representation of *vð* below).

(18)



In the above representation, the first of the two fricatives receives its voicing from the second one. This representation is supported by the fact that sequences of a voiceless and a voiced fricative are not allowed, thus indicating that the two fricatives share their voice element. The representation is also consistent with analyses of clusters in languages that allow only geminates and/or homorganic nasal-consonant clusters (see Harris 1990). The unlicensed position in such languages is analysed as only having one element (in the case of nasal-consonant clusters) or none (in the case of geminates), the source of the rest of the elements being the licensed position.

The implication of the above is that clusters of voiced fricatives in Greek respect the unmarked setting of the complexity parameter, which requires a smaller number of elements in the unlicensed position. This explains what the rules in (2b) and (2c) describe, but fail to explain – namely the lack of dissimilation in clusters of voiced fricatives.

The claim as to the existence of the complexity parameter can be tested on typological data. The subset relation expressed in (12), regarding fricative-stop clusters and clusters of two fricatives or two stops, constitutes a claim for the relative markedness of these cluster types. Precisely, it is claimed that fricative-fricative and stop-stop clusters are more marked than fricative-stop clusters. The relevant prediction for language typology is therefore that there exists an implicational universal, whereby the presence

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[8] In the case of voiced stops, Pagoni proposes an analysis that involves an interaction between a plain (voiceless) stop and a preceding nasal segment.

of fricative-fricative or stop-stop clusters in a language implies the presence of fricative-stop clusters.

Although I do not intend to conduct a full investigation of this universal here, the results of an initial investigation are encouraging. Greenberg (1978) examined word initial clusters in 104 languages and found strong tendencies in the direction of the predicted universal. Specifically, according to Greenberg, the existence of fricative-fricative clusters word-initially implies the existence of fricative-stop clusters in the same position, with one exception (Karen), and the existence of stop-stop clusters word-initially implies the existence of fricative-stop clusters in the same position, with two exceptions (Huichol and Takelma). More recent analysis of the three apparently misbehaving languages indicates that these do not in fact constitute exceptions (Morelli 1999). Morelli (1999) proceeds to an in-depth analysis of the potential counterexamples as she is arguing for the typological implication predicted here. Precisely, she claims that fricative-stop clusters are the most unmarked type of obstruent-obstruent clusters (more unmarked than fricative-fricative and stop-stop clusters) and she develops an optimality theoretic model to account for adult language typology.

As the focus of this paper is first language acquisition, I will test the proposal against developmental data. According to the complexity parameter, fricative-stop clusters are allowed under both the unmarked as well as the marked setting of the parameter. In contrast, fricative-fricative and stop-stop clusters are allowed under the marked setting of the parameter only. As a result, we predict that in a language that allows both of these cluster types, such as (modern) Greek, children will acquire the unmarked (fricative-stop) clusters first.

However, before this prediction can be tested,[9] some clarifications are in order. Although (modern) Greek allows both fricative-fricative/stop-stop and fricative-stop clusters, their distribution is partly influenced by sociolinguistic factors. While in some cases speakers have clear intuitions as to which cluster is involved in the pronunciation of a given word, some words allow either cluster, the fricative-fricative/stop-stop option being possibly associated with a higher register (Tserdanelis 2001). As a result of this situation, we are faced with a potentially confounding variable. If – upon testing children on their performance in fricative-fricative/stop-stop and fricative-stop clusters – we were to find that they performed better in fricative-stop contexts, it would remain unclear whether this is due to the complexity parameter being set as unmarked or whether the children were

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[9] For experimental testing of this prediction, see Sanoudaki (2007).

simply responding to the sociolinguistic situation, thus producing variants compatible with a lower register. However, it turns out that these two potentially determining factors can be teased apart once we approach the matter from a different perspective.

Assuming that child language is sociolinguistically consistent across ages, the parameter I propose makes a specific prediction with regard to children's acquisitional path. Although, due to the sociolinguistic component, it may be the case that all children perform dissimilation of fricative-fricative/stop-stop clusters some of the time, the current proposal also expects that younger children will produce a *higher ratio* of dissimilar to similar clusters when compared to older children, as their grammar has not yet reached the marked setting for the complexity parameter. If, on the other hand, the only factor involved in the children's production of fricative-fricative/stop-stop and fricative-stop clusters is sociolinguistic in nature, we expect that there should be no difference between the younger and the older children. Note that by comparing the *ratio* of the relevant clusters, we control for the fact that children's production tends to improve as children grow older (younger children tend to produce singletons instead of clusters).

## 3. The experiment

### 3.1. Goal

The purpose of this experiment is to test Greek children's production of similar (fricative-fricative and stop-stop) clusters. The goal of the experiment is to test the complexity parameter proposed in the previous section. Specifically, it is expected that the ratio of dissimilar to similar clusters will decrease with age. The experimental hypothesis is that children will produce a *higher ratio* of dissimilar to similar clusters when compared to older children. The null hypothesis is that there will be no difference between age groups.

(19) $H_1$ younger children > older children
$H_0$ younger children = older children

> higher ratio dissimilar/similar
= same ratio dissimilar/similar

## 3.2. Methods and materials

### *3.2.1. Subjects*

Fifty-nine monolingual Greek children were tested (21 boys and 38 girls). Nine more children were excluded from the study, since they refused to cooperate or did not manage to complete the task. The age range was from 2;03 to 5;00, mean age 3;08. The experiments took place in four different nurseries in Crete (three in Rethymno and one in Iraklio) and, in the case of one child only, in a relative's house.

Moreover, because these clusters are linked to sociolinguistic issues, and in order to control for possible sociolinguistic factors in children's production, children of different social backgrounds are tested. Specifically, children were tested in nurseries of two types, corresponding to two separate social classes: the first type consists of three state nurseries (including a Worker's Guild nursery) in working class areas, while the second nursery type consists of a single private nursery, in an area with a higher socio-economic profile.

The children were selected according to linguistic and general developmental criteria. The developmental criteria required normal development, i.e. no background of cognitive, behavioural, hearing or physical impairment. I asked the nursery staff whether the child had any relevant problems. All fifty-nine children participating in this study were reported by staff as being healthy. The linguistic criteria required that (i) the child's native language be Greek, (ii) the child be raised in a monolingual environment, (iii) the child have a normal linguistic development, (iv) the child be able to produce at least some consonant clusters. Finally, the children had to be willing to participate in a non-word repetition task.

### *3.2.2. Methodology*

A non-word repetition task was used. Children were asked to repeat novel, made-up words that had the desired structures. The task was chosen for its effectiveness in producing a large amount of relevant data, compared to spontaneous production. Also, novel words allowed me to control for familiarity effects, which would be present in imitation tasks containing existing words. Furthermore, using nonsense words allowed me to control the phonological environment of the clusters across conditions.

Non-word repetition has been used mainly as a test of working memory (e.g. Gathercole 1995; Gathercole *et al.* 1994; Laws 1998; cf. van der Lely and Howard 1993) and has been proposed as a screening measure for language impairment (e.g. Dollaghan and Campbell 1998; Weismer *et al.* 2000), but it is also used in studies examining young children's acquisition of phonology (e.g. Kirk and Demuth 2006; Zamuner and Gerken 1998; Zamuner, Gerken and Hammond 2004). Kirk and Demuth (2006), for example, used a non-word repetition task in order to examine English children's production of coda consonants. Moreover, it has been suggested (Kirk and Demuth 2006) that the results of imitation tasks do not differ in terms of accuracy from spontaneous production; see, for example, a production study by Kehoe and Stoel-Gammon (2001) involving both imitated and spontaneous production, which found no significant differences between the two production types.

In designing and conducting the experiment, extra care was taken to ensure the naturalness of the task. Firstly, the words were paired with pictures of novel animals, so that the words would have a referent; I thus made sure that the task is a linguistic one (rather than a general non-linguistic sound-production task). Secondly, the children did not hear the stimuli from a recording, but from a person (the experimenter), something that is more likely to occur in everyday life. Later evaluation of the spoken stimuli words by the experimenter showed consistent use of appropriate stress and segmental content. Thirdly, the task was not presented to the children as a request to repeat words, but as a game in which they were taking active part. The game was designed in a way that reflected real life interactions (see procedure).

I have good reasons to believe that I have succeeded in making the task natural and linguistic. Apart from the reassuring fact that children were enjoying the 'game' and some were asking for more, they were making comments that indicated that they were in an everyday situation, one that could have taken place in their classroom, and not just in an artificial experimental environment; for example: 'Will my sister meet these animals, too?' (Argiro 4;01).

Moreover, some children formed diminutives out of some words, in the regular way for Greek nouns. In the case of neuter nouns this is done by adding *-aki* to the stem of the noun, after removing the inflectional ending. So, for example, an animal called *kixrˈo*[10] became *kixrˈaki.*

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[10] This word is not one of the forms discussed in this section. It was used in one of the series of tests that I conducted with these children (Sanoudaki 2007).

| | | | | |
|---|---|---|---|---|
| (20) | *to* | *mikrˈo* | *kixrˈaki* | |
| | the N.SG | little N.SG | kixro N.SG.DIM | ‘the little kixro’ |

This involved recognising the word as a neuter singular noun by the ending *-o,* removing the ending and adding the diminutive suffix. This was a linguistic operation that could not be carried out unless the child was involved in a linguistic task.

### *3.2.3. Materials*

The experiment consisted of two conditions: the first condition involved words with clusters of two voiceless fricatives or two voiceless stops in initial position, and the second condition contained words with the same clusters in medial position. Specifically, the following combinations of consonants were tested:

(21) *fθ, xθ, kt, pt*

The construction of the non-words used in the experiment followed the phonotactics of Greek. The words were either feminine or neuter nouns, with inflectional endings *-a* (feminine), *-i* (feminine or neuter), or *-o* (neuter). No masculine endings were used, because they involve (in the nominative) a word-final consonant (*-s*), and that would increase the structural complexity of these trials. All words were bisyllabic, with a voiceless stop (*p, t* or *k*) as an onset for the non-target syllable. There were five stimuli in each condition. The stimuli of the first condition were the following:

(22) *fθˈoki,*[11] *xθˈapi*, *ktˈito*, *ptˈika*

The stimuli used in the word-medial condition were formed by reversing the syllable order. The stimuli were the following:

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[11] Notice that *k* (and all the other velar consonants) in Greek becomes palatal before a front vowel. For example, *fθˈoki* would be pronounced [*fθˈoci*]. In Cretan dialects, the velar might undergo even further fronting (Newton 1972). Indeed, all children exhibited some degree of fronting, the extent of which depended on the child’s background. However, that does not affect our experiment in any crucial way. The stimulus producer’s dialect has moderate fronting, typical of Cretan urban areas.

(23) *kifθˈo*, *pixθˈa*, *toktˈi*, *kaptˈi*

For uniformity, the target cluster always preceded the stressed vowel. This creates pairs such as *fθˈoki – kifθˈo*. Note that both members of these pairs are well-formed in Greek, which is characterised by a lexical accent system, restricted by the trisyllabic window – i.e. stress must fall in one of the last three syllables of the word.[12]

### *3.2.4. Procedure*

I first spent some time with the children in the classroom, taking part in their activities, so that I would become familiar to the children. After selecting children according to the linguistic and general developmental criteria discussed above, I tested each of the selected children individually in a separate room. Each session lasted about half an hour.

The test items were arranged in three different pseudo-random[13] orders so as to avoid sequence effects, and each of these orders was followed for a third of the children tested. There were four warm-up items without any clusters.

Pictures of novel animals were put inside a Russian doll representing a wizard. The child was told that the wizard had eaten some strange animals, and that he/she could free them by calling each animal by name. The child was then invited to open the wizard, take out the animals one by one, and say their name. If after two attempts the child was not replying, we would move on to the next animal/word, and the word would be added to the end of the list as the name of some other animal. The same (i.e. repetition of the word at the end) was done for words that were obscured by background noise. Designing the session in a way that involves an active task ensured that children's interest was kept throughout the experimental session.

Moreover, in order to vary the task, not all the pictures were inside the wizard-doll. Some were 'sleeping' inside a fairy's dress and the child was asked to wake them up, others were hiding inside a box with a small open-

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[12] For analyses of the Greek stress system see Arvaniti (1991), Drachman and Malikouti-Drachman (1999), Malikouti-Drachman (1989), Philippaki-Warburton (1976), Ralli (1988), Revithiadou (1999) amongst others. For the acquisition of stress in Greek see Tzakosta (2004).

[13] In the same list as items for other tests, see footnotes 9 and 10. Items were put in a random order, and then sequences consisting of three or more items belonging to the same category were broken up.

ing, through which only the child's hand could go, some others were absorbed in reading a book and got lost in its pages, some were in the belly of a smaller Russian doll representing a girl, where they went to keep warm, and, finally, some were hiding inside a pair of trousers, and the child was asked to find them so that I could put on my trousers. This way, the children's attention was constantly renewed and sessions were enjoyable for both the children and the experimenter.

During the session, there were spontaneous conversations between the child and the experimenter before, during and after the task with the intention of giving the child and the experimenter some rest and keeping the child's attention. From these conversations (all DAT-recorded) information on the child's production of singletons was extracted.

### *3.2.5. Transcription*

The responses were transcribed on-line by the experimenter. The transcription was done in a fairly broad way, using the International Phonetic Alphabet. The sessions were also DAT recorded. The original transcriptions were then checked and amended off-line by the experimenter, with the aid of spectrographic analysis when necessary. Spectrographic analysis was used when a response was not entirely clear and there was doubt as to the identity of the relevant consonants. Responses that were inaudible or covered by background noise were excluded.[14]

An independent transcription was made by a second transcriber, who is a Greek native speaker and is well-trained in doing transcriptions. Ten percent of the data were cross-checked. In particular, one-tenth of the responses of each child were transcribed. The consistency rate between the two transcriptions, focusing on the cluster data, was 96 percent.

## 3.3. Results

In this section, I present the results that are relevant to the research question. For general information on the children's performance, see Sanoudaki (2006).

I coded as 'similar' all responses that involve a fricative-fricative or stop-stop cluster. These include target-like clusters (24) as well as fricative-

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[14] In all tests such cases were between 0 and 0.7 percent of total responses.

fricative and stop-stop clusters whose members have a different place of articulation from the members of the target cluster (25).

(24) Similar clusters: target
a. Word-initial condition
*fθˈoki* → *fθˈoki* (Emanouela 4;11,21)
*ktˈito* → *ktˈito* (Argiroula 3;04,01)
*ptˈika* → *ptˈika* (Vasiliki 3;10,15)
*xθˈapi* → *xθˈapi* (Eleni 3;06,16)

b. Word-medial condition
*kaptˈi* → *kaptˈi* (Giota 3;04,16)
*kifθˈo* → *kifθˈo* (Eleni 3;06,16)
*pixθˈa* → *pixθˈa* (Antonia 2;11,20)
*toktˈi* → *toktˈ*i (Stavros 3;11,24)

(25) Similar clusters: different place of articulation
a. Word-initial condition
*ptˈika* → *ktˈika* (Sofia 3;01)

b. Word-medial condition
*pixθˈa* → *pifxˈa* (Mixaela 4;06,04)
*toktˈi* → *optˈi* (Aglaia 3;03)

I coded as ‘dissimilar’ all responses that involve a fricative-stop cluster. These include clusters whose members have the same place of articulation as the members of the target cluster (26) and clusters whose members have a different place of articulation from the members of the target cluster (27).

(26) Dissimilar clusters: same place of articulation
a. Word-initial condition
*fθˈoki* → *ftˈoki* (Dimitra 3;00,03)
*xθˈapi* → *xtˈapi* (Zoi 4;02,17)
*ptˈika* → *ftˈika* (Mirto 3;00)
*ktˈito* → *xtˈiko* (Manos 3;04,04)

b. Word-medial condition
*pixθˈa* → *pixtˈa* (Maro 3;09)
*kifθˈo* → *kiftˈo* (Manolios 4;00)
*toktˈi* → *toxtˈi* (Stamatis 3;08)
*kaptˈi* → *kaftˈi* (Manthos 3;00)

(27) Dissimilar clusters: different place of articulation
a. Word-initial condition
*ktˈito* → *ftˈito* (Fanouris 3;11,15)
*ptˈika* → *xtˈika* (Argiroula 3;04,11)

b. Word-medial condition
*pixθˈa* → *pifkˈa* (Thanos 3;11,26)
*pixθˈa* → *piftˈa* (Dimitra 3;00,03)

A comparison of children's similar and dissimilar responses across age groups was made. Group 1 contains the youngest children (covering one-year age difference starting with the youngest one 2;03–3;05 n=24), group 3 the oldest children (one-year age difference 4;00–5;00 n=17) and group 2 the children between the two other groups (3;06–3;11 n=18). Figure 1 compares children's similar and dissimilar responses in the word-initial condition.

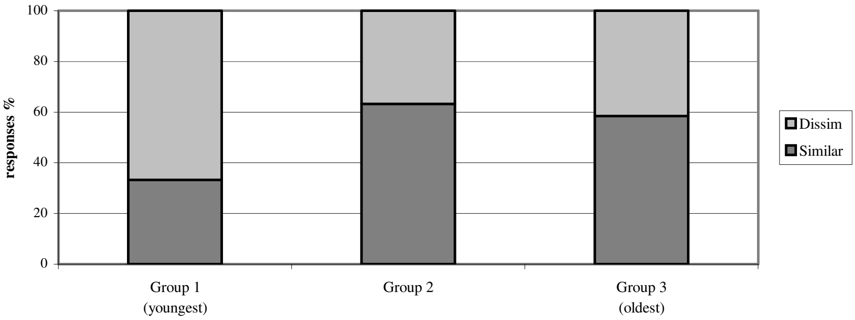

*Figure 1.* Percentages of similar and dissimilar responses in word-initial position by age group

The ratio of correct to dissimilar responses in group 1 seems to be different from that in groups 2 and 3. In a chi-square test performed to test the difference between age groups, a $\chi^2$ value of 8.034 had an associated probability value of p=0.018, DF=2. Such an association is extremely unlikely to have arisen as a result of sampling error. We can thus conclude that the three age groups are not the same. Figure 1 shows that it is group 1 that was different from the older groups; in group 1 the percentage of dissimilar responses is higher than in groups 2 and 3.

Similarly, figure 2 shows a comparison of the percentages of children's similar and dissimilar responses in the word medial condition.

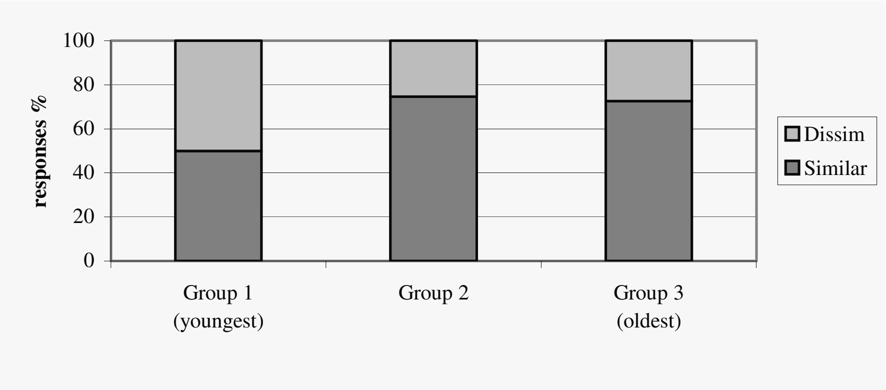

*Figure 2.* Percentages of similar and dissimilar responses in word-medial position by age group

As in the word-initial condition, the ratio between similar and dissimilar responses in group 1 seems to be different from that of the older groups. In a chi-square test performed to test the difference between age groups, a $\chi^2$ value of 9.532 had an associated probability value of p=0.009, DF=2. We can thus conclude that the difference between the three age groups is statistically significant. Figure 2 shows that it is group 1 – the youngest group – that is different from the older two; moreover, the difference lies in that the percentage of dissimilar responses is higher in group 1 than in groups 2 and 3.

Finally, a comparison of children's performance by social class was carried out. Figure 3 shows the corresponding percentages of target and dissimilar responses in the word-initial condition.

*Figure 3.* Percentages of similar and dissimilar responses in word-initial position by class

A visual examination of the figure shows that the results are comparable across nurseries. A chi-square test performed to test whether there is any difference between the two types of nurseries had a $\chi^2$ value of 0.030 with an associated probability value of p=0.863, DF=1, indicating that there is no statistically significant difference between nursery types.

Figure 4 shows the same comparison for the word-medial condition. The relationship between similar responses and dissimilar responses in the word-medial condition is comparable in both nursery types. A chi-square test performed to test whether there is any difference between nurseries gave a $\chi^2$ value of 0.007 with an associated probability value of p=0.935, DF=1, indicating that there is no statistically significant difference between nursery types.

*Figure 4.* Percentages of similar and dissimilar responses in word-medial position by class

### 3.4. Analysis

The ratio of dissimilar to similar responses was found to decrease with age. This is consistent with the experimental hypothesis, which was based on the complexity parameter. As mentioned earlier, the parameter differentiates similar from dissimilar clusters in that the latter involve segments of differential complexity allowed under both the unmarked and the marked settings of the parameter, while the former involve segments of equal complexity, allowed under the marked setting only.

Notice that any analysis that claims that similar clusters are more marked than dissimilar clusters would make the same prediction, even if the analysis assumes an alternative internal composition for the segments involved. In this study, I adopt the internal composition of segments proposed in the only major piece of research addressing the issue of the elemental composition of consonants in Greek (Pagoni 1993), although ultimately, more acquisitional research is necessary in order to evaluate competing proposals for the composition of segments.[15]

Finally, the experiment revealed no sociolinguistic variation in the application of dissimilation by Greek children. Children from different socio-economic backgrounds showed the same levels of dissimilation. This does not mean that sociolinguistic factors are not involved in the dissimilation phenomenon in Greek. It is possible that these factors are not manifested in child language because of the uniformly low register of child-directed speech. In any case, controlling for sociolinguistic variables allows us to make sure that we are examining the purely linguistic aspects of cluster acquisition in a reasonably uniform population.

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[15] As an anonymous reviewer correctly pointed out, research on clusters involving sonorant consonants (obstruent-sonorant and sonorant-obstruent clusters) would be an important step towards the evaluation of competing proposals on the composition of segments. This is so especially because Pagoni's analysis, which is adopted here as the only relevant proposal on consonantal representation in Greek, is couched in government phonology (following Harris 1990) and is thus not directly compatible with all areas of the CVCV model (this divergence is particularly acute in clusters involving sonorant consonants). Unfortunately, space restrictions prevent us from further discussing the issue here.

## 4. Speculations on diachronic change

Already in the nineteenth century it was argued that the main locus of language change is in language acquisition (Passy 1890, cited in Lightfoot 1999). The challenge is therefore to find the link between these two. In our case, the task is to reconstruct in a plausible way the diachronic evolution of Greek consonant clusters, bearing in mind that the evolution was the result of some change in speakers' grammars. This would involve determining how it was possible, at some point in history, for the grammars acquired by (ancient) Greek speaking children to be different from the grammar of their parents.

Lightfoot (1991, 1999)[16] proposes a link of language change with language acquisition in a cue-based model, in the spirit of the cue-based acquisition model proposed by Dresher and Kaye (1990). On this view, children do not try to match the input; rather, they scan their linguistic environment for cues that determine the setting of a parameter. Each parameter is associated with one cue by Universal Grammar.[17] Lightfoot argues that in cases when children fail to detect the cue for a parameter setting that their parents' language has, the setting changes: children will have a grammar that will generate forms that are different from the ones their parents' grammar generates.

One of the main possible reasons for the children's failure to find a cue is language contact. In situations of language contact, children start getting mixed input, after the addition of a new input language. If the new input language does not have the same setting for a certain parameter as the original input language, the expression of the relevant cue in the overall input will fall. If the expression of the cue falls under a certain threshold, the cue will become undetectable for the children (Lightfoot 1999). Lightfoot goes on to exemplify a case in which language change is a result of language contact: the loss of verb-second in English.

I propose that a similar situation may have occurred in the case of Greek clusters, as a result of language contact. Recall that ancient Greek had the marked setting for the complexity parameter, according to which the number of elements in an unlicensed position must be smaller than, or the same as, in the adjacent licensed position.

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[16] See also Kroch (2001).

[17] Note that Lightfoot departs from Dresher and Kaye's model, in claiming that there is no default setting for parameters.

(28) $\beta \leq \alpha$

The difference between the unmarked and marked setting is the 'the same as' part. This means that the cue for the marked setting of the parameter would be clusters containing an unlicensed position with the same number of elements as the licensed one: [$\beta = \alpha$]. A Greek child would scan the input for this cue, and find it in forms containing *pt, kt* (and possibly $p^ht^h$, $k^ht^h$) in word-medial and word-initial position. The linguist's problem now is to find out why the parameter changed from the marked to the unmarked setting.

Note that the change took place at some point during the first centuries AD, a period of Roman conquest. This was a period of influence and interaction for the two languages, Greek and Latin. Latin became more and more widespread as the power of Rome increased. Koine, the popular Greek of the time, having been the lingua franca of the East, was quite resistant, and did not disappear. Latin-speaking traders, officials and soldiers learned Koine (Horrocks 1997). The long-lasting presence of Romans in the area meant that Greek children of all ages would hear around them Greek, Greek spoken by native speakers of Latin, and some amount of Latin.

What was the structure of Latin, as far as obstruent clusters are concerned? Latin contained *pt* and *kt* clusters in word medial position (examples from Sihler 1995).

| | | |
|---|---|---|
| (29) | scriptus | (scribō 'scratch') |
| | actus | (agō 'drive') |
| | vectus | (vehō 'convey') |
| | coctus | (coquō 'cook') |

However, it did not have any such clusters word-initially. In fact, loans from Greek with word-initial *pt* were altered so that the end result does not contain this cluster (example in (30) from Goetz 1888).

(30) πτισάνη (*ptisˈanee*) > tisana 'pearl barley'

Both Latin and the Greek spoken by Latin native speakers would contain word-medial examples of the cue to the marked setting, but the word-initial expression of the cue would not exist in either, since no word-initial stop-stop clusters were allowed. As a result, the percentage of cues to the marked setting of the complexity parameter that Greek children would hear dropped, as they mixed with Latin speakers. In Lightfoot's (1999) terms, it is possible that as a result of these changes the expression of the cue in the overall input fell under a certain threshold. The input was too diluted to be able to cause a change in the setting of the complexity parameter from the unmarked to the marked value in a child's developing grammar. Therefore, in the grammar of Greek children, the parameter remained in the unmarked setting, according to which the number of elements in the unlicensed position must be lower than the number of elements in the licensed position. The forms with fricative-stop clusters instead of clusters of (voiceless unaspirated or aspirated) stops that were the outcome of this period reflect the unmarked setting of the complexity parameter.

Finally, during the twentieth century, the setting of the complexity parameter changed back to the marked value. The reasons for this change can be found in the introduction of compulsory schooling and the development of mass media. Both of these exposed Greek children to masses of compulsory Katharevusa input, which contained the fricative-fricative and stop-stop clusters that could trigger the change to the marked value of the complexity parameter.

## 5. Conclusion

This chapter was an investigation of the acquisition of fricative-fricative and stop-stop clusters in Greek, and of the related dissimilation phenomenon. The analysis abstracted away from social factors and attempted to tap into the strictly phonological factors at work. It was argued that similar (fricative-fricative/stop-stop) clusters are more marked than dissimilar (fricative-stop) ones. The difference is encoded in a complexity parameter, the two settings of which can be traced in historical and acquisition data.

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# Modelling initial weakenings

*Hidetoshi Shiraishi*

## 1. Introduction

Consonants in word-initial (or morpheme-initial) positions rarely undergo weakening processes. It is widely acknowledged that the initial C position patterns with the post-consonantal position in being the last to undergo lenition processes, such as spirantization or vocalization (e.g. Hyman 1975; Ségéral and Scheer 1999, 2008). A cross-linguistic survey of lenition contexts reports that if such strong positions are targeted by lenition, consonants in weak positions (intervocalic, preconsonantal, morpheme-final, word-final) are targeted as well, but that the reverse is not true (Kirchner 1998; Ségéral and Scheer 1999, 2008; Honeybone 2005).

In this chapter, I discuss a case of spirantization which is apparently at odds with this typological implication. The spirantization of Nivkh comprises such a case.[1] In this language, spirantization targets morpheme-initial plosives but leaves plosives in non-initial positions (medial and final) intact: *p*$^h$*oqi* 'air bladder' *mɨkɨk ɸoqi* 'air bladder of dace' but **mɨɣɨɣ ɸoʁi*.[2] In Nivkh, spirantization targets the initial plosives of morphemes which are non-initial in a specific domain (to be laid out below).[3]

Such a pattern of spirantization is problematic for many of the current approaches to lenition.[4] For instance, it cannot be accounted for by using

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[1] Nivkh (formerly called Gilyak) is a language isolate spoken by approximately 200 speakers in the Lower Amur region and the island of Sakhalin in the Russian Far East.

[2] The *k* > *ɣ* and *q* > *ʁ* alternations are discussed in §2 below.

[3] Ségéral and Scheer (2008) afford morpheme edges an exceptional status in the evaluation of strength and predict that they may pattern with weak positions (e.g. intervocalic), as is attested in the (historical) initial weakenings of Modern Greek or Mazovian Polish. Nivkh, however, is different from these languages in that the morpheme-initial position is the only target of spirantization.

[4] "We do not expect to find a language where the same input experiences lenition in the strong position, but remains undamaged (or even strengthens) in one or both of the weak positions" (Ségéral and Scheer 2008: 140).

positional faithfulness constraints, in which faithfulness constraints on strong positions are universally more highly ranked than faithfulness constraints on weak positions, thereby capturing the asymmetry between prosodically strong and weak positions (Beckman 1998). In Nivkh, exactly the opposite situation seems to hold.

Cross-linguistically, initial lenition is infrequent and when it happens it is often the case that its context is not phonologically transparent (e.g. Celtic, West Atlantic).[5] For this reason, many previous works regard such cases as manifestations of morphologically (or syntactically) motivated processes in the synchronic grammar of a language. Accordingly, many such instances are referred to by the phonologically neutral term ‘consonant mutation’ (or alternation) rather than lenition, which clearly implies a weakening of segments. In this respect, Nivkh is no exception and many previous works described spirantization under the rubric of ‘consonant alternation’ (e.g. Kreinovich 1937; Hattori 1988; Gruzdeva 1997; Mattissen 2003). Nevertheless, I will argue that Nivkh spirantization comprises a synchronic phonological process of lenition, and that any analysis which makes a heavy appeal to morpho-syntax fails to capture a number of phonological traits it exhibits. In this sense, the use of the term ‘alternation’ is misleading since it veils the distinction from processes which are heavily loaded with morpho-syntactic information, such as the consonant mutations in Celtic.

In this article, I propose an alternative analysis which regards Nivkh spirantization as an instance of a perceptually motivated process of lenition, defined as a phonological operation which diminishes the amount of information from a speech signal in order to accentuate a syntagmatic contrast (Harris and Urua 2001; Harris 2005). This analysis benefits from a number of advantages over previous ones. Notably, it decouples spirantization from its local melodic context, thereby circumventing the problem that the triggering (preceding) set of segments (vowel, glide, plosive) does not form a natural class (a problem which is first pointed out by Blevins 1993).

From the assumption that Nivkh spirantization is a perceptually motivated process, and that it applies to accentuate syntagmatic contrast, it is a short step to arrive at the idea that spirantization is only concerned with positions which are relevant for its purpose. Non-initial positions are not

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[5] Cases of an across-the-board application of lenition, as is frequently observed in the Central Italo-Romance languages, are not considered here. Lenition in these languages simply ignores word boundaries and thus it makes sense that the ‘word-initial’ positions pattern with word-internal weak positions.

targeted since they are irrelevant for the accentuation of syntagmatic contrast among constituents (morphemes) which comprise the relevant informational domain. In other words, such positions are inert, or invisible to spirantization. This observation leads us to the notion of ‘visibility asymmetry’ among different positions in the speech string (Dresher and van der Hulst 1994, 1998). Morpheme-initial positions enjoy the privileged status of being the head, and therefore their internal structure is visible to constituents of a higher level. In contrast, non-initial positions are dependents, and their internal structure is not visible. In our view, it is this asymmetry in visibility that underlies the initial spirantization of Nivkh.

This chapter is organized as follows. §2 sets out the basic phonology of Nivkh. §3 introduces the hypothesis on the historical origin of spirantization by Austerlitz (1977, 1990a). §4 reviews previous accounts of spirantization. §5 proposes a novel analysis. §6 discusses the two contexts where spirantization fails to apply (after a fricative or a nasal). §7 concludes.

## 2. Sketch of Nivkh phonology and consonant mutation

This section provides a descriptive sketch of Nivkh phonology with special emphasis on spirantization. In referring to the process, I will use the term consonant mutation without any theoretical implication. Unless otherwise mentioned, I describe the phonology of the West-Sakhalin dialect, which is a subdialect of the Amur dialect (for a more detailed description see Shiraishi 2006).

Nivkh has six vowels: *i*, *ɨ*, *e*, *a*, *o*, *u*. Diphthongs are all falling: *u͜i*, *e͜i*, *a͜i*, *ɨ͜i*, *o͜i*, *i͜u*, *e͜u*, *a͜u*, *ɨ͜u*, *o͜u*. The consonantal inventory is illustrated in the table below, where *ft*. and *len*. stand for *fortis* and *lenis* respectively.

(1) Nivkh consonants

| | labial | | alveolar | | (alveolo)-Palatal | | velar | | uvular | | larygl. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft. | len. | ft. | len. | ft. | len. | ft. | len. | ft. | len. | |
| plosive | $\text{p}^\text{h}$ | p | $\text{t}^\text{h}$ | t | $\text{tʃ}^\text{h}$ | tʃ | $\text{k}^\text{h}$ | k | $\text{q}^\text{h}$ | q | |
| fricative | ɸ | β | s | z | | | x | ɣ | χ | ʁ | h |
| nasal | m | | n | | ɲ | | ŋ | | | | |
| lateral | | | l | | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| trill | | r̥ | r | | | | |
| glide | | | | j | | | |

The laryngeal contrast of obstruents is realized only at the beginning of content words. In all other positions, the laryngeal realization is predictable from the context (Shiraishi 2006: 45–82). Plain (non-aspirated) plosives undergo voicing after a sonorant consonant, notably after a nasal (see the examples in (7) below), and in that case they are transcribed as [b], [d], [dʒ], [g] and [ɢ]. The affricates *tʃʰ*, *tʃ* pattern with stops in the phonology (e.g. in consonant mutation) and thus will be treated as such in what follows. I will refer to them collectively as plosives.

Nivkh is notable for the behavior of the rhotics (trills) *r̥*, *r*, which pattern with the fricatives, as we will see below. *r̥* is the voiceless counterpart of *r*. Austerlitz (1994a: 257) describes it as "an alveolar fricative with a preceding tap".

Velars and uvulars were in complementary distribution (uvulars in syllables headed by *a*, *o*, velars elsewhere) but their difference became phonemic after the massive introduction of loanwords, mainly from Chinese (Austerlitz 1990b: 177).

*h* is restricted to morpheme-initial position.[6] All other consonants (and vowels) are allowed morpheme-initially. Content words with an initial fricative are limited to certain word types such as taboo words, onomatopoeia, recent borrowings, transitive verbs and closed class items such as interrogative pronouns. This phonotactic restriction on fricatives provides a clue to the origin of consonant mutation, as we will see subsequently.

Monosyllabic roots prevail in the lexicon. Polysyllabic roots are fewer and most of them are disyllabic. Trisyllabic (or longer) roots do not exist in the native vocabulary.

Consonant clusters may arise up to two in root-initial position and up to three in root-final position. Modern Nivkh has no geminates.

In a polysyllabic root stress is fixed to the first syllable.

Consonant mutation involves the following obstruents.

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[6] Austerlitz (1990a) speculates that the Nivkh *h* is from an early **s*.

(2)

| | | | | |
|---|---|---|---|---|
| pʰ | tʰ | tʃʰ | kʰ | qʰ |
| ɸ | r̥ | s | x | χ |
| p | t | tʃ | k | q |
| β | r | z | ɣ | ʁ |

Aspirated plosives alternate with voiceless fricatives and plain plosives with voiced fricatives. Note that the alveolar plosives *tʰ*, *t* alternate with the rhotics *r̥*, *r*.[7] Consonant mutation thus occurs among obstruents which are homorganic, with the exception of the alternations between *tʃʰ*, *tʃ* and *s*, *z*.[8]

Descriptively, consonant mutation involves spirantization and hardening (occlusivization). Spirantization occurs when the initial plosive of a morpheme follows a vowel (3), glide (4) or a plosive (5) in the final position of a preceding morpheme within the XP.[9,10]

(3)

| | | |
|---|---|---|
| a. | tʰom | 'fat' |
| | tʃʰo r̥om | 'fish fat' |
| b. | tʃʰo | 'fish' |
| | lɨɣi so | 'salmon' |
| c. | pɨɲx | 'soup' |
| | tʃʰo βɨɲx | 'fish soup' |

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[7] In a cross-linguistic survey of spirantization, Gurevich (2004: 46–48) claims that when an alveolar stop participates in spirantization with other stops (*b* > *β*, *g* > *ɣ*), it surfaces as either *ɾ* or *ð* in most of the cases, but she also claims that the choice of the output is not arbitrary. An alveolar stop is flapped to *ɾ* only when there is no trill in the phonemic inventory of a language (which means that flapping is never neutralizing). Nivkh supports this claim since the phonemic status of *r*, and that of fricatives in general, is weak (see §3 below). At the diachronic stage in which spirantization arose, fricatives (except for *s* and *z*) were presumably not part of the phonemic inventory (Kreinovich 1937; Jakobson 1957; Austerlitz 1990a).

[8] In the South-Sakhalin dialect *s* and *z* are pronounced as palatals *ʃ* and *ʒ* respectively (Austerlitz 1956: 262).

[9] Examples with the credit SL are from Shiraishi and Lok (2002, 2003, 2004, 2007, 2008). Examples without credits are from my unpublished fieldnotes.

[10] Abbreviations are, unless otherwise mentioned, as follows; A: attributive, ADV: adverb, C: consonant, CAU: causative, CAUS: causee, CV: consonant–vowel, fort.: fortes, IND: indicative, len.: lenes, N: noun, NP: noun phrase, O: object, pl.: plural, PP: postpositional phrase, REF: reflexive, S: subject, SG: singular, V: verb, VP: verb phrase, XP: maximal projection.

| | | | |
|---|---|---|---|
| | d. | pota-[11,12] | ‘to process fish’ |
| | | lɨɣi βota- | ‘to process salmon’ (Panfilov 1965: 45) |
| | e. | kʰer̥qo- | ‘to fish with a hook’ |
| | | ɲemla xer̥qo- | ‘to catch lenok with a hook’ (Panfilov 1965: 45) |

| | | | |
|---|---|---|---|
| (4) | | tʃiɣr̥ | ‘tree’ |
| | | qoi̯ ziɣr̥ | ‘larch’ (SL2: 3) |

| | | | |
|---|---|---|---|
| (5) | a. | tʃiɸ | ‘trace’ |
| | | pʰ-ɨtɨk ziɸ | ‘father’s trace’ (SL1: 9) |
| | b. | tɨɸ | ‘house’ |
| | | galik rɨɸ | ‘Galik’s (name) house’ |
| | c. | tʰom | ‘fat’ |
| | | hɨi̯k r̥om | ‘fat of hare’ |
| | d. | pɨɲx | ‘soup’ |
| | | pʰeq βɨɲx | ‘chicken soup’ |
| | e. | tʃʰŋɨr̥ | ‘grass’ |
| | | kʰer̥q sŋɨr̥ | ‘seaweed’ (SL2: 54) |

Spirantization fails to apply when the plosive follows either a fricative (6) or a nasal (7).

| | | | |
|---|---|---|---|
| (6) | a. | tʰom | ‘fat’ |
| | | tʃʰxɨɸ tʰom | ‘bear fat’ |
| | b. | tʃoŋr̥ | ‘head’ |
| | | tʃʰxɨɸ tʃoŋr̥ | ‘bear head’ (SL3: 54) |
| | c. | pɨɲx | ‘soup’ |
| | | tʃʰxɨɸ pɨɲx | ‘bear soup’ |
| | d. | tʃus | ‘meat’ |
| | | tʃʰxɨɸ tʃus | ‘bear meat’ |

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[11] A final hyphen indicates verbal morphology which is omitted in this article.

[12] Transitive verbs which begin with a plosive all have N+V constructions. Such verbs are few for historical reasons (§3).

| | | | |
|---|---|---|---|
| (7) | a. | qʰal | ‘clan’ |
| | | pilaβon qʰal | ‘clan of Pilavon’ (SL1: 11) |
| | b. | kʰiri | ‘urine’ |
| | | qan kʰiri | ‘urine of dog’ (SL1: 21) |
| | c. | tʃoŋr̥ | ‘head’ |
| | | qan dʒoŋr̥ | ‘head of dog’ (SL1: 22) |
| | d. | par̥k | ‘only’ |
| | | aŋ bar̥k | ‘who else?’ (SL3: 26) |
| | e. | tɨɸ | ‘house’ |
| | | ɲɨɲ dɨɸ | ‘our house’ (SL3: 49) |
| | f. | tɨɸ | ‘house’ |
| | | ɲ-ɨkɨn dɨɸ | ‘my elder brother’s house’ |

The phonological context of hardening is complementary to that of spirantization; it applies when a morpheme-initial fricative follows either a fricative (8) or a nasal (9).[13]

| | | | |
|---|---|---|---|
| (8) | a. | xu- | ‘to kill’ |
| | | tʃʰxɨɸ kʰu- | ‘to kill bear’ (SL1:7) |
| | b. | ɸi- | ‘to live’ |
| | | βo ɲaqr̥ pʰi- | ‘to live in a village’ (SL1:7) |
| | c. | ɸɨɲ- | ‘to throw’ |
| | | tʃʰxɨɸ pʰɨɲ- | ‘to throw to bear’ (SL1:8) |
| | d. | ra- | ‘to drink’ |
| | | tʃʰax ta- | ‘to drink water’ (SL2:15) |
| | e. | r̥u- | ‘to follow’ |
| | | pʰ-ɨtɨk ziɸ tʰu- | ‘to follow father’s trace’ (SL1:9) |

| | | | |
|---|---|---|---|
| (9) | a. | xu- | ‘to kill’ |
| | | aŋ kʰu- | ‘to kill whom?’ (SL3:21) |
| | b. | r̥xɨr̥p- | ‘to forget’ |
| | | ɲɨŋ tʰxɨr̥p- | ‘to forget us’ (SL3:64) |

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[13] There is variation in the initial obstruent in the context after nasals and laterals, and there are instances of both application and non-application of hardening (Kreinovich 1937: 50; Gruzdeva 1997: 90–91). In my data, hardening applies in the majority of cases, but there is also an instance of non-application (Shiraishi 2006: 87–89).

| | | | |
|---|---|---|---|
| | c. | za- | ‘to beat’ |
| | | qan dʒa- | ‘to beat a dog’ (Kreinovich 1937: 46) |

Hardening does not apply when the fricative follows a vowel (10), a glide (11) or a plosive (12).[14]

| | | | |
|---|---|---|---|
| (10) | a. | xu- | ‘to kill’ |
| | | ŋa xu- | ‘to kill an animal’ (SL1:11) |
| | b. | ɣuz- | ‘to take’ |
| | | pʰ-saqo ɣuz- | ‘to take one’s own knife’ (SL2:14) |
| | c. | xau̯- | ‘to dry’ |
| | | ma xau̯- | ‘to dry fish’ (SL3:45) |

| | | | |
|---|---|---|---|
| (11) | | seu̯- | ‘to dry’ |
| | | kɨi̯ seu̯- | ‘to dry a sail’ |

| | | | |
|---|---|---|---|
| (12) | a. | xaβu- | ‘to warm’ |
| | | tɨmk xaβu- | ‘to warm one’s hands’ (SL1:12) |
| | b. | ɸi- | ‘to dwell’ |
| | | grot ɸi- | ‘to dwell in Grot (place)’ (SL3: 4) |
| | c. | ɣe- | ‘to marry’ |
| | | nanak ɣe- | ‘to marry elder sister’ (SL3: 53) |

As concerns the morpho-syntactic contexts, consonant mutation applies across morpheme boundaries within a syntactically defined domain, which is either complement-head (VP) or specifier-head (NP) in an SOV/AN word order.[15] Any deviation from this word order bleeds consonant mutation. For instance, the extraction of the object from the preverbal position (by topicalization, dislocation or focus) dissolves the domain of application. Likewise, the interruption of an OV sequence by a constituent of a major syntactic category (like an adverb) breaks the mutation domain down, as the examples in (18) illustrate (Mattissen 2003: 107, 157; Shiraishi 2004a: 188–189, 2006: 93–94).

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[14] Fricative-initial nouns are exempt from hardening for the reason to be laid out below.

[15] There are no morphological case markers for the nominative and the accusative case categories in Nivkh.

In principle, consonant mutation targets every morpheme-initial obstruent, i.e. it applies iteratively from the innermost morpheme to the outermost string of morphemes. These contexts are illustrated below.

(13) Initial consonant of a transitive verb
[NP$_{\text{(obj.)}}$+V]
lɨɣi βota-dʒ ‘to process salmon’ (Panfilov 1965: 45)
salmon to_process_fish-IND (citation form: *pota-*)

(14) Initial consonant of a noun (preceded by a modifier or a possessor)[16]
[N(P)+N]
tʃʰo βɨɲx ‘fish soup’
fish soup (citation form: *pɨɲx*)

(15) Initial consonant of suffixes or postpositions[17]
*-roχ/-toχ/-doχ*: allative case marker
a. pxi-roχ ‘to the taiga’ (SL2: 6)
b. tʰut-roχ ‘to the fireplace’ (SL2: 31)
c. tʃʰaχ-toχ ‘to the water’ (SL2: 58)
d. tʃʰɨŋ-doχ ‘to you (pl.)’ (SL2: 39)

(16) Initial consonant of a reduplicant[18]
[base+reduplicant]
a. pulk-βulk-u- ‘to blow up’ (SL1: 8)
b. tʃʰer̥k-ser̥k- ‘to break (intransitive)’ (SL1: 39)
c. ɣur-kur- ‘to stick’ (SL1: 26)

Consonant mutation fails to apply in the following environments.

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[16] Nivkh does not exhibit formal differences between a noun phrase and a compound (Panfilov 1958; Worth 1963; but see Kreinovich 1958 and Mattissen 2003: 83–85 for discussion). The first constituent receives primary stress in both compounds and noun phrases (Shiraishi 2006).

[17] Some verbal suffixes are exempt from consonant mutation (roughly 25% of all suffixes which begin with an obstruent; cf. Mattissen 2003: 81).

[18] The initial obstruent of the base surfaces unchanged in the reduplicant when the structural description of consonant mutation is not met, e.g. *tʃʰaɸ-tʃʰaβ-* ‘to get wet’ (SL2: 56). The mutation of the initial obstruent of the reduplicants in (16) thus cannot be due to reduplicative dissimilation.

(17) In intransitive sentences
[NP$_{\text{(subj.)}}$+V]
[$_{\text{NP}}$kʰɨsk][$_{\text{VP}}$qoju-tʃ] * kʰɨsk ʁoju-tʃ
cat cry-IND (SL2: 23)
'A cat cried.'

(18) Between an adverbial element and any following constituent
a. [$_{\text{PP}}$j-ax] [$_{\text{ADV}}$niɲaq][$_{\text{V}}$qʰo-ku-tʃ] *$_{\text{...}}$niɲaq χo-ku-tʃ
3SG-CAUS a_bit sleep-CAU-IND (SL1: 25)
'(She) let her sleep for a while.'

b. [$_{\text{ADV}}$niɲaq][$_{\text{ADV}}$toŋgur̥][$_{\text{V}}$lupr-lupr][$_{\text{V}}$iɲ-tʃ] *niɲaq roŋgur̥..
a_little like_this spoon_up eat- IND (SL5: 35)
'…(we) spooned up the food a little like this and ate.'

c. [$_{\text{NP}}$tʰɸɨsk][$_{\text{ADV}}$handʒtamar̥][$_{\text{V}}$r̥uβ-tʃ] *handʒtamar̥ tʰuβ-tʃ
fir perhaps to burn- IND (SL5: 69)
'…(she) burned perhaps fir.'

