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1 Introduction

The use of distinctive features in representations has become one of the most consistent characteristics of mainstream phonological theory. New features are introduced from time to time, and some existing features become disfavoured, yet the basic conception of a distinctive feature set remains constant. Similarly, the notion of a geometry of features - a hierarchical organization of those features within a single segment - now has an established history, although its details have been subject to regular revision. The motivation for positing structure inside segments comes from the desire to account for regular groupings of features and regular patterns of behaviour that show up across different languages. In short, features behave in a way that is clearly systematic, and the goal of feature geometry is to encode the properties of that system.

The widespread acceptance of distinctive features does not, however, imply that alternatives are not available. A significant challenge to feature-based models comes from Element Theory (Kaye *et al*. 1985; Harris & Lindsey 1995), which attempts to impose tighter restrictions on the generation of possible melodic expressions by proposing a reduced set of (single-valued) primes. Within this smaller inventory, some kind of geometric organisation is assumed to exist, too. For example, one grouping that has been suggested brings together the two 'source' elements |H| and |L| under a common LARYNGEAL node. In this paper I will discuss aspects of the phonological behaviour of these two primes, in order to provide additional support for the grouping just mentioned. In particular, I will claim they are united primarily by the strong affinity they both have for the units of prosodic structure.

The paper is organized as follows. I begin with an overview of the theoretical background to the discussion, including an insight into the nature of Element Theory and into the need for intra-segmental geometry. Section 3 shows how |H| and |L| behave as 'regular' elements by creating segmental contrasts, while section 4 describes their suprasegmental behaviour in tone and intonation systems. Then, section 5 develops the claim that |H| and |L| are closely associated with the units of prosodic structure in ways which set them apart from other members of the element inventory. This reinforces the suggestion that they be grouped together under a single structural node.

2 Theoretical background

2.1 Melodic primes

Assuming that the fundamental goal of a phonological theory is to model the knowledge possessed by speakers about the sound structure and sound patterns of their native language, then clearly any theory must be able to describe the set of representational units available to those speakers' mental grammars. This set will include both melodic units (i.e. those relating to the contrastive or qualitative properties of language sounds) and prosodic units (i.e. those relating to the structural or relational organization of melodic units).

While there exists some degree of consensus on the nature of prosodic units - where categories such as *prosodic word, foot, nucleus* and *syllable* are shared by several theories that appear to have little else in common - the same cannot be said of melodic units. On the contrary, how we envisage the inventory of melodic primes will vary significantly according to theoretical persuasion. Areas of disagreement typically include questions over whether primes should be single-valued (i.e. present versus absent; monovalent) or two-valued (i.e. plus versus minus; bivalent), whether they should be defined in terms of articulatory or acoustic properties, and whether or not they should be fully specified at different levels of analysis.

For the purposes of the present paper, the answers to these questions lead on directly from the choice of an Element Theory approach to melodic representation.[1] According to this view, segments are composed of one or more acoustically-motivated, single-valued primes or 'elements' taken from a universal set comprising between 5 and 8 members. Undisputed membership of this inventory is enjoyed by the three 'resonance' elements |A,I,U| and the two 'source' elements |H,L|. In broad terms, the first group is responsible for describing vowel contrasts and consonantal place specifications, while the second group describes (amongst other things) voicing contrasts, nasality and tonal properties. Additional elements assumed by some versions of the theory include primes relating to glottal states.

Melodic representations in Element Theory are compositional, meaning that individual elements can (and usually do) combine to form complex expressions. Within such an expression, each element contributes its own acoustic characteristics to the overall acoustic profile of the segment. However, single-element expressions are also possible, owing to the assumption that all elements are phonetically interpretable in isolation. Arguments that motivate the use of elements in phonological representations have been made in the relevant literature, and will not be repeated here. Instead, let us turn to the matter at hand.

1) See Harris & Lindsey (1995) and Neubarth & Rennison (in press) for a theoretical overview and a discussion of the arguments against working with a standard set of distinctive features.