(19) Between a subject and an object
[NP$_{\text{(subj.)}}$+NP$_{\text{(obj.)}}$]
[$_{\text{NP}}$j-ɨmɨk][$_{\text{VP}}$[$_{\text{NP}}$pʰ-oɣla] [$_{\text{V}}$kʰez-ŋan]][19] *j-ɨmɨk-ɸoɣla..
3SG-mother REF-child to_ tell-when (SL1: 9)
'…when the mother told her child...'

To summarize, the maximal domain of consonant mutation is XP, the maximal projection.[20]

Crucially, consonant mutation is sensitive to domain-internal morpheme junctures and thus does not apply across the board. In this connection, it should be pointed out that it fails to apply in a non-derived environment. In

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[19] The initial obstruent of *kʰez-* 'to tell' is a plosive, and not the expected *x*, even though it follows a vowel. This is because *oɣla* 'child' ends in a putative nasal, which is lost in the Amur dialect. The Sakhalin dialect has preserved this nasal and its corresponding form of *oɣla* is *eɣlŋ*. This nasal causes the opaque application of hardening in (19).

[20] Kaisse (1985: 181) states the domain of Nivkh consonant mutation as follows: "Lenition occurs between *a* and *b* where *b* c-commands *a*". Conteh, Cooper and Rice (1986: 111–112) report a similar domain for the consonant mutation of Mende (West Atlantic).

the examples below, the phonological conditions on consonant mutation are met and yet it does not apply. This is because these words are monomorphemic and do not constitute a derived environment.

| | | | | |
|---|---|---|---|---|
| (20) | a. | utku | *utɣu | ‘man’ |
| | b. | ɨkɨn | *ɨɣɨn | ‘elder brother’ |
| | c. | tʃaqo | *tʃaʁo | ‘knife’ |
| | d. | k$^h$uti | *k$^h$uri | ‘hole’ |
| | e. | ŋɨki | *ŋɨɣi | ‘tail’ |
| | f. | ŋɨɣs | *ŋɨɣtʃ | ‘teeth’ |

There are also instances of consonant mutation which do not involve active alternations (i.e. do not require an overt preceding morpheme). Such a static type of mutation is used to differentiate certain grammatical categories. Some of the intransitive/transitive verb pairs and noun/verb pairs constitute such an example.

| | | | | | |
|---|---|---|---|---|---|
| (21) | *Intransitive verb* | | | *Transitive verb* | |
| | a. | pɨks- | ‘to disappear’ | βɨks- | ‘to lose/to throw away’ |
| | b. | tɨu̯- | ‘get accustomed’ | rɨu̯- | ‘to teach’ |
| | c. | t$^h$a- | ‘it is roasting’ | r̥a- | ‘to roast’ |

| | | | | | |
|---|---|---|---|---|---|
| (22) | *Noun* | | | *Verb*[21] | |
| | a. | p$^h$uɸ | ‘saw’ | ɸuβ- | ‘to saw’ |
| | b. | tʃ$^h$aɸq | ‘chopsticks’ | saɸq- | ‘to eat with chopsticks’ |
| | c. | k$^h$es | ‘information’ | xez- | ‘to tell’ |

Nivkh has the transitive suffix *-u-* to signal the transitivity of verbs: *lirk-* ‘float, drift’, *lirk-u-* ‘to float something’. But there are also verb pairs in which the continuancy of the initial obstruent is the only signal of transitivity, as the examples in (21) show.[22]

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[21] A final fricative of verbal roots is voiced because of the putative nasal suffix, which is assumed to intervene between the verbal root and a following suffix (Jakobson 1957: 97).

[22] There are also cases of double marking in which transitivity is signaled by continuancy of the initial obstruent (fricative) and the presence of the suffix *-u-*: *tʃ$^h$e-* ‘to get dry (intransitive)’, *se-u-* ‘to dry something (transitive)’.

Regarding such pairs, and the restricted distribution of fricatives in word-initial position, it is often assumed that the initial fricatives of the transitive verbs are derived from an earlier plosive (Kreinovich 1937; Jakobson 1957; Austerlitz 1977: 18, 1980: 76, 1984, 1990a: 20). Jakobson hypothesizes that in the early stage of the language transitive verbs were obligatorily preceded by a deictic element *i-/e-* (third person singular pronominal object) when no object NP immediately preceded the verb.[23] This *i-/e-* triggered the spirantization of the following plosive, which is the initial segment of the following verb. It is assumed that it later dropped by a phonological process which deleted an initial unstressed (or weakly stressed) vowel – see §3 for details. * denotes a reconstructed form.

(23) *i-tʰa > *i-r̥a- > r̥a- ‘(s)he roasts something’

This ‘merger’ of the deictic element with the verbal root produced a number of fricative-initial transitive verbs, which could from that time be used without a preceding *i-/e-*. The merger also opened the way to the phonemic status of fricatives, which were mere allophones of plosives before this process took place.[24]

The prohibition of initial fricatives is observed in loanword phonology as well. Nivkh has a number of borrowings in which the initial fricative in the original form is replaced with a plosive (Kreinovich 1937: 53–54; Jakobson 1957: 93; Austerlitz 1984: 236).

| (24) | *Nivkh* | *Original form* | | *Language* |
|---|---|---|---|---|
| a. | tʃʰaɸq | saɸugu | ‘chopsticks’ | Udehe |
| b. | tʃʰoxtʃ- | sokto- | ‘to get drunk’ | Nanai |
| c. | qʰal | xala | ‘clan’ | Nanai |
| d. | tʃʰurx | surku | ‘wolfsbane’ | Ainu |

This restriction is no longer active and Nivkh has a number of borrowings with an initial fricative: *χaza* ‘scissors’ (Nanai *xaʒa*), *seta* ‘sugar’ (Nanai *seata*). These forms are considered to be late borrowings (Kreinovich

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[23] Verbal roots which begin with a cluster or a vowel still retain this deictic element: *i-ɣlu-* ‘to be afraid of’, *j-iz-* ‘to call’. This element disappears when an immediately preceding object NP is present: *tʃʰxiɸ kʰlu-* ‘to be afraid of a bear’.

[24] A few transitive verbs begin with a plosive (3de). These verbs all have the structure of N+V and are considered to have been formed at a later stage (Kreinovich 1937; Jakobson 1957).

1937: 54). Nonetheless, the adaptation pattern of the ‘well-assimilated’ loanwords in (24) hints at the existence of an early phonotactic restriction on initial fricatives.

Another aberrant behavior pattern of initial fricatives is that no initial fricative of nouns undergoes hardening.

| | | | | | | |
|---|---|---|---|---|---|---|
| (25) | a. | βo | ‘village’ | maɣr βo | ‘Maghr Village’ | (SL3: 34) |
| | b. | r̥ɨ | ‘door’ | tɨɸ r̥ɨ | ‘entrance door’ | |
| | c. | βo | ‘village’ | βɨɣ̥rkun βo | ‘Vygrshkun Village’ | (SL3: 5) |
| | d. | βɨɲ | ‘pot’ | la-ŋ βɨɲ | ‘pot from Amur (continent)’ | (SL1: 12) |

This is in sharp contrast with the initial fricatives of transitive verbs, which exclusively undergo hardening in mutation contexts.

The hypothesis on the historical development of fricatives by Jakobson and Austerlitz explains this noun/verb dichotomy as follows. Recall that the initial fricatives of the transitive verbs were assumed to be derived from plosive-initial forms by the merger of a deictic element *i-/e-*. The merger, however, did not wipe out the plosive-initial forms from the lexicon. These forms continued to be used in contexts where plosive-initial forms were preferred for phonological reasons, namely, after a nasal or a fricative (see §6 for details). In other words, plosive-initial forms of the transitive verbs survived as allomorphs.

In contrast, the initial fricatives of nouns are not derived from plosives. Unlike transitive verbs, fricative-initial nouns never had the opportunity to develop a plosive-initial allomorph.[25] Accordingly, they are forced to surface in the fricative-initial form even in contexts where phonology prefers forms with an initial plosive (i.e. after a nasal or a fricative). This is what we observe in the examples in (25).

This assumption has consequences for the status of spirantization and hardening in the synchronic grammar; it emphasizes the point that these two are qualitatively different processes and that they should not be regarded as two sides of the same coin, namely, consonant mutation (see Harris this volume). The remarkable difference can be seen in their domain of application: while spirantization applies exceptionlessly, the application of hardening is restricted to a closed set of lexical items (namely, transitive verbs). This difference leads us to the conclusion that hardening involves a

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[25] Shiraishi (2004b) proposes an analysis which accounts for this noun-verb dichotomy in the synchronic grammar.

process of allomorphy (in the narrow sense; cf. Booij 2005: 31–33) in the sense that it is restricted to a specific subset of words in the lexicon. This argument legitimates the exclusion of hardening from the current discussion and thus I will focus on spirantization in what follows.

## 3. The origin of spirantization

Any attempt to give a phonological rationale to Nivkh spirantization sticks in the cross-linguistically unusual context of spirantization after a plosive, as mentioned above. The most straightforward interpretation is to regard it as a case of phonological opacity, which arose historically from the transparent application of set of rules. This idea is encapsulated in the assumption on the origin of spirantization by Austerlitz, who postulates a diachronic development similar to that of Irish: intervocalic spirantization and subsequent loss of the triggering vowel (Austerlitz 1990a: 21, 1994b: 229–230).

Before going into the details of this hypothesis, however, I have to point out that evidence bearing on this issue is hard to come by in Nivkh. Unlike Celtic, Nivkh has no record of its archaic stages.[26] Neither is the amount of descriptions on its dialectal variation rich enough to attest an earlier form of the process, unlike the West Atlantic languages where almost every historical stage of consonant mutation is attested in some dialect or related language (Anderson 1976: 96). Since Nivkh is genetically not related to any known language, reconstruction by means of comparative method is impossible (Austerlitz 1984: 231). It should therefore be noted that Austerlitz's assumption is based on the 'internal' reconstruction of the language. With this proviso in mind, I will lay out his hypothesis in what follows.

As Austerlitz points out, many Nivkh roots are monosyllabic and they can be rich in clusters. According to Austerlitz, this suggests an earlier polysyllabicity, in which every cluster is derived from a sequence of CV syllables (Austerlitz 1990a: 21, 1994b: 229). In such a sequence, intervocalic plosives were weakened to fricatives. Subsequently, unstressed (or weakly stressed) vowels deleted. After the loss of the unstressed vowel, the two consonants became adjacent and formed a cluster. Hence, it is assumed that roots with an initial cluster and roots with a final cluster had different stress patterns: an initial cluster is the remnant of non-initial stress

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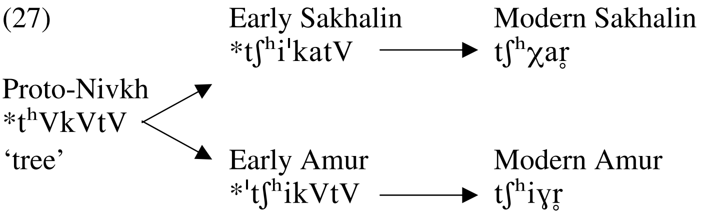
[26] The first sizable record of Nivkh dates back to late 19th century.

and a final cluster that of non-final stress (P stands for any plosive, F for any fricative, V for any vowel).

(26) a. Initial cluster: *PVˈPVPV > *PVˈFVFV > PFVF
b. Final cluster: *ˈPVPVPV > *ˈPVFVFV > PVFF

The correlation between position of stress and cluster is exemplified in the dialectal variation of the root ‘tree’ (Austerlitz 1980: 78, 1986: 188, 1994b: 229).

(27)



As concerns the position of stress, there is a strong tendency in the Modern Amur dialect to put it on the first syllable (Kreinovich 1979: 298). Stress patterns other than this are hardly observed (Shiraishi 2006: 30). This is in sharp contrast with the Modern Sakhalin dialect, which contains a number of polysyllabic roots with unstressed initial (Kreinovich 1979: 298–299).

Another remarkable distribution of obstruents in the Nivkh lexicon is the preference of fricatives (over plosives) in root-final position. According to Austerlitz (1980: 85, 1982: 83, 1990a: 20), the numerous fricative-final roots indicate that the final consonant was at one time followed by a vowel. This vowel triggered spirantization of the preceding plosive. When the final vowel did not bear stress, it dropped (apocope) and left the fricative as the final segment of the root (Austerlitz 1994b: 230).

(28) *ˈPVPV > *ˈPVFV> PVF

Plosive-final roots are fewer but do exist.[27] Austerlitz (1980: 81) assumes that these final (and medial) plosives were at one time geminates (*ˈPVPPV > PVP; e.g. **ˈtottV* > *tot* ‘arm’). This hypothesis is consistent with the

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[27] Nivkh has a number of nominal roots which end in *k* or *q*. According to Austerlitz (1984: 38), these two can be reconstructed as diminutive/nominalizing morphemes in many cases. On the other hand, roots ending in *p, t* and *tʃ* are rare.

cross-linguistic observation that geminates are immune to spirantization (Hayes 1986, Kirchner 1998, 2000, 2004, etc.).[28]

Unfortunately, there are no old records of the language, in which the reconstructed polysyllabic forms can be witnessed, as mentioned earlier. Nevertheless, Austerlitz (1977: 19, 1984: 236) hints at the adaptation pattern of loanwords as a possible support for his reconstruction. The examples below exhibit the same phonotactics as the reconstructed forms above, i.e. intervocalic spirantization and the deletion of unstressed vowels.

| (29) |  | *Nivkh* | *Original form* |  | *Language* |
|---|---|---|---|---|---|
|  | a. | ral | uˈdala | ‘frog’ | Uilta |
|  | b. | r̥ɨ | uˈtə | ‘door’ | Uilta |

There are no synchronic phonological processes in Modern Nivkh which can derive *ral* from *uˈdala*. The pattern of spirantization has apparently changed from what Austerlitz had assumed to be at one time prevailing in Nivkh. Nevertheless, I will show in the next section that spirantization exhibits traits of a synchronic phonological process and that it is too hasty to regard it as a remnant of what once was a productive phonological rule that has fossilized in the morpho-syntax of the language.

## 4. Review of previous analyses

Capturing Nivkh spirantization as a synchronic phonological process has not been the mainstream analysis/description in the literature.[29] The diffculty lies in its diffused phonological contexts. Notably, Nivkh is unusual in that it exhibits spirantization after a plosive. This runs counter to the cross-linguistically widely attested observation that spirantization rarely targets plosives after an obstruent (e.g. Kirchner 1998, Ségéral and Scheer 1999, 2008). It is therefore legitimate to ask whether we may capture spirantization after a plosive alongside spirantization after a vowel; Are they instances of the same process?

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[28] Kirchner notes that geminates never spirantize unless they are concomitantly degeminated: “geminate stops can undergo oral reduction, but only if they surface as singletons” (Kirchner 2001: 105); e.g. Tiberian Hebrew *zikkeer* (causative perfect) *zaaxar* (basic perfect) ‘remember’.

[29] Panfilov (1966: 62), who claims that Nivkh consonant mutation is an instance of sandhi, is perhaps the only exception.

Researchers who are skeptical about this view insist that spirantization should be seen as two separate processes, namely, assimilation (after a vowel) and dissimilation (after a plosive) (Kaneko 1999; Mattissen 2002, 2003). The latter occurs in order to circumvent the occurrence of adjacent plosives.

Alternatively, one may regard spirantization as a primarily morpho-syntactically motivated process and afford phonology only a minimal role. According to this view, the primary function of consonant mutation is to signal morpho-syntactic information. For instance, Watanabe (1992) claims that consonant mutation compensates for the lack of overt morphological case markers in Nivkh nouns.[30] On this view, Nivkh is comparable to Celtic, in which most of the mutation contexts are no longer motivated phonologically (Kaisse 1985; MacAulay 1992; Grijzenhout 1995; Kirchner 1998; Green 2005; Jaskuła 2008, etc.).[31] Accordingly, there is no need to account for the phonological peculiarities it exhibits.

In Shiraishi (2006), I argued that both approaches are unsatisfactory in that they fail to capture many of the notably phonological characteristics of spirantization. In particular, I argued that (i) spirantization exhibits traits of Prosodic Phonology, and (ii) spirantization in all contexts should be relegated to a unified account. In the remainder of this section, I will focus on (i) and point out the differences from truly morpho-syntactically motivated processes, such as the consonant mutation of Celtic.[32] The discussion on (ii) will be carried over to the next section.

First, Nivkh spirantization is transparent in the sense that every plosive alternates with a fricative which is (nearly) homorganic (§2). In contrast, many of the Celtic mutations exhibit (historical) gaps in the mutation paradigm: *b* > *v*, *g* > *ɣ*, but *d* > *ɣ* (Modern Irish),[33] *b* > *v*, *d* > *ð*, but *g* > Ø (Modern Welsh) (Jaskuła 2008).

Second, in many languages consonant mutation is bound to specific morpho-syntactic information such as gender/number/case, specific particles or prepositions (Celtic: MacAuley 1992), number/person (Iwaidja: Evans 1998) or noun class (West Atlantic: Anderson 1976). In contrast, Nivkh spirantization is not bound to particular morphological information.

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[30] Austerlitz (1990b: 174), however, claims that it is the fixed word order which indicates the grammatical role of constituents and not consonant mutation *per se*.

[31] Green (2005) argues that Celtic mutations involve alternations of suppletive forms and thus cannot be regarded as a phonological process in any sense.

[32] The difference from Celtic has been argued extensively by Mattissen (2003: 94–102) as well.

[33] In Old Irish (600–900 CE) the alternation was transparent: *d* > *ð* (Jaskuła 2008).

The only case which approximates such a grammaticalized case of consonant mutation is the lexicalization of initial fricatives of transitive verbs (§2), as pointed out by Mattissen (2003: 102). As I argued in the previous section, however, this is a qualitatively different process and deserves separate treatment from the spirantization discussed at hand (see Blevins 1993 for a similar view).

Third, while it is not unusual to find idiosyncratic exceptions to consonant mutation even in the native lexicon (e.g. Fula: Anderson 1976 and Lieber 1984), this is not the case in Nivkh (Austerlitz 1990b: 177; Mattissen 2003: 98).

Fourth, Nivkh spirantization is sensitive to pause-insertion. This contrasts with for instance Irish, in which consonant mutation applies even with the presence of a substantial pause (mutation indicated by italicized fonts).[34]

(30) Ba…..*dh*ochtuir i
was doctor her
'She…..was a doctor.' (Rotenberg 1978: 96)

Again, this sharply contrasts with Nivkh, in which spirantization fails to apply when a pause intervenes between the target and the triggering morpheme, as was first pointed out by Kreinovich (1937).

(31) a. qoi̯ 'larch'
βatʃ...qoi̯ *ʁoi̯ 'iron larch' (Kreinovich 1937: 15)
b. tʰom 'fat'
hɨi̯k̃tʰom *r̥om 'fat of a hare'

Pause sensitivity is used as a diagnostic for rule types in theoretical frameworks such as Lexical Phonology (Mohanan 1986, etc.) and Prosodic Phonology (Kaisse 1985, 1990, Nespor and Vogel 1986, Hayes 1990, etc.). The difference from Irish on this point should therefore not be overlooked.

To summarize, there are a number of differences between the spirantization of Nivkh and that of languages mentioned above. In the latter, the process is more or less fossilized in the morpho-syntax in the synchronic grammar, unlike Nivkh. This constitutes a critical difference at the synchronic level, even though the origin of the present situation might be his-

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[34] Similarly, in Irish mutation applies even with intervening material like an English expletive (Stenson 1990: 171).

torically traced back to a similar source (i.e. intervocalic spirantization and vowel loss).[35] Treating Nivkh spirantization as a primarily syntactic process incorrectly veils these differences from truly morpho-syntactically motivated processes. The next section sets out a novel approach.

## 5. An alternative approach

In her analysis of Nivkh spirantization, Blevins refers to its peculiar phonological context and notes that "The synchronic rule of spirantization in Gilyak appears to be a radical phonologization of what was once a simple process of intervocalic spirantization" (1993: 9, fn. 9). In this section, I will argue that with the right parameters set up, the phonological context of spirantization can be accounted for while at the same time restricting mutation patterns which are never attested in natural languages. The parameter involves one of 'visibility'.

As mentioned earlier, there are two phonological contexts which make a phonological account of spirantization a non-trivial task. First, the cross-linguistically unusual spirantization after a plosive should be accounted for. Second, the target of spirantization should be pinpointed to morpheme-initial positions to the exclusion of non-initial (medial and final) positions. Each of these contexts will be discussed in what follows.

### 5.1. A perceptual account of spirantization

In connection to the first issue, I have to point out that a primarily articulatory account of spirantization (Flemming 1995; Kirchner 1998, 2004, etc.) does not capture the characteristics of Nivkh spirantization correctly. As discussed at length by Kirchner (1998, 2004), articulatorily motivated spirantizations typically correlate with speech rate. That is, in faster speech rate spirantization expands its domain of application (e.g. Florentine Italian) or it targets segments which do not undergo spirantization in slower speech rate (e.g. Andalusian Spanish). Neither case is observed for the spirantization of Nivkh discussed at hand.

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[35] It is assumed that the consonant mutation of Irish ceased to act as a productive phonological process in the period of Old Irish (600–900 CE) (Grijzenhout 1995: 75–76).

Further support for the rejection of an articulatorily based account comes from the behavior of plosives after a nasal. It is cross-linguistically widely attested that spirantization tends to be blocked after a nasal, e.g. Spanish (Harris 1969), Liverpool English (Honeybone 2005), High German Consonant Shift (Honeybone 2005), etc. A number of analyses have been proposed to account for this observation (e.g. Hayes 1986; Kirchner 1998; Honeybone 2005). A review of these proposals reveals that they all involve an appeal to articulation. For instance, Honeybone (2005: 182) claims that nasals typically place-assimilate to a following plosive and that such a sharing of place (nodes) impedes the application of spirantization ('sharing gives strength'). Such an account is based on the observation that in these languages the N[asal]-C[onsonant] sequence is homorganic. In Nivkh, however, NC need not be homorganic (§2) and yet plosives do not spirantize after a nasal. The lack of homorganicity casts doubt on a primarily articulatory account of spirantization.

In Shiraishi (2006, 2008) I propose an alternative analysis of spirantization, which regards it as a perceptually motivated process of lenition. According to Harris, lenition is a phonological operation which diminishes the amount of information in order to accentuate syntagmatic contrast (Harris and Urua 2001; Harris 2005). When a plosive spirantizes, the closure phase of the plosive is suppressed and the abrupt and sustained drop in amplitude is lost from the speech signal. This signal cue characterizes the silent interval during the closure, and it is a crucial perceptual cue to perceive and identify the acoustic event as that of a plosive, together with formant transitions and the noise bursts of the release. Since spirantization removes such a cue, the spirantized segment lacks the selection of cues that are present in the non-spirantized congener. This loss of perceptual cue highlights the informational asymmetry between segments which stand in syntagmatic contrast to each other within a specific informational domain.

The maximal domain of application of spirantization (§2) shows that the relevant domain is XP (NP specifier-head and VP complement-head) in Nivkh. Within this domain, every morpheme-initial plosive of a non-initial morpheme undergoes spirantization, while the initial plosive of a domain-initial morpheme never undergoes it. From this distribution of spirantization, I assume that there is an informational asymmetry between the domain-initial morpheme and the remaining non-initial morphemes. By spirantizing the initial plosives of the latter, the domain-initial morpheme is syntagmatically highlighted.

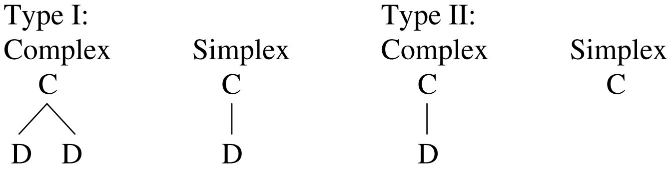
This analysis succeeds in explaining why Nivkh allows spirantization after a plosive. Under the perceptual account, spirantization need not be triggered by a local melodic context. Rather, spirantization is controlled by a non-local (prosodic) demand, which strives to create informational asymmetry among constituents within a designated domain. Accordingly, any plosive which is included in such a domain is a potential target of spirantization. In Nivkh, however, plosives fail to undergo spirantization in two contexts. First, spirantization is blocked after a nasal or a fricative (§2). I assume that this is due to local phonological (perceptual) factors which disfavor the succession of fricatives, or a nasal-fricative sequence (to be explained below in §6). Second, non-initial plosives are exempt from spirantization. I will discuss this in the next section.

Crucially, the current analysis rejects the view that spirantization in discrete contexts constitutes different processes such as assimilation and dissimilation (Kaneko 1999; Mattissen 2003). As argued in Shiraishi (2006, 2008), such a view fails to account for the characteristics which are shared by all instances of spirantization. These are (i) common outputs (fricatives) and (ii) common domain of application (XP). However, these shared characteristics are not adequately captured in such a view. Accordingly, it is mere coincidence that both dissimilation and assimilation yield a fricative, and that no other measures, such as vowel epenthesis, are taken to avoid the clustering of plosives or fricatives. Such a problem does not arise in the current analysis since it unifies spirantization in discrete contexts as all instances of a single process, namely, lenition.

### 5.2. Initial spirantization as visibility head-dependent asymmetry

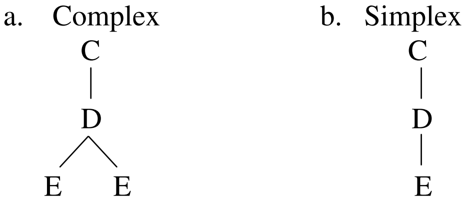
In the previous section, I argued that Nivkh spirantization is a perceptually motivated process, which highlights syntagmatic asymmetry in a specific informational domain. The notion of ‘asymmetry’ provides a key concept to the second issue – namely, the exclusion of non-initial plosives from spirantization targets. One way to capture asymmetry is to use the notion of ‘head’, which stands in contrast with ‘dependent’ (cf. Dresher and van der Hulst 1994, 1998; van de Weijer 1994; Harris 1994, 1997, among others). An asymmetry is observed typically if a head enjoys characteristics which are not allowed for dependents. For instance, a head may exhibit the maximum structural complexity which is allowed by a grammar whereas that of dependents may never exceed that of a head (Harris 1990, 1994; Dresher and van der Hulst 1998). This is illustrated below where the structural complexity of the nodes C exhibits asymmetry.

(32) Local complexity



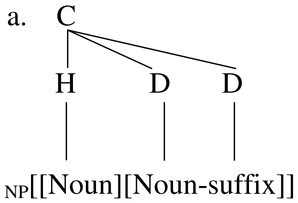
A thorough study of headedness by Dresher and van der Hulst (1994, 1998) reveals that the evaluation of complexity is often implemented in the internal structure of the immediate daughter node (D). This is called 'non-local complexity' and is illustrated below, where the complexity of the nodes C is evaluated in the substructures (E) of the daughter node (D).

(33) Non-local complexity


a. Complex b. Simplex

Given the spirantization pattern of Nivkh observed above, I assume that the initial morpheme of XP is the head and that it contrasts with all non-initial morphemes, which are dependents.[36] This is schematically illustrated below (H: head, D: dependent, C: constituent at a higher level).

(34) a.



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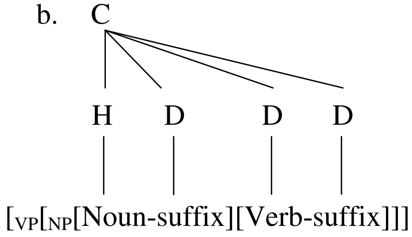
[36] Smith claims that the initial morpheme might be the prosodic head of a phonological phrase (Smith 2005: 14, fn.7). See also Nasukawa (2005) for a similar idea on Japanese.

b.



Heads may enjoy another priviledged property. They may look ‘deeper’ into the structure than the corresponding constituents of dependents (Dresher and van der Hulst 1994, 1998). This comprises an instance of ‘visibility’ head-dependent asymmetry (HDA-V). According to Dresher and van der Hulst, “heads require a deeper, more articulated analysis of the structure than the dependents” (1998: 333) and therefore “…heads will make their internal structure visible, whereas dependents will not” (1998: 338). This is exemplified, for instance in the stress pattern of languages which exhibits asymmetry in the assignment of main stress and secondary stress; main stress is sensitive to syllable quantity (heavy vs. light) whereas secondary stresses are not, and they fall on alternate syllables from the main stressed syllable. This is an instance of HDA-V, in which the foot bearing the main stress is the head and is sensitive to lower levels of the prosodic structure (the internal structure of syllable, or mora) whereas non-head feet have no access to this distinction (Dresher and van der Hulst 1998: 342–343).

This distinction is reminiscent of the asymmetry observed between morpheme-initial plosives and non-initial plosives in Nivkh. Spirantization leaves the latter intact as if they were not visible to the process. In Shiraishi (2006, 2008) I argue that they are exempt from spirantization since they are irrelevant for the syntagmatic asymmetry among morphemes; only plosives in morpheme-initial positions count.

We may regard this asymmetry as a case of HDA-V, where morpheme-initial positions comprise the head and non-initial positions dependents.[37] Assuming an intermediate level (M[orpheme]-plane) which mediates between the consonantal plane and a constituent at a higher level, where the complexity of segments is evaluated, HDA-V ensures that only the melodic content of consonants in head positions are visible to a higher level.

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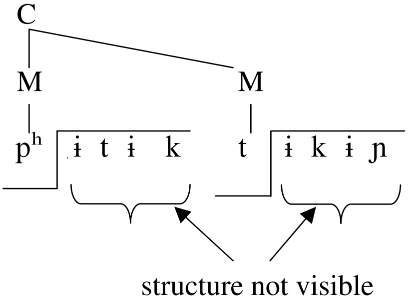
[37] The phonological significance of morpheme-initial positions as compared to non-initial positions has been pointed out repeatedly in the literature. See Smith (2005) for a review.

(35)



gloss: p$^h$-ɨtɨk ‘one’s own father’ tɨkɨɲ ‘nail’

At a higher level (C), there is a prosodic imperative to create syntagmatic asymmetry among constituents. This is implemented by assessing the melodic content of the segments on the consonantal plane. Following literature which assumes that segments are compositionally built up of phonological primes which are unary, I assume that plosives are structurally more complex than fricatives. A candidate for such primes in a phonologically elaborated framework of representations is ‘element’ (Harris 1994, 1996, 1997, 2004; Harris and Lindsey 1995; Harris and Urua 2001). Elements are subsegmental units which are phonetically expressible in isolation and are therefore more suitable than traditional binary features for expressing lenition as a loss of information from the speech signal (Harris and Urua 2001; Harris 2005). Under this view of elements, plosives are characterized by the elements [edge] and [noise], which are phonetically interpreted as abrupt and sustained amplitude drop, and noise burst, respectively. On the other hand, fricatives contain [noise] (aperiodic energy) like plosives, but no [edge]. When a plosive spirantizes to a fricative, the abrupt and sustained drop in amplitude is removed from the speech signal. In the phonological representation, this is expressed as the delinking of [edge]. In Nivkh, the prosodic imperative is that within XP, non-initial morphemes may not be headed by a plosive.[38] When this appears to be the case, spirantization activates and delinks [edge] from the speech signal.

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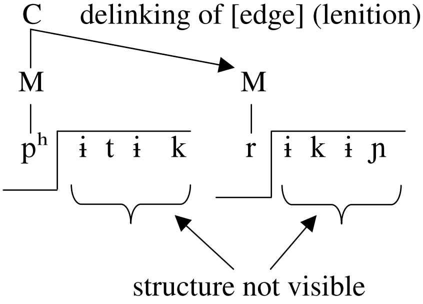
[38] We may further assume that the creation of such an asymmetry follows from a general condition on syntagmatic contrast in phonology, like the complexity condition (Harris 1990: 274, 1994: 170, 1996: 21) or the mismatch condition (van de Weijer 1994: 67).

(36)



gloss: $p^h$-ɨtɨk rɨkɨɲ ‘one’s own father’s nail’

The result is a syntagmatic asymmetry between string of morphemes in which “…prosodic heads enjoy a greater degree of melodic licensing potential than non-heads” (Harris 1997: 317).

Note that in the example above, the initial *r* of *rɨkɨɲ* seems less complex than a segment in its dependent *k*, being a fricative. This does not constitute a violation of head-dependent asymmetry, however, since on the M-plane “…there is no true asymmetry of complexity, but rather of visibility: in such cases, constituent units of a head are visible to a greater depth than the corresponding constituents of a dependent with respect to some mapping or projection of phonological structure from one plane to another” (Dresher and van der Hulst 1998: 318).

In sum, the notion of head is paramount at two levels. At the M-plane, it is the morpheme-initial position which is designated as the head in contrast to non-initial positions. Only the internal structure of heads are made visible to higher levels. At a higher level, which spans XP in Nivkh, the initial morpheme is the head and the remaining morphemes are appointed as dependents. Lenition is operative at this level and it strives to accentuate syntagmatic asymmetry among the constituents (morphemes). Phonologically, it is implemented as a spirantization at the consonantal plane, which is represented in the current framework as the delinking of [edge]. In this sense, Nivkh spirantization exemplifies a case of non-local complexity; the asymmetry in complexity is relevant at the higher level (XP), but the assessment of complexity is implemented in the internal structure of the daughter nodes (M-plane). At the latter level, HDA-V prevails since it is only the morpheme-initial position where complexity is assessed. Other positions are demoted to the status of dependent and are inert with respect to the assessment of complexity, and thus lenition.

## 6. The blocking of spirantization

As seen in §2, spirantization is blocked in two phonological contexts, namely, after a fricative or a nasal. Recall also that these are exactly the contexts where hardening applies. This section focuses on these two contexts and discusses why the creation of fricative-fricative and nasal-fricative sequences is avoided.

That a succession of fricatives is disfavored as outputs of phonological or morphological processes is reported cross-linguistically. In Polish, spirantization is blocked if it results in successive fricatives (Łubowicz 2002).

(37) dronǰ+ek > dron[ž]ek 'pole (diminutive)'
But: róžǰ+ek > róžǰek *róžž+ek 'brain (diminutive)'
(ǰ = postalveolar affricate; ž = postalveolar fricative)

In English, there is the occasionally observed hardening of *θ* to *t* after a fricative: [sɪkst] 'sixth', [twɛlft] 'twelfth', [fɪft] 'fifth' (Jones 1997; Wells 2000).

The problem with successive fricatives has a perceptual basis (Boersma 1998: 434). The cues in aperiodic signals are highly vulnerable and easily masked by other aperiodic noise (Wright 2004: 45). On the other hand, fricative-plosive clusters preserve auditory cues much better. In such a cluster the offset frequency of the fricative spectrum serves as a cue to the place of articulation of the following plosive (Wright 2004: 38).

In sum, successive fricatives yield weak auditory cues as compared to fricative-plosive clusters. Accordingly, I assume that in Nivkh the post-fricative context blocks spirantization for such perceptual reasons. This is an instance of dissimilation, disfavoring identical manner of articulation in successive fricatives. Similarly, when successive fricatives occur due to syntactic concatenation, hardening activates and a fricative-plosive sequence surfaces. This option, however, is available only to lexical items which have a plosive-initial allomorph, namely, transitive verbs (§2). Fricative-initial nouns lack such an allomorph and hardening does not apply.

The second context in which spirantization fails to apply is after nasals. But before discussing this context, I would like to emphasize again that in Nivkh the nasal-plosive cluster surfaces irrespective of whether these segments are homorganic or not (e.g. *pilaßon* $q^{h}$*al* [pilaβon q$^{h}$al] 'the clan of Pilavon'). I emphasize this because cross-linguistically, homorganic nasal-plosive clusters tend to block spirantization. This is reported, for instance, in Spanish (Harris 1969) and Liverpool English (Honeybone

2005). In these systems, plosives that constitute part of a geminate and/or a homorganic nasal-plosive cluster resist spirantization. In Spanish, spirantization of the voiced plosive is blocked in the latter context: *a Barcelona* [aβarθelona] but *en Barcelona* [embarθelona] (Honeybone 2005: 187). Liverpool English spirantizes non-initial *t*, *k*: e.g. *book* with a final [x] and *city* with a medial [θ]. In nasal-plosive clusters, however, spirantization is incomplete: *moment* with a final [tθ] and *inconvenience* with a post-nasal [kx] are the preferred forms (Honeybone 2005: 182). On the other hand, in Nivkh, a nasal-plosive cluster needs not be homorganic to block spirantization; any nasal-plosive cluster does so. This refutes an analysis which attributes the blocking of spirantization to (partial) geminate inalterability (Hayes 1986; Honeybone 2005, etc.). The lack of homorganicity between the nasal and the fricative indicates that an articulatory account is not promising.

As a first observation, it should be noted that the post-nasal context is a voicing-inducing context cross-linguistically (cf. Pater 1999 and references therein). While Nivkh follows this tendency (7), it does not neutralize the laryngeal contrast between fortis and lenis obstruents in this context (§2).

However, the maintenance of a laryngeal contrast in such a voicing-inducing context does not come for free. It is reported that languages which maintain a laryngeal contrast in post-nasal contexts adopt special measures to protect the voicelessness of plosives. Hayes and Stivers (1995) compared the pronunciation of nasal–plosive clusters of the pseudo-words *tompa* and *tomba* of English speakers in an experiment and observed that in *mp* the nasal was (relatively) short and the plosive long, whereas in *mb* the nasal was long and the plosive short. From this observation, they conclude that the greater length of the plosive in *mp* relative to *mb* is an important factor in maintaining the perception of the voicelessness of *p*. Another means of resisting voicing that they found was aspiration (vocal cord abduction). The plosive of *mp* had a significantly longer voice onset time than the plosive in *rp* (in the pseudo-word *tarpa*). Hayes and Stivers assume that aspiration is a speaker-specific strategy in English to maintain the voicelessness of *p* (Hayes and Stivers 1995: 30).

Hayes and Stivers' point is that voicing is preferred after nasals in all languages which have nasal-plosive clusters, and that this voicing is a threat to those languages which have a laryngeal contrast in this position. The result is that some languages give up on maintaining the laryngeal contrast (as in the native Yamato vocabulary of Japanese). English maintains the contrast by the enhancement strategies mentioned above: durational adjustment and aspiration. Nivkh patterns with English in maintaining a laryngeal contrast after nasals. Although no measurements were conducted, it is highly possible that Nivkh has enhancement strategies like English to over-differentiate the laryngeal contrast in post-nasal context. This is especially likely since Nivkh, like English, is an aspiration language (Shiraishi 2006).

In general, fricatives are less suited to bear a laryngeal contrast than plosives (Steriade 1993; Avery 1996; Jansen 2004). Fricatives have relatively restricted phonetic means of expressing laryngeal contrast as compared to plosives. Jansen notes that "[t]he continuous high airflow across an oral constriction required for the production of fricative noise puts inherent limitations on the number of laryngeal actions and configurations that are available" (Jansen 2004: 83).

The inferiority of fricatives in exercising a laryngeal contrast as compared to plosives is typologically confirmed. According to Jansen (2004: 79–80), the UCLA Phonetic Segment Inventory Database (UPSID, 1984 version) counts 236 (74.4%) languages out of 317 languages which have a laryngeal contrast (based on some sort of VOT (Voice Onset Time) distinction) in plosives, but only 119 (40.5%) of the languages have a laryngeal contrast in fricatives. This suggests that laryngeal contrasts (supported by voicing distinctions) are less stable in fricatives than in plain plosives (Jansen 2004: 80).

From these observations, I conclude that spirantization is blocked in the post-nasal context in order to maintain the laryngeal contrast. The voicing associated with nasals provides a constant pressure to the following obstruent to undergo voicing. To counterbalance this pressure and protect the laryngeal contrast, plosives fare better than fricatives. By not spirantizing the plosive, the laryngeal contrast maintains the rich phonetic means which are available in plosives (VOT, aspiration noise and release burst) but not in fricatives.

To conclude, the conflict here is between a syntagmatic contrast (lenition) and a paradigmatic contrast (maintain laryngeal contrast). The data show that it is the paradigmatic requirement that wins in this context.

## 7. Conclusion

By analyzing Nivkh spirantization as a perceptually motivated process of lenition, the current analysis succeeds in circumventing many of the problems which previous works faced. As I emphasized above, Nivkh spirantization exhibits traits of Prosodic Phonology, contradicting any attempt to categorize it as a morpho-syntactic process alongside the consonant mutation of Irish. I also showed that neither does it fit into the picture of an articulatory motivated process of lenition. The discussions above reveal that it is a qualitatively different process in which syntagmatic contrast and head-visibility are the key concepts to characterize its nature.

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# Part II

# Prosodic strength

# Against rhymal adjuncts: the syllabic affiliation of English postvocalic consonants

*Colin J. Ewen and Bert Botma*

## 1. Introduction

Botma, Ewen and van der Torre (2008) propose an analysis of postvocalic English liquids, in particular laterals, in which their syllabic affiliation varies, depending on a number of factors which we review briefly below. This analysis is formulated in terms of the basic assumptions with respect to syllable structure of the model of government phonology presented in Kaye, Lowenstamm and Vergnaud (1985, 1990) and Harris (1994), and crucially involves the claim that the 'rhymal adjunct' (or 'coda') position of standard government phonology should be reinterpreted as the specifier position of the following onset. In this paper we extend this approach to the analysis of nasal-consonant (NC) and *s*-consonant (sC) clusters.

The paper is organised as follows. In §2 we briefly review the arguments put forward by Botma, Ewen and van der Torre (2008), considering the problematic status of the rhymal adjunct position in 'standard' government phonology and outlining our 'onset-specifier' approach. In §3 and §4 we discuss the syllabic affiliation of NC and sC clusters respectively. In §5 we consider the question of whether the rhymal adjunct position can be dispensed with entirely.

## 2. The (non-)uniformity of licensing relations

A fundamental assumption of government phonology is that every segment must be licensed in order to be phonetically interpretable.[1] This is achieved by the Phonological Licensing Principle in (1) (Harris 1994: 156; for related notions of licensing, see e.g. Itô 1986 and Goldsmith 1990).

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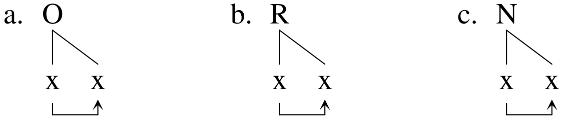
[1] In order to set the stage for a comparison between our proposal and the relevant aspects of 'standard' government phonology, much of the discussion in this introduction recapitulates that of Botma, Ewen and van der Torre (2008).

(1) Phonological Licensing
   a. Within a domain, all phonological units must be licensed save one, the head of that domain.
   b. Licensing relations are local and directional.

Licensing applies to all constituents, which in standard government phonology are head-initial. Hence all intra-constituent licensing relations are left to right, as in (2), where O, R and N are onset, rhyme and nucleus respectively.

(2)


Licensing also holds between syllabic constituents. For our purposes, two such instances of inter-constituent licensing are relevant, 'Onset Licensing' and (in spite of the absence of a coda constituent) 'Coda Licensing' (see Kaye, Lowenstamm and Vergnaud 1985, 1990; Harris 1994).

(3) a. Onset Licensing
   An onset head position must be licensed by a nuclear position.
   b. Coda Licensing
   A rhymal adjunct position must be licensed by an onset position.

These two relationships are shown in (4).

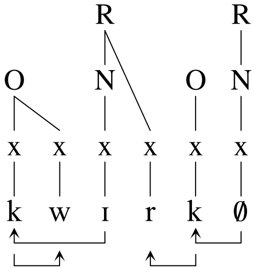
(4)


Crucially, the direction of licensing in (4) has changed to right to left. Harris observes that this reflects a general difference between intra-constituent and inter-constituent licensing; the first is head-initial, the second head-final.

Coda Licensing formalises the observation that the identity of the rhymal adjunct is restricted by the following onset (see in particular Kaye

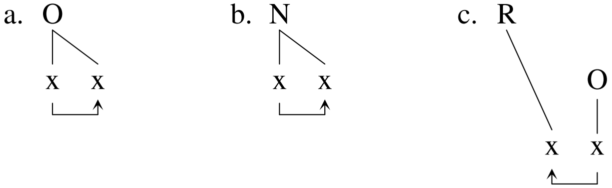
1990). One such restriction involves the fact that the rhymal adjunct can bear no distinctive specification for place of articulation. This is the case for English postvocalic liquids (including /r/ in rhotic dialects), as in *circle* and *filter*, for instance. Since /r l/ have no inherent place specification (i.e. they are predictably coronal), they can occur in the rhymal adjunct position. In addition, in many languages the rhymal adjunct position cannot have an independent laryngeal specification (for examples, see Lombardi 1991; Brockhaus 1995; Kehrein 2002). Onset Licensing and Coda Licensing together mean that in a rhotic dialect such as Scottish English, a word like *quirk* is analysed as having two onsets and two rhymes, as in (5), where the word-final consonant /k/ is analysed as an onset licensed by a domain-final empty nucleus (∅).

(5)



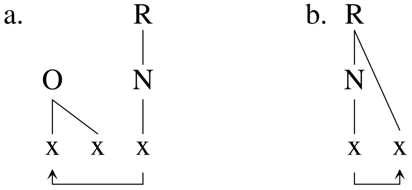
In addition to a distinction in the direction of licensing, 'standard' government phonology must also distinguish between two different types of licensing. This leads Harris to propose a 'restrictive sub-case of licensing', viz. 'government'. In a subset of licensing domains the licensed position displays what Harris refers to as 'a seriously depleted set of distributional options'. In other words, in these domains we find phonotactic restrictions, such that what can occur in the governed position is partially determined by the segment in the governing position. The set of 'governing domains' is shown in (6).

(6)



Of the two elements in a branching onset (6a), the second displays a restricted set of options, as does the second element of a branching nucleus (6b). Similarly, the rhymal adjunct position (the ‘coda’), as we have seen, is phonotactically restricted by the head of the following onset (6c). However, notice that the domains in (6ab) are constituents, but that the domain in (6c) is not, so that – as in the case of licensing – government cross-cuts constituency. Indeed, the set of *non-governing* licensing domains maintains this asymmetry, as in (7).

(7)



In (7a) the head of the rhyme licenses the head of the preceding onset, but does not govern it, nor does it form a constituent with it, while in (7b) the head of the rhyme licenses, but does not govern, the rhymal adjunct, which *is* its sister. In fact, it is unclear whether the potential set of *non-domains* has any formally distinct properties from, say, the set of non-governing licensing domains. Consider the non-domains in (8).

(8)

The head of the onset neither licenses nor governs the second position of a branching nucleus, even when they are adjacent, and similarly for the head of a nucleus and the second position of a preceding branching onset. Harris (1994: 170) appeals to the Minimality Condition (cf. Charette 1989) to account for this, as in (9):

(9) Minimality Condition

A position A is prevented from governing a position B, if the immediate projection of B’s head excludes A.

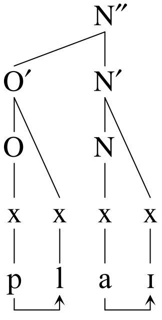
However, this is rather undermined by Harris’s contention that the coda–onset domain, i.e. (6c), ‘is exempt from this constraint’.

## 2.1. The onset-specifier approach

Botma, Ewen and van der Torre (2008) present a first approximation to a model which addresses some of the problems inherent in the standard government phonology approach to suprasegmental structure, while at the same time respecting the fundamental principles of that model; in particular, the dependency of certain syllabic positions on others, and the distinction between licensing and government. The crucial aspect of the proposal made by Botma, Ewen and van der Torre is that the rhymal adjunct position (i.e. the 'coda') is reinterpreted as the specifier position of the following onset. Furthermore, as we will see below, intersegmental relations of the sort under consideration here – whether government or licensing – largely hold only within constituents in this model, rather than in the apparently arbitrary set of licensing configurations in (6) and (7).

Following Levin (1985), and the tradition within dependency phonology (e.g. Anderson and Ewen 1987), Botma, Ewen and van der Torre further assume that a sequence of an onset and a rhyme forms a syllable, in which the head of the rhyme, itself a projection of the nucleus, is the head of the syllable (for a similar approach, see Botma, this volume). This X-bar structure is illustrated in (10) for the English word *ply*.

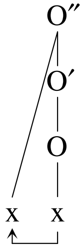
(10)



The onset-rhyme relationship is thus viewed as a Specifier-Head relationship, and the other two relationships in (10) as Head-Complement relationships.

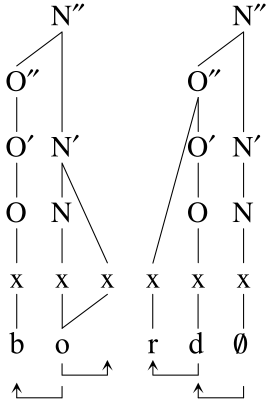
Consider next the coda-onset relationship in (6c). If a coda-onset sequence does indeed constitute a governing domain, then our previous discussion suggests that it should form a constituent which is headed by the onset. In other words, this suggests that the 'coda', rather than being a rhymal adjunct, is a specifier of the onset, as in (11).

(11)



This analysis allows Botma, Ewen and van der Torre to capture the phonotactic dependence of the ‘coda’ on the head of the following onset by its place in the structure. The result of this is that all licensing relations are now subject to constituency, as is illustrated in (12) for the word *board* in rhotic dialects:

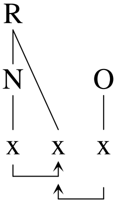
(12)



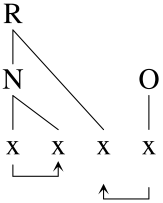
This model of syllable structure thus involves Specifier-Head relationships at two levels; the onset functions as a specifier of the nucleus (which may itself involve a Head-Complement relationship). The same configuration is found within the onset constituent itself.

There is one licensing relationship in standard government phonology that is not accounted for in (12), that holding between the head of the rhyme and the rhymal adjunct, as in (7b). This is not a phonotactic relationship; the *identity* of the rhymal adjunct does not depend on the head of the nucleus – but its occurrence does. Notice that this means that the rhymal adjunct position in a heavy syllable is doubly licensed, as in (13a), once by the head of the nucleus and once (under government) by the head of the following onset.

(13) a.



b.



This is the only terminal position to be doubly licensed in this way, which might reflect the weakness of this position. However, this seems odd, in the light of (13b), the structure for a superheavy syllable, where the rhymal adjunct position is *not* doubly licensed. And yet, in a superheavy syllable (i.e. one with a VCC rhyme), the rhymal adjunct position is much weaker than the corresponding position in a heavy syllable. For instance, a quantity-sensitive language may disallow superheavy syllables entirely – that is, it may prohibit branching at the level of the rhyme node if there is a branching nucleus. In addition, as we shall see, the constraints on the relationship between the rhymal adjunct and a following onset are typically more severe in a superheavy syllable than in a heavy syllable.

In what follows, we will argue that the rhymal adjunct in (13a) is more properly viewed as a complement of the nucleus, while the weaker position in (13b) can be assigned to the specifier position of the following onset. The syllabic affiliation of consonants as nuclear complement is not new; a similar proposal is made in Botma and van der Torre (2000), where it is suggested that at least some sonorant consonants may occupy the second position of a nucleus (see also van de Weijer 2002). Notice also that Harris (1994) incorporates something along these lines to account for the behaviour of /r/ in various non-rhotic dialects of English

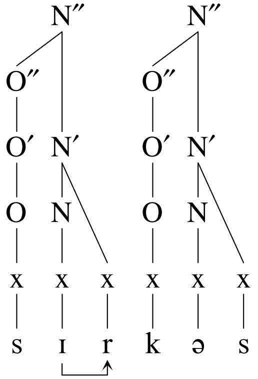
## 2.2. The syllabic affiliation of postvocalic RP English /l/

In Botma, Ewen and van der Torre (2008), where the onset-specifier approach discussed in §2.1 is first mooted, it is argued that the distribution of postvocalic /l/ can be appropriately accounted for if we recognise an onset-specifier (‘Spec-Onset’) position. In this section we summarise Botma, Ewen and van der Torre’s arguments for this, thereby setting the stage for our analysis of NC and sC clusters. Consider first of all the RP English data in (14), from Botma, Ewen and van der Torre (2008: 1258):

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (14) | a. | will | /wɪl/ | b. | pulp | /pʌlp/ | c. | — | */puːlp/ |
| | | heel | /hiːl/ | | hilt | /hɪlt/ | | cold | /kəʊld/ |
| | | | | | elk | /ɛlk/ | | — | */eɪlk/ |
| | | colour | /kʌlə/ | | Bilbo | /bɪlbəʊ/ | | — | */ʃʊlbə/ |
| | | pylon | /paɪlən/ | | kilter | /kɪltə/ | | shoulder | /ʃəʊldə/ |
| | | | | | Bilko | /bɪlkəʊ/ | | — | */ʃəʊlgə/ |

The data in (14) suggests that /l/ can follow short and long (or lax and tense) vowels in word-final position, and can occur intervocalically in foot-internal position (14a). However, although short vowels can be followed by /l/ and any consonant, either syllable-finally or intervocalically (14b), long vowels and diphthongs can only be followed by /l/ and another consonant if that consonant is coronal (14c).[2] In Harris's terms, this reflects the fact that constraints on the rhymal adjunct in superheavy syllables are in general much stronger than in heavy syllables. In Botma, Ewen and van der Torre's approach, the /l/ in these words occupies the relatively weak Spec-Onset position, as in (12) above. However, as indicated by (14b), a heavy rhyme with a liquid does not show this dependence; there seem to be no restrictions holding between the liquid and the following stop. This suggests that the liquid in these cases does not occupy the Spec-Onset position. Rather, it is part of the nucleus, as in (15), the representation of *circus* in a rhotic dialect such as Scottish English:

(15)



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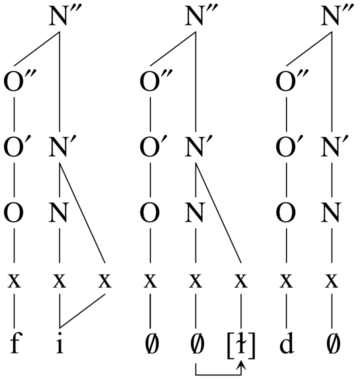
[2] The rhymal adjunct in these forms is also usually voiced (cf. e.g. *field*, *mild* vs. *f[iː]lt, *m[aɪ]lt), unless the preceding vowel is /əʊ/ (e.g. *moult*/*mould*, *colt*/*cold*). Botma, Ewen and van der Torre suggest that /əʊ/ in this context is derived from /ɒ/. For a similar claim, see Hayes (2009: 210–211).

Wherever possible, postvocalic sonorants occupy the nuclear complement position. It is only when this position is not available, or when other factors have precedence, that they occur elsewhere. A number of such situations can be identified.

Crucial to Botma, Ewen and van der Torre's analysis is the claim that the phonetic quality of a postvocalic liquid and its syllabic affiliation go hand in hand. Thus representations such as (13a) and (15) are appropriate only in cases where the postvocalic liquid is relatively 'dark', and hence influences the phonetic realisation of the preceding nuclear head, typically inducing 'breaking', diphthongisation or schwa 'excrescence' (see Gick and Wilson 2006 for discussion of these processes). If the postvocalic liquid is 'clear' (i.e. if it has a more consonantal realisation), it will generally have little or no influence on the preceding nuclear head, so that a word such as *fear* may be realised as [fiːr], rather than the [fɪəɹ] typically found in rhotic dialects with a relatively vocalic realisation of the liquid. In cases where the postvocalic sonorant has no influence on the preceding vowel, it does not form a constituent with it; rather, like other word-final consonants, it is the head of the following onset (cf. the final /k/ in (5)).

Yet another situation is presented by 'sesquisyllabic' realisations (Lavoie and Cohn 1999), involving a dark liquid following a complex nucleus, such as [fiːɫd] for *field.* In such sequences, which are often longer than 'normal' syllables, the liquid is syllabified as the complement of an empty-headed nucleus, as in (16):

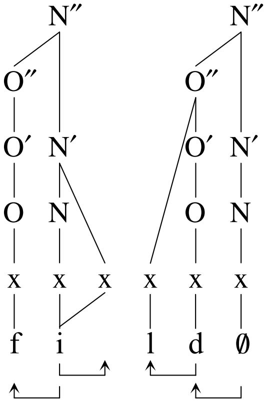
(16)



As Botma, Ewen and van der Torre observe, support for this structure is found in uncontroversially disyllabic realisations such as [fiːəɫd] and [fiːjʌɫd], in which the empty positions in (16) are filled.

In contrast, in a realisation of *field* that involves a clear liquid following a complex nucleus, i.e. [fiːld], the /l/ is located in the specifier position of the second syllable, as in (17) (cf. also (12) above).

(17)



As already noted, clear /l/ typically has no breaking effect on a preceding vowel. This follows from an analysis in which the vowel and /l/ occupy different syllabic constituents.

We believe that the distribution and phonetic realisation of liquids in English suggest that there are good grounds to assume the existence of a specifier position. In the remainder of this paper we consider two types of segment sequences to which the onset-specifier approach can be extended, NC clusters and sC clusters.

## 3. The syllabic affiliation of nasals and NC clusters

We start our discussion of English nasals by considering the onset position, where only /m n/ are found. Like liquids, nasals in onset position cannot take a complement.[3] We attribute the impossibility of a filled complement position to the relative sonority of nasals, which makes them unsuitable as licensors in the onset, which is a consonantal position. In this respect, nasals are similar to laterals, which display the same general distribution. Like /l/, /m n/ in word-initial onsets can be preceded only by /s/, which we

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[3] With the possible exception of /j/, as in *music*, *news*. This might suggest that /j/ occupies the onset complement or that it forms part of the nucleus (cf. e.g. Ladefoged 1993).

assume occupies the onset-specifier position (see §4 for further discussion of clusters involving /s/).

(18)

| *Onset specifier* | *Onset head* | *Onset complement* | |
|---|---|---|---|
| (s) | m | — | mere, smear |
| (s) | n | — | near, sneer |
| (s) | l | — | low, slow |

Notice, incidentally, that /n/ does occur in onset-complement position in other Germanic languages, such as Dutch, German and Old English, where we find initial /kn/ (but not /km/; see van der Torre 2003 for discussion of this asymmetry).

In other languages, nasals are also found in other positions. For instance, in languages with prenasalised stops, the nasal portion occupies the onset specifier in our analysis, since, like English 'coda' liquids, the nasal's place specification is predictable in this context. In languages like Polish, which has onset clusters such as /mw mr ml mn/ (cf. Gussmann and Cyran 1998), we assume that /m/ is capable of licensing sonorants, including /n/, in the onset complement.

The distributional restrictions on English word-internal onset nasals are different from those in word-initial onsets. In particular, word-internal nasals do not appear to permit a preceding filled specifier. Word-internal nasal-final clusters are in fact rather rare (and invariably non-Germanic). Some examples of clusters involving nasals are given in (19a). Notice that there do not appear to be any examples of word-internal clusters where the nasal is preceded by /s/; in the forms in (19a), <s> immediately preceding a nasal is voiced /z/.

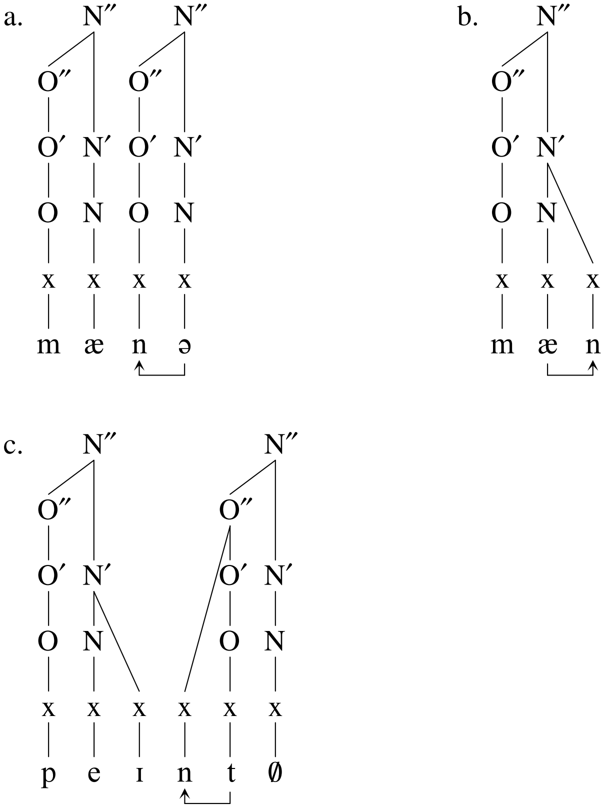
(19)

| a. | b. |
|---|---|
| jasmine | obnoxious |
| seismic | picnic |
| cosmos | acne |
| gizmo | technology |
| Bosnia | almanac |

We conjecture that the absence of word-internal /sm sn/ clusters reflects a distributional asymmetry in the onset-specifier position. With very few exceptions (e.g. *mountain*, *oyster*), it seems to be the case that this position can be filled only in word-initial and word-final contexts. This is of course what would be expected, given that the onset-specifier approach is intended to replace earlier accounts that assume ‘prependix’ and ‘appendix’ positions.

Turning now to postvocalic nasals, these can in principle occupy three distinct positions, i.e. the onset head, the nuclear complement and the onset specifier. These possibilities are illustrated in (20):

(20)



As in the case of liquids, we assume that single intervocalic nasals always occupy the onset-head position, as forced by the maximal onset principle (see e.g. Selkirk 1982). In addition, following our approach to postvocalic liquids outlined in §2, we suggest that the onset-specifier position is reserved for segments whose place is underspecified and is phonetically realised as coronal. This is the case in forms of the kind in (21), where the nasal is preceded by a long vowel or diphthong and itself precedes a coronal stop.[4]

(21) find, paint, mountain, flaunt

These words, then, receive the same analysis as *board* in (12) and *field* in (17).

At first sight, nasals do not seem to display the variability in phonetic realisation that we observed for liquids (and which, we argued, was the result of different degrees of vocalisation). However, postvocalic nasals are subject to optional weakening, which is manifested as 'nasal effacement' (Foley 1977), i.e. a process in which the nasal is lost, with nasality being retained as nasalisation on the preceding vowel; cf. Classical Latin *bonum* 'good-ACC' with Modern French *bon* /bɔ̃/. Nasal effacement involves an increase in the vocalicness of the nasal, together with increasing influence on the preceding nucleus, primarily in the form of nasalisation, and ultimate deletion of the nasal consonant.[5] In this respect, nasal effacement has an effect which is similar to that of liquid vocalisation.

The phonetic variability of postvocalic nasals is thus rather more restricted than that of liquids. In particular, the contrast between 'clear' and 'dark' realisations that we find for /l r/ is less obvious for nasals, presumably because the latter involve complete closure, and are therefore more consonantal than liquids. This suggests that in the context of a preceding long vowel or diphthong, /n/ always occupies the onset specifier, as in (20c). It is not clear whether this should lead us to expect that nasal effacement is more likely to occur following short vowels, when the vowel and the nasal are part of the same constituent, than after long vowels and diphthongs, when the vowel and the nasal belong to different constituents. We do not know of any experimental work that addresses this issue. In any case, what is clear is that the likelihood of nasal effacement also depends on segmental factors. For instance, the loss of a nasal consonant is more likely before voiceless than before voiced stops (see e.g. the data discussed in Pater 1999).

Let us next consider the other contexts in which postvocalic nasals are found. The distributional constraints on these sequences are illustrated by the examples in (22).

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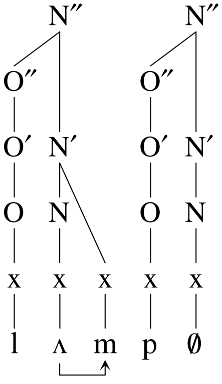
[4] Monomorphemic words ending in /aɪnt/ or /eɪnd/ are apparently not found.

[5] Vowel nasalisation has been claimed to induce lowering, but this correlation is by no means universal (see e.g. Ploch 1999 and references there).

| | | | | |
|---|---|---|---|---|
| (22) | lump | /lʌmp/ | — | */ɑːmp/ |
| | hamper | /hæmpə/ | — | */maʊmpən/[6] |
| | mint | /mɪnt/ | paint | /peɪnt/ |
| | lintel | /lɪntəl/ | mountain | /maʊntən/ |
| | hunk | /hʌŋk/ | — | */ɑːŋk/ |
| | hanker | /hæŋkə/ | — | */maʊŋkən/ |

As already noted, the data in (22) suggest that like /l/-stop clusters, NC clusters can be preceded by a branching rhyme only if the head of the following onset is coronal (see also (21) above). This lends support to the representation of *paint* in (20c), and to that for *lump* in (23).[7]

(23)



Botma, Ewen and van der Torre note that one problem which arises with respect to (23) is the fact that the nasal in *lump* (and similarly in words like *hunk*) is obligatorily homorganic with the following stop, although in (23) it is not part of the same constituent. However, this is only a problem insofar as we take the presence of a phonotactic relationship as an indication of constituency. In Harris (1994), phonotactic restrictions such as required

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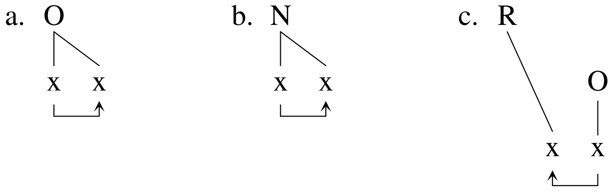
[6] Forms such as *chamber* /tʃeɪmbə/, with a superheavy rhyme containing a branching nucleus followed by a bilabial nasal, do occur, but, as Harris (1994: 77) observes, there are no more than a ‘handful’.

[7] As noted earlier, we do not know whether nasal effacement is more likely in *lump* than in *paint*. However, we do expect languages in which both nasals are effaced to neutralise preceding vowel length. Nasalised vowels generally pattern as long (i.e. they are complex nuclei), which suggests that nasal effacement also involves compensatory lengthening of the preceding short vowel. Compensatory lengthening is not expected to occur together with nasal effacement in onset-specifier position, since this position does not permit vowels.

place sharing are imposed by government relations, which, as we have seen, form a subset of the licensing relations. The three governing domains that Harris assumes were given in (6) above, and are repeated in (24) for convenience.

(24)



In each of these domains, the ‘distributional freedom’ of the governed segment is limited. However, closer inspection suggests that these phonotactic restrictions are not uniform, but are – at least in part – specific to the government relationship concerned. Conversely, there are also phonotactic restrictions between segments that are not in a governing relationship, as we will see below.

First, (24a) and (24b) differ from each other in that the governee in (24a), the onset, is more sonorous (and therefore, in Harris’s terms, melodically less complex) than its governor, while in (24b), the nucleus, this relationship is reversed. This is to be expected, given that the onset is a consonantal constituent, where the optimal head is low in sonority, whereas the nucleus, a vocalic constituent, displays the reverse characteristics. (24c), which is Harris’s equivalent to our representation in (20c), is like (24b) in this respect. But what is of direct relevance to the discussion at hand are the place restrictions on the governees in (24). In (24a) the governor and governee are typically heterorganic (banning onsets like */tl/). In (24c), however, the reverse holds; one of Harris’ main arguments for analysing coda-onset sequences as governing domains is the required homorganicity of coda nasals. However, (24a) shows that this is not a general requirement on governing domains – and hence its value as a diagnostic for constituency is questionable.

It should also be noted that in some languages the place specification of postvocalic preconsonantal nasals is determined by the vowel rather than by the following consonant. In this respect, it is interesting to look at data from a dialect of Dutch formerly spoken on the (ex-)island of Wieringen (see van Oostendorp 2000; for similar examples, see van der Torre 2003):

| (25) | | | *Standard Dutch* | *Wieringen* | |
|---|---|---|---|---|---|
| | a. | mond | [mɔnt] | [mɔŋt] | ‘mouth’ |
| | | dans | [dɑns] | [dɑŋs] | ‘dance’ |
| | b. | kind | [kɪnt] | [kɪnt] | ‘child’ |
| | | lamp | [lɑmp] | [lɑmp] | ‘lamp’ |

When a nasal is followed by a coronal and preceded by a low back vowel, it is realised as velar (25a). This does not happen after other vowels, or if the nasal is followed by a non-coronal, as in (25b). While such cases are much less frequent than the pattern of nasal place assimilation found in English (and Standard Dutch), they do show that this process cannot be equated with a specific domain – or with the lack thereof.

Finally, it is worth noting that there are also languages which display phonotactic restrictions between positions that are not part of the same constituent. One example concerns the distribution of nasality in onset-nucleus spans in languages like Wãnsöhöt (see Botma, this volume). This provides further support for the view that governing domains cannot be equated with any specific phonotactic restrictions.

Returning to the syllabic constituent structure of words like *lump*, *punt* and *hunk*, for which we have proposed that the nasal occupies the nuclear complement position, we suggest that the nasal’s place specification, which is provided by the following stop, is a consonantal property. In English (and in most other languages that allow word-internal NC clusters), nasals in the nuclear complement position cannot license an independent place element. We interpret this to mean that, because they are consonantal properties, such elements are marked when they occur in a vocalic position. In such cases, there would appear to be a number of possibilities: the nasal may remain unspecified for place (in which case it is realised as a ‘nasal glide’, as in Japanese; cf. e.g. Yip 1991), as nasalisation of the preceding vowel, as in French, or as both, depending on the following consonant type, as in Polish (see e.g. van de Weijer 1996). Alternatively, the nasal may receive its place element from the following onset, which, being a consonantal position, is capable of licensing distinctive place. This scenario is compatible with the dependency phonology analysis of Anderson and Ewen (1987), where the ‘categorial’ or ‘manner’ representation of nasal stops, i.e. |V;C|, contains two features, a (head) sonorant part and a (dependent) consonantal part. In the model proposed here, the C part is licensed by the following onset head, while the V part is licensed by the preceding nuclear head.

To conclude this section, we briefly consider the syllabic status of word-final nasals. In English these have distinctive place and, with the exception of /ŋ/, allow a preceding length contrast in vowels, as is illustrated in (26):

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (26) | a. | rum | /rʌm/ | b. | roam | /rəʊm/ | c. | beam | /biːm/ |
| | | run | /rʌn/ | | roan | /rəʊn/ | | bean | /biːn/ |
| | | rung | /rʌŋ/ | | — | */rəʊŋ/ | | — | */biːŋ/ |

As already noted in relation to liquids in §2.2, we argue that wherever possible, postvocalic sonorants occupy the nuclear complement position, as in (20b), rather than the rhymal complement or the onset of a following empty-headed syllable. This is the case in (26a), where /m n ŋ/ are preceded by a short vowel, but not in (b) and (c), where they are preceded by a diphthong or long vowel. We assume that the nasal here occupies the onset position of an empty-headed syllable, following 'standard' government phonology.

Our analysis of the forms in (26a) implies that the nuclear complement position licenses distinctive consonantal place, despite the fact that it is a vocalic position. However, notice that we can observe certain preferences in the licensing of place in vocalic and consonantal positions. A case in point concerns the distribution of /ŋ/, which in our approach is restricted to the nuclear complement (cf. */ŋæp/, */sŋæp/). It is not surprising that, of the nasals /m n ŋ/, it is /ŋ/ that limited to this position, since its dorsal place of articulation is relatively vowel-like.[8] We believe that the distribution of /ŋ/ is appropriately captured by limiting its occurrence to the nuclear complement. In this respect, we thus depart from traditional analyses, where [ŋ] is derived from underlying /ŋg/ by means of place spreading and deletion of the stop (see Gussmann 1998 for an approach along these lines in government phonology).

As in our discussion of nasal effacement in the nuclear complement and onset-specifier positions, a comment is in order regarding the possibility of effacement of word-final nasals. Here, too, we are unaware of any research into the *relative* likelihood of nasal effacement in this context. However, we conjecture that nasal effacement involves an intermediate phase in

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[8] For phonetic support for this observation, see Ohala and Ohala (1993). Notice, too, that some versions of feature geometry, e.g. Sagey (1986), assume that both vowels and velar consonants have a [dorsal] node.

which we might find evidence (phonetic and/or distributional) for treating long and short vowel environments differently, before we reach a situation where effacement has removed the consonantal part of the nasal entirely. Perhaps there is some support for this in Modern French, where we find nasal effacement in *bon* 'good-MASC', but also find feminine *bonne* [bɔn], with little or no nasalisation and a consonantal nasal, clearly derived from [bɔnə], where the nasal is unambiguously in the onset. We leave the details of such an analysis for further research.

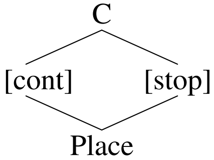
## 4. The syllabic affiliation of sC clusters

It has often been noted that /s/-stop clusters (henceforth sC clusters) have a special status in many Germanic languages, particularly in what is traditionally referred to as syllable-initial position.[9] Initial sC clusters violate the sonority sequencing principle, in that the /s/ is more sonorous than the stop, as well as the distributional generalisation that onsets contain a maximum of two consonants; the only initial CCC clusters that occur have /s/ as their first member, as illustrated in (27) for English and Dutch.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (27) | a. | *English* | | b. | *Dutch* | | |
| | | splash | /splæʃ/ | | splijten | /splɛɪtən/ | 'to split' |
| | | strict | /strɪkt/ | | strijken | /strɛɪkən/ | 'to iron' |
| | | scream | /skriːm/ | | schrijven | /sxrɛɪvən/ | 'to write' |

Various analyses have been proposed to account for the existence of these phenomena. We can distinguish two main types of approach. The first treats /s/ as forming a complex segment together with the following stop (see e.g. van de Weijer 1996; Fudge 1969; for a similar suggestion, see Kuryłowicz 1966), as in (28) (from van de Weijer 1996: 165):

(28)



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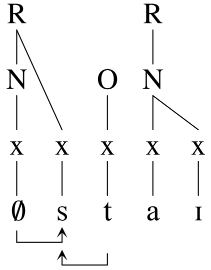
[9] For English see e.g. Kuryłowicz (1966); Kohler (1967); Fudge (1969); Fujimura and Lovins (1978); Ewen (1982); Selkirk (1982); Kaye (1992); van de Weijer (1996).

Van de Weijer (1996: 173) notes that such representations give 'a precise indication of the phonological nature of /s/ plus stop clusters: they are monopositional, but complex segments'. This approach, which we refer to as the 'complex segment' approach, thus treats sC as forming a constituent whose elements are particularly closely related, in that they are dominated by a single node.

In the second type of approach, /s/ occupies a position outside the basic syllable structure. Proposals along these lines involve an extrasyllabic position or 'prependix' (see e.g. Fikkert 1994), or, within work in the tradition of government phonology, a coda preceded by an empty nucleus, as in (29) for *sty* (see e.g. Kaye 1992; Harris 1994).

(29)



In such approaches, then, sC 'clusters' do not form a constituent. Rather, the remaining prevocalic consonants together constitute the onset, and phonotactic restrictions must be supposed to hold between these onset consonants, irrespective of any further restrictions holding between /s/ and the onset. This gains support from the fact that constraints holding between the members of a CC onset are typically unchanged when the onset is preceded by /s/, as shown by the English examples in (30).

| | | | | | | |
|---|---|---|---|---|---|---|
| (30) | a. | play | /pleɪ/ | b. | splay | /spleɪ/ |
| | | pray | /preɪ/ | | spray | /spreɪ/ |
| | | tray | /treɪ/ | | stray | /streɪ/ |
| | | — | */tleɪ/ | | — | */stleɪ/ |
| | | clay | /kleɪ/ | | sclere | /sklɪə/[10] |
| | | cray | /kreɪ/ | | scree | /skriː/ |

We refer to this as the 'bisegmental' approach.

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[10] A search of the *Oxford English Dictionary* reveals that words with initial /skl/ are very rare. Almost all of them are of Greek origin, and belong to specialised fields such as pathology (e.g. *sclerosis*) and zoology (e.g. *sclere*).

The two approaches make different predictions about the way in which sC clusters behave in languages. The bisegmental approach suggests that we should not expect to find situations in which the /s/ and the C behave as a unit; indeed, the analysis of the /s/ as being outside the syllable in which the CC onset occurs – effectively in the coda of the preceding syllable – suggests that /s/ should display 'coda-like' behaviour. On the other hand, in the complex segment approach we would expect to find behaviour involving a relationship between the /s/ and the following C which is closer than that which we usually find between two consonants in a cluster.

Previous accounts have thus attempted to provide a unified analysis of sC clusters, in terms either of the bisegmental or the complex segment approach. However, we argue that cross-linguistic evidence appears to suggest that the behaviour, and therefore the structure, of sC clusters is language-specific. We claim that in Germanic languages like English, there are reasons to view /s/ as forming a unit with a following stop; however, we will not adopt the view that such sequences occupy a single segmental position. In many other languages, /s/ is more appropriately analysed as occupying the coda of the preceding syllable; in this respect we follow the representational approach of government phonology (especially Harris 1994; but see below). We will not look in any detail at the evidence for claiming that the /s/ in an sC cluster in such languages does not form a constituent with the following consonant; such evidence is provided by, for example, historical change and loanword accommodation in Spanish (see e.g. Harris 1983), whereby a vowel is inserted before an initial sC cluster. In the standard government phonology analysis in (29) above, this involves merely a switch in parameter setting, such that an empty initial nucleus is not licensed, and hence must be realised phonetically. Other frequently cited cases include Sanskrit reduplication, where an sC cluster does not reduplicate as a whole (see e.g. Steriade 1988) and the distribution of the allomorphs of the definite article in Italian (see Kaye 1992; Harris 1994).

Other languages display phenomena which appear to suggest that the two elements of an sC cluster are *more* intimately related than the elements of a normal consonant cluster. As well as the fact that English (and other Germanic languages) allow triconsonantal clusters only when the first element is /s/, we also find the following:

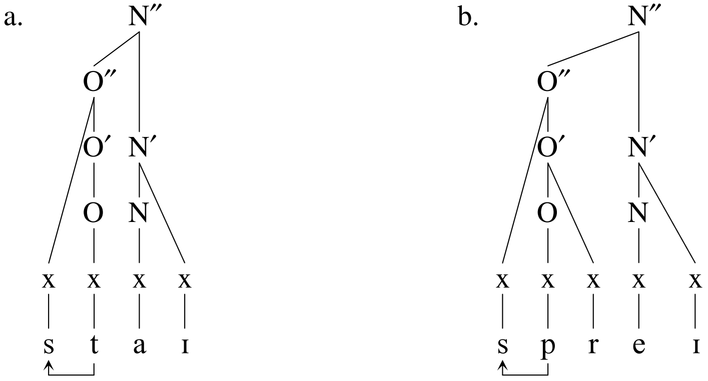
(31) a. sC clusters in English are often involved in metathesis processes and speech errors, such that the two elements of the cluster change places (e.g. historical changes such as Old English *dox* > Middle English *dosc* (Modern English *dusk*), Old English *wæfs*, *wæps*, *wæsp* > Modern English *wasp*, with dialectal forms such as *waps*, *wops*).

b. In Germanic alliterative verse sC clusters pattern only with identical sC clusters (e.g. /sp/ can alliterate with /sp/, but not with /st/ or /sk/). This contrasts with 'regular' clusters (e.g. /pr/ can alliterate with /pl/), and also with clusters containing /s/ followed by a sonorant consonant (e.g. /sl/ can alliterate with /sn/).

c. Vowel length in English is free before /st/ clusters (e.g. *fist* vs. *feast*; *cost* vs. *coast*; *best* vs. *beast*), but not before /sp/, /sk/ (e.g. *lisp* vs. **leasp*; *wasp* vs. **woasp*).

For Germanic, we adopt the view that /s/ in an initial sC cluster forms part of the onset, but rather than treating it as part of a complex segment, we claim that it occupies the onset-specifier position. Thus, rather than (29), we represent *sty* as in (32a), while *spray*, with an initial sCC cluster, will have the representation in (32b):

(32)



As we shall see, this proposal, like the complex segment analysis, adequately accounts for the distribution of English sC clusters.

Consider now the data in (33), which in relevant respects is parallel to that in (22) for NC clusters:

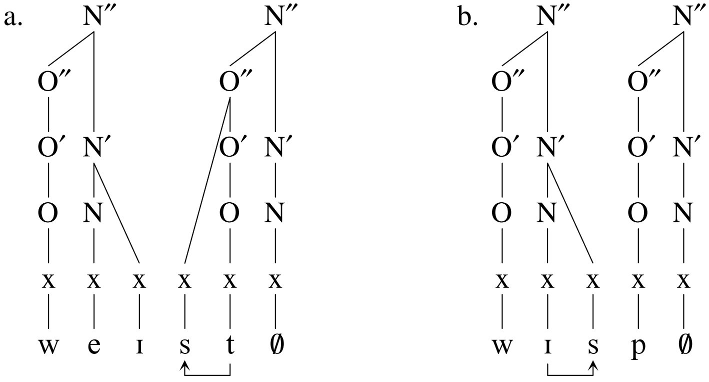
(33)

| | | | |
|---|---|---|---|
| lisp | /lɪsp/ | — | */liːsp/ |
| gospel | /gɒspəl/ | — | */aɪspəl/ |
| fist | /fɪst/ | yeast | /jiːst/ |
| pastel | /pæstəl/ | master | /mɑːstə/ |
| tusk | /tʌsk/ | — | */tuːsk/[11] |
| musket | /mʌskət/ | — | */mɛəskət/ |

As in the case of NC clusters, both word-final and intervocalic sC clusters can only be preceded by a long vowel or diphthong in English if the cluster is homorganic, i.e. if the head of the onset is /t/.

Given that the restrictions on the distribution of the various types of clusters is the same, one option would be to accord /s/ the same variability in syllabic affiliation as liquids and /n/. According to this approach, /s/ would occupy the Spec-Onset position after a long vowel or diphthong (where the onset head must be coronal), and the nuclear complement after a short vowel. These two possibilities are illustrated in (34).

(34)



This analysis successfully captures the distributional parallels between the various types of clusters. Notice too that the treatment of /s/ as an onset specifier in English allows us to add the examples in (35) to our survey of postvocalic sonorants in (22):

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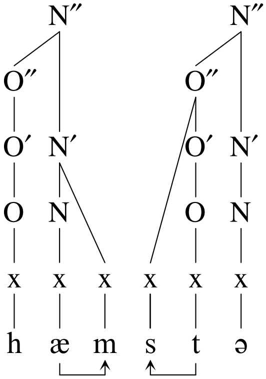
[11] Dialects with lengthened /ɑː/ (or /æː/), such as RP, permit branching rhymes preceding both /sp/ and /sk/, e.g. *clasp*, *flask, casket.*

| | | | | |
|---|---|---|---|---|
| (35) | hamster | /hæmstə/ | — | */haɪmstə/ |
| | monster | /mɒnstə/ | — | */meɪnstə/ |
| | tungsten | /tʌŋstən/ | — | */təʊŋstən/ |

These forms contain both a postvocalic nasal *and* an sC cluster. The nasal, then, must occupy the nuclear complement position, as in (36):

(36)



Notice that, as the representation in (36) predicts, we do not find oppositions between long and short vowels in this environment, even when the head of the onset is a coronal (cf. (35)). We should also notice that, as shown in (37), we do not find consonant clusters like those in (35) if the plosive is not coronal, even if the vowel is short:

| | | |
|---|---|---|
| (37) | */hɒmspə/ | */hɒmskə/ |
| | */mɒnspə/ | */mɒnskə/ |
| | */tʌŋspən/ | */tʌŋskən/ |

Related to this is the distribution of medial sCC clusters after long vowels and diphthongs, which again displays a place restriction: the head of the onset must again be coronal:[12]

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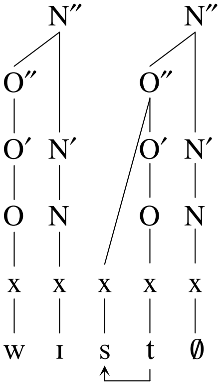
[12] We should add that such clusters with a non-coronal plosive are rare even after short vowels; *osprey* is one of the few examples. Furthermore, there are very few examples of words like *pastry* and *bistro*, with a long vowel preceding /str/.

(38) /peɪstrɪ/
*/peɪsprɪ/
*/peɪskrɪ/

The forms just considered are suggestive of an analysis of sC clusters in which the distinction in (34) is not between the syllabification of sC clusters after long vowels or diphthongs on the one hand and short vowels on the other, but between sC clusters containing a coronal plosive and those with a non-coronal. On this interpretation, /s/ preceding a coronal is always in Spec-Onset, even after a short vowel, while it is in the nuclear complement when the following plosive is non-coronal. Thus *whist* would have the representation in (39):

(39)



There are two areas of difficulty with our account of sC clusters. First, unlike liquids and nasals in clusters, the /s/ in an sC cluster apparently has no influence on the realisation of a preceding vowel, even when it is syllabified in the nucleus, as in (34b). The second problem is that, if we take the possibility of metathesis as an argument for constituency, the structure in (34b) does not lead us to expect that the members of the sC cluster are subject to potential metathesis, a phenomenon which is common in Germanic languages at least.

Syllabifying /s/ in the nucleus in (34b) leads to a slight refinement of our analysis of sC clusters in languages like Spanish, in which there is no apparent relationship between the two elements of the cluster.[13] Rather than

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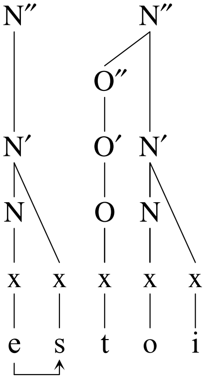
[13] One prediction that our account makes is that in languages like Spanish, where the elements of an sC cluster belong to different constituents, metathesis of /s/ and the following stop does not occur.

it being a rhymal adjunct, as for Harris (1994) (see (29) above), it too is a nuclear complement, as in (40), our representation of *estoy* 'I am':

(40)

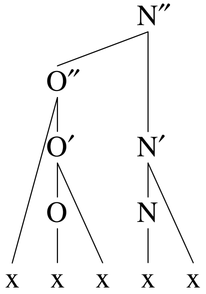


In a language like Spanish, then, the occurrence of an epenthetic vowel before an initial sC cluster is attributable to a parameter setting which prohibits an initial empty nucleus from licensing a complement.

## 5. Discussion and conclusion

In the preceding sections we have uncovered evidence for the syllabic affiliation of postvocalic liquids and nasals, as well as /s/ in sC clusters. In so doing, we have abandoned the rhymal adjunct node found in the versions of government phonology espoused by Kaye, Lowenstamm and Vergnaud (1985, 1990) and Harris (1994) in favour of an analysis whereby the segments in question are assigned to the nuclear complement position or the onset-specifier position, or indeed to the onset-head position. One question which arises from this treatment is whether the rhymal adjunct position can be dispensed with entirely, i.e. do we require a syllabic position corresponding to the traditional concept of 'coda'? Put differently, is a distinction required between 'rhymal adjunct' and 'nuclear complement', and hence between 'rhyme' and 'nucleus', or can we view the syllable as having maximally the structure in (41) (cf. *spray* in (32b))?

(41)

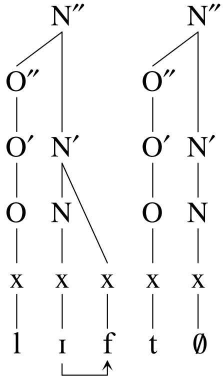


Given government phonology assumptions about syllable structure, together with the analysis adopted above, there are in fact very few remaining cases of English clusters where the first element might be assigned to a rhymal adjunct position (see Harris 1994: 66–83 for an overview). Unlike the cases for which we proposed a Spec-Onset analysis, clusters of two obstruents generally involve a non-coronal in first position (followed by a coronal), as in (42):

(42) a. strict, victim, factor, tact, chapter, apt
b. lift, after[14]

Like the cases discussed above, however, length distinctions do not seem to occur preceding such clusters. This suggests that the appropriate syllabification involves assigning the first obstruent to the nuclear complement position, as in (43):

(43)



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[14] The only other fricative other than /s/ that is possible in this context is /f/. The only long vowel that is found preceding /s f/ is /ɑː/ (or æː), in those dialects where this vowel has undergone lengthening.

Notice that the syllabic affiliation of cluster-initial /f/ is different from that of cluster-initial /s/, in that the latter, but not the former, occupies Spec-Onset.

We have proposed here a model of syllabic structure which, we claim, is more restrictive and more rigorous than that found in other models incorporating onset and rhyme/nucleus positions, both in government phonology and elsewhere. In particular, the model successfully characterises the relationship between the syllabic position of certain segment types and their phonetic realisation, and demonstrates that restrictions on rhyme structure are often a function of the syllabic affiliation of postvocalic consonants.

## Acknowledgements

This paper originated as a presentation at the workshop on *Strength Relations in Phonology*, held at Tohoku Gakuin University in Sendai in September 2006. We are grateful to members of the audience for their comments, to Ben Hermans for discussion of the ideas put forward in this paper, to an anonymous reviewer and in particular to the organisers of the workshop, Phillip Backley and Kuniya Nasukawa.

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# Defining initial strength in clusterless languages in Strict CV

*Nancy C. Kula and Lutz Marten*

## 1. Introduction

Strength is defined by position in Strict CV so that the strength associated to the initial position and the weakness associated to 'codas' is a result of their position with respect to empty positions in a configuration of strictly alternating C and V positions.[1] Within this configuration, government and licensing relations determine which positions are regarded as strong or weak. With respect to strength in initial position this must interact with a postulated initial (melodically empty) CV unit (Lowenstamm 1999) that marks the beginning of a word and that facilitates the categorisation of languages into those with only sonority-increasing clusters and those with either sonority-increasing or decreasing clusters in initial position.[2] While these findings provide profound insight into how grammar characterises languages into two types with respect to the initial cluster type attested and makes predictions on the expected strength in initial position in these languages, it remains to be seen whether languages without clusters can draw on the mechanisms developed to define strength in initial position. This paper investigates whether this expanded theory sheds light on strength in initial position in languages without clusters, here dubbed clusterless languages. It will be shown that, contrary to what is seen in languages with clusters where the absence of the initial CV unit implies a weak initial position, clusterless languages provide evidence that although the initial CV unit is absent, the initial position still exhibits properties of strength. This lack of predicted weakness will be accounted for by parameterising proper government and suggesting that this governing relation has no role to play in clusterless languages. In the absence of proper government, an alterna-

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[1] Strict CV is an emerging version of Government Phonology (Kaye, Lowenstamm and Vergnaud 1985, 1990) and is not to be confused with CV Phonology (Clements and Keyser 1983) or Radical CV Phonology (van der Hulst 1995).

[2] For ease of reference we will use simply 'initial CV unit' to refer to the 'melodically empty initial CV unit' for the remainder of this paper.

tive account of intervocalic weakening will also emerge from the discussion, in this way differentiating intervocalic from coda weakening. The paper develops as follows; §2 discusses how positional strength is defined in Strict CV; §3 discusses the distribution of the initial CV unit according to initial cluster type and the predictions that follow from this; §4 and §5 aim to characterise strength in initial position in clusterless languages in two ways – firstly by investigating whether the initial CV unit has a role to play in these languages (§4) and secondly by looking at empirical evidence of weakening and strengthening processes in clusterless languages of the Niger-Congo phylum (§5); §6 maps out an enhanced picture of positional strength in Strict CV and §7 offers some concluding remarks.

## 2. Positional strength in Strict CV

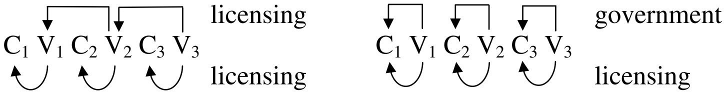
Strict CV, owing to Lowenstamm (1996), is an offshoot of Government Phonology (Kaye, Lowenstamm and Vergnaud 1985, 1990), also referred to simply as CVCV theory, which argues that phonological representations at the skeletal level consist of strictly alternating C and V positions. This implies that representationally there are no branching onsets or nuclei. The effect of surface consonant clusters is thus achieved by differing government and licensing configurations. In this sense languages differ not with respect to whether they allow branching structure or not but according to the government and licensing relations that they are able to sanction. Government and licensing, apart from sanctioning different syllable structure types, are the two main forces driving strength relations, defined specifically as in (1) based on formulations in Szigetvári (1999) and Scheer (2004).

(1) Government: inhibits the segmental expression of its target
Licensing: enhances the segmental expression of its target

In this sense then government is seen as a detrimental force to the expression of a segment, or more neutrally, to melody (i.e. the elements of which segments are composed). A position that is governed is less able to sanction the expression of material. Thus a C or V position that is governed diminishes its potential to license melodic material. Licensing on the other hand has a positive effect of sanctioning the expression of melody in the licensed position. An interesting and important change that has taken place in the transition from standard Government Phonology to Strict CV is that all (realised) nuclei in a domain or phonological word *must* license and govern. In contrast, in standard Government Phonology (SGP henceforth) all contentful nuclei license a preceding onset and also a preceding nucleus in order to propagate licensing potential through a phonological domain. The one outstanding unlicensed nucleus is deemed the head of the domain. Government on the other hand is a special type of licensing that is reserved for relations defining branching constituents (constituent government) or non-branching ones (inter-constituent government) or that holds between nuclei (proper government) used to define the occurrence of empty nuclei within a configuration. With the goal of simplifying the theory and placing no restrictions on nuclei, which even in SGP are able to both govern and license, nuclei in Strict CV are treated as being endowed with licensing and governing potential which they always aim to dispense. Thus a realised V position will always license and govern preceding material defining a phonological domain by a series of lateral relations (see Scheer 2004). Consider the illustration in (2) that compares a phonological domain in SGP and in Strict CV.

(2) Government and licensing relations in phonological domains[3]

a. SGP b. Strict CV



In SGP $V_3$ is the head of the domain (a role which is decided on language specific grounds) and the main source of licensing potential for the whole domain. By this token, $V_3$ licenses $V_2$ which in turn licenses $V_1$ making these nuclei able to license the C position that precedes them. No government is involved. In Strict CV, on the other hand, each V position both licenses and governs the preceding C position. The idea that licensing potential is distributed from a head nucleus to the other nuclei in the domain, as seen in the SGP illustration in (2a), is lost. The main motivation for this is to keep licensing relations local and lateral. For SGP to retain licensing in (2a) it is generally assumed that the inter-nuclear relations involve hierarchical relations occurring at a higher nuclear level.

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[3] We use C and V for both SGP and Strict CV just for ease of comparison here. SGP notationally uses O and N for Onset and Nucleus, which dominate timing slots of a skeletal tier. In Strict CV the sequence of C's and V's defines both the constituents and the timing tier.

A positive effect of the Strict CV configuration in (2b) is that strength by position can be defined via the four logical interactions between government and licensing as illustrated in (3).[4]

(3) A position *x* may be:[5]

| | *governed* | | *licensed* | | *strength status* |
|---|---|---|---|---|---|
| a. | – | (good) | + | (good) | strong |
| b. | + | (bad) | + | (good) | weak |
| c. | – | (good) | – | (bad) | weak |
| d. | + | | – | | not an option |

We see in (3a) that if a position is not governed but is licensed it is strong because by being ungoverned its ability for segmental expression is not inhibited and in addition by being licensed its ability for segmental expression is enhanced. It will thus be a good position for segments to be expressed, reflected in no reduction in the amount of contrasts that can be expressed in such a position. If, as in (3b) on the other hand, a position is licensed, and therefore good for segmental expression, but is also governed, a consequence of which implies inhibition in the ability to sanction segmental expression, there will be a struggle between two opposing forces resulting in a reduction in the number of contrasts that may be expressed in such a position in comparison to one that is not governed but licensed. Unlicensed positions are in general bad for segmental expression because such positions are not sanctioned to enhance melodic expression. Unlicensed and ungoverned positions as in (3c) will retain some ability to ex-

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[4] While it follows that a 'coda' can be characterised as weak in SGP because it is unlicensed by virtue of being followed by an empty nucleus, no difference in licensing is expressed between an initial and an intervocalic position, which are equally licensed but only the latter is (more widely) subject to weakening effects. We return to this issue in §3.

[5] The tags *good* and *bad* here are to be understood in relation to the realisation of melody. A position that is not governed is *good* because it escapes an influence that inhibits the expression of melody. A position that is governed is *bad* because it is subjected to an influence that inhibits melodic expression. A position that is licensed is *good* because it is subject to an influence that enhances melodic expression. And a position that is not licensed is *bad* because it fails to be subjected to an influence that enhances melodic expression. A position that is not licensed but is governed cannot exist because the absence of licensing indicates that the licensor (the adjacent vowel) is empty, in which case it also cannot act as a governor. The configuration in (3) follows from the fact that licensing relations are always local while government relations (such as proper government) may be non-local.

press information because though they are not licensed they are also not governed and are therefore not inhibited in the expression of segmental material. This is another case of opposing forces resulting in a reduction of the expression of contrasts, but as the position is not licensed it lacks positive influence and will therefore be weak. Positions that are unlicensed but governed are not an option because they present a contradiction in terms; if a position is unlicensed it is because it lacks a licensor, meaning that it is followed by an empty position. Since only realised filled positions are licit licensors and governors, a position cannot be unlicensed but governed – if it lacks a licensor then it also lacks a governor.

The strength abilities of positions can therefore be seen as part of a continuum from the strongest position where the two forces of government and licensing reinforce each other with positive effect, through an intermediate position where they oppose each other, ending with the weakest position where the two forces reinforce each other with a negative effect. Between the latter two options (3b) and (3c), where government and licensing oppose each other, (3b) is considered stronger than (3c) by virtue of having a positive setting for licensing. Positionally (3a) characterises the initial or post-coda position, (3b) the intervocalic position and (3c) the coda.

Cross-linguistically it has been overwhelmingly observed that codas and intervocalic positions are usual targets of weakening processes. Ségéral and Scheer (2001: 24) give the following list of weakening processes and the positions they are most readily attested in.

(4)

| *Weakening process* | *in coda* | *in V_V* |
|---|---|---|
| devoicing | typical | improbable |
| deaspiration ($C^h$ → C) | typical | improbable |
| velarisation (l,n → ɫ,ŋ) | typical | improbable |
| s-debuccalisation (s → h) | typical | improbable |
| liquid gliding (r,l → j) | typical | improbable |
| depalatalisation (ɲ → n) | typical | improbable |
| l-vocalisation (ɫ → w/o) | typical | improbable |
| r-vocalisation/loss ([kaad] ‘card’) | typical | improbable |
| [NC]hom: nasal homorganicity | typical | improbable |
| spirantisation (b,d,g → β,ð,ɣ) | improbable | typical |
| voicing (t → d) | improbable | typical |

From this set we see the imbalance between the coda and the intervocalic position with the former attesting more weakening processes than the intervocalic position from this sample set, argued to follow from the lack of licensing in coda positions.

By making reference to governing and licensing relations as discussed above, Strict CV is able to capture these observations. Note that the use of 'coda' is only notational in Strict CV since only a sequence of strictly alternating C and V positions is allowed and no level of the syllable (as in SGP) is adhered to. A 'coda' is therefore strictly defined as a C position followed by an empty V position, as seen in the representation of English *cat* in (5).

(5) C V $C_2$ $V_2$
| | |
k æ t ∅

As already pointed out earlier in the discussion of the impossibility of having an unlicensed and ungoverned position, only realised vowels are licit governors and licensers. Thus in (5) $C_2$ hosting the word-final /t/ cannot be licensed (or governed) by the empty final position $V_2$ and is therefore subject to weakening effects as defined by the configuration in (3). Word-internal codas in words like English *contain* for example are subject to the same treatment as word final codas in Strict CV since they are similarly followed by an empty V position. Intervocalic weakening, as seen in spirantisation processes in Spanish, for example, is treated as following from the weakening expected of a position that is governed despite being licensed. Note that by this token the initial position should also be weak since it is licensed but governed. This will be the main concern of §3.

Let us complete the picture by considering cases involving consonant clusters which are all represented as separated by an intervening empty nucleus. Does this entail that the initial C in every cluster is predicted to be weak? Obviously this is not desired. To understand how this is avoided we must elaborate on the nature of consonant cluster relations. Under specific conditions, certain consonant clusters, particularly ones of increasing sonority, are able to have a relation that renders the intervening V position between them inert.[6] This follows from the more general distribution of cluster types across languages, an issue we will discuss for the initial position in §3. In SGP such structures are presented in a branching structure

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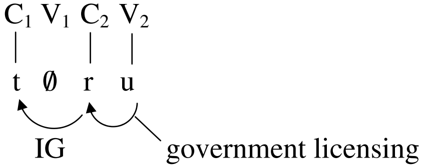
[6] Kula (2002) refers to this state as an inability to project, which entails the inability to participate in any relations in the representation.

and in addition have a governing relation that indicates the strict ordering of the members of the cluster. Scheer (2004 and elsewhere) argues at length that having both branching structure and governing relations is a duplication of tasks which have essentially the same goal – a restriction in the ordering relation of the cluster (see also Takahashi 2004). Strict CV therefore simplifies the representation by only having a governing relation holding between the members of the cluster termed infra-segmental government (Scheer 1996). Infra-segmental government (IG) is an asymmetric relation that holds between two positions where the governor is more complex than the governed position.[7] When this relationship holds between two C positions, the intervening V position is licensed to be empty. Essentially it is treated as not being part of the configuration by virtue of being sandwiched in a relation between the two flagging C positions, and as such, it is not regarded as a potential governor of the initial C in a CC cluster. Instead, the V position following the cluster indirectly acts as the licensor of both C positions in the cluster by licensing $C_2$ to govern $C_1$ by virtue of which $C_1$ is licensed. This is the manifestation of government licensing in Strict CV from SGP (see Charette 1991 for details). Consider the illustration of this in English *true* in (6), where IG stands for infra-segmental government.

(6)



Thus as shown in the governing and licensing relations in (6), $C_1$ and $C_2$ contract a relation that renders $V_1$ inactive thereby allowing $V_2$ to license $C_2$ for its own expression and also to allow it to govern $C_2$, in this way also indirectly licensing $C_1$. By this token the initial position is not weak be-

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[7] Scheer (2004: 64) defines infra-segmental government specifically as involving government of an empty position within the melodic make up of a segment:

a. A consonant A may contract a governing relation with its neighbour B iff there is a place-defining autosegmental line where A possesses a prime, while the corresponding slot in the internal structure of B is empty. In this situation, the prime belonging to A governs the empty position of B.

b. The empty nucleus enclosed within such a domain of infra-segmental government is circumscribed. Its Empty Category Principle is satisfied.

Note that this presents a type of government that still retains the basic idea of government, namely, the inhibition of segmental/melodic expression.

cause it is licensed. However, if we allow for the fact that all nuclei play the dual role of governing and licensing in Strict CV then $V_2$ still has governing potential that it needs to expend. If $C_1$ or $C_2$ are governed by $V_2$ then we predict that whichever is governed will be weak with a reduction in the contrasts that can be expressed. This is untrue for $C_1$ based on cross-linguistic observation that the initial position is strong, so having $C_1$ governed is an undesirable outcome. $C_2$ on the other hand does display restrictions on the number of contrasts expressed in it but we know already that this is due to the infra-segmental governing relation that holds between $C_1$ and $C_2$, particularly in sonority-increasing clusters. The reduction in contrast expressed in $C_2$ can therefore not be due to it being governed by $V_2$. In §3 we discuss where the governing potential of $V_2$ goes to.

With regard to positional strength in Strict CV we have seen that by reference to government and licensing and how these two relations interact within a domain we can characterise the fact that codas, both final and internal, are weak because they always consist of a C position followed by an empty V position that is unable to license them. Intervocalic positions are weak or can show a tendency to be weak because they are both governed and licensed. So far, we have not seen how the word-initial position is differentiated from an intervocalic C position which is also followed by a realised vowel that can act as its licensor and governor and therefore make it also subject to some weakening effects. We turn to the resolution of this issue presently, after a word on how empty positions are regulated in Strict CV.

As we have seen from the representation of codas and clusters in Strict CV, a plethora of empty positions is postulated by the theory and it would be good to lay out how these are regulated, when they are permissible, and what characteristics they have. Every empty position in a representation must be licensed via the Empty Category Principle in (7), which differs only minimally from that proposed in SGP (Kaye 1990).

(7) Empty Category Principle (ECP)
A nucleus may remain phonetically unexpressed iff it is;
- a. properly governed
- b. enclosed within a domain of infra-segmental government or
- c. domain-final

(7b) is the case we have just seen with the cluster in (6), while (7c) is a parametric option that some languages employ. Those languages that allow words to end in a consonant have the setting for this parameter *on* and those that have the parameter *off* always require words to end in a realised vowel. Proper government in (7a) is a way of sanctioning empty positions by ensuring that they are licensed via government by a following realised vowel. This implies that every empty position sanctioned by proper government must be followed by a vowel that acts as its licensor. A realised vowel may only properly govern one vocalic position and so cannot sanction a sequence of empty positions. Thus all empty positions must be licensed in one of the three ways above to ensure that they are structurally licit. However, their potential for licensing and government is entirely lost – they can neither license nor govern.

Let us now consider how the strength associated with initial position is accounted for in Strict CV.

## 3. The initial CV unit and its predictions

Lowenstamm (1999), in accounting for the distribution of word-initial clitics in Tiberian Hebrew, among other Semitic languages, proposes the idea that the beginning of a word is marked by an initial CV unit, qualifying this as applying only to words of major lexical categories. This, for example, explains why lexical words are able to act as hosts to clitics which themselves lack structure. The main motivation for the initial CV unit is that it allows reference to the left edge of the word, which, as Ségéral and Scheer point out, has been the basis of many disjunctive rules in phonology since SPE. The environments {#__, C__} have been used to define phonological rules contrasted from the final position or the coda {__#, __C}. The use of the initial CV unit turns what is otherwise a phonological diacritic into a phonological object that not only uniquely identifies the initial position but may also help explain some distributional patterns. Like all other empty structure in Strict CV, the initial CV unit must be licensed by proper government as defined in the ECP in (7). Under this understanding, the initial CV unit can only be present in cases where a licensor is available – in particular, a following realised vowel acting as licensor via proper government. Once the initial CV unit is licit in a representation we expect that it plays a role in various phonological alternations. Let us review three arguments that support the existence of an initial CV unit.

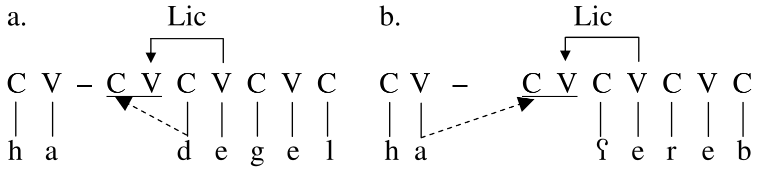
Lowenstamm (1996) analyses alternations between long vowels and gemination in the prefixation of the singular definite article *ha-* in Tiberian Hebrew with recourse to the initial CV unit. As the data in (8a–c) show, the prefix *ha-* causes the initial consonant of a noun to geminate, unless that consonant is a guttural. In the case of gutturals, there is no gemination but instead a lengthening of the prefix vowel, as seen in (8d).

(8) Tiberian Hebrew singular definite article alternations

| | | | | | |
|---|---|---|---|---|---|
| a. | √dgl | degel | ‘flag’ | ha-ddegel | ‘the flag’ |
| b. | √klb | keleb | ‘dog’ | ha-kkeleb | ‘the dog’ |
| c. | √nʕr | naʕar | ‘young man’ | ha-nnaʕar | ‘the young man’ |
| d. | √ʕrb | ʕereb | ‘evening’ | ha:-ʕereb | ‘the evening’ |
| | | | | (*ha-ʕʕereb) | |

The distribution in (8) follows neatly under an analysis that assumes the initial CV unit, which can be licensed in this case by the initial vowel of the noun. Being licensed in the structure, it can be the target of gemination in (9a) or of vowel lengthening in (9b), just in case the initial consonant of the noun is unable to geminate.[8]

(9)



Under the initial CV unit the two attested effects of prefixation in Tiberian Hebrew can rightly be treated as the only two logical outcomes. Such alternations therefore provide independent support for assuming an initial CV unit.

A second important issue that Lowenstamm argues the initial CV unit accounts for is the distribution of initial clusters. So far we have argued that clusters of increasing sonority are represented via an infra-segmental gov-

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[8] Notice that by assuming an initial CV unit in Tiberian Hebrew it must be categorised contrary to surface facts as a language with only sonority-increasing clusters in initial position. However, Tobias Scheer and Delphine Seigneur point out to us that there is compelling evidence that nouns treated as having clusters of the sonority-decreasing type initially actually betray remnants of an intervening schwa-like melody manifested in the spirantisation of following stops. This ongoing debate is beyond the scope of this paper.

erning relation that renders the intervening vowel inert. What we have said nothing about is how clusters of decreasing sonority are handled. Word-internally the brief discussion of word-internal codas revealed that such clusters are separated by an empty nucleus, as in the English example *contain*. If we take into account that infra-segmental government is regulated by strict directionality (i.e. head-final), then word-initial clusters of the sonority-decreasing type cannot be licensed via infra-segmental government. In this case, as in the case of the internal /nt/ cluster, we assume that the cluster is derived via proper government, which has the effect of totally inhibiting the segmental expression of its target. Thus in English *contain* the idea is that the V position containing /a/ properly governs the preceding empty position to allow it to remain empty. Sonority-decreasing initial clusters will therefore be treated as involving proper government. The question that arises then is that if languages like English are able to license word-internal clusters of decreasing sonority (henceforth referred to as RT clusters) via proper government, why can they not do the same in initial position?

Lowenstamm (1999) and later Scheer (2004) argue that the initial CV unit can be used to explain a cross-linguistically observed implicational relation in the distribution of clusters in initial position – namely, if a language has word-initial RT clusters then it also has initial TR clusters (where the latter refers to sonority-increasing clusters). The reverse, on the other hand, does not hold. So a language may have only TR initial clusters, like English, but not initial RT clusters. The claim is that this follows from the presence versus absence of the initial CV unit in the two language types; the initial CV unit is present in TR-only languages but absent in languages with no restrictions on the initial cluster type.[9] Consider how this follows from the illustrations in (10) and (11), where IG stands for infra-segmental government, PG stands for proper government, and the initial CV unit is underlined.

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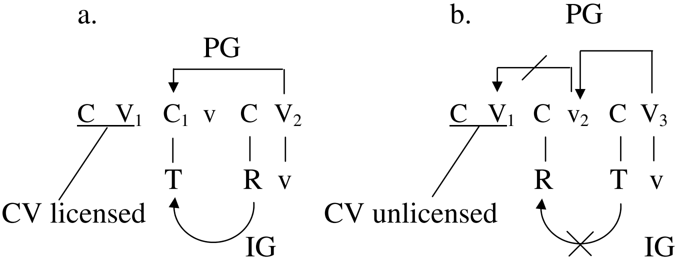
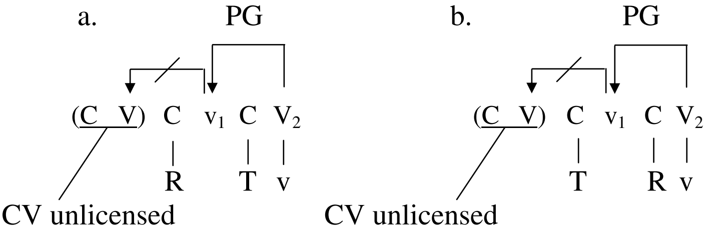
[9] There is some debate surrounding the alternating nature of the initial CV unit. Regarded simply as a boundary marker, we would expect it to be present in all languages. Yet going a step further and suggesting that its presence accounts for differences in syllable structure types implies that it must be parametric. Scheer (2005, 2007) argues that it is part of the morpho-syntactic information sent down to the phonology to facilitate the interface between syntax and phonology. Simplifying somewhat, we will assume for the present discussion that it is parametric, available in some languages but not in others.

(10) TR-only languages (French, English)



In (10a) we see the initial TR cluster licensed by infra-segmental government that goes from right to left. As we have already discussed, assuming the presence of the initial CV unit implies that it must be licensed in order to be licit in the structure. This licensing comes via proper government of $V_1$ by $V_2$. Now if (10a) represents a language with TR clusters then (10b) cannot hold in that same language because the initial CV unit would fail to be licensed in this instance. Given the directionality of infra-segmental government the RT cluster in (10b) cannot be licensed by it and must be licensed by proper government where $V_3$ properly governs $V_2$. $V_2$ being unrealised is unable to properly govern $V_1$ thereby rendering the initial CV unit unlicensed. $V_3$ cannot directly properly govern $V_1$ as this would entail a locality violation since $V_2$ though unrealised is an active member of the representation, unlike the inert cluster-sandwiched vowel of (10a). It is therefore not possible for an RT cluster to appear in a licit structure in a language that has the initial CV unit. The presence of an initial CV unit therefore characterises a language as having clusters of increasing sonority in initial position but not ones of decreasing sonority. Let us now consider the case of languages without the initial CV unit representing languages with no restriction on initial cluster type.

(11) Both RT and TR cluster languages (Czech, Moroccan Arabic, Polish)



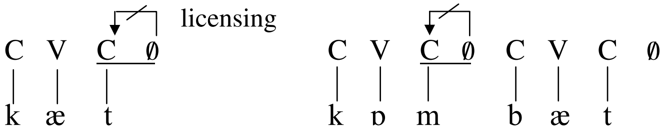
The initial RT cluster in (11a) is licensed via proper government by $V_2$ properly governing $V_1$. In this case, if an initial CV unit were available it would fail to be licensed. The TR cluster in this language type must also be licensed via proper government because as a language without an initial CV unit the government potential of $V_2$ would land on both C positions of the cluster if infra-segmental government, under which $V_1$ would be inert, were assumed. Under this analysis a potentially available initial CV unit would fail to be licensed.

Thus the distributional facts of word-initial clusters follow from the fact that TR-only languages fail to license the initial CV unit whenever they are faced with an RT cluster, while languages entertaining both cluster types, which have no initial CV unit, face no such dilemma. The initial CV unit thus aids the characterisation of these two language types.

The final motivation for the initial CV unit comes from the characterisation of strong positions, as alluded to above and as discussed in detail in Ségéral and Scheer (2001). As noted in §2, strong positions can be regarded as positions which are licensed but not governed. We ended §2 with the challenge that it was not clear how the initial position could be differentiated from the intervocalic position since both are followed by a realised vowel that both licenses and governs the preceding C position, in this case making both positions weak. The attentive reader would have already worked out how this is resolved by the presence of the initial CV unit. In (10a), for example, the initial CV unit provides a landing site for the governing potential of $V_2$ which would otherwise have landed on $C_1$. Thus by virtue of having the initial CV unit in (10a), we are able to define languages with initial TR-clusters as having a strong initial position. By the same token we can also represent positions in the 'coda-mirror' in identical fashion. 'Coda-mirror' is a term coined by Ségéral and Scheer (2001) to refer to positions that are a mirror image of the coda position. Ségéral and Scheer argue that these positions are always strong, in contrast to the weak coda. In Strict CV terms the coda is any position that is followed by an empty position, the mirror image of which is any position that is preceded by an empty position. It is for this reason that Ségéral and Scheer argue that post-coda positions and initial positions must be represented in identical fashion, echoing the Coda Licensing Principle of Kaye (1990). The initial CV unit, as shown in (12), facilitates the formalisation of this observation.

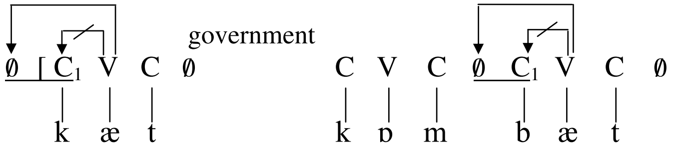
(12) a. Coda positions: *weak*

final coda internal coda



b. Coda-mirror positions: *strong*

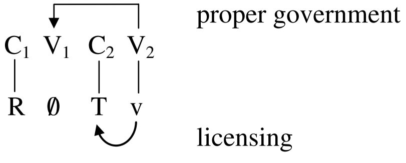
initial position post-coda position



(12a) shows that coda positions that are considered to be weak are represented in an identical fashion whether they are final or internal; the coda is weak in both cases because it lacks a licensor – the unrealised final vowel cannot act as a licensor. (12b) shows that by making reference to the initial CV unit (represented here as occurring before the square bracket) the initial position and the post-coda position can be represented identically matching their observed strong status. In both cases the strong position $C_1$ is preceded by an empty position that must be licensed via proper government by a following realised vowel which, as such, will not govern $C_1$; the latter then emerges as strong since it is licensed but escapes government.

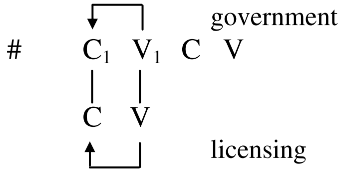
On the other hand, languages without an initial CV unit – i.e. languages allowing initial RT clusters – will have an initial position that has tendencies for weakness because in this case the initial vowel of the word is empty and cannot act as a licensor of the initial C position. Consider the case of an initial RT cluster in (13).

(13)



In this case the initial position is weak because it is unlicensed; $V_1$ being empty by virtue of being properly governed by $V_2$ cannot act as a licensor of $C_1$. In this same language type the initial position still remains weak even in words where $V_1$ is realised because, in the absence of an initial CV unit, $V_1$ will both govern and license $C_1$, the opposing forces resulting in at least some weakening effects as discussed in §2 and exemplified here in (14).

(14)



There is empirical evidence supporting weakness in initial position in some North-Eastern Polish dialects discussed in Kijak (2005), where a process of yod strengthening fails to hold in initial position as well as all weak positions in contrast to the post-coda position. Consider the following examples from the Kurp and Mazovian dialects, taken from Kijak (2005).

(15) Generalisation: j → ʑ / C __

| | *Polish* | *Kurp* | *Mazovian* | |
|---|---|---|---|---|
| a. | b**j**awɨ | b**ʑ**awɨ | b**ʝ**awɨ | 'white' |
| b. | kɔb**j**ɛta | kɔb**ʑ**ɛta | kɔb**ʝ**ɛta | 'woman' |

but j → j /

| | *# __* | *V__V* | *__ C* | *__ #* |
|---|---|---|---|---|
| c. | jɑbłko 'apple' | jɑjeczko 'egg' | bajka 'fairytale' | bój 'battle' |
| d. | jagoda 'berry' | zɑjɑc 'rabbit' | czajnik 'kettle' | kraj 'country' |

The two dialects of Polish in (15) pattern as expected if they have no initial CV unit; the initial position is weak, showing no yod strengthening just like in other weak positions in (15cd). In contrast to this, the post-coda position in these dialects is strong because it is a position that occurs after an empty V position but is followed by a filled V position. In each case in the Polish dialects in (15ab) the post-coda consonant shown in bold escapes the governing power of the following V position because it must properly govern the V position between the clusters; the post-coda position is therefore licensed but ungoverned and therefore a strong position. This contrast in the representation of the post-coda position and the initial position is achieved in this case precisely because an initial CV unit is absent.

From the foregoing we have seen at least three compelling arguments in favour of an initial CV unit as a part of phonological representation determined on parametric grounds on a language-by-language basis. Firstly, we are able to account for otherwise puzzling clitic alternations as attested in Tiberian Hebrew. Secondly, we can account for the patterning of languages with regard to the distribution of initial clusters where languages of Indo-European origin only allow TR clusters while those that are not of Indo-European origin allow both TR and RT clusters in initial position. Thirdly, we are able to characterise the initial position as strong in a similar manner to the post-coda position by maintaining that just like the latter position, the initial position is strong because it is not governed.

Kristo and Scheer (2005) summarise these findings under the claim that the presence or absence of the initial CV unit is concurrent with the following three otherwise seemingly unrelated typological features:

(16) Properties that differentiate the two language types

| a. without initial CV | b. with initial CV |
|---|---|
| i. initial clusters that violate sonority sequencing | i. initial clusters do not violate sonority sequencing |
| ii. possibility of first vowel of word to alternate with zero | ii. impossibility of first vowel to alternate with zero |
| iii. initial C is weak | iii. initial C is strong |

The initial CV unit therefore aids the characterisation of languages according to the types of clusters that they have in initial position, and further, makes predictions on whether the initial position is strong or weak.

With this ample discussion on the characterisation of initial strength in Strict CV we can move on to tackle languages without clusters. How do they fit into the picture and what predictions does the foregoing discussion make with regard to them? The three properties discussed in (16) are only dimly helpful as they are after all aimed at languages without clusters. Property (i) is irrelevant since there are no clusters. Property (ii) would favour (16b) since languages without clusters exhibit no vowel-zero alternations and therefore point to an initial CV unit. Property (iii) can be decided based on empirical evidence. As it stands we are unable to decide (based on these properties) whether the initial position in clusterless languages tolerates an initial CV unit which may further help us decide whether the initial position is strong or weak.

## 4. Casting doubt on the initial CV unit in clusterless languages

We have argued in the previous section that a language like English possesses an initial CV unit that explains why clusters of decreasing sonority are not possible in this language. We also know, as shown by example (9b), that English allows a C position in initial position to be followed by a realised V position. In this case as well we want to claim that the initial position is strong and therefore an initial CV unit must precede it. We can easily extend this argument to languages without clusters and make the prediction that if a language lacks clusters and shows strength in initial position then an initial CV unit must be present. If, on the other hand, the initial position has weakening tendencies, then we could claim that the initial CV unit is absent, hence the weakness. This is a position we must entertain for those words in languages with both TR and RT clusters that allow no initial clusters. For the languages with initial clusters, we are able to make a decision as to whether they possess the initial CV unit based on their cluster patterning. In languages without clusters this is obviously not a possibility and it is necessary to find independent grounds on which we can ascertain this. On the face of it, it is quite easy to argue that an initial CV unit can easily be licensed in a clusterless language that does not allow the initial vowel in a word to alternate with zero because this vowel can always act as a proper governor of the initial CV unit and thereby license it. With the initial CV unit present we can then make the prediction on theoretical grounds that the initial position must be strong because the initial C position escapes government which targets the vowel of the initial CV unit. Our theory therefore points us in the direction of an initial CV unit, but can we find other evidence to support this in the absence of initial cluster patterning?

One way would be to determine whether prefixation processes, as seen in Tiberian Hebrew, for example, take recourse to an initial CV unit in clusterless languages. Bantu languages, which are rich in affixation and attest an abundance of morphology-phonology interactions, seem a good basis for this investigation. Note though that in treating Bantu languages as clusterless we refer particularly to the fact that they do not have TR or RT clusters (what we may term *true* clusters) at the beginning of the word or indeed anywhere else in the word apart from NC clusters. In the same vein languages with only geminate clusters will be treated as clusterless. We return to this issue at the end of §4.5.

Let us consider a few examples that shed light on the status of the initial CV unit in Bantu. We focus in particular on processes that are not only commonplace in Bantu but also fairly widespread; gliding accompanied by compensatory lengthening, vowel and consonant elision and the effects of prefix deletion.[10] In each of these cases, following fairly basic analyses, we will access whether the presence of an initial CV unit is compatible with the attested outputs.

### 4.1. Gliding and compensatory lengthening

Lumasaaba, a Bantu language of Eastern Uganda (Brown 1972), exhibits compensatory lengthening when gliding results from two vowels coming into contact just in case the initial vowel is high. Gliding and the resultant compensatory lengthening can be seen between a prefix and a stem. In (17) we see this for nominal prefixation where *mu*- and *mi*- (here underlined) are prefixed to a vowel-initial stem. The examples here involve two prefixes and a stem, the second prefix providing the relevant environment.

(17) a. u-mu-ana → umwaːna ‘child’
b. gi-mi-eŋia → gimyeːɲa ‘song’

Vowel hiatus is not allowed in Lumasaaba; when two vowels come in contact they either fuse to create a long vowel or if the first vowel is high as in (17ab) it becomes a glide while the adjacent vowel lengthens. The standard analysis assumes that the high vowel loses its association to a vocalic position and becomes a secondary articulation on the preceding consonant. The position that the high vowel vacates is then filled by the initial vowel of the stem which lengthens as a result. In (18) we give a representation of this analysis in Strict CV showing both the case when an initial CV unit is absent (18a) and when it is present (18b). Recall that the initial CV unit is postulated as occurring before words of major categories and therefore not before prefixes. The initial CV unit is underlined in (18b).[11]

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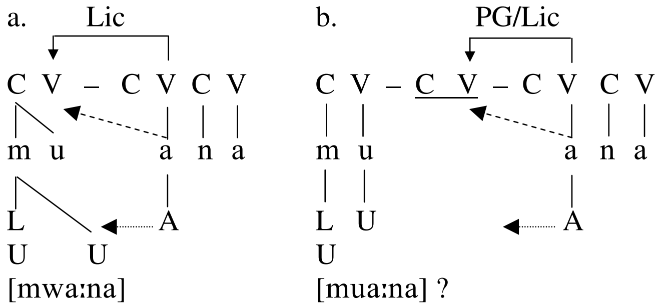
[10] Arguments presented here are drawn from Kula (2006b).

[11] Strict CV assumes as in SGP that segments are composed of elements which are the objects that are manipulated in featural changes. See Harris and Lindsey (1995) on elements. Here we use the elements |A I U L|, which are most closely related to coronality, palatality, labiality and nasality, respectively.

(18)



We treat gliding as resulting from restrictions on the combinations of elements that vowels are composed of, particularly, restrictions on spreading.[12] In (18a) an |A|-element must spread when two vowels are juxtaposed but cannot spread into an expression that contains |U| or |I|. The mandatory spreading need of the |A|-element forces the |U|-element to shift to the preceding C position becoming part of the representation of /m/ where it assumes a dependent position in the elemental representation that can be loosely interpreted as resulting in secondary articulation on the labial nasal, more precisely resulting in a labialised labial nasal. The |A|-element now occupying two V positions is realised as long, resulting in the output [mwaːna] 'child'. Recall that (18a) does not assume an initial CV unit before the stem *-ana* whereas (18b) does. In this case the |A|-element spreads into the empty position in the initial CV unit, which is licensed in the representation by proper government. In this case, there is no pressure on the |U|-element of the prefix vowel to shift to the representation of /m/ in the prefix, meaning that we end up with a hiatus situation, the avoidance of which was the initial motivation for the attested phonological processes. Perhaps this representation could be resolved at the phonology-phonetics interface, where the hiatus between a short and long vowel could be phonetically interpreted as a glide followed by a long vowel; but this would fail to relate compensatory lengthening only to those environments where gliding takes place. In fact, under the assumption of an initial CV unit, we

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[12] We assume that the elements |A I U L| can get different interpretations depending on whether they appear in a C or V position. We also assume complex structures within the elemental representation so that the same element can appear in the same representation if it assumes different positions of either head or dependent as seen with |U| in the representation for what we can consider a labialised labial nasal /$m^w$/ in (18a). See Kula (2008) on complex elemental representations but also Botma (2004) on a similar approach.

would expect all vowel-initial stems to have a long vowel regardless of what the preceding prefix is – a fact that cannot be substantiated.

Thus though it seems that the representation in (18b) which assumes the initial CV unit could be salvaged by phonetics, the representation in (18a) more straightforwardly accounts for the cause and effect relation seen between gliding and compensatory lengthening.

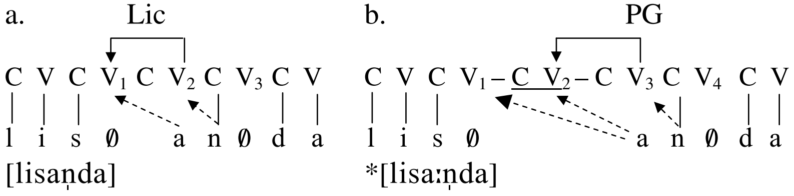
## 4.2. Vowel elision

A process of vowel elision occurs in a prefix in Lumasaaba whenever the prefix (of CV shape) is followed by a stem that contains a nasal-consonant sequence. As shown in (19), the vowel of the prefix is deleted with the effect of causing the nasal of the NC sequence to become a syllabic nasal. The prefix whose vowel deletes is underlined in (19).

| | | | | | |
|---|---|---|---|---|---|
| (19) | a. | li-si-anda | → | lisan̩da | 'piece of charcoal' |
| | b. | ga-ma-anda | → | gaman̩da | 'charcoal' |

We will standardly assume that a syllabic nasal is represented as a nasal that is simultaneously in a C and a V position. Looking at the representation in (20a), vowel deletion resulting in syllabic nasal formation follows directly from the representation in the absence of the initial CV unit. In this case, the position left vacant by the elided vowel ($V_1$) is assumed by the vowel of $V_2$, thereby leaving $V_2$ vacant. $V_2$ cannot remain empty since it is not licensed to remain so – its potential proper governor $V_3$ is empty. $V_2$ is therefore rescued by the nasal spreading into it, resulting in its syllabic status. If, on the other hand, we assumed an initial CV unit as in (20b), we predict an output where the syllabic nasal is preceded by a long vowel. In this case we must claim that the presence of the initial CV unit causes the initial vowel of the stem in $V_3$ to spread into $V_2$ and then the newly formed long vowel shifts one place leftwards to fill the gap left by the prefix vowel elision in $V_1$. Empty $V_3$ then results in the creation of a syllabic nasal. These processes are in themselves not improbable but must be dispelled as they lead us to an incorrect output. The representation in (20a) without the initial CV unit again provides a simpler picture; the loss of one segment is compensated for by another in order to retain the structure of the word.

(20)



Thus, the absence of an initial CV unit is more strongly supported by the vowel elision facts.

## 4.3. Consonant elision

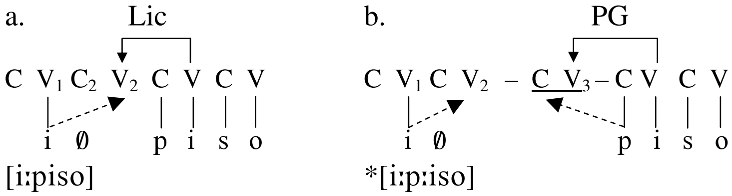
Alongside vowel elision in prefixes in Lumasaaba is a parallel process of consonant elision in some -VC- shaped prefixes; this results in either vowel lengthening of the prefix vowel (21ab) or, if the stem contains a nasal-consonant sequence, the nasal (like in vowel elision) becoming syllabic, in which case the prefix vowel does not lengthen (21cd).

(21) Lumasaaba

| | | | | |
|---|---|---|---|---|
| a. | in-piso | → | iːpisa | 'needle' |
| b. | in-fula | → | iːfula | 'rain' |
| c. | in-nepoŋgu | → | in̩ewoŋgu | 'bag' |
| d. | in-beba | → | im̩beba | 'rat' |

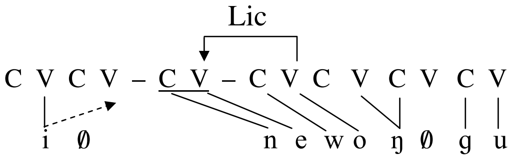
As in the vowel elision case, the facts follow directly from the absence of an initial CV unit; the deleted segment of $C_2$ results in vowel lengthening of $V_1$ into $V_2$ as illustrated in (22a). Contrary to this an initial CV unit would predict gemination of the stem-initial C in addition to vowel lengthening since, as shown in (22b), the initial CV unit would be licensed in the structure and able to attract adjacent segments to fill it, just like in the Tiberian Hebrew case.

(22)



Similarly, having an initial CV unit for data such as (21cd) where syllabic nasal formation rather than vowel lengthening takes place, wrongly predicts that under consonant elision both vowel lengthening and syllabic nasal formation will occur since inclusion of an initial CV unit facilitates this in the leftward reshuffling of structure.

(23)



*[iː-newoŋgu]

What the facts of Lumasaaba in (21) show is that when a segment is deleted in the prefix, either vowel lengthening or syllabic nasal formation occurs, never both, pointing to fact that there is only one empty position created by consonant deletion and not two as would be the case if an initial CV unit were assumed.

## 4.4. Prefix deletion

We finally look at a prefix deletion process of Luganda, another Bantu language of Uganda (see Ashton *et al.* 1954 for details). The process deletes the nominal class 5 prefix *-ri-* resulting in gemination of the stem-initial consonant, as shown in (24a–c). This gemination can be seen as another case of compensatory lengthening allowable in Luganda where geminates are acceptable. If the stem already begins with a geminate as in (24d) then the prefix is not deleted. The plural forms in the rightmost column show that no gemination occurs with non-alternating prefixes such as the plural prefix *ama-*.[13]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (24) | a. | e-ri-lagala | → | eddagala | 'medicine' | ama-lagala | (PL.) |
| | b. | e-ri-kubo | → | ekkubo | 'road/path' | ama-kubo | (PL.) |
| | c. | e-ri-yiinja | → | ejjinja | 'stone' | ama-yinja | (PL.) |
| | d. | e-ri-ggwa | → | eriggwa | 'thorn' | ama-ggwa | (PL.) |

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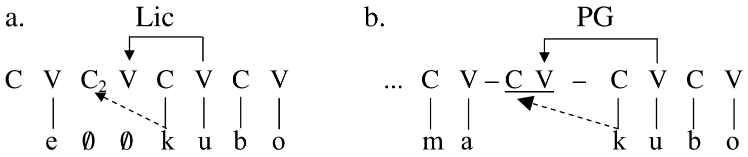
[13] /l/ becomes /d/ and /y/ becomes [dʒ] under a standard hardening process in (24a) and (24c), respectively. We briefly discuss these fortition processes in §5.1.

The stem-initial C gemination is straightforwardly accounted for in (25a) by the spreading of the stem-initial /k/ into $C_2$ which is left vacant by the deleted prefix. Assuming an initial CV unit on the other hand would fail to capture the connection between the gemination process and prefix deletion and further predict gemination even when the prefix is not deleted, as with the plural forms illustrated here in (25b).

(25)



[ekkubo] 'path' *[amakkubo]

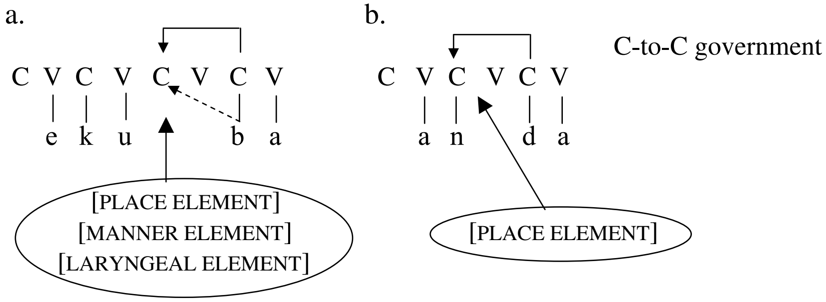
Based on the empirical evidence discussed in the preceding four examples, there seems little motivation for considering the initial CV unit as a part of the representation in Bantu. The question is why should this be and does this extend to all clusterless languages? We will claim yes.

## 4.5. Parametric proper government

As has already been pointed out, the initial V position of any word in clusterless languages is filled and therefore always available as a potential proper governor and licensor for the initial CV unit. Why does it fail to perform this task? The logical conclusion we must reach is that proper government is simply not active in these languages. This follows from the fact that every vowel must always be realised and processes like vowel-zero alternations as attested in languages like Polish and French, for example, do not occur in these languages. Our proposal is thus that proper government is a parametric option that languages may or may not have, and clusterless languages always opt to set this parameter *off*. In fact, we further postulate that this is the default setting of the parameter and only when it is necessary in a language to define cluster types is the setting changed.

Under this assumption then NC clusters (pseudo-geminates) and geminates are not accounted for by proper government (as also argued in Kula 1999). A crucial difference between these clusters and what we have earlier referred to as *true* clusters is that they have the requirement to share certain features or elements. This implies that true clusters, where there is no such feature sharing (but feature mismatch as seen in infra-segmental government) are not licensed in these languages. We will claim that the V position sandwiched in geminate and pseudo-geminate clusters is licensed by a C-to-C government relation which requires at least some features to be shared by the two C positions. Apart from this requirement C-to-C government is essentially the same as infra-segmental government in terms of how the intervening V is licensed and made inert, but differs from it in having no complexity requirement. Consider the representation of this in (26), where C-to-C government defines configurations where all the elements of one C position are shared with another; the geminate case in (26a), and one where only the place element is shared – the pseudo-geminate cluster in (26b).

(26)



[ekubbo] 'path' (Luganda)

[-anda] 'charcoal' (Lumasaaba)

Let us consider in (27) the four logical combinations between proper government and the occurrence of the initial CV unit and what language type they entail.

(27) Proper government and the initial CV unit

| *proper gvt.* | *initial CV unit* | *language type; examples* |
|---|---|---|
| ✓ | ✓ | initial TR only; English, French |
| ✓ | ✗ | TR and RT initially; Czech, Polish |
| ✗ | ✗ | no true clusters; Bantu, Japanese |
| ✗ | ✓ | not an option[14] |

Thus while the presence of proper government in a language tells us nothing about whether an initial CV unit will be available or not, its absence tells us categorically that the initial CV unit is absent as it will

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[14] The presence of an initial CV unit without proper government is not an option because the initial CV unit requires proper government in order to be licensed.

never be able to be licensed. (27) may also provide an independent way of assessing the status of proper government in a language; if the presence of true clusters in a language is indicative of the presence of proper government then the absence of true clusters must imply the absence of proper government (see Nasukawa 2005 for a potential counter-example from Japanese).

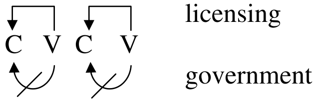
Having established now that clusterless languages lack an initial CV unit, does this entail that the initial position in these languages will be weak analogous to languages with both RT and TR clusters that lack the initial CV unit? No, because we have established the absence of the initial CV unit on the grounds of lack of proper government by which we essentially remove the requirement for vowels to govern the C position that precedes them. In this case we expect the initial position to be strong because it is only licensed but not governed.

In the next section we provide empirical support for considering the initial position as strong in clusterless languages by analysing the distribution of weakening and strengthening processes.

## 5. Strength in initial position without the initial CV unit

The configuration that emerges from the forgoing discussion is the one in (28) below, where each C position is licensed by the following V position but not governed since proper government is inactive. The initial position is strong because it is licensed but ungoverned.

(28)



We will consider two pieces of evidence for strength in initial position; a widespread hardening process that affects the initial and the post-coda position in a number of Bantu languages; and a number of weakening processes in Gújjolay Eegimaa (Atlantic) that occur to the exclusion of the initial position. The discussion of Gújjolay Eegimaa will also lead us to a novel proposal for intervocalic weakening.

## 5.1. Fricative and liquid hardening in Bantu

A number of Bantu languages have a hardening process that changes liquids and fricatives to stops when a nasal prefix precedes them, thereby creating nasal stop clusters.[15] Since these are the only cluster types attested in word-internal position we can suppose that the process also applies word-internally preferring a strong segment in post-coda position. Consider the data in (29) from Kula (2002: 68). The prefix *n-* marks the 1st person singular.

| (29) | | verb stem | N+verb stem | | |
|---|---|---|---|---|---|
| | a. | βila | mbila | 'I sew' | (Bemba) |
| | b. | leka | ndeka | 'I stop' | (Bemba) |
| | c. | londa | oːndodo | 'ascend' | (Kwanyama) |
| | d. | vevela | oːmbelela | 'dip into food' | (Kwanyama) |
| | e. | reheete | ndeheete | 'I have paid' | (Kikuyu) |
| | f. | ɣoreete | ŋgoreete | 'I have bought' | (Kikuyu) |
| | g. | βora | mboreete | 'lop off' | (Kikuyu) |

Strengthening and hardening, which are treated in the literature as fortition, are here suggestive of strength in initial position. There are also subtle indications that strength occurs towards the left edge of the word in Bantu as the initial position usually attests the greatest number of contrasts, which are considerably reduced in recessive positions.

## 5.2. Lenition processes in Gújjolay Eegimaa

Gújjolay Eegimaa (GE henceforth) is an Atlantic language of Senegal that exhibits a range of weakening processes that will aid our assessment of strength in initial position in this clusterless language. GE exhibits NC clusters and geminates in a consonant system that contrasts bilabial, alveolar, palatal and velar plosives and nasals, a small set of fricatives

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[15] Also relatively widespread and detrimental to the current analysis is post-nasal voicing which occurs in the same environment. Interestingly, it also occurs in Kikuyu which would seem to show conflicting evidence for the initial position. Needless to say, lumping together all Bantu languages under one rubric is probably not a wise thing. We leave a detailed analysis of individual Bantu languages to a future occasion.

consisting of /f/ and /s/, one lateral /l/ and the two glides /w/ and /y/. The vowel system is relatively more complex contrasting five ATR vowels with five non-ATR ones. All the data to be discussed here are drawn from Sagna (2008).

In the data in (30) we see that the fricative counterparts of /p c k/ only surface in intervocalic and final position, as summarised in (31).

| | | | | | | |
|---|---|---|---|---|---|---|
| (30) | a. | pɑn | future particle | b. | cʊkkʊlɩ | proper name |
| | | ɛɸɑɸ | ‘dust’ | | eʃɑn | ‘canteen’ |
| | | ɛtoɸ | ‘type of container’ | | ɛŋɔʃ | ‘hat’ |
| | c. | kɑkkɑn | ‘it is’ | | | |
| | | ɛxɔt̩ | ‘stick’ | | | |
| | | ɛxɔx | ‘tie’ | | | |

(31)
$$\{\text{p c k}\} \rightarrow \{\text{ɸ ʃ x}\} \text{ respectively} \Big/ \left\{ \begin{array}{c} V\_\_V \\ \_\_\# \\ *\#\_\_ \end{array} \right\}$$

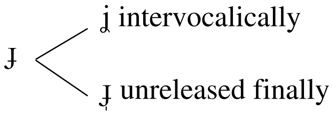
The voiced counterparts /b ɟ g/ also show weakening effects with only the plosives occurring in initial position while their fricative and unreleased counterparts occur in intervocalic and final position respectively, as shown in the data in (32) and summarised in (33).

| | | | | | | |
|---|---|---|---|---|---|---|
| (32) | a. | bɑy | ‘where’ | b. | gɑrɑfɑ | ‘bottle’ |
| | | ɛβɑŋ | ‘put down’ | | ɛlɩɣɩs | ‘summit’ |
| | | ɛxob̥ | ‘crab’ | | ɛxɔg | ‘be close’ |
| | c. | ɟɑŋgʊ | ‘church’ | | | |
| | | ɛʝɔβɑ | ‘dog’ | | | |
| | | ɛbɑɟ | ‘have’ | | | |

(33)

b < β intervocalically
  b̩ unreleased finally

g < ɣ intervocalically
  g̩ unreleased finally

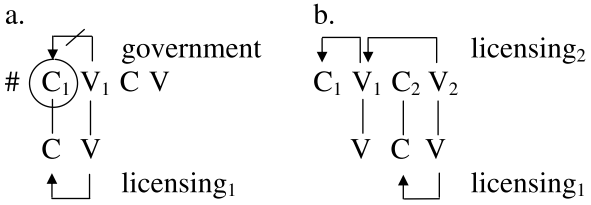


As the data in (30) and (32) show, GE exhibits a distinction between where plosives and their fricative counterparts occur. Plosives only occur in initial position while their weaker forms occur either in final position or in intervocalic position. At least based on these data it is clear to see that the initial position is differentiated as being strong in contrast to the final and intervocalic position. If we contend with earlier findings that GE does not have an initial CV unit because proper government is not active and by virtue of which it lacks true clusters, then we can explain why the initial position is strong – it is a licensed but ungoverned position.

We must also further consider the fact that although the data in (30) make no distinction with regard to the coda and the intervocalic position, (32) does. Our current proposal that proper government is inactive in clusterless languages implies that there is no difference in licensing relations between the initial and intervocalic positions. Recall that intervocalic positions are accounted for as weak in Strict CV by virtue of the fact that they are both governed and licensed. Without government this is no longer possible in clusterless languages; the intervocalic position, like the initial position, is only licensed.

In order to resolve this problem we will return to an idea put forward in SGP that claims that licensing potential is inherited throughout the domain and not a property that every V position is endowed with as assumed in Strict CV. Under this guise one V position is the source of all licensing potential that is propagated throughout the whole domain from one V position to another. In this case a V position must license the C position that precedes it but also empower a preceding V position to license. Consider how this differentiates the intervocalic position from the initial position in clusterless languages.

(34)

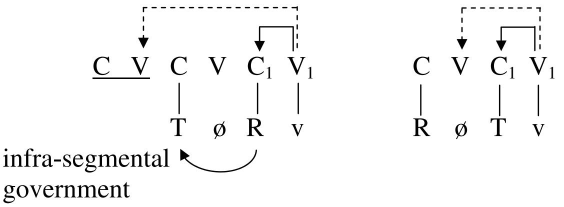


(34a) shows the initial position in a clusterless language where proper government is inactive and there is no initial CV unit. In this case the initial position is licensed by $V_1$ and must be strong. The licensing that $C_1$ receives in (34a) is to be differentiated from that which $C_2$ gets in (34b) in that, while all the licensing potential of $V_1$ in (34a) is spent on $C_1$, the licensing potential of $V_2$ in (34b) must be divided between two targets $C_2$ and $V_1$ since $V_2$ must also additionally license $V_1$ with the potential to be able to license $C_1$. By this token, every intervocalic position will be licensed to a lesser extent, i.e. with less licensing potential than a non-intervocalic position and will therefore be liable to weakening effects.[16]

Assuming the notion of inherited licensing potential does not change the picture already established for strength relations in languages with true clusters and their recourse or not to the initial CV unit, because proper government is still active in these languages. Inherited licensing potential actually reinforces the generalisations already established for languages with true clusters. Consider the cases below where in each case the source of licensing in $V_1$ is inherited from a recessive V position. Here, licensing relations are indicated by solid arrows and government by dotted arrows.

(35) a. initial TR only
initial CV unit
strong initial position

b. initial RT and TR clusters
no initial CV unit
weak initial position



Nothing changes in (35ab) as in each case $C_1$ is the sole target of the licensing potential of $V_1$.

The same holds for a post-coda position that is defined as strong, as this position also receives licensing potential that is not further divided. In effect, inheritance of licensing potential provides further support for the coda-mirror; C positions that are preceded by an empty position will receive the full licensing potential of their licensing V position because this position is not required to license the following V position because it is empty.

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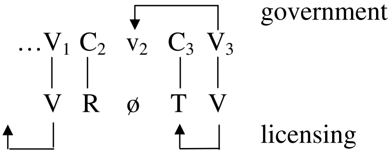
[16] See Harris (1997) and Kula (2006a) for further discussion on inherited licensing and depletion of licensing potential.

(36) Coda-onset position and licensing potential



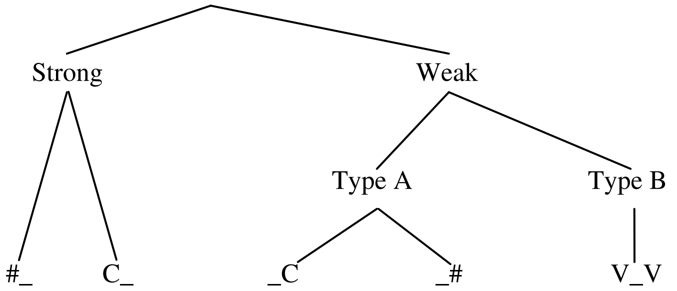
Thus in (36) the licensing potential of $V_3$, itself inherited from a recessive V position, is fully spent on $C_3$ because $V_3$ does not need to license $V_2$ – an empty position that must be properly governed. We are thus by this token able to differentiate the intervocalic position from the initial position while also still capturing that weakening in this position is to be differentiated from that in a coda position which by contrast lacks licensing.

## 6. Enhanced picture of positional strength

The picture of positional strength that emerges, adapted from Ségéral and Scheer (2001) and Kristo and Scheer (2005), to include clusterless languages is as follows:

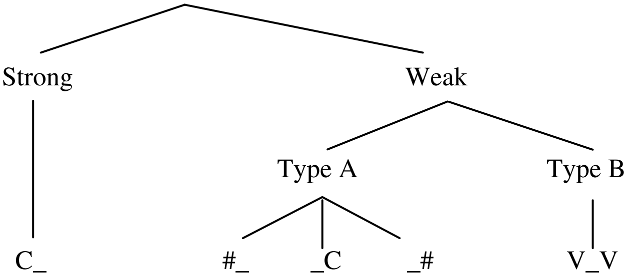
(37) Positional strength relations in Strict CV

a. with initial CV unit: strong initial position
(initial TR-only languages)



b. ✓ (✓) (✓) ✓ ✓
(clusterless)

c. without initial CV unit: weak initial position
(initial RT and TR clusters)



Clusterless languages are sandwiched between the two types of cluster languages showing affinities with both language types in particular respects. By virtue of having a strong initial position they pattern with TR languages in (37a), yet they also pattern with RT languages in not having an initial CV unit. The post-coda context (C_) and the coda followed by a C context (_C) are presented in brackets for the clusterless languages in (37b) because they do not involve true clusters but rather NC clusters. The strength relations posited, however, also hold for these clusters. This distribution seems to favour the idea that it is the possibility or impossibility of alternation of the initial vowel that makes the greatest contribution towards the characterisation of the initial position as strong or weak.

## 7. Conclusion

This paper has shown that the initial CV unit has been used in Strict CV to neatly account for the distribution of cluster types in initial position, with TR languages showing the presence of an initial CV unit and RT clusters showing its absence. Apart from this characterisation into language types it has also been shown that the initial CV unit is used by TR languages as the cushion by which the initial position can successfully evade detrimental government forces and thereby remain strong. Strong positions in Strict CV are those that are licensed but avoid government. In this sense it seems as though there is a strong correlation between the presence of an initial empty CV unit and a strong initial position in a language. However, we have seen strong evidence to suggest that, despite having an initial strong position, the only tenable conclusion for clusterless languages is that they lack an initial CV unit. As per definition of strength in Strict CV it is assumed that the initial position is not governed in clusterless languages and the absence of a proper governor emerges as the most viable explanation that follows from general structural constraints holding in this language type. By parameterising proper government this proposal removes the postulated requirement of Strict CV that nuclei *must* license *and* govern. Nuclei must license but government is a parametric option that emerges with the increased complexity of the language, particularly with regard to whether consonant clusters are allowable or not. Under this thinking intervocalic weakening is explained by taking recourse to the idea of inherited licensing potential under the premise that licensing potential diminishes with increased licensing targets. In this way it is possible to differentiate between the weakness of a coda and the weakness of an intervocalic position while retaining the central tenet of Strict CV of lateral relations that adhere to locality.

On the whole then, the presence or absence of an initial CV unit cannot act as a sole factor in determining whether a language has a strong or weak initial position; rather, a language with a strong initial position is one that is able to ensure that the initial position escapes government. In the case of TR languages the initial CV unit provides a good alternative target of governing potential while in clusterless languages the absence of proper government, motivated by the lack of empty positions, ensures that the initial position can never be subject to government and is therefore strong.

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# Strength relations between consonants: a syllable-based OT approach

*Karen Baertsch and Stuart Davis*

## 1. Introduction

This paper examines strength or sonority relations between consonants within and across syllable boundaries with a specific focus on the relationship between onset clusters and codas on the one hand, and the relationship between onset clusters and syllable contact sequences on the other.

Let us first consider the relationship between onset clusters and codas. While there is an abundance of work that examines the nature of onset clusters and codas (both within individual languages and across languages) very little research has examined the relationship that exists between onset clusters and codas. Kaye and Lowenstamm (1981) proposed an implicational universal based on theoretical grounds that the presence of a complex onset in a language implies the presence of a coda in that language. Both the empirical evidence for this proposal and the consequences of this proposal for syllable phonology have largely gone unexamined. One implication of Kaye and Lowenstamm's proposal for syllable typology is that maximal syllable types would be as in (1a–c) while (1d) would be ruled out (contra Blevins 1995).

(1) Maximal syllable types under Kaye and Lowenstamm's proposal

a. CV b. CVC c. CCVC d. *CCV

While there are indeed languages that do have CCV as their maximal syllable (e.g. Fongbe, Lefebvre and Brousseau 2002), its relative infrequency suggests that Kaye and Lowenstamm's implicational universal may at least be a real typological tendency. Another type of example illustrating the relationship between onset clusters and codas concerns parallel diachronic developments affecting both of these. Davis and Baertsch (2005a) discuss the development of Pali from Sanskrit (Zec 1995; Wetzels and Hermans 1985) and Middle Indic from Sanskrit more generally (Vaux 1992). Sanskrit allowed coda consonants in a fairly unrestricted way and true onset clusters (i.e. obstruent + sonorant clusters), but Pali has tight restrictions on the coda and does not allow onset clusters. They also discuss the development of Campidanian Sardinian (Bolognesi 1998) from Latin where historic /l/ has changed to /r/ both in coda position and as the second member of an onset, but remains /l/ as a single onset. Davis and Baertsch (2005a) maintain that such diachronic changes affecting both onset clusters and coda segments are connected and are not independent developments.

Another relationship that we will consider in this paper is that between onset clusters and syllable contact sequences (i.e. a consonant sequence over a syllable boundary). Consider, for example, the comparison of Standard Bambara which is a CV language (ignoring a possible coda nasal which some consider as syllabic) with Colloquial Bambara. Through vowel syncope, Colloquial Bambara has developed onset clusters and syllable contact sequences as seen in (2) below (data from Diakite 2006).

(2) Standard versus Colloquial *Bambara*

| Standard | Colloquial | |
|---|---|---|
| [buu.ru] | [bru] | 'bread' |
| [mo.ri.ba] | [mor.ba] | a name |
| [ma.ri.fa] | [mar.fa] | 'gun' |
| [ba.ra.ma] | [bra.ma] or [bar.ma] | 'pot' |
| [fa.ra.ti] | [fra.ti] or [far.ti] | 'carelessness' |
| [kabila] | [ka.bla] | 'tribute' |
| [melekuya] | [mel.ku.ya] | 'literature' |

The above examples not only show the simultaneous development in Bambara of onset clusters and syllable contact sequences, but they also show a link between the nature of the coda and the second member of the onset cluster: namely, both are consonants of high sonority. The high sonority preference for these positions has been noted by various researchers as a cross-linguistic tendency. Some researchers such as Clements (1990), Zec (1988), and Orgun (2001) have noted the preference for coda consonants to be of high sonority and have suggested constraints on coda sonority that give preference to high sonority codas. Other researchers such as Gouskova (2001), Smith (2003), and Green (2003) have focused on onset clusters, positing constraints on sonority distance or compound/conjoined constraints that have the effect of favoring a high sonority consonant as the second member of an onset cluster. The connection between these two positions has also been observed in the phonological acquisition literature by such researchers as Levelt and van de Vijver (1998), Levelt, Schiller, and

Levelt (1999), and Lleó and Prinz (1996). But none of these researchers formally propose to connect the high sonority preference for these two positions in the syllable. In §2 of this paper, we will offer a model of the syllable, the split margin approach, which formally relates the second member of the onset with a coda and will pursue some of the implications of this. In §3 of the paper, we will briefly discuss the analysis of onset clusters under the split margin approach. In §4 of the paper, we will explore the formal links between onset clusters and codas by examining their patterning in Campidanian Sardinian and Bambara. §5 explores the formal links between onset clusters and syllable contact sequences. §6 concludes the paper with directions for future research.

## 2. The split margin approach to the syllable

In §1, we noted Kaye and Lowenstamm's (1981) proposed implicational universal that the presence of an onset cluster in a language implies the presence of a coda. We also noted links between onset clusters and codas such as the high sonority preference for both the coda consonant and the second member of an onset cluster. In this section we will offer a formal way of understanding these links through a presentation of the split margin approach to the syllable, originally developed in Baertsch (2002) and Baertsch and Davis (2003ab). After presenting the split margin approach we will briefly consider an application of it to developmental phonology and to a synchronic problem in Winnebago (Hocank).

The split margin approach to the syllable expands on Prince and Smolensky's (1993) Margin Hierarchy which gives preference to consonants of low sonority in all margin positions within the syllable. While this captures very well the preference for single onset segments, it says little about the preference for high sonority in other margin positions. The split margin approach views the margins of a syllable as being composed of two types of structural positions rather than Prince and Smolensky's one. This provides us with the theoretical construct to account for the behavior of each position individually as well as the interaction between positions within and across syllables.

In Baertsch's (2002) split margin approach to the syllable, Prince and Smolensky's (1993) Margin Hierarchy expressed as optimality-theoretic constraints is augmented so as to distinguish between structural positions that prefer low sonority (a syllable-initial consonant) and those preferring high sonority (codas and the second member of an onset cluster). Prince and Smolensky's Margin Hierarchy is retained in this approach as the $M_1$ hierarchy, given in (3), which addresses the low sonority preference for singleton onsets and the first segment of onset clusters.

(3) The $M_1$ hierarchy
$*M_1/[+lo] >> *M_1/[+hi] >> *M_1/r >> *M_1/l >> *M_1/Nasal$
$>>*M_1/Obstruent$

The $M_2$ hierarchy given in (4) addresses the preference for high sonority in singleton codas and in the second segment of onset clusters. In this way, the $M_2$ hierarchy is similar to Prince and Smolensky's Peak Hierarchy as far as sonority is concerned.

(4) The $M_2$ hierarchy
$*M_2/Obstruent >> *M_2/Nasal >> *M_2/l >> *M_2/r >> *M_2/[+hi]$
$>> *M_2/[+lo]$

We retain Prince and Smolensky's Peak Hierarchy and note that while the $M_2$ hierarchy in (4) appears to allow and even prefer ([+lo]) vowels in what would be margin positions, these segments are also subject to the Peak Hierarchy which draws such segments into peak position rather than allowing them to surface as coda segments. The $M_1$ hierarchy interacts with the Peak hierarchy in a similar way, preventing vowels from surfacing in onset position, as we see in (5).

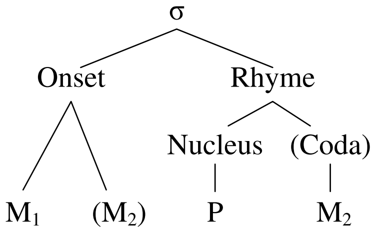
(5) The $M_2$ hierarchy in competition with the Peak hierarchy

| /ii/ | $*M_1/[+hi]$ | $*M_2/[+hi]$ | $*P/[+hi]$ |
|---|---|---|---|
| ☞ $i_P i_P$ | | | ** |
| $i_P j_2$ | | *! | * |
| $j_1 i_P$ | *! | | * |

In this rather simplified example, subscripts indicate the surface position of the underlying high vowel. The second candidate, in which the second high vowel is parsed as a coda consonant is rejected in favor of the first candidate which parses both vowels in peak position. The third candidate, in which the first high vowel is parsed as an onset consonant is likewise rejected.[1]

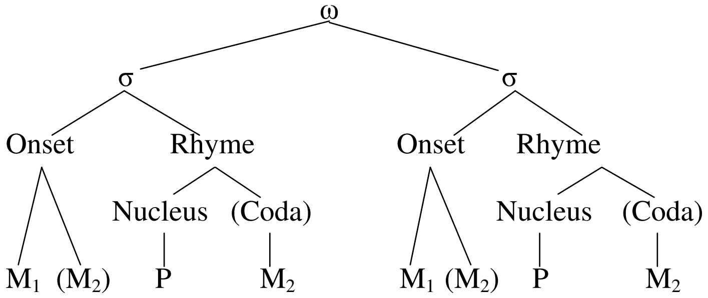
Under the split margin approach, the structure of a syllable and the constraint hierarchies that are active in each structural position are shown in (6), which depicts a language that allows both complex onsets and coda segments.

(6) Syllable-internal structure



This construct also allows us to examine the relationship across a syllable boundary – the syllable contact relationship. The syllable contact environment is shown in (7)

(7) Syllable contact environment



At the syllable juncture, a syllable-final $M_2$ segment (a coda) is adjacent to a syllable-initial $M_1$ segment (an onset or the first segment of an onset cluster). Note that in the syllable-internal situation in (6), a consonant cluster consists of an $M_1$ segment adjacent to an $M_2$ segment as well. The differ-

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[1] However, there may be language-specific rankings in some languages that give preference to one of the other candidates in (5). In general, we will not discuss the patterning of glides in this paper. They can either surface as margin segments or peak segments depending on the language, a fuller discussion of which is beyond the scope of this paper.

ence between the two situations is that within the syllable (complex onset), the adjacent segments under discussion are dominated by a syllable node. In the syllable contact situation, the adjacent segments are not dominated by a syllable node, but rather by a higher domain (the phonological word in this example).

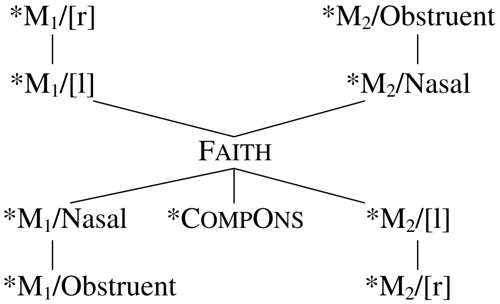
This theoretical approach affords us a number of advantages in syllabification. The $M_1$ hierarchy encodes the preference for low sonority segments in singleton onset position and in its interaction with faithfulness constraints allows for a 'maximum sonority level for singleton onsets' beyond which segments will simply not be parsed as onsets. In some cases, this maximum level may be very high (non-high vowels are absolutely banned from onset position in English) or lower on the sonority scale (as in Yakut, where rhotic consonants along with any segments more sonorous than rhotics are banned (Baertsch 2002)). The same ($M_1$) hierarchy interacts with the $M_2$ hierarchy and the Peak hierarchy to determine which segments are (dis)preferred in onset position in comparison with other syllable positions.

The $M_2$ hierarchy encodes the preference for high sonority segments in singleton coda position and its interaction with faithfulness constraints determines a 'minimum sonority level' for codas. In interaction with the $M_1$ hierarchy and the Peak hierarchy, the $M_2$ hierarchy determines which segments prefer to be in coda position as opposed to the other available positions. The interaction of the $M_1$ and $M_2$ hierarchies can determine the outcome of a single intervocalic consonant. If the segment is on the high sonority end of the sonority scale, as the flap is in English, it may be syllabified as a coda segment followed by an onsetless syllable (VC.V) in violation of the Maximal Onset Principle. If, on the other hand, the segment is on the low sonority end of the scale, it will certainly be syllabified as an onset (V.CV) in accord with the Maximal Onset Principle.

The split margin approach to the syllable provides us with a theoretical explanation for some previously puzzling facts as well. For example, in acquisition, it is possible for children to display an asymmetrical pattern of segmental acquisition in onset vs. coda position. Fikkert (1994) describes such a child, Jarmo, who, at about two years of age, had acquired obstruents and nasals in onset position (as singleton onsets). This acquisition pattern is in accord with the split margin approach in that he began acquiring onsets on the low sonority end of the scale and was working his way up from that point. At the same point in time, he had also begun to produce some coda segments in word-internal position. We focus here on the word-internal coda position primarily because of the question of whether word-final consonants are codas or are adjoined to the word (see Piggott 1999 for a detailed discussion of this phenomenon). In word-final position Jarmo's production was somewhat more erratic, however, in word-internal position he produced only laterals and rhotics as singleton codas. This is also consistent with the split margin approach in that he began acquiring codas on the high sonority end of the scale and was working his way toward the low sonority end of the scale. What surprised Fikkert and seemed not to fit well into the sequence of acquisition predicted by the theory at that time, was that Jarmo had also begun to produce some onset clusters consisting of obstruent plus liquid at that time. This was difficult to explain in the framework Fikkert was employing primarily because the expectation was that the segments that surfaced in onset clusters (whether in first or second position) should be segments that are also produced as singleton onsets.

Under the split margin approach, the acquisition pattern just discussed is expected to occur. Under this approach, the acquisition of the onset position itself will be accomplished by the demotion of *$M_1$/Obstruent below FAITH followed by the additional demotion of *$M_1$/Nasal below FAITH to produce the onset inventory Jarmo displayed. The acquisition of the coda position is independent of the acquisition of onsets and proceeds by the demotion of *$M_2$/[r] below FAITH (while *P/[r] continues to dominate FAITH) followed by the demotion of *$M_2$[l]. Because the second onset position is also an $M_2$ position, the ranking FAITH >> *$M_2$/[r] along with the demotion of *COMPLEXONSET below FAITH as shown in the diagram in (8) is sufficient for onset clusters consisting of an obstruent plus rhotic to surface in the child's speech even though he has not yet acquired rhotics as singleton onsets at this point in time.

(8) Constraint ranking for acquisition



This constraint ranking allows for obstruents and nasals as single onsets (i.e. *$M_1$/Nasal and *$M_1$/Obstruent are ranked below FAITH); it allows for laterals and rhotics to be single codas (i.e. *M$_2$/[l] and *M$_2$/[r] are ranked below FAITH), and it allows for complex onsets of obstruent-plus-liquid (i.e *COMPLEXONSET is ranked below FAITH), thus accounting for Jarmo's acquisition pattern.

An additional application of the split margin approach to the syllable comes from Dorsey's Law in Winnebago (Hocank). Dorsey's Law breaks up potential obstruent-sonorant onset clusters by inserting an epenthetic vowel between these two segments as we see in (9). (The Winnebago data are from Miner 1979, 1992, 1993 and Hale and White Eagle 1980.) Alderete (1995) observes the apparent oddity of Dorsey's law since it acts to break up potential obstruent-sonorant onset clusters which are the most preferred clusters cross-linguistically.

(9) Dorsey's Law in *Winnebago* (*Hocank*)

| | | |
|---|---|---|
| /hipres/ | [hi.pe.res] | 'know' |
| /krepnã/ | [ke.re.pã.nã] | 'unit of ten' |
| /sgaa/ | [sgaa] | 'white' |
| /kšee/ | [kšee] | 'revenge' |
| /haracab-ra/ | [ha.ra.cab.ra] | 'the taste' |
| /ha-k-ru-gas/ | [ha.ku.ru.gas] | 'I tear my own' |
| /pšoopšoc/ | [pšoo.pšoc] | 'fine' |

What we see in the data in (9) is that two obstruents can occur word-initially or syllable-initially as long as one is a strident, as shown by the words for 'white' and 'fine' in (9) above. These are clusters we would analyze as adjunct clusters along with s-clusters in English. Over a suffix boundary, Hocank allows a sequence of an obstruent followed by a sonorant in separate syllables as in 'the taste' in (9) above. But morpheme-internally, no obstruent-sonorant onset clusters occur (Alderete 1995, based on Susman 1943 and Miner 1993).

A phonetic explanation has been proposed for this phenomenon arguing that the audible release of the obstruent before the sonorant is misperceived as a vowel. The vowel is perceived to be colored by the post-sonorant vowel because of anticipatory articulation of vowel gestures and is then phonologized since the inserted vowel counts for stress placement and can be stressed (see Blevins 2004 and Fleischhacker 2002 for a discussion of the phonetics of the phenomenon and Hale and White Eagle 1980 and Halle and Vergnaud 1987 among others for formal analyses of the interaction of Dorsey's Law with stress). The difficulty we see with this phonetic explanation is that it does not explain why the "misperception" occurs in Hocank but not in English (or other languages) where the same underlying sequences occur as onset clusters with no vowel epenthesis. Thus we note Alderete's (1995) query – Why would Dorsey's Law break up potential obstruent-sonorant onset clusters when they are cross-linguistically the most preferred complex onsets?

Alderete's (1995: 48) answer is that a syllable contact constraint is active in Hocank such that there cannot be a sonority rise of greater than one sonority interval over a syllable boundary. Consequently, in Alderete's analysis Dorsey's Law occurs so as to break up bad syllable contact (i.e. rising sonority over a syllable boundary). The difficulty with this analysis is that it seems to predict that word-initial clusters like the one shown in the word meaning 'unit of ten' in (9) should not be broken up because syllable contact is not at issue word-initially. Alderete's (1995: 49) analysis suggests that words that begin with such a cluster initially actually begin with a "silent vowel" so that the syllable contact constraint would apply to them. However, there is no independent evidence for the silent vowel (e.g. it does not interact with stress as the epenthetic vowel does and has no reflex diachronically).

Our proposed explanation for the Dorsey's Law facts in Hocank is that Dorsey's Law occurs due to language-internal pressure for obstruent-sonorant sequences (and other sonority-governed clusters) not to surface. The salient observation about Hocank is that the language disallows sonorant consonants in coda position as well. While this observation may seem unconnected to Dorsey's Law, under the split margin approach to the syllable, it is crucially connected. Given the $M_2$ hierarchy, if a language does not allow sonorant consonants in coda position, then the entire $M_2$ hierarchy (abbreviated as $*M_2$ in (10)) dominates FAITH (DEP being the faithfulness constraint violated by the winning candidates in Hocank), while most of the $M_1$ hierarchy (abbreviated as $*M_1$) is dominated by FAITH. Thus, CVC reduplication as in (10) results in the epenthesis shown in candidate (b) motivated not by a syllable contact restriction but by the dispreference in Hocank for parsing a rhotic in coda position.

(10) *Hocank* /R+šara/ [šarašara] 'bold in spots'

| / šar+šara / | $*M_2$ | DEP | $*M_1$ |
|---|---|---|---|
| a. šar.ša.ra | $*M_2$/[r]! | | $*M_1$/Obs, $*M_1$/Obs, $*M_1$/[r] |
| b. ☞ ša.ra.ša.ra | | * | $*M_1$/Obs, $*M_1$/Obs, $*M_1$/[r], $*M_1$/[r] |

Given the high ranked nature of the $*M_2$ hierarchy in Hocank, it follows that complex onsets (which include an $M_2$ position) are disallowed as well. Under the split margin approach to the syllable, a language will not allow onset clusters unless at least a portion of the $M_2$ hierarchy (along with the *ComplexOnset constraint) is dominated by Faith. In fact, even if the *ComplexOnset constraint itself is dominated by Faith, complex onsets will be disallowed unless the relevant $M_2$ constraints are also dominated by Faith, as we see in (11).

(11) *Hocank* /krepnã/ [ke.re.pã.nã] 'unit of ten'

| /krepnã/ | *$M_2$ | Dep | *$M_1$ | *CompOns |
|---|---|---|---|---|
| a. krep.nã | **! | | ** | * |
| b. kre.pã.nã | *! | * | *** | * |
| c. ☞ ke.re.pã.nã | | ** | **** | |

This analysis thus far provides a principled analysis of the epenthesis in Hocank without resorting to structures for which there is no overt evidence. However, there is one remaining issue outstanding in Hocank and that is the analysis of stem-final consonants. Recall the word meaning 'the taste' in (9) repeated below in (12). Here we see that Dorsey's Law does not apply over a stem-final boundary and the obstruent-sonorant sequence surfaces.

(12) Lack of Dorsey's Law over a stem-final boundary
/haracab-ra/ [ha.ra.cab.ra] *[ha.ra.ca.ba.ra] 'the taste'

Here we suggest that stem-final codas that are not word-final may, in fact, surface as an $M_2$ element compelled by a high ranked alignment constraint requiring a stem-final element to be syllable final, i.e. AlignR (stem, syllable), namely that the right edge of the stem aligns with the right edge of the syllable. The /b/ in (12) is in stem-final position. This alignment constraint prevents Dorsey's Law from applying to (12), as shown in (13).

(13) /haracab-ra/ [haracab-ra] 'the taste'

| /haracab-ra/ | AlignR(stem, syllable) | *$M_2$ | Dep | *$M_1$ |
|---|---|---|---|---|
| a. ☞ ha.ra.cab.ra | | *$M_2$/Obs | | **** |
| b. ha.ra.ca.bra | *! | *$M_2$/r | | **** |
| c. ha.ra.ca.ba.ra | *! | | * | ***** |

We thus understand Dorsey's Law epenthesis as providing evidence for the relation between onset clusters and codas and for the split margin approach to the syllable more generally. There is internal pressure from within the phonology of Hocank for the sonorant not to surface as a second member of the onset since Hocank does not permit sonorants to surface in coda position.

## 3. Onset clusters

In this section we consider the strength or sonority relation within a complex onset by a consideration of how onset clusters are analyzed within the split margin approach to the syllable. We will show that our optimality-theoretic analysis of onset clusters has implications for syllable typology.

In the split margin approach, onset clusters are accounted for in an optimality-theoretic grammar by the local conjunction of the $M_1$ constraints in (3) with the $M_2$ constraints in (4), repeated below for convenience (and where the parentheses indicate vocalic elements that are typically realized in syllable peaks by the Peak constraints and so will not be at issue in the discussion here).

The $M_1$ hierarchy
(*$M_1$/[+lo] >> *$M_1$/[+hi]) >> *$M_1$/r >> *$M_1$/l >> *$M_1$/Nasal
>> *$M_1$/Obstruent

The $M_2$ hierarchy
*$M_2$/Obstruent >> *$M_2$/Nasal >> *$M_2$/l >> *$M_2$/r >> (*$M_2$/[+hi]
>> *$M_2$/[+lo])

The conjoined constraints are intrinsically ranked with respect to each other (reflecting the ranking of the component $M_1$ and $M_2$ hierarchies). Given this, a cluster of an obstruent followed by a rhotic will be the favored onset cluster. This is because *$M_1$/Obs is the lowest ranking $M_1$ constraint and *$M_2$/r is the lowest ranking (relevant) $M_2$ constraint. As a consequence, the conjunction $[_\sigma$*$M_1$/Obs&*$M_2$/r would be the lowest ranking of the conjoined *$M_1$&*$M_2$ constraints (where we use $[_\sigma$ to indicate the domain of the local conjunction as the beginning of the syllable, i.e. the syllable onset). Consider the Spanish data in (14). As these data show, Spanish allows for obstruent-sonorant onset clusters but not obstruent-obstruent ones. An underlying obstruent-obstruent cluster that could potentially surface in syllable-initial position (14c), actually surfaces with a prothetic vowel (a violation of the constraint Dep), but the underlying obstruent-sonorant sequences of (14ab) are allowed to surface as complex onsets.

(14) Exemplification from *Spanish*

| | | | |
|---|---|---|---|
| a. | /blanka/ | [blaŋ.ka] | ‘white’ |
| b. | /pronto/ | [pron.to] | ‘soon’ |
| c. | /sposa/ | [ɛs.po.sa] | ‘wife’ |

The patterning of (14) reflects the constraint ranking in (15) with the relevant tableaux shown in (16) and (17). The Spanish analysis in (15)–(17) shows how the split margin approach neatly accounts for onset clusters, especially the preference for obstruent-sonorant onset clusters.

(15) Constraint ranking for *Spanish*
[$_\sigma$*M$_1$/Obs&*M$_2$/Obs >> DEP >> [$_\sigma$*M$_1$/Obs&*M$_2$/l
>> [$_\sigma$*M$_1$/Obs&*M$_2$/r

(16) /bla/ [bla]

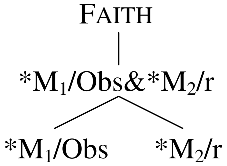
| /bla/ | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/Obs | DEP | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/l | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/r |
|---|---|---|---|---|
| a.☞ bla | | | * | |
| b. ɛb.la | | *! | | |

(17) /spo/ [ɛs.po]

| /spo/ | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/Obs | DEP | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/l | [$_\sigma$*M$_1$/Obs&<br>*M$_2$/r |
|---|---|---|---|---|
| a. spo | *! | | | |
| b.☞ ɛs.po | | * | | |

What is interesting is that this approach provides a natural explanation for Kaye and Lowenstamm’s proposed implicational universal discussed in §1 that the presence of a complex onset in a language implies the presence of codas in that language. Given the logic of constraint conjunction, a conjoined constraint must dominate the individual conjuncts for it to be active in a language. If the conjoined constraint [$_\sigma$*M$_1$/Obs&*M$_2$/r is ranked low enough (below the relevant faithfulness constraints) so as to allow for onset clusters (as in Spanish) then it must follow that rhotics be allowed as single codas given that a conjoined constraint outranks each of the single conjuncts. This is shown in (18).

(18)



The consequence of this ranking is that if a language allows for an onset cluster, it also allows for the presence of a coda, thus giving a formal explanation for Kaye and Lowenstamm's observation that the presence of a complex onset implies the presence of a coda. (It should be noted, though, that Kaye and Lowenstamm do not make predictions on the relationship between the complex onset and the coda.) If we then consider syllable typology, we would expect to find languages whose maximal syllable is CV (constraint ranking 19a), CVC (19b), and CCVC (19c).

(19) Accounting for syllable typology
  a. ranking for a CV language
    [$_\sigma$*M$_1$/Obs&*M$_2$/Son >> *M$_2$/Son >> FAITH

  b. ranking for a CVC language
    [$_\sigma$*M$_1$/Obs&*M$_2$/Son >> FAITH >> *M$_2$/Son

  c. ranking for a CCVC language
    FAITH >> [$_\sigma$*M$_1$/Obs&*M$_2$/Son >> *M$_2$/Son

However, a language whose maximal syllable is CCV with the hypothetical ranking in (20) is problematic given the role of constraint conjunction. First, it would require a conjoined constraint to be lower ranked than one of the individual conjuncts. And second, a surface obstruent-sonorant onset cluster (CCV) incurs violations of both *M$_2$/Son (ranked above FAITH) and the conjoined constraint. The violation of *M$_2$/Son would be fatal.

(20) Hypothetical ranking of a CCV language
  *M$_2$/Son >> FAITH >> [$_\sigma$*M$_1$/Obs&*M$_2$/Son

Even though it was noted earlier following (1) that some CCV languages do occur, such as Fongbe, we suggest here that such languages have a ranking for a CCVC language as in (19c). Their lack of codas has more to do with the lack of potential codas in input sequences. While this issue is a subject for future research, it is interesting to note that Haitian Creole, which some researchers consider to reflect the grammar of its primary African substrate language Fongbe (Lefebvre 1998), maintains coda consonants. This makes sense if Fongbe is a covert CCVC language with the ranking of (19c). The lack of apparent codas in Fongbe may be due to the nature of the input sequences.

In the next section we consider diachronic implications of the split margin approach. If a CCVC language (19c) starts to lose or restrict its coda consonants it should also lose or restrict its onset clusters accordingly. Relatedly, if a CV language (19a) starts to acquire onset clusters it should also acquire coda consonants. As far as we are aware, this diachronic link has not been previously noted by others.

## 4. The diachronic link between onset clusters and coda

Having developed a formal analysis of onset clusters within the split margin approach to the syllable, we analyze in this section two cases that exemplify the diachronic link between onset clusters and codas. In §4.1, we consider Campidanian Sardinian, a daughter of Latin in which codas and onset clusters become more restrictive than in Latin. In §4.2, we will consider a formal analysis of the difference between Standard and Colloquial Bambara where syllable structures have become less restrictive in the colloquial language. In both Campidanian Sardinian and Colloquial Bambara, constraints have acted upon the coda and the second member of an onset in a parallel way reflecting a link between these two positions.

### 4.1. Campidanian Sardinian

Campidanian Sardinian (Bolognesi 1998; Alber 2001; Smith 2003; Frigeni 2003, 2005) descends from Latin, a CCVC language (ignoring the issue of s-clusters and certain cases of complex codas) in which basically any consonant (regardless of sonority value) could be a single coda. Latin codas can be accounted for by the constraint ranking in (21) where the entire $M_2$ hierarchy is dominated by FAITH.

(21) Ranking of the $M_2$ Hierarchy in Latin
FAITH >> $*M_2$/Obstruent >> $*M_2$/Nasal >> $*M_2$/l >> $*M_2$/r ...

Latin allows for onset clusters consisting of an obstruent followed by a sonorant. This means that the relevant conjoined constraints are also ranked below FAITH as in (22).

(22) Ranking permitting obstruent-sonorant onset clusters in Latin
FAITH >> $[_\sigma$*$M_1$/Obs&*$M_2$/l >> $[_\sigma$*$M_1$/Obs&*$M_2$/r >> …
>> *$M_2$/l >> *$M_2$/r

Campidanian Sardinian (henceforth Sardinian), on the other hand, has a syllable structure that is more restricted than in Latin both with respect to the nature of the coda and the onset clusters. Moreover, the language distinguishes initial syllables which allow onset clusters from non-initial syllables which lack them for the most part. (See Alber 2001 on the importance of the initial syllable in Sardinian.) We focus on the initial syllable. In Sardinian, the only (unassimilated) singleton coda allowed is the rhotic. Coda laterals from Latin have rhotic reflexes in Sardinian as exemplified in (23). (The lateral can occur syllable-initially in Sardinian, a position governed by the $M_1$ hierarchy.)

(23) ALBUS > arba ‘white’
(ORKU > orku ‘ogre’)

We can account for this by the ranking in (24) whereby the relevant faithfulness constraint, ID[MANNER], is ranked below *$M_2$/l. ID[MANNER] is violated if a lateral liquid changes to a rhotic liquid or vice-versa. The relevant tableau is shown in (25) where we assume (given richness of the base) an input lateral.

(24) Ranking for Sardinian
*$M_2$/l >> ID[MANNER] >> *$M_2$/r

(25) /alba/ [ar.ba] ‘white’

| /alba/ | *$M_2$/l | ID[MANNER] | *$M_2$/r |
|---|---|---|---|
| a. al.ba | *! | | |
| b. ☞ ar.ba | | * | * |

In comparison to the ranking in Latin (26), the Sardinian ranking in (24) ranks the FAITH constraint ID[MANNER] below *$M_2$/l disallowing lateral codas but still above *$M_2$/r thus permitting rhotic codas.

(26) Ranking for Latin
ID[MANNER] >> $*M_2/l$ >> $*M_2/r$

What is interesting in Sardinian and what previous researchers have noted but have viewed as an independent change is the loss of the lateral when it is the second member of an onset cluster as in (27a). Rhotics in clusters remained (27b).

(27) Onset clusters

| | *Latin* | *Sardinian* | |
|---|---|---|---|
| a. | plus | prus | 'more' |
| | clave | krai | 'key' |
| | (longus | longu | 'long') |
| b. | primu | primu | 'first' |
| | cras | krazi | 'tomorrow' |

The change follows naturally from the ranking in (24) under the split margin approach, as we see in the tableau in (28).

(28) /plus/ [prus] 'more'

| /plus/ | $*M_2/l$ | ID[MANNER] | $*M_2/r$ |
|---|---|---|---|
| a. plus | *! | | |
| b. ☞ prus | | * | * |

We show the fuller ranking with the relevant conjoined constraints in (29) along with a more detailed tableau in (30). What (29) shows is that the domination of ID[MANNER] by $*M_2/l$ also entails its domination by $*M_1/Obs\&*M_2/l$. Thus, it is expected that if Latin /l/ has become [r] in coda position in Sardinian then it should do the same as the second member of a complex onset. And given the ranking in (29), Latin obstruent-rhotic onset clusters remain unchanged in Sardinian, in (31). Thus, our analysis under the split margin approach formally connects the historical change in the coda (23) with the change in onset clusters (27a).

(29) Fuller ranking for Sardinian
$[_\sigma *M_1/Obs\&*M_2/l$ >> $*M_2/l$ >> ID[MANNER] >> $[_\sigma *M_1/Obs\&*M_2/r$ >> $*M_2/r$

(30) /plus/ [prus] ‘more’

| /plus/ | [$_{\sigma}$*M$_1$/Obs &*M$_2$/l | *M$_2$/l | ID[MANNER] | [$_{\sigma}$*M$_1$/Obs &*M$_2$/r | *M$_2$/r |
|---|---|---|---|---|---|
| a. plus | *! | * | | | |
| b. ☞ prus | | | * | * | * |

(31) /primu/ [primu] ‘first’

| /primu/ | [$_{\sigma}$*M$_1$/Obs &*M$_2$/l | *M$_2$/l | ID[MANNER] | [$_{\sigma}$*M$_1$/Obs &*M$_2$/r | *M$_2$/r |
|---|---|---|---|---|---|
| a. ☞ primu | | | | * | * |
| b. plimu | *! | * | * | | |

There are other interesting details of Sardinian codas discussed in Davis and Baertsch (2004) and in our work in progress that we do not discuss here.[2] Nonetheless, as reflected in our analysis presented in (24)–(31), Sardinian provides a clear illustration of the diachronic link between onset clusters and codas such that a restriction that has developed on codas (i.e. the restriction against laterals) is mirrored in the second position of onset clusters because both are M$_2$ positions.[3] The parallel nature of the restriction is neatly captured in the split margin approach.

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[2] Sardinian codas are more complicated than is implied here in that, in addition to the sonority constraint that only allows the highly sonorous rhotic as a single (unassimilated) coda, Sardinian has also witnessed the rise of the Coda Condition (in the sense of Itô 1986, where a coda shares place features with a following onset) in comparison to Latin. Specifically, with the exception of a singleton coda [r], as in *arba* ‘white’ in (23), Sardinian obeys the coda condition. This means that Sardinian codas may include an obstruent only if it is the first part of a geminate (ignoring certain problems regarding the syllabification of s-clusters) or a nasal if it is homorganic to a following onset. While we do not analyze this here, one would need to reference a coda condition constraint in addition to the *M$_2$ constraints. Details are worked out in Davis and Baertsch (2005ab). Sardinian thus offers an interesting interplay of coda (M$_2$) constraints that reference high sonority (Zec 1988) and the classic Coda Condition (Itô 1986).

[3] That said, it should be made clear that the tableaux shown for Sardinian in examples like (25) and (30) reflect the synchronic state. We do not show the stages by which the rankings for Latin as reflected in (21) and (22) evolved into the Sardinian ranking in (29). We do predict that the change from *l to [r] in the onset cluster either occurred simultaneous with or prior to the change of *l to [r] in the coda. Under our theory we would not expect the change of lateral to rhotic in the coda to occur prior to that change in the onset cluster. Evidence that the *l-to-[r] change

## 4.2. Bambara

In the previous section, we detailed how a language becomes more restricted in its syllable structure with respect to both codas and second members of onsets in a parallel way, reflecting the $M_2$ position of the syllable. In this section, we will consider the opposite case where a language becomes less restrictive in its syllable structure with respect to these two positions. We will exemplify this with a consideration of the comparison of Standard Bambara with Colloquial Bambara. We make an assumption here that the former is a more conservative variety while the latter develops from it.

Recall from the Bambara data in (2) repeated below as (32) the difference between Standard Bambara and the colloquial language. (The data and discussion here are based on Diakite 2006, the author being a native speaker linguist.)

(32) Standard versus Colloquial *Bambara*

| Standard | Colloquial | |
|---|---|---|
| [buu.ru] | [bru] | 'bread' |
| [mo.ri.ba] | [mor.ba] | a name |
| [ma.ri.fa] | [mar.fa] | 'gun' |
| [ba.ra.ma] | [bra.ma] or [bar.ma] | 'pot' |
| [fa.ra.ti] | [fra.ti] or [far.ti] | 'carelessness' |
| [kabila] | [ka.bla] | 'tribute' |
| [melekuya] | [mel.ku.ya] | 'literature' |

As the comparison between the Standard and Colloquial Bambara data reveals, the colloquial language has a syncope process that preferably deletes a non-final high vowel, though a non-high vowel can be deleted if there are no target high vowels. The effect of this is to make syllable structure less restrictive in Colloquial Bambara than in Standard Bambara which is basically a CV language (ignoring the issue of a possible coda nasal in Bambara which some analyze as syllabic). Through syncope, Colloquial Bambara has developed both complex onsets and codas, so that CVC and CCV syllables are allowed in addition to CV syllables. What is noteworthy is that syncope in Bambara either creates a complex onset in which the second member is a sonorant (e.g. [bra.ma] 'pot', [ka.bla] 'tribute]) or a

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occurred first in the onset cluster comes from Catalan dialects discussed by Pons (2008) where laterals have become rhotics as a second member of an onset but not in coda position. We leave the details of this matter for future research.

coda in which the single coda consonant is a sonorant (e.g. [mar.fa] 'gun', [mel.ku.ya] 'literature'). In other words, the result of syncope leaves a sonorant in M$_2$ position; it never results in an obstruent in that position. Consider, for example, the words given in (33) taken from Diakite (2006: 6).

| (33) | Standard | Colloquial | | |
|---|---|---|---|---|
| | [safunɛ] | [sa.fnɛ] | (*[sfa.nɛ]) | 'soap' |
| | [kalabãci] | [kla.bã.ci], [kal.bã.ci] | (*[ka.lab.ci]) | 'hypocrite' |

The examples in (33) make clear that the result of syncope does not leave an obstruent in M$_2$ position. Given this, we can account for the difference between Standard and Colloquial Bambara by a difference in the ranking of the *M$_2$ constraints. Under the assumption that Standard Bambara is a CV language, all the *M$_2$ constraints would be high ranking. Colloquial Bambara, on the other hand, witnesses the demotion of *M$_2$/sonorant (collapsing *M$_2$/r, *M$_2$/l, and *M$_2$/nasal) below a constraint (or series of constraints) that favor syncopated outputs (which we will call SYNCOPE here and leave the details for further research). Standard Bambara would have the constraint ranking in (34) with a relevant tableau in (35). Here we focus on the analysis of codas.

(34) Ranking for Standard Bambara
*M$_2$/Obs >> *M$_2$/Son >> SYNCOPE >> *M$_1$/Son >> *M$_1$/Obs

(35) /moriba/ [mo.ri.ba] a name

| /moriba/ | *M$_2$/Obs | *M$_2$/Son | SYNCOPE | *M$_1$/Son | *M$_1$/Obs |
|---|---|---|---|---|---|
| a. ☞ mo.ri.ba | | | * | ** | * |
| b. mor.ba | | *! | | * | * |

The winning candidate in (35a) violates SYNCOPE in that it does not undergo syncope. The losing candidate in (35b) respects SYNCOPE, but this results in a violation of the higher ranked *M$_2$/Son constraint since it has [r] in coda position. The winning candidate has no codas thus respecting the higher ranked *M$_2$ constraints. Turning to Colloquial Bambara, we can analyze it by the demotion of the *M$_2$/Sonorant constraint below SYNCOPE. The ranking for Colloquial Bambara is given in (36) with the relevant tableau in (37). (Note that the ranking in (36) between *M$_2$/Son and *M$_1$/Son is not crucial, just as long as *M$_2$/Son is ranked below SYNCOPE.)

(36) Ranking for Colloquial Bambara
*$M_2$/Obs >> SYNCOPE >> *$M_2$/Son >> *$M_1$/Son >> *$M_1$/Obs

(37) /moriba/ [mor.ba] a name

| /moriba/ | *$M_2$/Obs | SYNCOPE | *$M_2$/Son | *$M_1$/Son | *$M_1$/Obs |
|---|---|---|---|---|---|
| a. mo.ri.ba | | *! | | ** | * |
| b. ☞mor.ba | | | * | * | * |

The winning candidate in (37b) has a sonorant in its coda. The demotion of *$M_2$/Son below SYNCOPE in Colloquial Bambara allows for a sonorant in coda position.

We now consider the fuller ranking with the relevant conjoined constraints in (38) accounting for the nature of the complex onset. In Standard Bambara complex onsets are not allowed. What (38) shows is that the domination of SYNCOPE by *$M_2$/Son also entails its domination by $[_\sigma$*$M_1$/Obs&*$M_2$/Son. Thus, just as possible forms with a coda consonant cannot surface in Standard Bambara neither can a possible form with a complex onset. This is shown by the tableau in (39).

(38) Ranking for Standard Bambara with conjoined constraints for complex onsets
$[_\sigma$*$M_1$/Obs&*$M_2$/Son >> *$M_2$/Son >> SYNCOPE >> *$M_1$/Son >> *$M_1$/Obs

(39) /kabila/ [ka.bi.la] 'tribute'

| /kabila/ | $[_\sigma$*$M_1$/Obs &*$M_2$/Son | *$M_2$/Son | SYNCOPE | *$M_1$/Son | *$M_1$/Obs |
|---|---|---|---|---|---|
| a. ☞ ka.bi.la | | | * | * | ** |
| b. ka.bla | *! | * | | | ** |

Candidate (39b) violates the *$M_2$/Son constraint because of [l] being the second member of a complex onset. Candidate (39a) is thus the winner since it does not violate *$M_2$/Son even though it violates SYNCOPE, but that is not a fatal violation since it is lower ranked than *$M_2$/Son. (Note that a possible candidate like [kab.la] for (39) would be ruled out by *$M_2$/Obs which is necessarily higher ranked than *$M_2$/Son given the *$M_2$ hierarchy in (4).)

For Colloquial Bambara, just as the demotion of the *M$_2$/Sonorant constraint below SYNCOPE as given by the ranking in (36) was able to account for the syncopated output in (37b) with a coda consonant, the further demotion of the conjoined constraint [$_\sigma$*M$_1$/Obs&*M$_2$/Son below SYNCOPE as shown by the fuller ranking in (40) is able to account for the output with a complex onset as seen by the tableau in (41).

(40) Ranking for Colloquial Bambara with conjoined constraints for complex onsets
SYNCOPE >> [$_\sigma$*M$_1$/Obs&*M$_2$/Son >> *M$_2$/Son >> *M$_1$/Son >> *M$_1$/Obs

(41) /kabila/ [ka.bla] 'tribute'

| /kabila/ | SYNCOPE | [$_\sigma$*M$_1$/Obs<br>&*M$_2$/Son | *M$_2$/Son | *M$_1$/Son | *M$_1$/Obs |
|---|---|---|---|---|---|
| a. ka.bi.la | *! | | | * | ** |
| b. ☞ka.bla | | * | * | | ** |

(Note that a possible candidate like [kab.la] for (41) would still be ruled out by *M$_2$/Obs since that would be higher ranked than the conjoined constraint [$_\sigma$*M$_1$/Obs&*M$_2$/Son though this would not be an intrinsic ranking.) Our detailed analysis of the different varieties of Bambara accounts for the parallel emergence of both onset clusters and codas in Colloquial Bambara. Along with the Campidanian Sardinian case discussed in §4.1 it provides strong evidence for the link between onset clusters and codas that is insightfully captured by the split margin approach.

## 5. Syllable contact

In this section, we first show how the split margin approach to the syllable can be extended to account for strength or sonority relations between consonants in syllable contact position (i.e. when two consonants are adjacent over a syllable boundary).[4] We then show how our analysis using the split

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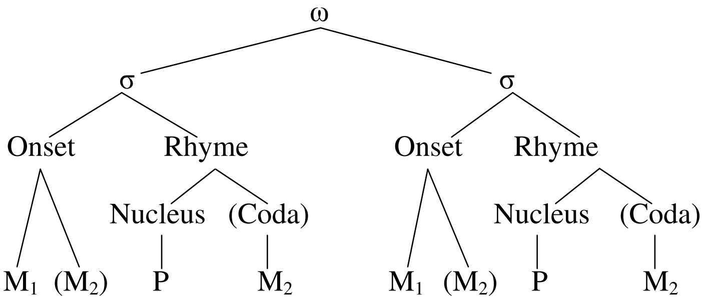
[4] Here we do not detail the background literature on syllable contact. We note here the seminal work of Vennemann (1988) which builds on Hooper (1976) and Murray and Vennemann (1983). Vennemann (1988: 40) states the Syllable Contact Law as follows, "A syllable contact A$B is the more preferred, the less the consonantal strength of the offset A and the greater the consonantal strength of the onset

margin approach to the syllable makes predictions regarding the relationship between clusters that comprise complex onsets and clusters that can appear over a syllable boundary.

In §2 of this paper, we briefly introduced the diagram in (7), repeated below as (42), that illustrates the syllable contact environment under the split margin approach to the syllable. The syllable contact environment in (42) is where the $M_2$ (coda) of the first syllable comes into contact with the $M_1$ (initial onset consonant) of the second syllable.

(42) Syllable contact environment



In examining the syllable contact environment in (42) there are two matters of consequence. Firstly, in the syllable contact situation, the coda of the first syllable is governed by the $M_2$ hierarchy in (4) and the adjacent initial onset consonant of the second syllable is governed by the $M_1$ hierarchy in (3). Given that the preferred $M_2$ consonant is one of high sonority and the preferred $M_1$ consonant is one of low sonority, then the preferred syllable contact sequence (i.e. $M_2.M_1$) is one with falling sonority. Secondly, a syllable contact situation is similar to that of a complex onset since in both

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B.” Given the split margin approach to the syllable we state syllable contact in terms of sonority. Informally, we view syllable contact as the avoidance of rising sonority over a syllable boundary and the preference for sonority fall. Davis (1998) and Baertsch and Davis (2005) give a detailed review of the use of syllable contact constraints in Optimality Theory. They note that most previous research uses a syllable contact constraint along the lines of Bat-El (1996: 304) that states, “The onset of a syllable must not be of greater sonority than the last segment in the immediately preceding syllable.” What we show in the present paper is that there is no constraint along the lines of Bat-El (1996), rather the preference for falling sonority of syllable contact is an automatic consequence of the split margin approach to the syllable.

situations a consonant cluster consists of an $M_1$ segment adjacent to an $M_2$ segment. The difference between the two situations is that within the syllable (complex onset), the adjacent segments under discussion are dominated by a syllable node. In the syllable contact situation, the adjacent segments are not dominated by a syllable node, but rather by a higher domain – the phonological word, as shown in (42). This construct also allows us to examine the relationship across a syllable boundary – the syllable contact relationship. We can analyze this relation between a syllable-final $M_2$ segment (a coda) and the adjacent syllable-initial $M_1$ segment (an onset) by a conjoined margin constraint that references the phonological word (rather than the syllable) as its local domain.

In order to make clear the difference between a conjoined margin constraint that has the phonological word as its local domain versus one that has the syllable as its local domain, let us consider the specific example of Modern English obstruent-plus-nasal sequences and Modern English nasal-plus-obstruent sequences. As is well-known, obstruent-nasal sequences are not allowed as a syllable onset (ignoring here the separate problem of a word-initial /sn/ cluster) so that there are no syllables that begin with pronounced [kn] in Modern English. On the other hand, there are many words of Modern English that have a word-internal nasal-obstruent sequence as in ‘bamboo’ where the nasal obstruent sequence occurs over a syllable boundary. With respect to the split margin approach to the syllable a possible syllable-initial obstruent-nasal cluster is similar to a word-internal nasal-obstruent cluster in that with both cluster types there is an obstruent in $M_1$ position adjacent to a nasal in $M_2$ position. This is shown in (43) where (43a) represents a case with the domain as syllable onset and (43b) as the phonological word as the domain.

(43) a. $[_\sigma$k n b. m $_\sigma]$ $[_\sigma$b
| | | |
$M_1$ $M_2$ $M_2$ $M_1$

The onset cluster illustrated in (43a) does not occur in Modern English while the syllable contact cluster in (43b) does, as exemplified by the cluster in the word ‘bamboo’. We can capture the occurrence of (43b) and the nonoccurrence of (43a) by the ranking in (44) using two similar conjoined margin constraints that differ only in their domain of application.

(44) Modern English ranking with local domains indicated

$[_\sigma$ *$M_1$/Obs&*$M_2$/Nasal >> Faith >> *$M_1$/Obs& $M_2$/Nasal$]_{wd}$

As seen by the tableaux in (45) and (46) this ranking disallows onset clusters of onset-plus-nasal while allowing for a nasal-plus-onset over a syllable boundary.

(45) /knut/ [kɪ.nut] ‘Cnut’ (name of an 11th century English king)

| /knut/ | [$_\sigma$ *M$_1$/Obs&*M$_2$/Nasal | DEP | *M$_1$/Obs&*M$_2$/Nasal]$_{\text{wd}}$ |
|---|---|---|---|
| a. knut | *! | | * |
| b. ☞ kɪ.nut | | * | |

(46) /bæmbu/ [bæm.bu] ‘bamboo’

| /bæmbu/ | [$_\sigma$ *M$_1$/Obs&*M$_2$/Nasal | DEP | *M$_1$/Obs&*M$_2$/Nasal]$_{\text{wd}}$ |
|---|---|---|---|
| a. ☞ bæm.bu | | | * |
| b. | | *! | |

If we consider the tableaux in (45) and (46) in more detail we note that the winning candidate in (46a) violates the conjoined constraint *M$_1$/Obs&*M$_2$/Nasal]$_{\text{wd}}$ because of the nasal-obstruent cluster, but this is not a fatal violation since the constraint is lower ranked than the DEP constraint which the losing candidate in (46b) violates. Note that the winning candidate (46a) does not violate high ranked [$_\sigma$ *M$_1$/Obs&*M$_2$/Nasal. Now compare (46a) with (45a). Here we see that when a candidate like (45a) violates [$_\sigma$ *M$_1$/Obs&*M$_2$/Nasal because of its [kn] cluster in the syllable onset, it necessarily also violates *M$_1$/Obs&*M$_2$/Nasal]$_{\text{wd}}$ because the onset cluster is also within the phonological word thus incurring a violation of both conjoined constraints. Thus, we see that under the split margin approach to the syllable, syllable contact sequences can be captured by the same types of conjoined margin constraints that account for the occurrence of onset clusters with the difference that the conjoined constraints accounting for syllable contact sequences do not have the syllable as its domain, just the phonological word.

An intriguing prediction emerging from the split margin analysis given here, that has gone unexpressed (and unobserved) in other approaches, is that there is a close relationship between the clusters that can appear in a complex onset and those that can occur in syllable contact. Since as shown in (45a), a violation of the conjoined constraint within the syllable (onset) entails a violation of the conjoined constraint within the phonological word, then the possible onset clusters in any language should be a subset of the possible mirror-image clusters allowed in the situation of syllable contact.

For example, if [bl] is permitted as a possible onset, then [lb] should occur over a syllable boundary. Consider English which allows complex syllable onsets such as [bl] in *blue*, [dr] in *dream*, and [kl] in *clear*; we note that English also allows the mirror-image clusters in syllable contact such as [lb] in *el.bow*, [rd] in *ar.dent*, and [lk] in *tal.cum*. The relationship between these cluster types is demonstrated by the tableaux in (47) and (48) with the English words *blue* and *elbow*, where the [$_\sigma$ *M$_1$/Obs&*M$_2$/[l] constraint is ranked low enough so that /bl/ onset clusters are allowed.

(47) /blu/ [blu] *blue*

| /blu/ | [$_\sigma$ *M$_1$/Obs &*M$_2$/nasal | Dep | [$_\sigma$ *M$_1$/Obs &*M$_2$/l | *M$_1$/Obs& *M$_2$/l]$_{\text{wd}}$ |
|---|---|---|---|---|
| a. ☞ blu | | | * | * |
| b. bɪ.lu | | *! | | |

(48) /ɛlbo/ [ɛl.bo] *elbow*

| /ɛlbo/ | [$_\sigma$ *M$_1$/Obs &*M$_2$/nasal | Dep | [$_\sigma$ *M$_1$/Obs &*M$_2$/l | *M$_1$/Obs& *M$_2$/l] $_{\text{wd}}$ |
|---|---|---|---|---|
| a. ☞ ɛl.bo | | | | * |
| b. ɛ.lɪ.bo | | *! | | |

In (47a) we see that the winning candidate violates [$_\sigma$ *M$_1$/Obs&*M$_2$/[l] and *M$_1$/Obs&*M$_2$/[l]$_{\text{wd}}$, but these constraints are both ranked below the relevant faithfulness constraint Dep. As can be inferred from the comparison (47a) with (48a), if (47a) with an onset cluster [bl] is allowed to surface, then the syllable contact cluster [l.b] in (48) must surface as well because, in a real sense, the [l.b] cluster with a lateral coda followed by an obstruent is less marked (i.e. has less constraint violations) than the [bl] onset cluster. Thus we formally account for the observation that possible onset clusters should be a subset of the possible mirror-image clusters allowed in the situation of syllable contact. This relationship is predicted for any language that allows both onset clusters and clusters in syllable contact.

The tableaux shown in (45)–(48) neatly account for the syllable structure for a language like English that has both complex onsets and codas. Different rankings of the conjoined margin constraints can account for languages with other syllable types. For example, many Turkic languages allow for consonantal sequences over a syllable boundary but do not have complex onsets. This can be accounted for by the tableaux in (49) and (50) where the maximal syllable would be CVC. (We use DEP as the relevant faithfulness constraint that militates against vowel insertion.)

(49) /CVCCV/ [CVC.CV]

| /CVCCV/ | $[_\sigma$ *M$_1$&*M$_2$ | DEP | *M$_1$&*M$_2]_{wd}$ |
|---|---|---|---|
| a. ☞ CVC.CV | | | * |
| b. CV.Ci.CV | | *! | |

(50) /CCVCV/ [Ci.CV.CV]

| /CCVCV/ | $[_\sigma$ *M$_1$&*M$_2$ | DEP | *M$_1$&*M$_2]_{wd}$ |
|---|---|---|---|
| a. CCV.CV | *! | | * |
| b. ☞ Ci.CV.CV | | * | |

Similarly, the ranking shown in (51) and (52) with all the conjoined constraints being high ranked would account for a language with no onset clusters or syllable contact clusters. That is, the ranking in (51) and (52) would be applicable to a language whose maximal syllable was CV.

(51) /CVCCV/ [CV.Ci.CV]

| /CVCCV/ | $[_\sigma$ *M$_1$&*M$_2$ | *M$_1$&*M$_2]_{wd}$ | DEP |
|---|---|---|---|
| a. CVC.CV | | *! | |
| b. ☞ CV.Ci.CV | | | * |

(52) /CCVCV/ [Ci.CV.CV]

| /CCVCV/ | $[_\sigma$ *M$_1$&*M$_2$ | *M$_1$&*M$_2]_{wd}$ | DEP |
|---|---|---|---|
| a. CCV.CV | *! | * | |
| b. ☞ Ci.CV.CV | | | * |

Notice that the various rankings of the conjoined constraints in (47)–(48), (49)–(50), and (51)–(52) account for the syllable typology mentioned in (19) where the ranking in (47)–(48) accounts for a language whose maximal syllable is CCVC, the ranking in (49)–(50) accounts for a language whose maximal syllable is CVC, and the ranking in (51)–(52) accounts for a language whose maximal syllable is CV. What is of note is that no ranking of these constraints can produce a language with onset clusters but lacking a consonant sequence over a syllable boundary. This is shown by the tableaux in (53) and (54) with the ranking of the conjoined margin constraints referencing the phonological word being higher ranked than DEP with the conjoined margin constraints referencing the syllable onset being lower ranked than DEP.

(53) /CVCCV/ [CVC.CV]

| /CVCCV/ | $*M_1\&*M_2]_{wd}$ | DEP | $[_\sigma *M_1\&*M_2$ |
|---|---|---|---|
| a. CVC.CV | *! | | |
| b. ☞ CV.Ci.CV | | * | |

(54) /CCVCV/ [Ci.CV.CV]

| /CCVCV/ | $*M_1\&*M_2]_{wd}$ | DEP | $[_\sigma *M_1\&*M_2$ |
|---|---|---|---|
| a. CCV.CV | *! | | * |
| b. ☞ Ci.CV.CV | | * | |

Crucial is the candidate in (54a) that has an onset cluster. As shown in (54), this candidate violates both conjoined margin constraints and so cannot surface as the winner under the ranking shown in (53)–(54). The ranking in (53)–(54) allows for only CV syllables as with the ranking shown in (51)–(52). The result of this discussion on syllable typology under the split margin approach to the syllable is the implication that if a language has onset clusters then it should have syllable contact clusters as well with the specific prediction that the permitted onset clusters are a subset of the possible mirror-image clusters allowed in syllable contact. This is similar to Kaye and Lowenstamm's (1981) implicational universal discussed earlier in this paper that the presence of an onset cluster in a language implies the presence of a coda in that language, but is not exactly the same since our discussion of codas has been restricted to word-internal codas (i.e. codas in a syllable contact situation) and we view the patterning of word-final codas as a separate issue (especially in light of Piggott 1999).

## 6. Conclusion

This paper has discussed strength or sonority relations between consonants within and across syllable boundaries from a formal optimality-theoretic perspective incorporating the split margin approach to the syllable.

In the first part of the paper we considered the relation of the consonants within the syllable, specifically analyzing the link between consonant clusters and codas under the split margin approach to the syllable. The formal relationship demonstrated between a second member of an onset and a coda, both $M_2$ positions under the split margin approach to the syllable, allowed us to offer an understanding of a range of synchronic and diachronic phenomena such as the acquisition pattern of Jarmo discussed in §2 as well as a new explanation for Dorsey's Law in Winnebago (Hocank).

After discussing the formal nature of onset clusters in §3, we then considered the diachronic implications of the split margin approach by showing how changes in one of the $M_2$ positions can have an effect on the other. We specifically considered the case of Campidanian Sardinian which has a syllable structure more restricted than in Latin in a way that affects the coda and the second member of a complex onset in a parallel manner. We also considered the case of Colloquial Bambara that has developed both complex onsets and codas in a parallel manner. We have shown how these diachronic developments are closely connected formally and are not independent developments.

In §5 we showed how the split margin approach to the syllable can be extended to account for strength or sonority relations between consonants over a syllable boundary (i.e. in syllable contact position). We then showed how our analysis makes specific predictions regarding the relationship between consonant clusters that comprise a complex onset and those that can occur over a syllable boundary. As far as we are aware, such predictions have not been formally observed previously. An intriguing prediction is that the permitted onset clusters in a language are a subset of the possible mirror-image clusters allowed in syllable contact. This is an empirical issue that needs further exploration.

There are many other issues that emerge from our analysis that we leave for future research such as the status of coda clusters, word-final codas, the analysis of exceptional s-clusters and other types of adjunct clusters, and accounting for languages that seem to have CCV as their maximal syllable. Nonetheless, we conclude that the split margin approach to the syllable developed here from an optimality-theoretic perspective makes intriguing predictions about the relationship between consonants within and across syllable boundaries.

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# The phonological structure of the Limburg tonal accents

*Ben Hermans*

## 1. Introduction

Most Limburg dialects, spoken in the southeast of the Netherlands and the adjacent regions in Belgium and Germany, are characterized by a contrast between two tonal accents, usually called Accent1 and Accent2. In this paper I propose a phonological representation of these accents. The essence of my proposal is that Accent1-words contain a bimoraic stressed syllable, whereas Accent2-words have a monomoraic stressed syllable. Due to this difference, the mapping between the intonational melodies and the segmental string proceeds differently; in the case of Accent1 the melodies are located in one syllable only. In the case of Accent2, on the other hand, they are spread out over two adjacent syllables, at least in principle. Phonetically, then, the contrast is primarily realized in terms of an alignment difference. This difference, I claim, is the consequence of another important phenomenon: moraic constituents are essentially metrical in nature, having a head and, possibly, a dependent. This being the case, a monomoraic heavy syllable cannot attract the entire sentence melody. Contrary to this, a bimoraic heavy syllable does allow the entire sentence melody to be located in one syllable only. The idea that moraic constituents are metrical is a rather unusual merger of Moraic and Government Phonology.

The fundamental question, of course, is what causes the contrast between monomoraic versus bimoraic heavy syllables. This question has a historical and a synchronic dimension. For reasons that primarily have to do with lack of space I will concentrate on the synchronic side of the question. From this point of view the answer is as follows. A heavy syllable can only project two moras if both segments that create heaviness are present at the underlying level. On the other hand, if a segment is created by the phonology, then it cannot receive a mora. The constraint accounting for the different behavior of underlying and surface segments is the HEAD-DEP constraint. Essentially, this entails that the contrast between Accent1 and Accent2 is derived from an underlying contrast in vowel length.

Underlyingly short vowels that are lengthened have Accent2, and underlyingly long vowels are realized with Accent1.

Having outlined a theory of the representation of the tonal accents I proceed to propose an account of an interesting accent shift. Words with an underlying Accent2 change their accent into Accent1 if the stem has an underlyingly voiced consonant which is followed by an abstract (empty) vowel with a morphemic status. I claim that this is further evidence for the metrical nature of moraic constituents. I propose that a prevocalic consonant is parsed under the same mora as the vowel following it. Following standard assumptions of Government Phonology I propose that a dependent cannot be too complex in a sufficiently weak position. A voiced consonant counts as too complex in a doubly weak position. Consequently, it cannot be located in that position. In Limburg this is repaired in such a way that the relevant syllable is pushed outside the foot. Since the weak syllable is located outside the foot, the syllable remaining in the foot must become bimoraic. This, then, creates the basic Accent1 constellation, a bimoraic stressed syllable.

We can see, then, that the Limburg tonal accents force us to reconsider some basic ideas concerning syllable structure. First of all, we have to give up the hypothesis that length and weight are both expressed by moras. Length is expressed at the segmental level, and weight is expressed by moras. A second very important hypothesis we can infer from the Limburg tonal accents is that the constituents created by moras are essentially metrical in nature. That means that they have a head, and, possibly a dependent. Furthermore, the Limburg accents confirm one of the fundamental hypotheses of Government Phonology; rich structure avoids weak positions. For the Limburg phonological system it implies that voicing is not allowed in the weak position of a moraic constituent.

This article has the following structure. §2 is purely descriptive. It presents the main facts of the modern Limburg dialect. The data are ordered in such a way that they reflect the history of the accents. In §3 I present an analysis of the tonal component of the two accents; in Accent1 the sentence melodies are realized within one syllable only, whereas in Accent2 these melodies tend to have a wider scope. In §4 I show how the distinction at surface level is derived from a contrast at the underlying level. The central hypothesis of this section is that underlyingly long vowels project two moras, and underlyingly short vowels one. In §5 I present an analysis of the effects of Schwa Apocope. Here the most important hypothesis is that a segment in a doubly weak position cannot be too complex.

## 2. A description of the facts

In this section I give a complete overview of the facts. The data are essentially taken from the modern dialects of the central part of Limburg. I am a speaker of one of these dialects myself, namely the dialect of Maasbracht, located in the center of the Dutch province of the Netherlands. These data can be verified by consulting Kats' work on the dialect of Roermond, the most important city in this region (Kats 1939, 1985). The two tonal accents are indicated with superscripts. I have ordered the modern data according to historical criteria, that is, all vowels with a common source in Westgermanic (WGM) are grouped together. Sometimes the WGM source in its turn derives from a different Germanic vowel. Whenever the difference between the WGM and the Germanic stages is relevant I have made it explicit. For instance, the notation ɛː < ai indicates that WGM /ɛː/ developed from Germanic /ai/.

(1) Long mid and low vowels received Accent1

a. Monosyllabic forms

WGM eː

| | | | |
|---|---|---|---|
| eː < eː | | eː < eo | |
| [breː$^{1}$f] | 'letter' | [leː$^{1}$f] | 'nice' |
| [veː$^{1}$l] | 'fall, 1/3P.SG.PAST.' | [reː$^{1}$m] | 'belt' |
| [leː$^{1}$t] | 'allow, 1/3P.SG.PT.' | [deː$^{1}$p] | 'deep' |

WGM oː

| | | | |
|---|---|---|---|
| | with Umlaut | | |
| [hoː$^{1}$t] | 'hat' | [vrøː$^{1}$x] | 'early' |
| [stoː$^{1}$l] | 'chair' | [køː$^{1}$l] | 'cool' |
| [boː$^{1}$k] | 'book' | [zøː$^{1}$t] | 'sweet' |

WGM ɛː (< ai)

| | |
|---|---|
| [sniə$^{1}$] | 'snow' |
| [iə$^{1}$r] | 'honor' |
| [kiə$^{1}$t] | 'shag' |

WGM ɔː (<au)

| | | with Umlaut | |
|---|---|---|---|
| [bruə$^1$t] | ‘bread’ | [styə$^1$ts] | ‘thrust, 2P.SG.PRT.’ |
| [luə$^1$n] | ‘wage’ | [tyə$^1$n] | ‘tone, PL.’ |
| [ɣruə$^1$t] | ‘big’ | [ɣryə$^1$ts] | ‘proud’ |

WGM aː

| | | with early Umlaut | |
|---|---|---|---|
| [drɔː$^1$t] | ‘thread, SG’ | [kiə$^1$s] | ‘cheese’ |
| [zwɔː$^1$r] | ‘heavy’ | [ʃiə$^1$r] | ‘scissors’ |
| [ʃɔː$^1$p] | ‘sheep, SG’ | [sliə$^1$ps] | ‘sleep, 2P.SG.PRT.’ |
| | | with later Umlaut | |
| | | [drœː$^1$j] | ‘thread, PL’ |
| | | [pœː$^1$l] | ‘pole’ |
| | | [ʃœː$^1$p] | ‘sheep, PL’ |

b. Polysyllabic forms (with voiced or voiceless intervocalic C):

| | | | |
|---|---|---|---|
| [eː$^1$dər] | ‘everybody’ | [preː$^1$stər] | ‘priest’ |
| [hiə$^1$rɪŋ] | ‘herring’ | [ruə$^1$mə] | ‘Rome’ |
| [jɔː$^1$mər] | ‘regrettably’ | [nɔː$^1$bər] | ‘neighbor’ |
| [wɔː$^1$pə] | ‘weapon’ | [kluəst$^1$ər] | ‘monastery’ |

The examples show that, no matter what their structure is in terms of the number of syllables or the laryngeal features of the intervocalic consonant, words with long vowels that originate in WGM mid or low vowels always received Accent1.

Long high vowels and falling diphthongs, on the other hand, developed Accent2. Examples are given in (2).

(2) Long high vowels and falling diphthongs received Accent2:
WGM iː uː ai au

a. Monosyllabic forms

Forms ending in a(n underlyingly) voiced consonant

| | | | |
|---|---|---|---|
| [wiː$^{2}$t] | ‘far’ | [tiː$^{2}$t] | ‘time’ |
| [ʃiː$^{2}$n] | ‘appearance’ | [sliː$^{2}$m] | ‘slime’ |
| [wiː$^{2}$n] | ‘wine’ | [tuː$^{2}$n] | ‘fence’ |
| [vuː$^{2}$l] | ‘dirty’ | [lɛi$^{2}$t] | ‘grief’ |
| [klɛi$^{2}$t] | ‘dress’ | [dɛi$^{2}$l] | ‘part’ |
| [bɛi$^{2}$n] | ‘leg’ | [bɔu$^{2}$m] | ‘tree’ |

Forms ending in a voiceless consonant

| | | | |
|---|---|---|---|
| [sliː$^{2}$k] | ‘mud’ | [buː$^{2}$k] | ‘belly’ |
| [wiː$^{2}$k] | ‘neighborhood’ | [struː$^{2}$k] | ‘bush’ |
| [vuː$^{2}$s] | ‘fist’ | [hɛi$^{2}$t] | ‘hot’ |
| [zwɛi$^{2}$t] | ‘sweat’ | [rɔu$^{2}$k] | ‘smoke’ |

b. Polysyllabic forms

| | | | |
|---|---|---|---|
| [tiː$^{2}$ɣər] | ‘tiger’ | [viː$^{2}$vər] | ‘pond’ |
| [duː$^{2}$zəɲc] | ‘thousand’ | [zyː$^{2}$vər] | ‘pure’ |
| [zɛi$^{2}$vər] | ‘saliva’ | [rɛi$^{2}$ɣər] | ‘heron’ |
| [tɔu$^{2}$vər] | ‘practise witchcraft’ | [rœy$^{2}$vər] | place name |
| [luː$^{2}$stər] | ‘listen’ | [buː$^{2}$tə] | ‘outside’ |
| [mɛi$^{2}$stər] | ‘master’ | | |

The forms in (2) are arranged slightly differently from the ones in (1). Among the monosyllabic forms I have made a distinction between words ending in a voiced consonant versus those ending in a voiceless consonant. On the basis of (2) we can conclude that falling diphthongs and high vowels received Accent2, irrespective of the number of syllables, and also irrespective of the voice quality of the consonant following the stressed syllable.

Forms containing a short stressed vowel followed by a tautosyllabic sonorant consonant also received Accent2. Again this is true regardless of the laryngeal character of the consonant following the stressed syllable, or the number of syllables. This is shown in (3).

(3) Short vowels followed by a tautosyllabic sonorant consonant received Accent2

a. Monosyllabic forms
WGM eː
Forms ending in a(n underlyingly) voiced consonant

| | | | |
|---|---|---|---|
| [dɪŋ$^2$k] | ‘thing’ | [ɣɑŋ$^2$k] | ‘corridor’ |
| [lɑŋ$^2$k] | ‘long’ | [hɑɲ$^2$tç] | ‘hand’ |
| [wær$^2$m] | ‘warm’ | [zwær$^2$m] | ‘swarm’ |
| [mɑ$^2$n] | ‘man’ | [mɪ$^2$n] | ‘nasty’ |
| [bɑ$^2$l] | ‘bal’ | [mɔ$^2$l] | ‘mole’ |
| [stɑ$^2$l] | ‘sty’ | [væ$^2$l] | ‘skin’ |
| [vɔ$^2$l] | ‘full’ | [brɪ$^2$l] | ‘glasses’ |

Forms ending in a voiceless obstruent

| | | | |
|---|---|---|---|
| [vɑl$^2$s] | ‘false’ | [vɔl$^2$k] | ‘people’ |
| [klɑŋ$^2$k] | ‘sound’ | [stɑŋ$^2$k] | ‘stench’ |
| [ʃær$^2$p] | ‘sharp’ | [kɛr$^2$k] | ‘church’ |

b. Polysyllabic forms

| | | | |
|---|---|---|---|
| [kɔl$^2$dər] | ‘nonsense’ | [kæl$^2$dər] | ‘cellar’ |
| [dʊn$^2$dər] | ‘thunder’ | [mɑr$^2$mər] | ‘marble’ |
| [vær$^2$kə] | ‘pig’ | [mɑɲ$^2$tçəl] | ‘coat’ |
| [wɪɲ$^2$tçər] | ‘winter’ | [stæm$^2$pəl] | ‘stamp’ |
| [wɪm$^2$pel] | ‘flag’ | [tæm$^2$pəl] | ‘temple’ |
| [vɪn$^2$stər] | ‘window’ | [wɑŋ$^2$kəl] | ‘unstable’ |

The distribution of the two tonal accents became contrastive, at least to a certain extent, when the rule of Open Syllable Lengthening (OSL) created long monophthongs. All stressed vowels that underwent this rule received Accent2.

(4) Short vowels lengthened by OSL received Accent2

a. Forms containing a poststress voiced consonant
Lengthened WGM i

| | | | |
|---|---|---|---|
| [zeː$^2$və] | ‘seven’ | [steː$^2$vəl] | ‘boot’ |
| [teː$^2$ɣəl] | ‘tile’ | [zeː$^2$ɣəl] | ‘seal’ |
| [weː$^2$zəl] | ‘weasel’ | [heː$^2$məl] | ‘heaven’ |

Lengthened WGM u (in some examples also Umlauted)

| | | | |
|---|---|---|---|
| [koː$^{2}$ɣəl] | ‘bullet’ | [voː$^{2}$ɣəl] | ‘bird’ |
| [zoː$^{2}$mər] | ‘summer’ | [vløː$^{2}$ɣəl] | ‘wing’ |
| [tøː$^{2}$ɣəl] | ‘bridle’ | | |

Lengthened WGM e

| | | | |
|---|---|---|---|
| [kɛː$^{2}$vər] | ‘bug’ | [vlɛː$^{2}$ɣəl] | ‘naughty boy’ |
| [zɛː$^{2}$ɣə] | ‘blessing’ | [kɛː$^{2}$rəl] | ‘bloke’ |
| [wɛː$^{2}$rəlt] | ‘world’ | [mɛː$^{2}$rəl] | ‘blackbird’ |

Lengthened WGM o

| | | | |
|---|---|---|---|
| [bɔː$^{2}$və] | ‘on top of’ | [kɔː$^{2}$rə] | ‘corn’ |
| [ɔː$^{2}$və] | ‘oven’ | | |

Lengthened WGM a

| | | | |
|---|---|---|---|
| [vaː$^{2}$dər] | ‘father’ | [naː$^{2}$ɣəl] | ‘nail’ |
| [waː$^{2}$ɣə] | ‘cart’ | [snaː$^{2}$vəl] | ‘beak’ |
| [haː$^{2}$mər] | ‘hammer’ | [staː$^{2}$məl] | ‘stammer’ |
| [kaː$^{2}$mər] | ‘chamber’ | [ʃaː$^{2}$məl] | ‘wretched’ |

b. Forms containing a poststress voiceless consonant

Lengthened WGM i u e a

| | | | |
|---|---|---|---|
| [zeː$^{2}$kər] | ‘certain’ | [steː$^{2}$kəl] | ‘sting’ |
| [toː$^{2}$tər] | ‘mud’ | [køː$^{2}$təl] | ‘dung’ |
| [bɛː$^{2}$tər] | ‘better’ | [kɛː$^{2}$təl] | ‘kettle’ |
| [waː$^{2}$tər] | ‘water’ | [kaː$^{2}$tər] | ‘male cat’ |

The forms in (4) are arranged according to the voice/voiceless quality of the intervocalic consonant. Within the class of forms containing a voiced intervocalic consonant I have distinguished forms on the basis of vowel quality. To save space no such distinction is made within the class of forms containing an intervocalic voiceless consonant.

The examples in (4) show that OSL ultimately created vowels with Accent2 that were identical (at least from the point of view of the modern dialects) to originally long vowels with Accent1. Thus, originally short high vowels developed a different accent from the originally long mid vowels. The former received Accent2, whereas the latter had Accent1. Also, the lengthened mid vowels developed a tonal accent that contrasted with the accent of the originally long, lower mid vowels (which in many dialects changed into a centering diphthong (cf. (1)). The first group received Accent2, whereas the second group had Accent1. Finally, the rounding and raising of the old long, low vowel created a contrast with the output of OSL operating on the mid back vowel. The former had Accent1, whereas the latter developed Accent2. The reader can find examples of the emerging contrasts by comparing the forms in (1) with those in (4).

Of course, the accentual contrast could only arise in the domain of polysyllabic words, because, by definition, OSL could only apply in polysyllabic words. In monosyllables the tonal accents were still fully predictable, and distributed along the lines exemplified in (1)–(3); high vowels, falling diphthongs and short vowels followed by a tautosyllabic sonorant had Accent2, whereas non-high vowels had Accent1.

This situation radically changed with the arrival of another famous rule: Schwa Apocope. Words that were affected by this rule received Accent1, but only if the pre-schwa consonant was not voiceless. This is illustrated in (5).

(5) Forms that underwent Schwa Apocope received Accent1, but only if:

a. schwa was preceded by a sonorant

Long high vowels or diphthongs

| | | | |
|---|---|---|---|
| [liː$^1$n] | ‘line’ | [miː$^1$n] | ‘mine, N’ |
| [pruː$^1$m] | ‘plum’ | [ʃyː$^1$r] | ‘shack’ |
| [uː$^1$r] | ‘hour’ | [muː$^1$l] | ‘mouth, pej.’ |
| [wɛi$^1$] | ‘meadow’ | [vrɔu$^1$w] | ‘woman’ |
| [klɛi$^1$n] | ‘small’ | [tɔu$^1$w] | ‘rope’ |

Short vowels

| | | | |
|---|---|---|---|
| [hɑl$^1$] | ‘hall’ | [kær$^1$] | ‘kart’ |
| [hɛl$^1$] | ‘hell’ | [stær$^1$] | ‘star’ |
| [kɪn$^1$] | ‘chin’ | [spɪn$^1$] | ‘spider’ |
| [stʏm$^1$] | ‘voice’ | [sɔm$^1$] | ‘sum’ |
| [trʊm$^1$] | ‘drum’ | [vlɑm$^1$] | ‘flame’ |

b. or schwa was preceded by a voiced obstruent

Long high vowels or diphthongs

| | | | |
|---|---|---|---|
| [wiː$^1$s] | ‘melody’ | [ʃiː$^1$f] | ‘disc’ |
| [duː$^1$f] | ‘pigeon’ | [ʃruː$^1$f] | ‘screw’ |
| [sluː$^1$s] | ‘sluice’ | [klɛi$^1$n] | ‘small’ |
| [rɛiː$^1$s] | ‘journey’ | [ɔu$^1$x] | ‘eye’ |

Short vowels

| | | | |
|---|---|---|---|
| [ɛr$^1$f] | ‘court’ | [tær$^1$f] | ‘wheat’ |
| [vɛr$^1$f] | ‘paint’ | [wɪl$^1$x] | ‘willow’ |
| [zɑl$^1$f] | ‘ointment’ | [hɑl$^1$f] | ‘half, A, FEM’ |

c. but not if schwa was preceded by a voiceless obstruent

Long high vowels or diphthongs

| | | | |
|---|---|---|---|
| [miː$^2$t] | ‘piled hay’ | [riː$^2$k] | ‘rich’ |
| [riː$^2$p] | ‘ripe’ | [piː$^2$p] | ‘pipe’ |
| [luː$^2$k] | ‘shutter’ | [ruː$^2$t] | ‘window glass’ |
| [spruː$^2$t] | ‘sprouts’ | [tuː$^2$t] | ‘pointed bag’ |
| [wɛi$^2$t] | ‘wheat’ | [zɛi$^2$p] | ‘soap’ |

Short vowels

| | | | |
|---|---|---|---|
| [stɑŋ$^2$k] | ‘stench’ | [vʊŋ$^2$k] | ‘sparkle’ |
| [plɑn$^2$tɕ] | ‘plant’ | [plɑŋ$^2$k] | ‘plank’ |
| [vɑl$^2$k] | ‘falcon’ | [wɔl$^2$k] | ‘cloud’ |

Recall that forms that did not have a schwa, and therefore did not undergo Schwa Apocope, have Accent2. This means that an accentual contrast developed in words with high vowels, falling diphthongs and short vowels (followed by a tautosyllabic sonorant consonant). To see this, compare the forms in (2) and (3), on the one hand, with those in (5a) and (5b), on the other.

Forms that had undergone OLS before they were subject to Schwa Apocope behaved entirely identical to forms that only underwent Schwa Apocope; they developed Accent1, unless the pre-schwa consonant was a voiceless obstruent. This is illustrated in (6).

(6) Forms that underwent OSL and Schwa Apocope received Accent1, but only if:

a. schwa was preceded by a sonorant

| | | | |
|---|---|---|---|
| [kɛː$^1$l] | ‘throat’ | [mɛː$^1$l] | ‘flour’ |
| [zɔː$^1$l] | ‘sole’ | [haː$^1$n] | ‘rooster’ |
| [zwaː$^1$n] | ‘swan’ | [vaː$^1$n] | ‘flag’ |
| [naː$^1$m] | ‘name’ | [raː$^1$m] | ‘window’ |
| [taː$^1$l] | ‘language’ | [zaː$^1$l] | ‘hall’ |

b. or schwa was preceded by a voiced obstruent

| | | | |
|---|---|---|---|
| [vreː$^1$j] | ‘peace’ | [zeː$^1$f] | ‘sieve’ |
| [stoː$^1$f] | ‘stove’ | [støː$^1$x] | ‘sow’ |
| [nɛː$^1$f] | ‘nephew’ | [bɔː$^1$x] | ‘bow’ |
| [naː$^1$s] | ‘nose’ | [flaː$^1$j] | ‘flat cake’ |
| [slaː$^1$f] | ‘slave’ | [maː$^1$x] | ‘stomach’ |

c. not if schwa was preceded by a voiceless obstruent

| | | | |
|---|---|---|---|
| [beː$^{1}$t] | 'bite' | [bɛː$^{1}$k] | 'brook' |
| [wɛː$^{1}$k] | 'week' | [knɔː$^{1}$k] | 'bone' |
| [hɔː$^{1}$p] | 'hope' | [baː$^{1}$t] | 'profit' |
| [zaː$^{1}$k] | 'case' | [taː$^{1}$k] | 'task' |
| [smaː$^{1}$k] | 'taste' | [spaː$^{1}$k] | 'spoke' |

One could also say that high vowels, falling diphthongs, closed syllables and lengthened vowels received Accent2, unless two conditions obtained simultaneously: (i) Schwa Apocope applied and (ii) the pre-schwa consonant was voiced (either a voiced obstruent, or a sonorant). This is further confirmed by an interesting group of forms where the vowel is lengthened by analogy, rather than by OSL. Since in these forms there was no schwa, one of the necessary conditions for Accent1 was not met; hence they received Accent2. A few examples are given in (7).

(7) Schwa-less forms that were lengthened by analogy always received Accent2

a. Forms ending in a voiced consonant (obstruent or sonorant)

| | | | |
|---|---|---|---|
| [smaː$^{2}$l] | 'narrow' | [laː$^{2}$m] | 'crippled' |
| [paː$^{2}$t] | 'path' | [raː$^{2}$t] | 'wheel' |

b. Forms ending in a voiceless obstruent

| | | | |
|---|---|---|---|
| [ɣaː$^{2}$t] | 'whole, N' | [naː$^{2}$t] | 'wet' |
| [vaː$^{2}$t] | 'tub' | [saː$^{2}$p] | 'juice' |

We can summarize the relevant facts in the following way: (i) stressed syllables containing long high vowels, falling diphthongs or short vowels followed by a tautosyllabic sonorant consonant received Accent2; (ii) non-high long monophthongs received Accent1; (iii) vowels that were lengthened by OSL also received Accent2, even though they are realized (in modern dialects) as non-high monophthongs; (iv) forms that lost a schwa by Schwa Apocope received Accent1, but only if the prevocalic consonant was voiced (either a sonorant, or a voiced obstruent).

This interpretation of the facts is more or less standard. With the exception of (iii) there is almost complete agreement in the literature. Some classical sources that should be mentioned are Frings (1913, 1916), Schmidt (1986, 2002) and Welter (1929, 1938). De Vaan (1999) is a recent overview of the literature. With respect to (iii) I follow a recent (2006) manuscript by Paul Boersma. He claims that Accent2 is the original tonal accent in lengthened vowels. This is a slight divergence from classical assumptions. The differences between these two interpretations need not concern us here. I should also point out that recently Gussenhoven has developed an alternative theory of the tonogenesis of the two tonal accents, one that diverges radically from the classical view (Gussenhoven 2000c). I cannot review that theory here, for reasons having to do with lack of space. Suffice it to say that Gussenhoven fully recognizes the truth of the historical distribution as they are presented here. That means that on top of the theory he proposes some additional theory must be invoked to explain this distribution. Since the latter theory is needed anyway, Gussenhoven's theory seems superfluous. It can therefore not be accepted, on the grounds of Occam's Razor.

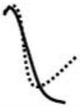
Having gone through the historical developments, we can now make the first step towards an analysis of the synchronic state emerging from the history. I propose that a syllable with Accent1 attracts all tonal segments of an intonational melody, whereas a syllable with Accent2 can only attract one tonal segment. This being the case, the remaining tones of the melody must be assigned to the post-stress syllable. The alignment difference is caused by an important difference in syllable structure: Accent1 words have bimoraic heavy syllables, whereas Accent2-words have monomoraic heavy syllables.

## 3. The mapping of the intonational melodies

In formal analyses of the two accents it is usually taken for granted that tone is all that matters. Thus, in a number of publications Gussenhoven and his coworkers claim that in the modern systems there is a tonal contrast in the lexicon, such that words with Accent1 lack a lexical tone, whereas words with Accent2 have a high tone on a syllable's second mora – see Gussenhoven (1999, 2000ab, 2004), Gussenhoven and Aarts (1999), Gussenhoven and Bruce (1999), Gussenhoven and Peters (2004), Gussenhoven and van der Vliet (1999), Peters (2006ab). Concerning the historical developments the same claim is being made; the development of the two accents is literally tonogenesis, with a high tone being created on the second mora.

In a recent talk Wolfgang Kehrein (2007) has shown that this approach cannot capture the most basic property of the two tonal accents; essentially the two accents have the same intonational melodies. The crucial difference is caused by the fact that in Accent1 the intonational melodies are realized *earlier* than in Accent2. Thus, if the sentence melody contains a rise, expressing a question, then Accent1-words have an early rise, and Accent2-words have a late rise. Similarly, if the sentence melody contains a fall, expressing declarative meaning, then Accent1 has an early fall, whereas Accent2 has a late fall. Thus, there is no segment with some inherent or fixed tone, one that remains stable under all intonational melodies. In that sense, Kehrein concludes, the two accents have nothing to do with tone at all. They are just the result of a difference in timing of the sentence melodies. Kehrein's argument can be illustrated with data from the dialect of Roermond, as they are described in Gussenhoven (2000ab). Consider the pitch patterns in the column on the left in the following table:

(8) Pitch patterns in Roermond (taken from Gussenhoven 2000a)

| | **FOCUS NONFINAL** | **FOCUS FINAL** |
|---|---|---|
| **Declarative** |  |  |
| **Interrogative** |  |  |

The patterns in the column on the left clearly indicate that the two tonal accents differ exclusively in terms of timing. In the declarative intonation, both accents are realized as a fall; Accent2, represented with a dotted line, is realized with a late fall, one that starts at the beginning of the post-stress syllable; Accent1 is characterized by a fall that already takes place in the stressed syllable. In the interrogative both accents are realized with a rise; Accent2 is realized with a late rise, in which two syllables are involved; the stressed syllable has a low tone, and the post-stress syllable begins with a high tone. In Accent1 this rise is located in the stressed syllable. In (9) I give a concrete example illustrating the timing difference in the declarative. This example is taken from Gussenhoven (2000a). Underneath the lines containing the Limburg words I have given Gussenhoven's tonal representations.

(9)

[ Mien ERM$^{I}$ zitte aan mien henj vas ]
$L_i$ H* $L_i$
my arms sit to my hands attached
'My arms are attached to my hands'

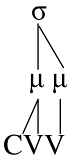
[ Miene ERM$^{II}$ zit aan miene handj vas ]
$L_i$ H*H $L_i$
my arm sits to my hand attached
'My arm is attached to my hand'

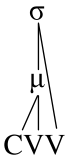
It should be noted that, in (8), the two patterns in the column on the right differ in more complex ways. Later in this section I will show that this difference can be derived from the timing difference.

Having shown, following Kehrein, that timing is all that matters, rather than tone, the question is how to represent this. Kehrein suggests that it should be represented as some kind of accent mark at the mora level, with Accent1 having an accent on the first mora of a heavy syllable, and Accent2 on the second mora. While this is descriptively adequate, the question must be asked what this means in terms of formal representations. Usually, accents are considered to be instantiations of something else, like tone or foot structure. Here Kehrein's proposal remains obscure.

I propose that in Limburg the accentual difference is a consequence of syllable structure. Accent2-words have a monomoraic stressed syllable, whereas Accent1-words have a bimoraic stressed syllable. Schematically, the difference can be depicted in the following way:

(10) Representation of Accent1 Representation of Accent2





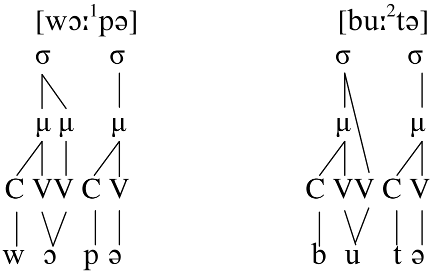
Straight lines indicate headedness. The first mora is the head of the syllable. Moraic constituents are also assumed to contain a head. Thus, the vowel following the onset consonant is the head of the first mora, a hypothesis that will become important in my analysis of Schwa Apocope. In the case of Accent1 the second V node is the head of the second mora.

I claim that the melodies of sentence intonation are mapped differently onto these two representations. This can be clarified most easily with question intonation. Following Gussenhoven (2000ab) I assume that the question morpheme consists of the sequence LH. Furthermore, every sentence terminates in an L-boundary tone. The mapping difference is a consequence of the following constraint:

(11) TONELICENSING
A tone must be licensed by the head of a moraic constituent

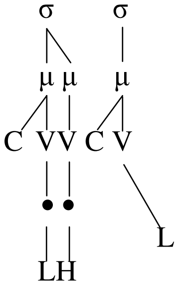
Let us now see what happens when the LH-question morpheme and the L-boundary tone are mapped onto two representative forms, like [wɔː$^1$pə] 'weapon' (1b) and [buː$^2$tə] 'outside' (2b). At the syllable level these forms have the following representation:

(12)



In the case of an Accent1-word both tones of the question morpheme are associated to the two segments in the domain of the main stressed syllable of the sentence. The boundary tone is realized on the last moraic segment of the sentence. If the word [wɔː$^1$pə] 'weapon' occupies the final position of the sentence and has the main stressed syllable of that sentence, it receives the following tonal structure in a question:

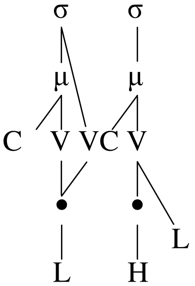
(13) [wɔː¹pə] Question intonation



I have placed the boundary tone on a separate tier. This is expressed by a difference in linking. The tones of the question morpheme are indirectly attached to the timing units, through the intervention of the tonal nodes; the boundary tone is directly attached to the segmental tier. The reasons for doing so will become clear later in this section. In the configuration in (13) all tones satisfy TONELICENSING. Phonetically this is realized with a steep rise in the main stressed syllable of the sentence. This is correct, as is shown by the table in (8), in particular by the unbroken line in the box exemplifying interrogative intonation in focus non-final position.

What happens if an Accent2-word like [buː²tə] occupies the focus position of a sentence, so that it receives the sentence melody? This time, the second segment of the stressed syllable cannot have an independent tone because of TONELICENSING. This, of course, does not necessarily mean that the segment cannot have a tone at all. What happens is that it receives its tone parasitically, through spreading of the tone that does satisfy licensing. This spreading operation is triggered by the fact that a syllable in the most prominent position of the sentence must have a tone, a constraint that must be high ranked in all languages where intonational morphemes are phonologically relevant. Now the following representation is created:

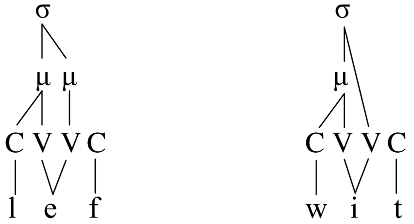
(14) [buː²tə] Question intonation



Due to TONELICENSING, the second tone of the question morpheme is associated to a segment in the post-stress syllable. This, then, implies that, in the case of an Accent2-word, the question morpheme is realized in the domain of two syllables. When the word is also in the final position of the sentence, the boundary low tone is also realized in that word. The boundary tone is interpreted in the maximally unmarked way. Consequently, if it is accompanied by a high tone in the same syllable it creates a falling pitch. Phonetically, the tonal configuration in (14) is realized with a prolonged low tone in the main stressed syllable, followed by a high tone in the next syllable, which steeply falls if that syllable is final in the sentence. This is a correct representation of the facts.

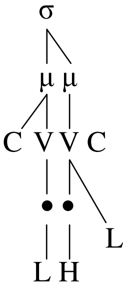
Basically the same procedure applies if the primary stressed syllable is also the final syllable of the sentence, which happens in the case of monosyllabic words. The pitch patterns occurring in this environment are given in the rightmost column in (8). Let us first consider the question intonation again. Two representative monosyllabic words are [leː$^{1}$f] ’nice’ (cf. (1a)) and [wiː$^{2}$t] ‘far’ (cf. (2a)). At the syllable level these forms have the following representation:

(15) [leː$^{1}$f] [wiː$^{2}$t]



For the time being I leave aside the question how the postvocalic consonant is syllabified. The Accent1-word [leː$^{1}$f] gets the following tonal structure in question intonation:

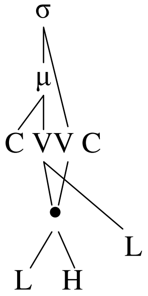
(16) [leː$^{1}$f] Question intonation



Phonetically, this configuration should be realized as a steep rise, followed by a steep fall, in a single syllable. This is correct, as is shown by the steady line in the relevant box in (8), exemplifying the pitch of Accent1 in the interrogative, focus final position.

In the interrogative intonation a monosyllabic Accent2-word is realized with a relatively steady low tone followed by a sudden rise, as is shown by the table in (8). Accent2-words provide just one tonal position in the stressed syllable. Since nothing follows the stressed syllable, the tonal root node has to carry both tones of the question morpheme. To ensure that the second segment of the long vowel also receives a tone, the tonal root node spreads to that position. Following TONELICENSING, the boundary tone is associated to the first half of the long vowel. Thus the representation in (17) is derived:

(17) [wiː$^2$t] Question intonation



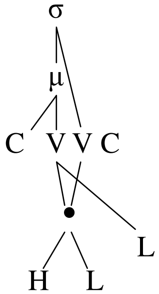
How is this constellation realized phonetically? Disregarding the boundary tone we would expect a tone that gradually rises while the vowel is being pronounced. To explain the actually attested pitch pattern I propose that the phonetic manifestation of the boundary tone consists of the delay of the rise. Phonetically, then, the phonological representation in (17) is realized as a low tone that covers the entire first half of the long vowel. Then, with the beginning of the second half a steep rise is started. All in all, the long vowel will thus be realized with a long low tone, followed by a steep rise. This is a correct representation of the facts.

In the declarative intonation, in focus non-final position, Accent1-words are characterized by an early fall, and Accent2-words by a late fall, as can be inferred from the table in (8). It seems most straightforward, then, to postulate a HL-declarative morpheme. In all cases where the focus syllable is non-final, representations are created that reflect the phonetics quite closely. Our Accent1-example [wɔː$^1$pə] (cf. (1b)), for instance, would get

HL in its stressed syllable, and in the final syllable it would get the L-boundary tone. This matches the phonetic realization of this form in this environment. Our example of an Accent2-word, [buː²tə] (cf. (2b)), would get a H-tone in the stressed syllable. The second tone of the declarative morpheme would be assigned to the next syllable. The post-stress syllable would also realize the boundary tone. This also closely matches the phonetic realization of this form in this environment. Furthermore, the Accent1-words can also be correctly derived in the environment where the main stressed syllable is simultaneously the final syllable (the focus final position). Our representative example [leː¹f] (cf. (1a)), would receive the HL-declaration morpheme, and the second tonal position would also realize the L-boundary tone. A falling tone would therefore be predicted phonetically, and this is correct.

Nonetheless, in one environment the HL-declarative morpheme turns out to be quite problematic. It cannot account for the phonetic realization of a monosyllabic Accent2-word located in a main stressed syllable if that syllable is also final. Looking at the table in (8), we note that in this environment the pitch first drops and then goes up again. The analysis developed so far would predict a drop, as can be inferred from the following representation.

(18) [wiː²t] Declarative intonation; wrong output

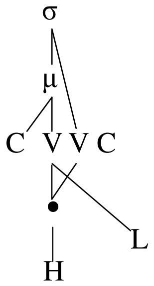


The final rise of the Accent2-words in this environment is an important exception to the otherwise valid generalization that the essential difference between Accent1 and Accent2 is one of timing. How can this puzzling rise be derived with the representations developed so far?

I propose that the HL-tones of the declarative are derived by default; H is assigned to the head segment of the main stressed syllable, and L is assigned to the dependent tonal position, if there is one. Technically, this means that there is no HL-declarative morpheme. Accent1-words have two tonal positions in the stressed syllable, so these words receive a HL-default sequence, at least if the main stressed syllable is not final. If it is final, it also receives HL, but in this environment the L is a boundary tone. Accent2-words have just one tonal position in the main stressed syllable. This receives a High tone by default. If the main stressed syllable is not final, then the L-boundary tone is located further to the right. The stressed syllable is then phonetically realized as level high, as we have seen in table (8).

Were does the falling-rising contour come from when the main stressed syllable of an Accent2-word is final? Here it becomes important that the boundary tone occupies its own tier. Phonologically, an Accent2-syllable in final position has the following structure:

(19) [wi:$^2$t] Declarative intonation; correct output



A high tone is assigned by default. Inserting a default low tone in the second half of the long vowel is not possible, because that tone would not be properly licensed. It must therefore receive its tone through spreading. The L-boundary tone, located on a separate tier, is associated to the first half of the long vowel. How is this configuration realized phonetically? The first timing unit of the long vowel has a low tone and a high tone phonologically. Logically, there are three ways to realize them phonetically – with a falling pitch, with a mid tone, or even with a rise. I propose that, if the phonology allows more then one phonetic interpretation, then the simplest one will be actualized. This is the falling pitch. After the fall has been realized, a rise must follow. This is required by the phonological representation, because the second half of the long vowel carries a phonological high tone. Thus the structure in (19) is realized with a falling-rising pitch.

In this section I have suggested, following Kehrein (2007), that the basic difference between Accent1 and Accent2 is one of timing. In my analysis the timing difference is caused by a difference in syllable structure.

Accent1-words have bimoraic stressed syllables whereas Accent2-words have monomoraic stressed syllables. Due to the TONELICENSING constraint, moraless segments cannot carry an independent tone; their phonetic pitch is determined by the tone of the preceding mora-head. On the basis of these representations the sentence melodies are correctly assigned to the segments. In the next section I will try to answer the question what causes the difference in syllabification.

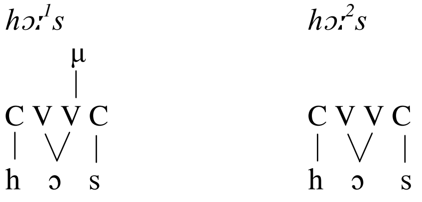
## 4. Accent1 and Accent2 in UR and SR

In the preceding section I have proposed that the essential difference between the two accents, relative timing, can be derived from a difference in syllable structure; words realized with Accent1 have a stressed syllable with two moras, and words with Accent2 have a stressed syllable with one mora only. In this section I will try to answer two questions. First I raise the question how the surface difference between the two accents is reflected in the underlying structure. I propose that at the underlying level Accent1 is a long vowel, whereas Accent2 derives from an underlyingly short vowel. Then, in the second subsection, I will investigate how the underlying representations are mapped onto surface representations.

### 4.1. Accent1 and Accent2 at UR

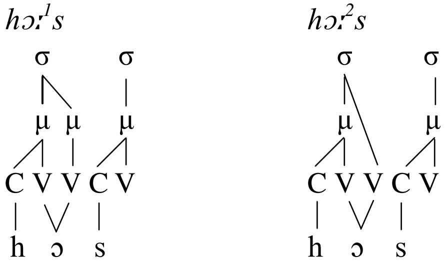
The claim that Accent1 is bimoraic whereas Accent2 is monomoraic seems to indicate that, at the underlying level, the contrast must be expressed in terms of the presence versus absence of a mora. Thus, a minimal pair existing in modern Limburg, like *hɔː*$^1$*s* 'haste' and *hɔː*$^2$*s* 'sock', would seem to have the following structure at the underlying level:

(20) Imaginable but rejected underlying representations



Somehow, the underlying contrast would map onto surface representations of the type we have seen in the preceding section. They would look as follows:

(21) Syllable structure of *hɔː$^1$s* and *hɔː$^2$s*



The mapping between underlying and surface structure would be controlled by faithfulness constraints.

There are two problems with underlying representations of the type indicated in (20). The first one is obvious, but it is conceptually not so important. With the second problem exactly the opposite is true; it is more important conceptually, but it also requires more explanation. I will therefore start with the first problem.

It is relatively easy to see that the representations in (20) can be further simplified into an underlying length contrast. Instead of (20) we would have:

(22) Imaginable and accepted underlying representations

The underlyingly long vowel would receive two moras, whereas the underlyingly short vowel would get just one. I will show in a moment that in Optimality Theory constraints exist with exactly that effect. Of course, the short vowel would have to get lengthened. This is also quite easy to account for, as I will show in a moment. Economy, then, is a first argument for the hypothesis that the contrast between the two tonal accents is not based on moras at the underlying level, but rather on vowel length. Let us now turn to the second objection against this hypothesis.

It is usually claimed in Optimality Theory that languages do not contrast in terms of syllable structure (Prince and Smolensky 1993; McCarthy and Prince 1993, 1995). Within one single language one cannot have a contrast between forms like *pa.pra* (the dot denoting a syllable boundary) versus *pap.ra*. Of course, it might be the case that other factors intervene, like morphological structure, or segmental length, or even segmental quality. These factors might lead to a surface contrast like the one just described. Apart from these complicating factors, however, it clearly is the case that contrasts of this type are ruled out. In other words, if some position in the syllable allows some phonological structure in a certain word, then there is no other, contrasting word where the same position all of a sudden does not allow this configuration. In our schematic example, for instance, *pa.pra* and *pap.ra* cannot happily live together in the same language. In Optimality Theory the lack of contrast relying on syllable structure is expressed by the theory of faithfulness. There are no constraints specifically requiring faithfulness to the syllable node, so it is impossible that a lexical contrast based on it can be maintained at the surface.

Let us, with this in mind, go back to the underlying representations I am arguing against, the ones in (20). At first sight it seems quite easy to maintain these representations on the surface, so that they are realized as the structures in (21). Optimality Theory famously recognizes constraints requiring faithfulness to the (underlying) moras. Properly ranking these constraints would precisely have the effect of mapping the underlying representations in (20) to the surface representations in (21). Notice, however, that the family of constraints requiring faithfulness to moras is based on a theory which strongly differs from the one I am using here. In the traditional versions of mora-theory the mora is not merely a node in the structure of the syllable, it also expresses length. Here, I have crucially abandoned the latter relation; moras have nothing to do with length at all. Length is expressed at the level of the timing units, as in the theories predating mora-theory. In a theory of this type the mora is comparable to the syllable node, in the sense that it belongs to the prosodic nodes, which are not under the control of faithfulness constraints. If it is the case that there are no faithfulness constraints controlling the presence or absence of moras, then there is just no way in which the underlying contrast in (20) can be manifested as the surface distinction in (21). If the segmental string *hɔs* is syllabified in a certain way in some form, then it will be syllabified in exactly the same way in all forms. This concludes my arguments against postulating an lexical mora contrast of the type illustrated in (20).

The distinction between bimoraic and monomoraic heavy syllables bears some similarity with a distinction that was quite common in classical theories of the syllable, and is still common in the standard version of Government Phonology. I am referring to the fact that in these theories there are also two types of heavy syllable; the ones with a branching nucleus and those with a branching rhyme. I have the following distinction in mind:

(23) Two types of heavy syllables in classical theories

Of course, in theories of this type the difference in branchingness is a consequence of the quality of the segment immediately following the nuclear head. In theories where a consonant is not allowed in the nucleus a branching rhyme is created, whereas a long vowel creates a branching nucleus. This seems to be different from the types of representation I have introduced in the preceding section, for which (21) is exemplaric. The configurations in (21) show that long vowels can have both representations, in the same language.

However, there is also one very important point in which the representations in (23), so typical for classical theories of the syllable, agree with the representations in (21), that are representative of the syllable theory I am proposing. That common property is headedness. A mora is a constituent with a head, just like a nucleus in the classical theories. On a higher level, one mora is the head of the syllable, just like the nucleus is the head of the rhyme at a higher level. Head-dependency relations are expressed with straight versus slanted lines, with straight lines representing heads and slanted lines dependent positions. The fact that moras are headed constituents will play an important role in the mapping of the underlying distinctions of the type given in (22) to the surface representations in (21). I have already shown in the preceding section that this idea also plays a crucial role in my analysis of the timing difference, which is the main phonetic expression of the two tonal accents. I have claimed there that a tone must be licensed by a segment in the head position of a mora.

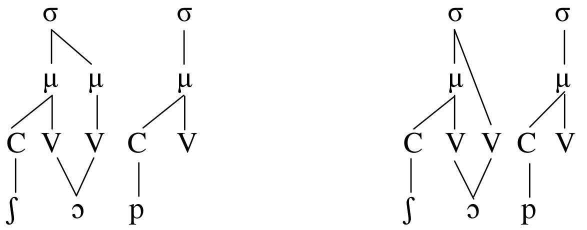
Curiously enough, the syllable theory I am proposing here also shares one property with the first version of mora theory, proposed in Hyman (1985). With Hyman I maintain that a prevocalic consonant is located in the same mora as the vowel. The difference with Hyman, of course, is that this position in the mora makes the consonant a dependent of the vowel. This will become very important in my analysis of the accent shift that accompanies the loss of a schwa.

In this subsection I have explained the underlying representation of the two tonal accents. At the underlying level the contrast between the two accents is one of length, with Accent1 deriving from an underlyingly long vowel and Accent2 from an underlyingly short vowel, which is lengthened at the surface. This claim entails that length distinctions are not expressed by moras, but rather by timing units, as in classical theories of the syllable. This, in turn, means that a mora is granted the status of a prosodic constituent, on a par with the syllable node. Like the syllable node, it has a head and possibly a dependent. Let us now turn to the question of how the underlying representations are mapped onto surface representations.

### 4.2. Accent1 and Accent2 at SR

The best way to start the discussion is by looking at the simplest cases first. These are the ones with an underlyingly long vowel. I have given examples of these in (1). A representative example is *ʃɔː*$^{1}$*p* 'sheep'. Historically, these forms had a long mid or low vowel. In the synchronic system they have a long vowel with Accent1, indicating that long vowels receive two moras. Why do long vowels receive two moras, rather than just one? Why, in other words, is the structure in (24a) correct, whereas the one in (24b) is wrong?

(24) Syllable structure of [ʃɔː$^{1}$p]


a. Correct structure
b. Incorrect structure

Obviously, in (24a) the two timing units (root nodes) making up the long vowel are each dominated by a mora. In (24b), on the other hand, one root node is dominated by a mora whereas the second is not. The latter violates one of the laws governing the proper layering of prosodic structure. Normally, segments are dominated by moras, which are dominated by syllables, which are dominated by foot structure. In order to distinguish the two structures and to guarantee that the one on the left is preferable, we have to make use of one aspect of strict layering, viz. the constraint requiring that segments be dominated by moras. I have formulated this constraint in (25).

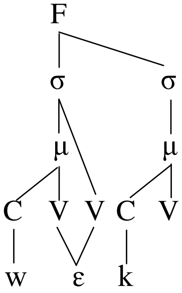
(25) STRICTLAYERING
A segment is dominated by a mora

The representation on the left does not violate STRICTLAYERING, whereas the configuration on the right does. Therefore, all things being equal, an underlyingly long vowel will receive two moras. On the grounds of the principles explained in the preceding section these two moras allow the vowel to attract both tones of the intonational melody.

It is often assumed that a consonant following a long vowel occupies the onset of an empty syllable. In Government Phonology this is the norm. I adopt this hypothesis here. Furthermore, the consonant must occupy the mora of the empty syllable, because in the syllable theory I am proposing onset consonants are linked to the head mora. The presence of the consonant enforces the presence of a vowel position under the head mora, because otherwise the consonant would be the only segment occupying this position. This is a violation of the surface true generalization that syllabic consonants are not allowed in Limburg. In terms of Optimality Theory it is better to insert a V-root node than to have a representation where a consonant occupies the only position under the head mora.

Underlyingly long vowels followed by a consonant thus receive two moras under the stressed syllable. The postvocalic consonant is syllabified in the onset position of a mora, and the head of the mora is an empty vowel. Let us now turn to the forms with an underlyingly short vowel. A representative form is *wɛː*$^2$*k* (cf. (6b)). Historically, the long vowels with an Accent2 derive from a short vowel, as I have shown in the first section. Synchronically, the syllable structure of forms of this type is as in (26). The crucial property of forms with Accent2 is the fact that they have a monomoraic stressed syllable. Consequently, they cannot attract both tones of the intonational melody, not even if the stressed syllable is heavy. This results in a late realization of the tonal movements of the intonational melodies, as I have shown in §2.

(26) Syllable structure of [wɛː$^2$k]

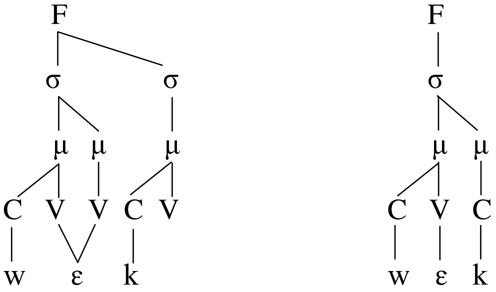


The two obvious questions, of course, are why the underlyingly short vowel is lengthened, and why the lengthened vowel does not receive two moras, but only one. It is not difficult to find a reasonable answer to the first question. One of the constraints generally accepted in Optimality Theory is *Stress-to-Weight* (Kager 1999). This constraint requires that a stressed syllable be heavy. I formulate it as follows:

(27) σ-BINARITY
The head syllable of a foot must branch

If this constraint is higher ranked than the constraint precluding insertion of a vowel (DEP-V), lengthening of the stressed syllable becomes possible, at least in principle. However, it is not the only way to satisfy σ-BINARITY. One obvious alternative is to syllabify the consonant in the coda position of the stressed syllable. In (28) I compare the two competing representations.

(28) Syllable structure of [wɛː$^2$k]

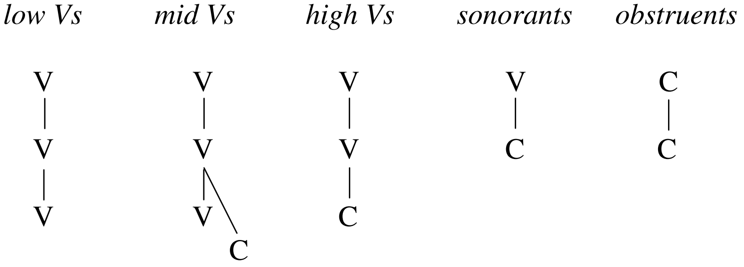

a. Correct structure
b. Incorrect structure

The constraint that plays an important role in blocking the representation on the right is one that disallows segments of low sonority in the head position of a mora. In Limburg the segments avoiding that position are high vowels and all segments of lower sonority. To generalize over all these segments I propose the following constraint:

(29) μ → Son
A consonant on the projection line may not occupy the head position of a mora

Following a suggestion in van der Hulst (2005) I propose that C and V are the central features in phonology. Varying the position of these two elements in the segmental tree allows us to distinguish all major classes of the so-called sonority scale. I try to clarify this in (30).

(30) A geometric theory of the sonority scale



The elements of the highest line are comparable to the classical root nodes. On the third line and below C and V elements replace the classical aperture features. In between them there is an intermediate 'root node' which is not unlike the classical oral cavity node. The elements having head status are on what is sometimes called the 'projection line' (Botma 2004).

High vowels are true vowels in the sense that they have a vocalic root node and also a vocalic secondary root node. Nonetheless, they also share something with obstruents and sonorant consonants; they form a natural class with true consonants because they have a consonantal element on the projection line.

The constraint I have proposed in (29) penalizes a mora whose head is a high vowel, a sonorant consonant or an obstruent. Mid and low vowels in the mora's head position are fine. Low vowels do not have a consonantal element at all, and mid vowels do not have a consonantal element on the projection line. In order to ensure that the representation in (28a) is derived rather than the one in (28b), μ → Son must dominate Dep-V, just like σ-Binarity. This can be shown with the tableau in (31).

(31) μ → Son, σ-Binarity » Dep-V

| C V C<br>w ɛ k | μ → Son | σ-Binarity | Dep-V |
|---|---|---|---|
| μ μ<br>C V C<br>w ɛ k | *! | | |
| μ μ<br>☞ CV VCV<br>w ɛ k | | | ** |
| μ μ<br>CV CV<br>wɛ k | | *! | * |

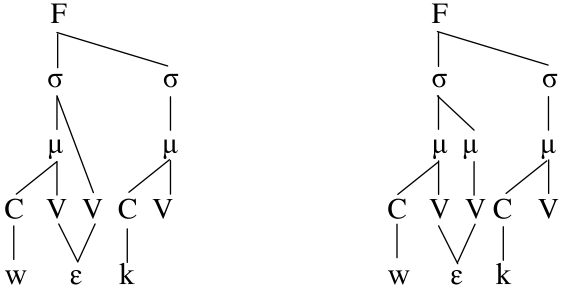
The optimal candidate has a lengthened vowel. This, then, is my answer to the first question. Underlyingly short vowels are lengthened because of the ranking μ → Son, σ-Binarity » Dep-V.

What guarantees that the lengthened short vowel receives one and only one mora? To explain this fact I follow a proposal by Alderete (1999). He shows that there are many languages in which an epenthetic vowel tends to avoid the head position of a foot. In other words, epenthetic vowels do not like to be stressed. To account for this phenomenon he postulates a family of Head-Dep constraints. The particular instance of this family we need is the following:

(32) Head-Dep
If a segment is the head of a mora in the SR, then it has a correspondent in the UR

This constraint penalizes a mora containing a segment that does not have a source in the underlying representation. This constraint, then, favors the representation in (33a) over the one in (33b).

(33) Syllable structure of [wɛː$^2$k]


a. Correct structure b. Incorrect structure

The constraint HEAD-DEP explains why a lengthened vowel gets just one mora, at least in principle. Now we must guarantee that it will get one mora only. We must therefore give HEAD-DEP its proper place in the hierarchy. For one thing it must be ranked above STRICTLAYERING, as is shown in the following tableau.

(34) HEAD-DEP » STRICTLAYERING

| C V C<br>w ɛ k | HEAD-DEP | STRICTLAYERING |
|---|---|---|
| ☞ μ μ<br>CV VCV<br>w ɛ k | * | * |
| μ μ μ<br>CV V CV<br>w ɛ k | **! | |

In this tableau the first candidate is optimal, because it violates HEAD-DEP only once. The rejected candidate is blameless with respect to STRICTLAYERING, but that goes at the cost of a double violation of HEAD-DEP. This shows that STRICTLAYERING must be ranked below HEAD-DEP. Furthermore, the constraint μ → Son must dominate HEAD-DEP, as shown by the tableau in (35).

(35) μ → Son » HEAD-DEP

| C V C<br>w ɛ k | μ → Son | HEAD-DEP |
|---|---|---|
| μ μ<br>☞ CV VCV<br>w ɛ k | | ** |
| μ μ<br>C V C<br>w ɛ k | *! | |

The losing candidate does not violate HEAD-DEP, because no vowel has been inserted. In the optimal candidate the consonant is syllabified in the onset of an empty syllable, creating an extra violation of HEAD-DEP. This shows that μ → Son must dominate HEAD-DEP. Let us now see what other rankings are required between the constraints proposed thus far.

First of all, σ-BINARITY must dominate STRICTLAYERING:

(36) σ-BINARITY » STRICTLAYERING

| C V C<br>w ɛ k | σ-BINARITY | STRICTLAYERING |
|---|---|---|
| μ μ<br>☞ CV VCV<br>w ɛ k | | * |
| μ μ<br>C V CV<br>w ɛ k | *! | |

The losing candidate does not violate STRICTLAYERING, thereby creating a violation of σ-BINARITY. In the winning candidate the opposite relation holds. This proves that STRICTLAYERING must be dominated by σ-BINARITY.

In the first section I have shown that, in the history of the Limburg accents, long high vowels got Accent2. Synchronically, this is basically also true. The systematic exception will be explained in the next section. To account for the fact that also synchronically long high vowels only receive one mora, the ranking μ → Son » STRICTLAYERING is required. This is shown in the tableau in (37). The example figuring in this tableau is *sli:*$^{2}$*k* 'mud' (cf. also (2)).

(37) μ → Son » STRICTLAYERING

| CCVVC<br>s l i k | μ → Son | STRICTLAYERING |
|---|---|---|
| ☞ μ μ<br>CCVVCV<br>s l i k | * | * |
| μ μ μ<br>CCVVCV<br>s l i k | **! | |

Since all its segments are dominated by a mora, the losing candidate does not violate STRICTLAYERING. However, that creates a double violation of μ → Son, because now two root nodes of low sonority are dominated by a mora. On the other hand, the optimal candidate contains only one violation of μ → Son, thereby creating one violation of STRICTLAYERING. This proves the correctness of the ranking μ → Son » STRICTLAYERING.[1]

Two fundamental problems must still be solved. The first one concerns the underlyingly short vowels that remain short at the surface. The second one has to do with the relation between foot structure and syllable structure. I will answer these two questions in the remainder of this section.

My analysis of the lengthening of underlyingly short vowels predicts, strictly speaking, that there are no words with a short vowel preceding just one consonant. The set of constraints I have worked out so far can successfully derive a long monomoraic vowel from an underlyingly short vowel, as I have shown in the preceding tableaux. An underlying form like /wɛk/, for instance, surfaces as *wɛː*$^2$*k*. However, if that is true, how can we explain that there are underlyingly short vowels that remain short at the surface? There are many examples of stable short vowels – that is, vowels which are not lengthened by the constraints developed so far. A few examples are given in (38).

---

[1] The single violation of μ → Son is a consequence of the fact that a syllable must have a mora head. This shows that the laws of prosodic layering are stricter with respect to heads than they are for dependents. In any case, a syllable without any mora at all is simply impossible. Naturally, the constraint requiring this must be higher ranked than μ → Son.

(38) Stable short vowels

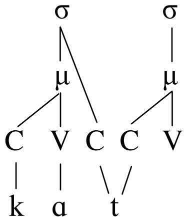
| | | | |
|---|---|---|---|
| kɑt | ‘cat, SG.’ | kɑtə | PL. |
| ʃtæk | ‘stick, SG.’ | ʃtækə | PL. |
| mɑn$^2$ | ‘man, SG.’ | mæn$^1$ | PL. |
| kɑl$^2$ | ‘nonsense, SG.’ | kɑl$^1$ | ‘speak, 1P.SG.PRT.’ |

I propose that morphemes with stable short vowels have a postvocalic geminate consonant. The underling representation of *kat*, for instance, is as follows:

(39) Underlying representation of stable short vowels

If vowel lengthening were to apply, then a superheavy syllable would be created, and that is universally not allowed, as we have seen. The correct syllabification parses the first root node of the geminate in the coda of the stressed syllable, and the second root node in the onset of the empty syllable. The correct syllable structure of a syllable with a stable short vowel is given in (40).

(40) Syllable structure of [kɑt]



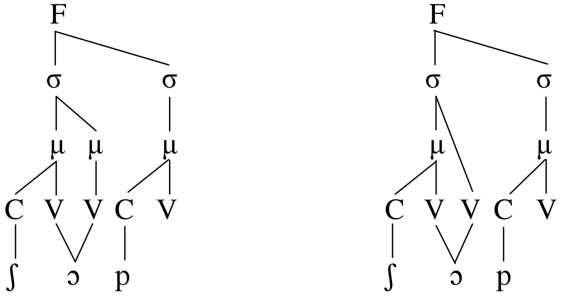
This representation predicts that syllables with stable short vowels are realized with Accent2, because these syllables are monomoraic. They can therefore only realize one segment of the intonational melody, so that the second tone must be realized on the next (audible) syllable. For the most part this prediction is borne out. The complication comes with the systematic exception that will be explained in the next section. The last form of (38) is representative of the problem that remains to be solved there.

My account of the stable short vowels might strike the reader as rather farfetched, because the geminate consonants are phonetically not long at all.

Interestingly, however, it has been shown already in van der Hulst (1984) that there is a lot of independent evidence for these geminates. The interested reader should consult this work.

The last problem that remains to be solved concerns the relation between foot structure and syllable structure. This is an important issue, because it will help us to gain insight into the notorious Limburg accent shift that will be explained in the next section. Specifically there are two constraints that still remain to be ranked. One is FOOTBINARITY and the other is STRICTLAYERING. Consider the following two representations.

(41) Syllable structure of [ʃɔː$^1$p]



a. Correct structure

b. Incorrect structure

We have seen before that an underlyingly long vowel receives two moras (unless it is high). This has been explained with the constraint STRICTLAYERING. The effect of that constraint has been illustrated in (24). Notice now that the creation of two moras in the stressed syllable creates a trimoraic foot. This is a violation of FOOTMAXIMALITY, which requires that a foot can maximally contain two moras. On the other hand, if only one mora is created in the domain of the long vowel, then FOOTMAXIMALITY is not violated, but STRICTLAYERING is. Since the representation in (41a) must be optimal, STRICTLAYERING must dominate FOOTMAXIMALITY.[2] This can be clarified with the tableau in (42). I have indicated foot structure with brackets.

---

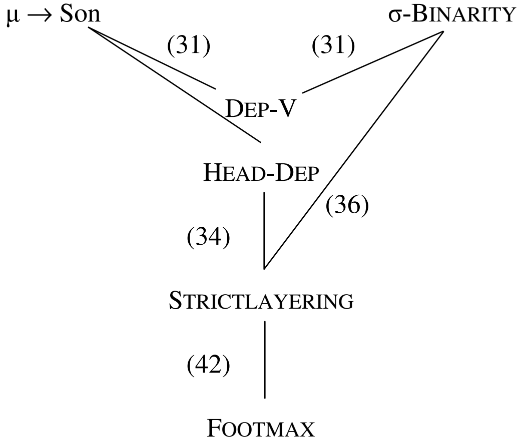
[2] There is another candidate that satisfies both constraints, one in which the unstressed syllable is not dominated by the foot. It will become clear in the next section that this is not possible at all in Limburg – footless syllables are simply not permitted. There is one systematic exception only, as I show in the next section.

(42) STRICTLAYERING » FOOTMAXIMALITY

| CVVC<br>ʃ ɔ p | STRICTLAYERING | FOOTMAX |
|---|---|---|
| ☞ μ μ μ<br>(CVVCV)<br>ʃ ɔ p | | * |
| μ μ<br>(CVVCV)<br>ʃ ɔ p | *! | |

To summarize, in this section I have proposed that at the underlying level the contrast between Accent1 and Accent2 is reduced to a length contrast. Underlyingly long vowels are syllabified with two moras, unless they are high, in which case they receive one mora only. High vowels pattern with short vowels, which also receive one mora, even if they are lengthened at the surface. I have argued that the relevant constraints are ranked as in (43).

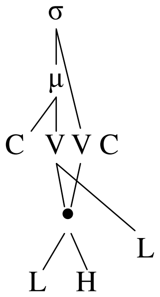
(43) Topology of the Limburg grammar, Part I



Bimoraic syllables attract both tones of the intonational melodies. Monomoraic syllables can house only one tone of the intonational melodies. This is a consequence of the constraint TONELICENSING, as explained in §2. TONELICENSING is the source of the timing difference, which is the phonetic manifestation of the two tonal accents. Accent1 realizes the pitch changes in the domain of the stressed syllable, whereas Accent2 realizes them at the break of the stressed syllable and the post-stress syllable. If there is no post-stress syllable, then Accent1 realizes the changes early in the stressed syllable, whereas Accent2 realizes them late in the stressed syllable.

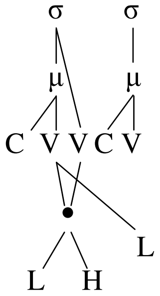
Only one point concerning the relation between syllable structure and intonation remains to be made explicit. Consider again the representation of the form *wi:*$^2$*t* in (17), repeated below.

(44) [wiː$^2$t] Question intonation



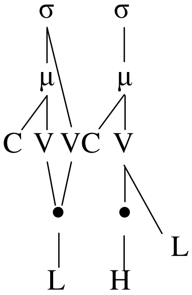
In §2 I did not clarify the syllable structure of the postvocalic consonant, but here I have shown that it occupies the onset of an empty syllable. The full structure of this form should therefore be as follows.

(45) [wiː$^2$t] Question intonation; full representation



The full representation shows that empty syllables are not able to carry a tone. If they were able to do so, then, instead of the correct representation in (45) we would get the following undesirable result.

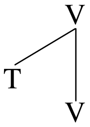
(46) [wiː$^2$t] Question intonation; wrong output



Now the second segment of the intonational melody and the boundary tone are associated to the empty syllable. Phonetically, this would be realized as a low tone on the stressed syllable. The two tones of the empty syllable would be phonetically silent, which is entirely wrong. It is clear, then, that empty syllables are not able to carry tone. How can this be explained?

I propose that tones must occupy a dependent position on the primary root node. This being the case, there must be another element on the root node that forces the tone into the dependent position. Consequently, there must be a secondary root node on the projection line. A tone is only well formed, then, in a structure of the following type:

(47) Position of a tone in a segment



If no further structure is attached to the secondary root node the representation in (47) will be realized as a schwa. Minimally, then, a vowel with a tone is realized as a schwa. A vowel without the secondary root node does not receive phonetic realization, as we have seen in this section. Such a vowel cannot have a tone, because, if it could, then the tone would not occupy a dependent position.

I have now developed an almost complete theory of the phonological structure of the Limburg tonal accents. Only one major problem remains, one that has occupied scholars for almost a century now. I will try to solve that problem in the next section.

## 5. The notorious Limburg accent shift

In §1 I showed that, in the history of the tonal accents, Accent2 changed to Accent1 when a schwa was dropped. Examples illustrating this process were presented in (5). Some of them are repeated below. To prove that these forms originally had a schwa I also give their equivalent in modern German, where the rule of Schwa Apocope was much more restricted.

(48) The effect of Schwa Apocope

| | *Limburg* | | *Modern German* |
|---|---|---|---|
| a. | Long vowel or diphthong | | |
| | [pruː$^1$m] | ‘plum’ | Pflaume |
| | [wiː$^1$s] | ‘melody’ | Weise |
| | [duː$^1$f] | ‘pigeon’ | Taube |
| | [ʃruː$^1$f] | ‘screw’ | Schraube |
| | [rɛi$^1$s] | ‘journey’ | Reise |
| | [ɔu$^1$x] | ‘eye’ | Auge |
| b. | Short vowel | | |
| | [hɑl$^1$] | ‘hall’ | Halle |
| | [hɛl$^1$] | ‘hell’ | Hölle |
| | [stʏm$^1$] | ‘voice’ | Stimme |
| | [spɪn$^1$] | ‘spider’ | Spinne |
| | [vɛr$^1$f] | ‘paint’ | Farbe |
| | [zɑl$^1$f] | ‘ointment’ | Salbe |

In §2 I also showed that Schwa Apocope did not lead to an accent shift if the consonant preceding schwa was voiceless. This was illustrated in (5c). Some of the examples given there are repeated in (49), together with their equivalents in modern German.

(49) No effect if schwa was preceded by a voiceless consonant

| | | |
|---|---|---|
| [piː$^2$p] | ‘pipe’ | Pfeife |
| [ruː$^2$t] | ‘window glass’ | Raute |
| [zɛi$^2$p] | ‘soap’ | Seife |
| [luː$^2$k] | ‘shutter’ | Luke |
| [plɑn$^2$tɕ] | ‘plant’ | Pflanze |
| [wɔl$^2$k] | ‘cloud’ | Wolke |

The accent shift did not apply either when a form did not have a schwa. This was shown with the forms in (2), some of which are repeated in (50), together with their modern German equivalents.

(50) No effect if there was no schwa

| | | |
|---|---|---|
| [klɛi$^2$t] | ‘dress’ | Kleid |
| [lɛi$^2$t] | ‘grief’ | Leid |
| [wiː$^2$n] | ‘wine’ | Wein |
| [ʃiː$^2$n] | ‘appearance’ | Schein |
| [tuː$^2$n] | ‘fence’ | Zaun |
| [bɔu$^2$m] | ‘tree’ | Baum |

In modern Limburg the accent shift that was initiated by the loss of schwa has sometimes led to alternations. Some examples illustrating this are given below.

(51) Synchronic alternations in modern *Limburg*

a.

| *Singular* | *Plural; suffix –e* | |
|---|---|---|
| dr[uː$^1$]f | dr[uː$^2$]ve | ‘grape’ |
| d[uː$^1$]f | d[uː$^2$]ve | ‘pigeon’ |
| beg[iː$^1$]n | beg[iː$^2$]ne | ‘beguine’ |
| pr[uː$^1$]m | pr[uː$^2$]me | ‘plum’ |

b.

| *Singular* | *Plural; zero suffix* | |
|---|---|---|
| ken[iː$^2$]n | ken[iː$^1$]n | ‘rabbit’ |
| b[ɛi$^2$]n | b[ɛi$^2$]n | ‘leg’ |

c.

| *1PER. SG.* | *1, 3PER. PL.* | |
|---|---|---|
| bl[iː$^1$]f | bl[iː$^2$]ve | ‘stay’ |
| sjr[iː$^1$]f | sjr[iː$^2$]ve | ‘write’ |
| sjr[uː$^1$]f | sjr[uː$^2$]ve | ‘screw’ |

d.

| *Predicative* | *Attributive, FEM.* | |
|---|---|---|
| gr[iː$^2$]s | gr[iː$^1$]s | ‘grey’ |
| st[iː$^2$]f | st[iː$^1$]f | ‘stiff’ |
| w[iː$^2$]s | w[iː$^1$]s | ‘wise’ |
| f[iː$^2$]n | f[iː$^1$]n | ‘refined’ |
| br[uː$^2$]n | br[uː$^1$]n | ‘brown’ |

Some of these alternations are quite regular in modern Limburg, such as the singular-plural alternation illustrated in (51a), the verbal alternation in (51c), and also the adjective alternation in (51d). These modern alternations never occur if the historical version of the stem ended in a voiceless consonant. This becomes particularly clear if we look at the singular-plural alternations in nouns and verbs.[3]

(52) No alternations in modern Limburg if the stem ends in a voiceless consonant

| | | | |
|---|---|---|---|
| a. | *Singular* | *Plural; suffix –e* | |
| | p[iː$^{2}$]p | p[iː$^{2}$]pe | ‘pipe’ |
| | w[iː$^{2}$]k | w[iː$^{2}$]ke | ‘neighborhood’ |
| | l[uː$^{2}$]k | l[uː$^{2}$]ke | ‘hatch’ |
| | pr[yː$^{2}$]s | pr[yː$^{2}$]se | ‘German’ |
| b. | *1PER. SG.* | *1, 3PER. PL.* | |
| | kn[iː$^{2}$]p | kn[iː$^{2}$]pe | ‘pinch’ |
| | l[iː$^{2}$]k | l[iː$^{2}$]ke | ‘resemble’ |
| | h[uː$^{2}$]k | h[uː$^{2}$]ke | ‘squat’ |
| | r[ɔu$^{2}$]k | r[ɔu$^{2}$]ke | ‘smoke’ |

The best way to start the discussion is to look at a form like *d*[uː$^{1}$]*f* (51a), and compare the structure we predict with the one that is actually attested. The two representations are given in (53).

(53) Syllable structure of [duː$^{1}$f]

a. Correct structure b. Incorrect structure

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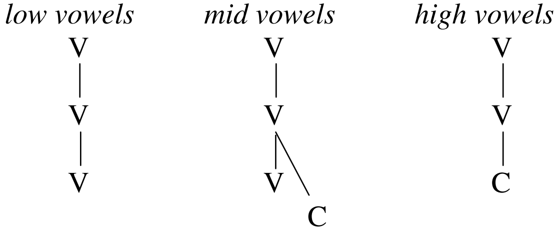
[3] In the adjective paradigm there is an interesting complication in the stems ending in a voiceless obstruent. In the predicative form the stem is not followed by a vowel, just as in (51d). In the feminine form, however, a schwa appears. So we get forms like [laː$^{2}$t] ‘late, PRED.’, [laː$^{2}$tə] ‘late, ATTR. FEM.’. I will not discuss the appearance of the schwa here, though I will point out that also in the adjective paradigm there is no accentual alternation if the stem ends in a voiceless obstruent.

Our system predicts the representation in (53b) to be correct. This is a consequence of the ranking μ → Son » STRICTLAYERING, motivated in (37) (cf. also the topology in (43)). According to this ranking a high long vowel tends to avoid a mora, creating a violation of STRICTLAYERING. Of course, we are partly on the right track, since, when the stem is followed by an overt vowel this is exactly the pattern we find. Obviously, then, there is some force at work overriding the expected monomoraic structure and creating a bimoraic heavy syllable. Which force is this?

Now the status of a prevocalic consonant becomes crucial. In the system I have proposed it occupies a position under the head mora. In the domain of that mora it is a dependent. If it also occupies a position in an unstressed syllable, then it is doubly dependent, one could say; it is a dependent of a mora, which is in a syllable that is a dependent of the head syllable. Of course, it has always been one of the main goals of Government Phonology to develop a representation that can explain why the intervocalic, foot-internal consonant is weak. Here, I propose that it is weak because it occupies a doubly dependent position.

It has been pointed out many times that weak positions tend to avoid segments with a complex structure (Harris 1990, 1994, 1997; Harris and Kaye 1990; Harris and Lindsey 1995). One particularly convincing case is the reduction of mid vowels to high or low vowels. Mid vowels are more complex than high and low vowels. To see this, consider again the representation I have proposed for high, mid and low vowels in (30). They are repeated below.

(54) Vowels on the complexity scale



The mid vowels are a combination of C and V below the secondary root node. Therefore, their representation is a proper superset of the structure of high and low vowels. Standard Government Phonology holds that it is this representational richness that tends to be avoided in a weak position. The crucial constraint disallowing complexity in a weak position is the COMPLEXITYCONDITION. I propose the following formulation:

(55) COMPLEXITYCONDITION – general scheme
At level X branchingness is not allowed in a constituent with dependency degree Y, where Y > 0

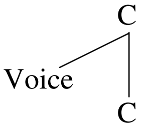
The condition includes two variables; one allows variation at the level in the segment where complexity is not allowed, and the other permits variation in the degree of weakness; a position can be moderately weak, as happens with the vowel in an unstressed syllable, it might be doubly weak, as with the onset in an unstressed syllable, or it might even have a triple degree of weakness, as I will show later. There must, however, be some degree of dependency, because a head position does not avoid rich structure. That is why I have added the restriction that the degree of dependency must be greater than zero.

Having two variables the COMPLEXITYCONDITION is actually a family of related constraints. The specific instance I am going to use is the one in (56).

(56) COMPLEXITYCONDITION – one specific instance
On the primary root node branchingness is not allowed in a constituent with dependency degree 2

This constraint disallows a segment in the onset of an unstressed syllable, if that segment has a root node with two daughters. The laryngeal features are located on the root node. Furthermore, voice is monovalent, of course, with the classical [+voice] being replaced by Voice and the obsolete [–voice] by literally nothing.[4] Schematically, voicing occupies the following position in a segment:

(57) Position of Voice in a segment (obstruent)



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[4] Of course, there is a lot of evidence that this is not universally true. There are many languages where [–voice] is the active value and [+voice] is phonologically inert. I will neglect this important issue here. Also, I will neglect the issue of which feature replaces [+voice]. For our purposes only two things are important: laryngeal features are a property of the primary root node, and [+voice] (or rather Voice) is the active value in Limburg, with [–voice] being absent.

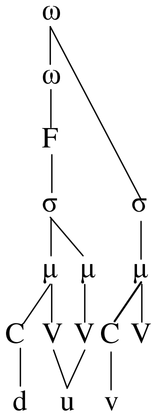
The presence of Voice entails that the root node branches. According to the COMPLEXITYCONDITION that is not allowed in the onset of an unstressed syllable. On the other hand, voiceless consonants are allowed in that position, because, lacking any laryngeal specification, they do not have a branching root node.

In principle we can now understand why the representation in (53b) is incorrect; it contains a voiced consonant in a doubly weak position. The obvious question now is, why the incorrect representation is changed into the correct one, (53a). Here we have to rely on faithfulness. Concretely, faithfulness to the presence of Voice is high ranked. This being the case, the specification Voice cannot be deleted. Another strategy must therefore be found to satisfy the COMPLEXITYCONDITION. I propose that the unstressed syllable containing the constellation in (57) is parsed outside the foot. In that position it is no longer doubly dependent. Consequently, the COMPLEXITYCONDITION is satisfied. Since a foot must be minimally bimoraic, a mora must be inserted in the domain of the stressed syllable. This creates the representation in (53a).

The basic proposal, then, is that the COMPLEXITYCONDITION pushes a syllable with a voiced consonant in the onset out of the foot. The remaining foot must be bimoraic. In this analysis the interaction of the COMPLEXITYCONDITION and the requirement on the minimal size of a foot have the effect of changing Accent2 into Accent1, if the intervocalic consonant is voiced. However, many questions remain to be answered before we can definitely accept this proposal. Let us turn to them now.

The first question is where the syllable that is pushed out of the foot is parsed. Where is this syllable located if not in the foot? I propose that it is located in the Word Appendix (cf. Booij and Rubach 1984; Booij 1995, among others). Formally, the appendix constitutes a second shell of the prosodic word. In this view the full prosodic structure of the form [duː$^1$f] is as in (58). Notice that the empty syllable with its voiced onset is outside the foot, because it occupies the appendix position. Being in the adjoined position of the prosodic word, it is not a dependent of the head of the word (the foot). It is therefore not in a doubly weak position, so that the COMPLEXITYCONDITION is satisfied.

(58) Prosodic structure of [duː$^1$f]



The configuration created under the pressure of the COMPLEXITYCONDITION contains a bimoraic high vowel. This violates the constraint μ → Son, which is highly ranked, as we have seen in (43). We must conclude that the COMPLEXITYCONDITION is even higher ranked; it must crucially dominate μ → Son. This can be shown with the tableau in (59). Brackets indicate foot structure:

(59) COMPLEXITYCONDITION (CC) » μ → Son

| CVVC V<br>d u v | CC | μ → Son |
|---|---|---|
| ☞ μ μ μ<br>(CVV)CV<br>d u v | | * |
| μ μ<br>(CVVCV)<br>d u v | *! | |

The most important question we have to answer is why a full vowel, or an audible vowel, does not lead to an accent shift. Remember that forms like [duː$^2$ve] 'pigeons' (51a) do not shift their accent, although they have an unstressed syllable with a voiced consonant. The explanation is actually not difficult to find. It is well known that only segments of low complexity are allowed in the appendix (Booij 1995). Here we see an instance of this phenomenon. A vowel is only allowed in the appendix if it is just a bare root node. I propose the following constraint:

(60) *App/Struc
A secondary vocalic root node is not allowed in the Appendix

The minimal vowel that is audible is a vowel with a primary and a secondary root node, which is phonetically realized as schwa. The appendix does not tolerate this vowel, or any other audible vowel. The constraint banning structure from the appendix must dominate the ComplexityCondition. This is demonstrated in the following tableau. Curly brackets indicate prosodic word structure.

(61) *App/Struc » CC

| CVVC V<br>d u v ə | *App/Struc | CC |
|---|---|---|
| ☞ μ μ<br>{(CVVCV)}<br>d u v ə | | * |
| μ μ μ<br>{{(CVV)}CV)}<br>d u və | *! | |

The rejected candidate does not violate the ComplexityCondition, because the voiced consonant in the onset occupies the appendix position. It is therefore not in a doubly dependent position. However, satisfaction of the ComplexityCondition conflicts with *App/Struc, because the vowel of the unstressed syllable is audible, that is, it has a secondary vocalic root node. In the first candidate the opposite situation holds; the ComplexityCondition is violated, because now the voiced consonant does occupy a doubly dependent position. This might be bad enough, but the good thing about it is that it satisfies the constraint *App/Struc. Given the ranking *App/Struc » CC, the first candidate will be the winner.

Interestingly, there is one environment where audible vowels do appear in the appendix. This happens when a voiced geminate, be it an obstruent or a sonorant, is located between two vowels. In this environment Accent1 appears without exception. (62) gives some examples illustrating this.

(62) Accent1 always appears after a short V if the following C is voiced

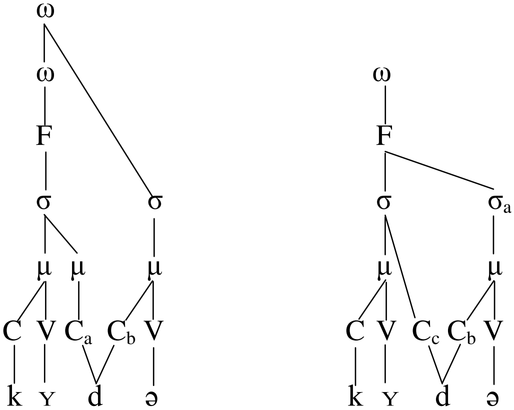
| | |
|---|---|
| [kʏ$^1$də] | ‘herd’ |
| [bɑ$^1$gə] | ‘piglets, pl.’ |
| [kɑ$^1$lə] | ‘speak, 1per. sg. prt.’ |
| [ɪ$^1$ŋəl] | ‘angel’ |

Recall that, in my analysis, stressed vowels are always long, unless they are followed by a geminate. Since the vowels in the examples above are short, the postvocalic consonant must be long, phonologically. Why, then, do these geminates always create Accent1 if they are voiced?

I propose that this phenomenon is a consequence of another instance of the COMPLEXITYCONDITION. Suppose the unstressed vowel would be parsed in the weak position of the foot. In that case the voiced geminate occupies a three-way dependent position. Being in the weak position of the onset and in the weak position of the foot, the second half of the geminate would be doubly dependent. On top of that, the first half would be in the dependent position of the head mora of the stressed syllable. I have indicated this with subscripts in the representation in (63b). Triple weakness, then, is not allowed in Limburg. The constraint ruling this out has the same formulation as the one in (56), but instead of '2' it has degree '3'. I will refer to this instance of the COMPLEXITYCONDITION as CC-3. Suppose, on the other hand, that the unstressed vowel is parsed in the appendix. In that case the representation in (63a) is created. Here the unstressed syllable dominating the second half of the geminate is no longer in a weak position of the foot. Therefore, the geminate occupies a doubly dependent position; its first half is dependent on the head mora, and its second half occupies an onset position.

(63) A case of triple weakness

a. Correct structure b. Incorrect structure



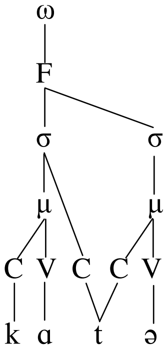
CC-3 must be ranked over *APP/STRUC, as the following tableau shows.

(64) CC-3 » *APP/STRUC » CC

| CVC C V<br>kʏ d ə | CC-3 | *APP/STRUC | CC |
|---|---|---|---|
| μ μ<br>{(CVC CV)}<br>kʏ d ə | *! | | * |
| ☞ μ μ μ<br>{{(CVC)}CV)}<br>kʏ d ə | | *! | * |

Both candidates violate CC, which is caused by the fact that a geminate occupies a dependent position in two different syllables. On top of that the first candidate violates CC-3, because its unstressed syllable is a dependent in the foot. To avoid that, the unstressed vowel is parsed in the appendix, even if that creates a violation of *APP/STRUC. The ranking CC-3 » *APP/STRUC, then, explains why short vowels followed by an intervocalic voiced consonant always have Accent1. In this respect they differ markedly from short vowels followed by an intervocalic voiceless consonant. These always have Accent2. A representative example is [kɑ$^2$tə] 'cats, PL.' (cf. also (38)). The fact that only Accent2 can appear in this environment directly follows from my analysis. Being voiceless, the intervocalic consonant is not subject to the COMPLEXITYCONDITION. The stressed syllable receives one mora only, because otherwise μ → Son would be violated. Having one mora only, the stressed syllable can attract only one tone of the sentence melody. This is the hallmark of Accent2. The prosodic structure of [kɑ$^2$tə] is given in (65).

(65) Prosodic structure of [kɑ$^2$tə]

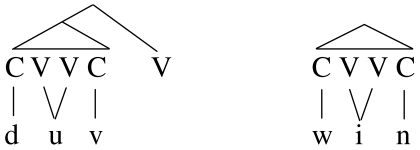


It is interesting that in Limburg voiced obstruents and sonorants behave identically with respect to the COMPLEXITYCONDITION. If my account of the accent shift in terms of the COMPLEXITYCONDITION is on the right track, then that clearly indicates that sonorants must somehow be specified for voicing. Perhaps they carry a spontaneous voicing node, as suggested in Rice (1993). I will not pursue this issue here.

The last important problem that remains to be solved concerns forms like [wiː$^2$n] and [klɛi$^2$t], which have a stem ending in an underlyingly voiced obstruent or a sonorant.[5] These forms preserve Accent2, as we have seen in (50). Historically they did not have a schwa. The analysis as it stands now predicts that forms of this type should not exist. Synchronically, they should behave identically to forms like [duː$^1$f] or [pruː$^1$m] (cf. (51)), which historically did have a schwa. The problem is that cases like [klɛi$^2$t] also end in an empty vowel in my analysis. There must be an empty vowel for the simple reason that superheavy syllables are phonologically two syllables, the last one being empty. If, synchronically, there is no difference between forms that used to have a schwa and forms that did not have a schwa, historically, then how can we account for the difference in their behavior?

I would like to propose that the forms where the accent alternates under the pressure of the COMPLEXITYCONDITION are morphologically complex. The non-alternating forms are not complex, morphologically. In almost all cases, this difference reflects the historical stage; alternating forms have lost an old schwa, whereas non-alternating forms never had a schwa. I have shown this already in (2a) and (5). The morphological distinction can be illustrated with the two representative nouns [duː$^1$f] and [wiː$^2$n].

(66) Morphological structure of /duːv/ and /wiːn/



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[5] There is independent evidence that the obstruent of this form must be voiced at the underlying level, although, admittedly, it is devoiced phonetically in word-final position. In Limburg, *d* is always weakened to *j* in intervocalic position; voiceless *t*, on the other hand, is never weakened. When a vowel follows the stem [klɛi$^2$t] (or actually /klɛid/), weakening does apply, as in the plural [klɛijər]. This shows that [klɛi$^2$t] ends in an underlying /d/.

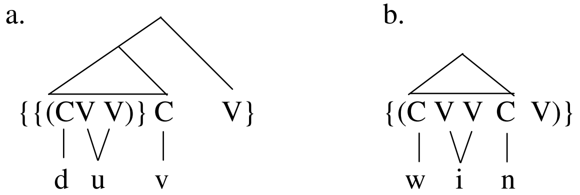
This morphological bifurcation occurs in all major categories. In adjectives, the empty morpheme presumably marks the feminine gender in attributive position, because in this position all adjectives have Accent1, provided their stem ends in a voiced consonant. Examples illustrating this I have already given in (51d). In verbs, the empty vowel presumably marks the present tense in strong verbs, because all strong verbs have Accent1 in the present tense, provided, of course, their stem ends in a voiced consonant and no other overt suffix follows. Finally, in nouns it denotes class membership. It is a declination marker, so to speak. It does not mark gender because alternating nouns can have any gender, although, admittedly, the feminine gender predominates; a simple demonstration: /duː$^{1}$v/ 'pigeon' is feminine, /ɔu$^{1}$x/ 'eye' (5b) is neuter, and /duː$^{1}$m/ is masculine.

Following in particular van Oostendorp (2004) I propose that the edges of prosodic words tend to fall together with morphological boundaries. In Optimality Theory generalizations of this type belong to the 'alignment family'. The constraint that is important for us is the following:

(67) ALIGN-PW/MW
The right edge of the non-minimal word (appendix) must be aligned with the right edge of the morphological word

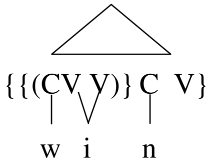
If we now relate the morphological distinctions illustrated in (66) to the prosody, then we get the following structures:

(68) Alignment of prosody and morphology in /duːv/ and /wiːn/



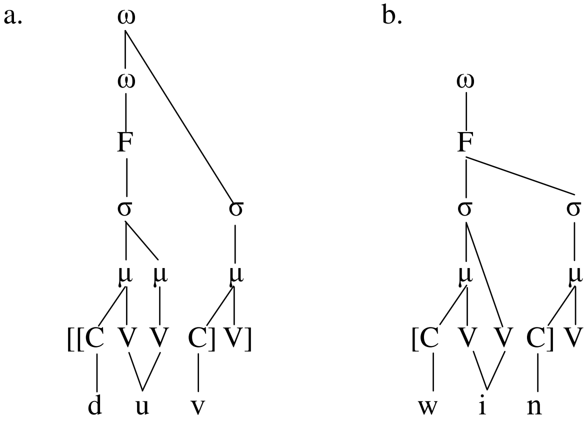
To save space I have indicated prosodic structure with brackets. In the case of /duː$^{1}$v/ the syllable *duː* is contained in a foot, which in its turn is contained in the first shell of a prosodic word. The empty syllable is contained in the second shell of the prosodic word. The right edge of that constituent is nicely aligned with the right edge of the whole morphological word. This representation therefore satisfies ALIGN-PW/MW. The prosody-morphology relation is entirely different in the case of /wiː$^{2}$n/. In this form both syllables are contained in a single foot, which is contained in a single prosodic word. This representation vacuously satisfies the alignment constraint, because the prosodic word of this form is not minimal; it is not an appendix. It is impossible to build a prosodic structure over /wiː$^{2}$n/ that is identical to that of /duː$^{1}$v/. If that were done, ALIGN-PW/MW would be violated. This is shown in (69).

(69) Improper alignment of prosody and morphology in the case of /wiːn/



Here the second shell of the prosodic word, the appendix, is not aligned with a morphological constituent. It therefore violates ALIGN-PW/MW. We can conclude that in a case like /wiː$^{2}$n/, which is non-complex morphologically, it is impossible to construct an appendix. On the other hand, in cases like /duː$^{1}$v/, which are morphologically complex, it is possible to construct a multi-layered phonological word. Now it becomes clear why the morphologically non-complex forms do not allow the accent shift. The shift is triggered by the COMPLEXITYCONDITION. Essentially, this condition pushes a syllable with a voiced consonant in the onset out of the foot, where it lands in the appendix position. However, if there is no appendix position, then the syllable simply cannot find a proper place in the prosodic structure. It must therefore stay within the foot. Consequently, no additional mora needs to be inserted to satisfy the minimal size constraint. Thus, only one mora is located in the stressed syllable, so it can attract only one tone. That is the quintessence of Accent2. In sum, no accent shift is possible if a form is morphologically non-complex. To clarify this I give the full prosodic representation of the two forms /duː$^{1}$v/ and /wiː$^{2}$n/. This time I have indicated morphological structure with (square) brackets.

(70) Prosodic structure of [duː$^1$f] compared to [wiː$^1$n]



In the representation on the left there is an appendix, so the syllable that is forced out of the foot can find a home there. This is not possible in the representation on the right, because there no appendix can be constructed. In this form, then, the COMPLEXITYCONDITION is violated.

In order to guarantee that no appendix is constructed to serve as a shelter for a footless syllable, the alignment constraint must dominate the CC. This is demonstrated in (71).

(71) ALIGN-PW/MW » CC

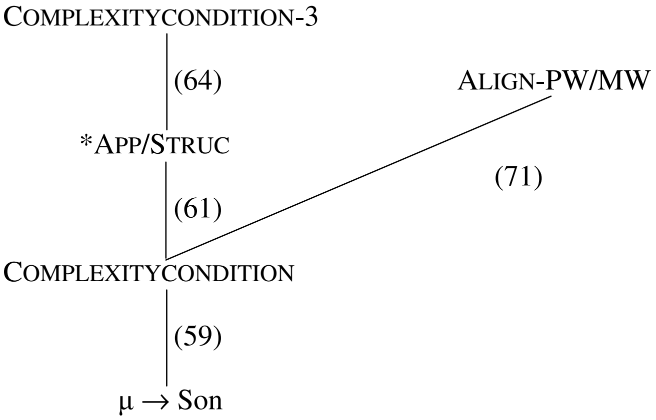
| CVVC<br>w i n | ALIGN-PW/MW | CC |
|---|---|---|
| ☞ μ μ<br>{([CVVC]V)}<br>w i n | | * |
| μ μ μ<br>{{([CVV)}C]V}<br>w i n | *! | |

The first candidate does not violate the alignment constraint, since there is no second shell. This creates a violation of the COMPLEXITYCONDITION. The second candidate does contain a second shell, housing the syllable that is pushed out of the foot. In this way the COMPLEXITYCONDITION is satisfied; but now the alignment constraint is violated. Given the proposed ranking the first candidate is optimal.

In this section I have proposed an analysis of the notorious Limburg accent shift. I have proposed that the shift is triggered by the COMPLEXITY-

CONDITION. This constraint penalizes a rich segment in a doubly dependent position. The effect is that a voiced consonant in the onset of an unstressed syllable is pushed out of the foot. A new mora must then be inserted to make the foot binary. In this way an Accent2 is changed into Accent1. The switch can only occur in morphologically complex forms. Schwa-less forms were not morphologically complex in the history of the language, and they still aren't in the synchronic grammar. Full (audible) vowels do not allow the shift either. That follows from the fact that an appendix can only house an empty vowel. The core of my analysis of the notorious Limburg accent shift is summed up in (72).

(72) Topology of the Limburg grammar, Part II



## 6. Conclusion

I have argued that the contrast between Accent1 and Accent2 can be expressed in terms of syllable structure. Accent1 contains a bimoraic stressed syllable and Accent2 contains a monomoraic stressed syllable. The moraic contrast creates a timing difference in the realization of the intonational melodies. Under Accent1 the pitch changes are realized relatively early, whereas they are realized relatively late under Accent2. The crucial constraint regulating the interface between syllable structure and intonational melodies is TONELICENSING. The specific theory of the syllable I have proposed severs the traditional link between length and weight. Instead, the mora is viewed as a constituent containing a head and possibly a dependent. This being the case, it is more like a syllable node. From this it follows that the mora cannot be subject to faithfulness constraints. We can therefore not use moras at the underlying level to express a contrast. I have shown that, at the underlying level, the moraic contrast can be derived from a length contrast. Accent1 words have an underlyingly long vowel, and Accent2 words an underlyingly short vowel. The crucial constraint taking care of the interface between the underlying level and the surface level is HEAD-DEP. Due to this constraint, a vowel that is short at the underlying level cannot be parsed under a mora. The constituent nature of the mora plays a crucial role in my analysis of the notorious Limburg accent shift. I have argued that this shift can be explained by the COMPLEXITYCONDITION. A voiced consonant is representationally rich. For that reason it avoids the onset of an unstressed syllable. It is therefore preferably parsed in an appendix position. That is only possible, however, if the vowel following the voiced onset is empty and has morpheme status. The grammar accounting for the accentual complexities of Limburg is presented in (43) and (72).

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# Projection of licensing potency from a phonological expression

*Yuko Yoshida*

## 1. Introduction

This paper highlights the distribution of lexical accent in two dialects of Japanese, and discusses the relation between accent and the quality of co-occurring vowels. On the question of the asymmetric distribution of the five vowels in Tokyo Japanese (TJ) and in Kyoto Japanese (KJ) in relation to accent, the following situation holds. In Tokyo Japanese /a/ and /i/ show a tendency to carry lexical accents in native nouns, whereas /u/ is the least likely vowel to be accented. By contrast, in Kyoto Japanese the lexical accent of native nouns is attracted to /u/. The phonological elements proposed in government phonology (GP) (Kaye, Lowenstam and Vergnaud 1985, 1990; Charette and Göksel 1996; Harris and Lindsey 1995) account directly for this asymmetric distribution of lexical accents by referring to the headed status of the simplex melodic expressions $|\underline{A}|$ and $|\underline{I}|$ in TJ and $|\underline{A}|$ and $|\underline{U}|$ in KJ. The identity of the metrical head of a word domain thus depends upon the quality of the melodic expressions present in that domain.

## 2. Pitch accent in Japanese

### 2.1. Data

This study focuses on native nouns with inherent lexical accents comprising two (C)V pairs. Focusing on words of this length enables us to explore a large number of examples, 513 words in all; these exhibit a fairly equal distribution of accents, and furthermore, they are not affected by metrical operations taking place in Japanese (see Yoshida 1999 on the issue of metrical accent assignment). Words consisting of three (C)V pairs are plentiful, unlike native words of four or more (C)Vs in length; however, they are subject to changes in accent pattern, resulting in a choice of alternative pitch patterns for each item (Yoshida 1999). All of the forms to be examined here are used in both the dialects under discussion, either as main forms or at least as alternative forms.

## 2.2. Lexical accent in Tokyo Japanese

As previous work has shown (Haraguchi 1977, 1991; McCawley 1968), words in TJ can be either accented or accentless. If accented, the location of the accent may be either metrically predictable or otherwise lexically designated. A drop in pitch marks the location of the accent, and the whole pitch pattern becomes predictable once the location of the accent is identified: morae to the left of the accented mora should be high pitched except for the word-initial mora, unless this initial mora is itself accented. The distinction between words without an accent and those with word-final accents becomes clear only after a case marker such as *-ga* (nominative marker) is suffixed. The data in (1) represent all three accent types occurring in bimoraic words: two lexically accented classes and the accentless class of TJ nouns. The common understanding is that a lexical accent may be located on any vowel in the word. A bar over one or more segments indicates that the relevant part is high-pitched, and an asterisk (*) denotes the lexical accent. O stands for onset and N for nucleus.

(1) Contrast: lexically accented and accentless terms in TJ

Words comprising two morae (O)N(O)N

| | | | | |
|---|---|---|---|---|
| a. | $\overset{*}{\overline{\text{ha}}}\ \text{si}$ | 'chopstick' | $\overset{*}{\overline{\text{ha}}}\ \text{si –ga}$ | 'chopstick-NOM.' |
| b. | $\text{ha}\ \overset{*}{\overline{\text{si}}}$ | 'bridge' | $\text{ha}\ \overset{*}{\overline{\text{si}}}\ \text{–ga}$ | 'bridge- NOM.' |
| c. | $\text{ha}\ \overline{\text{si}}$ | 'edge' | $\text{ha}\ \overline{\text{si –ga}}$ | 'edge- NOM.' |

For comparison, below I present data which illustrate pitch patterns in words comprising two morae in Kyoto Japanese.

## 2.3. Lexical accent in Kyoto Japanese

KJ and TJ differ crucially in the following ways: first, with regard to the location of lexical accents in corresponding forms; second, with regard to whether the initial mora of the word is subject to high-pitch sharing if the pitch is shared in the word in question; and third, with regard to the number of classes of accentless words with respect to pitch sharing. Two classes of accentless words are marked either by the high-pitch shared by all segments within the prosodic domain (2c), or the presence of a high-pitch only on the rightmost nucleus of the prosodic domain (2d).

(2) Contrast: lexically accented and accentless terms in KJ

Words comprising two morae (O)N(O)N

| | | | | |
|---|---|---|---|---|
| a. | $\overset{*}{\overline{\text{ka}}}$ ki | 'hedge' | $\overset{*}{\overline{\text{ka}}}$ ki -ga | 'hedge- NOM.' |
| b. | ka $\overset{*}{\overline{\text{ki}}}$ | 'oyster' | ka $\overset{*}{\overline{\text{ki}}}$ -ga | 'oyster- NOM.' |
| c. | $\overline{\text{ka ki}}$ | 'persimmon' | $\overline{\text{ka ki -ga}}$ | 'persimmon- NOM.' |
| d. | a $\overline{\text{si}}$ | 'reed' | a si $\overline{\text{-ga}}$ | 'reed- NOM.' |

## 3. Vowels and accent distribution

### 3.1. Introduction

This study focuses on the quantitative distribution of the five vowels in Yamato (native) words, in relation to accented positions in the word. An exhaustive list of native words is available from the Osaka and Tokyo Accent Database (Sugito 1996), which contains 65,928 words with pitch markings. An advantage of using this database for the present study is that it includes information concerning whether or not individual entries existed in the Heian period (AD 794–1192). This assists in the collection of genuine native terms, which is crucial for excluding a plethora of Sino-Japanese words that were nativised in terms of their phonological forms, including their accentuation; in these words, the accent occurs consistently and predictably on the initial vowel (Yoshida 1999). This is due to the fact that the majority take one of three forms: either (C)VN, where no accent is expected on N (a so-called moraic nasal consonant), or (C)VCV, where the second vowel is predictably an epenthetic vowel[1], or (C)VV, where the VV indicates a diphthong in which the second V is rarely accented.

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[1] The epenthetic vowel for this type of word is usually /u/, though /i/ occurs when preceded by a front vowel (Itô and Mester 1996; Tateishi 1990; Yoshida 2003). Accents are rarely found on these vowels in TJ.

### 3.2. Distribution of vowels

Native words have been grouped according to vowel quality in an attempt to establish whether the quality of the vowel shows any relevance to pitch accent in TJ. The following tables show the distribution of vowels and lexical accents in native nouns comprising two (C)V pairs. Three accentual patterns are possible: accent on the initial V, on $V_1$ or $V_2$, or accentless. These data allow us to refer to the distribution of vowels, regardless of accent location.

*Table 1.* Vowel distribution in nouns with initial accent ((C)$V_1$(C)$V_2$)

| | *$V_1$* | *$V_2$* | *Total* |
|---|---|---|---|
| /a/ | 71 | 41 | 112 |
| /i/ | 30 | 59 | 89 |
| /u/ | 37 | 26 | 63 |
| /e/ | 5 | 28 | 33 |
| /o/ | 37 | 26 | 63 |
| Total | 180 | 180 | 360 |

*Table 2.* Vowel distribution in nouns with final accent ((C)$V_1$(C)$V_2$)

| | *$V_1$* | *$V_2$* | *Total* |
|---|---|---|---|
| /a/ | 70 | 68 | 138 |
| /i/ | 34 | 63 | 97 |
| /u/ | 54 | 12 | 66 |
| /e/ | 2 | 24 | 26 |
| /o/ | 26 | 19 | 45 |
| Total | 186 | 186 | 372 |

*Table 3.* Vowel distribution in accentless nouns ((C)$V_1$(C)$V_2$)

| | *$V_1$* | *$V_2$* | *Total* |
|---|---|---|---|
| /a/ | 42 | 39 | 81 |
| /i/ | 31 | 50 | 81 |
| /u/ | 31 | 7 | 38 |
| /e/ | 7 | 25 | 32 |
| /o/ | 36 | 26 | 62 |
| Total | 147 | 147 | 294 |

We see fewer accents falling on /u/ in $V_2$ position and on /e/ in $V_1$ position. The likelihood of an accent falling on each vowel in $V_1$ and $V_2$, is as follows. The majority of word-final accents cluster on /a/ (38%) and /i/

(25%), while the two mid vowels /o/ (20%) and /e/ (8%) attract fewer accents. Not many lexical accents appear on /u/ (13%).

Now, although we know how likely it is for each of the five vowels to attract an accent, it should be noted at the same time that the numbers of tokens of each vowel occurring in the samples are not evenly distributed. In fact, we see immediately an uneven distribution of vowels: both word-initial position and word-final position take /a/ or /i/ more frequently than the other vowels. This suggests that simply comparing the numbers of accented vowels does not reveal with any accuracy the true pattern underlying accent distribution. The proportion of accented vowels should instead be calculated in relation to the total number of tokens of the vowel in question.

### 3.3. Accent ratio per vowel

In order to test the 'accentability' of all five vowels in TJ and KJ, this section examines the ratio for each accented vowel out of the total number of tokens of that vowel.

Let us first consider the accent ratio for Tokyo Japanese. The following tables show how all the vowels are distributed for the three accentual patterns in TJ. Both vowels are extracted from all (C)$V_1$(C)$V_2$ native nouns, giving a total of 1,026 (513x2=1,026) in all 513 samples. Here, 42% of all tokens of /a/ are accented whereas only 29.3% of all /u/ tokens are found with accents.

*Table 4*. Tokyo Japanese: accented versus total

| | *accented* | *total* | *Ratio* |
|---:|---:|---:|---:|
| /a/ | 139 | 331 | 42.0% |
| /i/ | 93 | 267 | 34.8% |
| /u/ | 49 | 167 | 29.3% |
| /e/ | 29 | 91 | 31.9% |
| /o/ | 56 | 170 | 32.9% |
| Total | 366 | 1026 | |

To establish the pecking order of the five vowels in terms of their 'accentability' in accordance with table 4, we should take /a/ (42%) as the most popular, followed by /i/ (34.8%), /o/ (32.9%), /e/ (31.9%), and finally /u/ (29.3%). Note that this order does not correspond to the number of occurrences of each vowel: more tokens of /u/ (167) are found than tokens of /e/ (91).

Turning to the accent ratio for Kyoto Japanese, the following table shows how all the vowels are distributed for the three accentual patterns in KJ, where two accentless types are merged into one. Just as for TJ, both vowels are extracted from the set of $(C)V_1(C)V_2$ native nouns, giving a total of 1,026 (513x2=1,026) in all 513 samples. In fact, final accent in KJ is far less common than initial accent, which allows us to predict the accent location, assuming the word is accented. Yet the quality of the vowel is still important for accentuation, and there is always the possibility of a word being accentless.

*Table 5*. Kyoto Japanese: accented versus total

| | *accented* | *total* | *Ratio* |
|---:|---:|---:|---:|
| /a/ | 89 | 331 | 26.9% |
| /i/ | 46 | 267 | 17.2% |
| /u/ | 75 | 167 | 44.9% |
| /e/ | 13 | 91 | 14.3% |
| /o/ | 47 | 170 | 27.6% |
| Total | 270 | 1026 | |

Striking differences emerge when the ratios of accented /u/ in the two dialects are compared. In KJ, /u/ is the most likely to be accented, whereas in TJ is the least likely. By contrast, the other high vowel /i/ is the second least accented vowel in KJ but the second highest in TJ.

This distribution of accent in KJ easily overturns the null-hypothesis by the Chi-squared test ($\chi^2$):

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

The Chi-square value $\chi^2$ =35.25, with 4 *df* (degrees of freedom) and $p<0.01$, shows that accent distribution is not random in KJ[2].

### 3.4. Possible analyses and problems

It is tempting to resort to the fact that TJ high vowels are subject to devoicing when they are sandwiched between, or word-finally preceded by, voice-

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[2] TJ accent distribution, however, requires a compromise to the standard by setting the probability of error threshold to p<0.17 to show statistical significance. In this paper, I only present the observed tendency demonstrated above.

less consonants. This phenomenon is typical of Japanese dialects in and around the Tokyo area, where accents are avoided on the devoiced high vowels in TJ (Haraguchi 1991; Yoshida 1999). This certainly applies in the case of /u/, which obviously repels accents, but not in the case of the other favoured accent site /i/, which is susceptible to devoicing in the same environment. Therefore this means of accounting for accent distribution does not capture the asymmetric distribution of accents on the two high vowels.

A framework that employs only phonological features would also fail to account for these accent distribution facts. In TJ, a low vowel /a/ and a high front vowel /i/ do not make a natural grouping. The only way to group the two would be to label them as peripheral, although this is also problematic since /u/ should also be included in this category as a high back peripheral vowel. Meanwhile, it is similarly difficult to identify /a/ and /u/ as a natural set, these being the two accent-attracting vowels in KJ. A further challenge would be to explain why in the two dialects different pairs attract the highest proportion of accents. The grouping is well accounted for in the theory of phonological government, however.

The next section shows how the asymmetries between these two dialects can be captured. Of particular significance here are the three vowels /a i u/: /a/ is a preferred accent site in both dialects, while /i/ and /u/ each show a distributional preference in one of the focus dialects, KJ or TJ. In government phonology (GP) terms, these three vowels are simplex phonological expressions, as the following section explains.

## 4. Phonological elements: accents and the head of the word domain

### 4.1. Introduction

The distribution of accents across the five vowels finds an explanation in the theory of government-licensing (Charette 2000; Charette and Göksel 1996; Harris and Lindsey 1995; Kaye 1995; Kaye, Lowenstam and Vergnaud 1990), according to which phonological elements contract licensing relations between one another. In fact, the nuclear position that dominates a phonological expression with a potential licensor element has a strong tendency to be the head nucleus of its word domain, that is, the accented V.

(3) Licensing Principle (Kaye 1995)
All phonological positions save one must be licensed within a domain. The unlicensed position is the head of the domain.

All phonological domains are, without exception, subject to this principle, including the word domain where one nuclear position serves as the head. The word domain head is the nucleus with the primary accent (see also Yoshida 1999).

### 4.2. Phonological elements and licensing

The five vowel system of Japanese offers a good illustration of how phonological expressions (PEs) are composed of three phonological elements; as proposed in the GP literature, these are |A| (non-high), |I| (front/palatal) and |U| (labial/round). Elements are structural objects which are defined cognitively rather than phonetically. In addition, they are univalent units, only one value being considered phonologically significant for each element. In other words, an element is monovalent, being present in one class of segments but absent from the complement set (Harris and Lindsey 1995).

Both TJ and KJ have the five vowel system /a e i o u/, the null hypothesis being that the same licensing constraints apply in both two dialects. Yet the actual phonetic values of /u/ in the two dialects are dramatically different: in TJ, /u/ is an unrounded high back vowel whereas in KJ it is rounded. As discussed above, the two dialects show differing accentual behaviour, which in turn suggests they have non-identical vowel inventories. Indeed, in loanwords, an epenthetic vowel tends not to be the target of accentuation in TJ, whereas in KJ such a vowel often provides the location for an accent. In the following examples, epenthetic vowels are underlined.

(4) a. TJ loanwords: an epenthetic /u/ in the antepenultimate V

| | *antepenult.* | ~ | *accent shift* | *gloss* |
|---|---|---|---|---|
| i. | so N $\overset{*}{\text{b}\underline{\text{u}}}$ re ro | ~ | so N b$\underline{\text{u}}$ $\overset{*}{\text{re}}$ ro | *sombrero* ‘hat’ (Spanish) |
| ii. | a re $\overset{*}{\text{r}\underline{\text{u}}}$ giː | ~ | a $\overset{*}{\text{re}}$ r$\underline{\text{u}}$ giː | ‘allergy’ (German) |
| iii. | n/a | | pu ro $\overset{*}{\text{da}}$ k$\underline{\text{u}}$ sho N | ‘production’ |

b. KJ loanwords: accent placement on epenthetic /u/

i. ma k$\overset{*}{\underline{u}}$ do ‘McDonald’ (clipped form)

ii. bi s$\overset{*}{\underline{u}}$ ko bisu- ‘biscuit’ (clipped), -ko ‘little’ (name of biscuit)

In view of the realisation of PEs in both TJ and KJ, I propose the following:

(5) a. |A| is a natural head, and is the only element to take a complement in TJ and KJ;

b. Licensing of a complement in PE balances the *potency* of the licensor.

The vowel inventory of TJ is expressed as |$\underline{\text{A}}$| for /a/, |$\underline{\text{I}}$| for /i/, |U| for [ɯ], |$\underline{\text{A}}$.U| for /o/, and |$\underline{\text{A}}$.I| for /e/, where underlining represents headedness. The KJ vowel inventory is analysed as |$\underline{\text{A}}$| for /a/, |$\underline{\text{U}}$| for [u], |I| for /i/, |$\underline{\text{A}}$.U| for /o/, and |$\underline{\text{A}}$.I| for /e/. It should be noted that the constraint in (5a) excludes |I.U| for /y/, which is present in some Japanese dialects such as Ishigaki (Ryukyu).

(6) a. Tokyo Japanese
|$\underline{\text{I}}$| |U|
|$\underline{\text{A}}$.I| |$\underline{\text{A}}$.U|
|$\underline{\text{A}}$|

b. Kyoto Japanese
|I| |$\underline{\text{U}}$|
|$\underline{\text{A}}$.I| |$\underline{\text{A}}$.U|
|$\underline{\text{A}}$|

TJ has the simplex PEs |$\underline{\text{A}}$|, |$\underline{\text{I}}$| and |U|, which are interpreted as the vowels /a/, /i/ and /u/, respectively. Note, however, that the phonetic value of /u/ in SJ is actually [ɯ], an unrounded high back vowel. Lacking the salient (i.e. rounding) property of the |U| element, this simplex expression |U| must be a non-headed PE. By contrast, |A| and |I| are headed simplex PEs. Below I expand on the claim that only |U| is a headless expression, unlike |$\underline{\text{A}}$| and |$\underline{\text{I}}$|.

In view of these observations concerning the structure and headedness of simplex PEs, a proposal can be made regarding the relation between pitch accent and vowel quality in Japanese. A pitch accent, either lexical or assigned, is the manifestation of headedness in a word domain (Yoshida 1999). If the melodic content manipulates a position into adopting headedness within the domain, then it seems natural that a position dominating a headed expression should attract the word accent.

(7) Headedness of a (simplex) PE at the melodic level projects up to the word level.

In the following section I consider the behaviour of the other dialect KJ in relation to the proposal in (7). When we observe another class of words, loan words with vowel epenthesis, we see there is a correlation between the headedness of the PE and accent properties (Yoshida 2003). It is recognised that the epenthetic vowel /u/ rarely attracts the word accent; for this reason, then, it is appropriate to consider this vowel in the data being tested for accent-repelling elements. On the other hand, the distribution of lexical accents on native nouns would reveal accent-attracting PEs.

### 4.3. KJ and headship in the word domain

Words in KJ apparently have the same segmental composition as the corresponding TJ words, but with different accentuation. The vowel inventory of Kyoto Japanese resembles that of the Tokyo dialect (i.e. both employ /a e i o u/), though the phonetic quality of /u/ in particular is striking to non-Japanese ears. /u/ in TJ is an unrounded [ɯ], as mentioned above, whereas in many Kansai (western) dialects including KJ it is a rounded [u]. Recall that the most common vowel for lexical accent in KJ is /u/, in contrast to TJ. Following the claim put forward here – namely, that the headedness of a PE projects up to the prosodic domain – the PE for /u/ in KJ must be |U̲|. This leads us to define another set of PEs for the KJ vowel inventory.

The PEs in KJ are proposed as follows: |U̲|, |A̲|, |I|, |A̲.I| and |A̲.U|, where A is the natural head – see (5a). The headed expressions |U̲| and |A̲| project their licensing potential to the prosodic level; thus the two most likely targets for lexical accent in KJ are /a/ and /u/.

In terms of simplex PEs, the likelihood of /a/ and /i/ in TJ and /a/ and /u/ in KJ to attract pitch accents finds a direct explanation in the way the headedness of a PE contributes to prosodic headship. Furthermore, the articulatory qualities of /u/ in the two dialects support the proposed difference between headed and non-headed |U|: the absence in TJ of the element |U|'s salient property, roundness, is captured by the headless status of the PE for /u/ [ɯ], whereas fully rounded /u/ [u] in KJ should be expressed as headed |U|.

At this point we might question why two vowel inventories which share many properties and have a good deal in common should nevertheless come with different PEs. An explanation for this is to be found in those phonological phenomena involving the complex PEs for /e/ and /o/. A constraint on the balancing of licensing potency (5b) will be considered in §5.

### 4.4. Headedness and high vowel devoicing

The difference in headedness of the PEs for the two high vowels in TJ and KJ is further supported by the facts of so-called high vowel devoicing (HVD). In TJ it is well known that the back and front high vowels undergo devoicing when they occur either between voiceless consonants or domain-finally after a voiceless consonant.

(8) High Vowel Devoicing in TJ

| | | | |
|---|---|---|---|
| a. | Front vowels | si̥ k ka ri | 'steadily' |
| | | pi̥ t ta ri | 'exactly' |
| b. | High vowels | su̥ k ka ri | 'completely' |
| | | pu̥ t tsu ri | 'abruptly' |

Kansai dialects such as KJ are usually treated as non-HVD dialects. In fact, the front high vowel in KJ is reportedly subject to HVD (Fujimoto 2005), while the high back vowel is less susceptible to HVD. In (9) the same data demonstrates how the two high vowels in KJ compare with those in TJ.

(9) High Vowel Devoicing in KJ

| | | | |
|---|---|---|---|
| a. | Front vowels | si̥ k ka ri | 'steadily' |
| | | p̥i t ta ri | 'exactly' |
| b. | High vowels | su k ka ri | 'completely' |
| | | pu t tsu ri | 'abruptly' |

## 5. Licensing and complex PEs

### 5.1. Introduction

At the segmental level there are some phonological phenomena that involve licensing between phonological elements and PEs. Unlike the case of the simplex PEs observed above, licensing at the segmental level will be balanced and the licensing potency will not remain the same when projected up to the prosodic domain. Some issues relating to segmental operations are discussed below to illustrate the balancing of PEs.

### 5.2. Headedness in conflict in TJ

The vowels /e/ and /o/ are represented as complex PEs: [e] as a combination of |A| and |I|, and [o] as a combination of |A| and |U|. To determine which of the two combined elements is the head element in /o/, it is a straightforward matter: this vowel combines the licensor expression |$\underline{A}$| and the headless expression |U|, with |$\underline{A}$| simply passing on its headedness to the compound expression to license |U|. For /e/, however, the combination of the two headed expressions |$\underline{A}$| and |$\underline{I}$| creates a headedness conflict. The headedness of both cannot be combined to boost the licensing potential of the complex PE; rather, they cancel out each other's licensing potency. The low occurrence of /e/, as evidenced by the data in tables 4 and 5, provides evidence for this conflict of headedness. This is also the reason why /o/ is permitted to bear more accents than /e/ does.

The simplex headed expressions |$\underline{A}$| and |$\underline{I}$| attract accents the most frequently, followed by the two complex expressions /o/ and /e/; finally, the headless expression |U| attracts the fewest accents. The PEs that attract an accent are |$\underline{A}$| and |$\underline{I}$|, both of which are headed, whereas the headless PE, |U|, appears to repel accents. This suggests that licensing power is consumed when elements are combined, thereby weakening the ability of the head element to transmit potential to support headship at the prosodic level.

Yet this line of argument leads to another implication in TJ: the headedness of a PE is passed on and determines the headedness of the word domain. The PE for /e/ should be headed, in order to account for the relatively high proportion of accented /e/ tokens compared with tokens of accented (headless) /u/. Below I discuss how this balancing is resolved in KJ.

## 5.3. Complex PEs in licensed positions in KJ

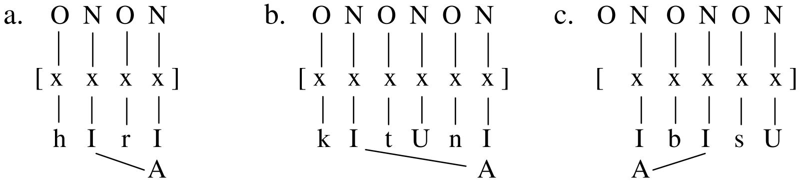
Referring back to the proposal in (7), I demonstrate here the natural consequence of projecting segmental headedness up to the prosodic level. Headedness at the segmental level is projected up to determine accent location in the word domain; thus a licensed position is not subject to this kind of projection. The fact that fewer accents are found in a slot dominating a complex PE is therefore a manifestation of the licensing relation which characterises a complex PE: the licensed position at the segmental level is not projected to the prosodic level.

This is supported by evidence from vowel harmony. Recall that the PEs in KJ are analysed as follows: |U|, |A|, |I|, |A.I| and |A.U|, where |A| is the natural head. As mentioned briefly, in terms of segmental composition the 513 bimoraic nouns examined above are the same in both TJ and KJ. However, the dialects in and around Kyoto display some unique characteristics involving the negation of verbs, which result in a vowel harmony effect yielding /e/ from a high front vowel. Of interest here is the fact that, despite lexical /e/ being infrequent in both KJ and TJ, this vowel has a relatively favoured status in KJ. /e/-harmony processes demonstrate how the balancing of PEs operates in KJ: the nuclear position dominating the PE |A.I| (for /e/) is in many cases a licensed position in the process of vowel harmony. A nuclear position dominating |I| is naturally licensed by another nuclear position dominating |A|. The examples in (10) show the effects of vowel harmony in a noun. Corresponding TJ forms are given for comparison. This harmony process is active in loanwords (10a) and Sino-compounds (10b), as well as in native *Yamato* words (10cd). The harmonised vowel is represented by *e*.

| (10) | *KJ* | *TJ* | |
|---|---|---|---|
| a. | h*e*re | hire | ‘fillet’ (of meat) |
| b. | keNn*e*nji | keNninji | ‘Ken’nin’ (temple name) |
| c. | k*e*tune | kitune | ‘fox’ |
| d. | eb*e*su | ebisu | ‘Ebisu’ (god of wealth and trade) |

In KJ, if a licensor |A| element is present in the word domain, then the headless expression |I| has to be licensed by that licensor |A|.

(11)



Along the same lines, we also find examples of harmony spanning morphological boundaries. In such cases, however, the harmony is active only when the |A| licensor is located in an adjacent nucleus.

(12) a. No adjacency (with no resulting harmony)

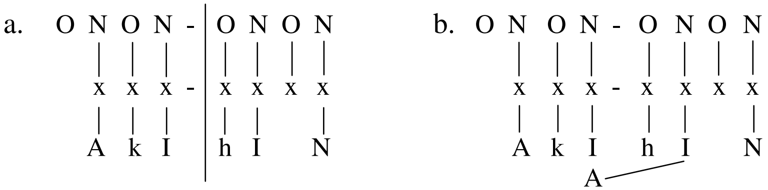
| | |
|---|---|
| oki-hiN | 'get up - not' |
| aki-hiN | 'get bored - not' |

b. |A| licensor adjacent

| | |
|---|---|
| aka-heN | 'open - not' |
| oka-heN | 'put - not' |
| uke-heN | 'take - not |
| toke-heN | 'melt - not' |
| o-heN | 'be - not' |

The verb stems in (12a) do not have an |A| licensor which is in morpheme-final position and adjacent to the initial nucleus of the negative suffix; therefore, as (13a) shows, no harmony effects are observed.

(13)



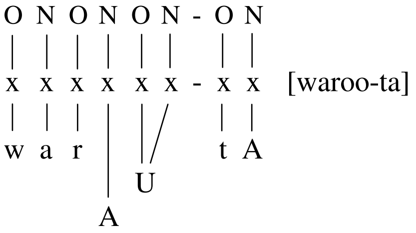
Although two conditions are required for |A|-licensor harmony to operate, one lexical and the other morphological, the process is a productive one in the Kyoto dialect. KJ /e/ is composed of |A| and |I|, where the headed |A| naturally licenses headless |I|, giving |A.I|. By contrast, this harmony process is not found in TJ, where /e/ is a combination of |A| and |I|. Note how the licensor aggregate for /e/ in TJ, formed by a combination of two headed elements, results in the low incidence of the vowel /e/ lexically, marking the loss in potency of the licensor |A|. In terms of accent distribution, in KJ too, a slot occupied by the vowel /e/ is a licensed one, thus the lowest number of lexical accents is found in this position.

/o/ is a frequently accented vowel in KJ. The licensor aggregate for /o/ is not completely exhausted in this dialect, and it will still remain a strong licensor of the prosodic domain. Here is one instance of a merger process involving |A| and |U|, the result of which spans two nuclear positions. Yet the |U| element originates in an onset, this process showing that the merging of |A| and |U| is productive in KJ. The past tense form of verbs whose stems end in the sequence /aw/ results in a form with a long vowel /o:/[3].

| | | | | | |
|---|---|---|---|---|---|
| (14) | a. | waraw- | 'to laugh' | waroota | 'laughed' |
| | b. | moraw- | 'to receive' | moroota | 'received' |
| | c. | kiraw- | 'to hate' | kiroota | 'hated' |

In GP terms, the glide /w/ is viewed as the |U| element, and forms the PE |A.U|. KJ, just like TJ, does not license empty domain-final nuclei (Kaye, Lowenstamm and Vergnaud 1990; Yoshida 1999), meaning that the nuclear position following the onset dominating /w/ must be filled phonetically:

(15)



Of course, further evidence besides this merger process would be desirable in order to strengthen these arguments for the licensing potency of combined |A| and |U|.

## 6. Conclusion

This paper has demonstrated how accent distribution can be accounted for within the theory of government, the analysis relying on a particular correlation between two independent levels of structure pivoted around the

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[3] The stem form is established by observing what happens when the negative suffix '-anai' is added. In this case the result is *warawanai*.

skeletal tier. The difference between the most and least frequent vowels lies in the headedness of the respective PEs which represent the relevant segments. An approach based on the headedness of PEs is independently motivated by the facts of vowel harmony observed in the Kyoto dialect.

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