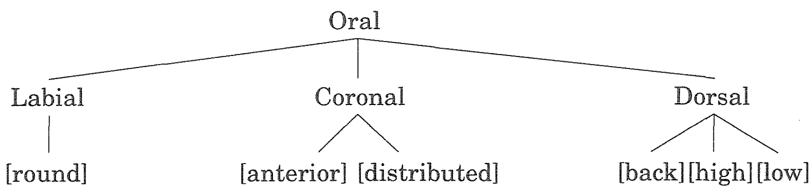
Regardless of whether we choose to work with elements, features, particles, components, or any other kind of melody units for that matter, we must consider the following question. Is our inventory of primes simply a list of properties that pattern independently of each other in representations, or should we recognize some internal organization within that inventory - groups of primes, or hierarchical relations between primes, for example - to reflect similarities in distribution or dynamic phonological behaviour? Sections 4 and 5 below will address this issue with particular reference to |H| and |L|. I will present evidence for a separate LARYNGEAL node comprising these two elements, the motivation coming from the similar relationship they both have with the units of prosodic structure.

2.2 Structure within segments

Since the mid-1980s the phonology literature has been experimenting with ways of incorporating internal structure into melodic representations, most often through the use of dependency relations or category groupings. The geometric model proposed in Clements (1985) sparked a flurry of interest in this area, the same basic idea being taken up shortly afterwards by Sagey (1986), McCarthy (1988), Halle (1992) and others. Before long, the label 'feature geometry' had evolved as a cover term for the numerous feature-based models of this type, many of which employed bivalent features of the *SPE* (Chomsky & Halle 1968) type and focused on the internal composition of consonants. The resulting feature trees tended to be relatively large and structurally complex, owing to the sizable number of features involved. Generally, such trees were built around the articulatory groupings of melodic units.

The primary motivation for intra-segmental geometry comes from the observation that only a subset of all possible feature combinations is ever exploited in the construction of a language's inventory of contrastive sounds. Moreover, the same combinations are seen to occur across many different languages in a way that is clearly systematic. For example, the hierarchical structure in (1) allows us to capture the fact that (the marked value of) the feature [distributed] can never contribute to the description of a low vowel.

(1)



A further assumption of feature geometry models is that a *bona fide* melodic expression (i.e. one belonging to the universal set of potentially contrastive segments) can be generated by selecting a single articulator (e.g. Labial, Dorsal, etc.), together with the appropriate dependent feature(s), from a cavity node such as Oral. Since the representation of a low vowel involves a specification of the feature [low], which is a dependent of the Dorsal articulator, the same representation cannot also make reference to [distributed], which is dependent on the presence of the Coronal node. The co-occurrence of the two features [low] and [distributed] is thus ruled out, as this may be achieved only by the (illegal) selection of more than one primary articulator in the description of a single segment.

Whilst filtering out unattested feature combinations, feature geometry is also intended to capture the appropriateness of combinations that regularly do occur. The hyponymous relation between Labial and [round], or between Dorsal and [back], where the properties of the dominating articulator node are inherent in the chosen terminal feature, is encoded in the dependency (i.e. implicational) relation that holds between the two. In the geometric models mentioned above, this relation tends to reflect the physical limitations imposed upon speech sounds by the human vocal organs.

Besides attempting to account for the distributional or contrastive properties of a language's sound system, feature geometry also aims to impose restrictions on the kinds of dynamic phonological processes we are likely to observe. In Odden (1991) a feature geometric structure is proposed for vowels, and is driven by assumptions similar to those already mentioned - namely, that (i) every group node or individual feature may be accessed by attested vocalic processes, and (ii) no process need refer to more than a single constituent in its description. At the same time, the structure serves to rule out unattested phenomena; for example, it predicts that no structure-changing process will target high rounded vowels exclusively, since the respective features [high] and [round] belong to different articulatory groups.

Several other models employing a feature-based geometry have been proposed, including Goad (1991), Humbert (1989) and Mester (1988). Although these make interesting observations concerning the nature of segment-internal structure, they will not be discussed here.[2] The notion of geometric structure has also been extended to frameworks where distinctive features are rejected in favour of fully interpretable melodic primes. In particular, the development of Dependency Phonology (Anderson & Ewen 1980, 1987) has witnessed a number of proposals for intra-segmental organization, where melodic primes are arranged into clusters labelled 'sub-gestures', which are themselves dominated by larger 'gesture' groupings (van der Hulst 1994, 1995).

To a lesser extent, the Element Theory model introduced in §2.1 has also been exposed to geometric treatment, although, like any other theoretical approach, we encounter a certain amount of variation in the way that particular aspects of the theory have been accepted. The minority view would maintain that each melodic element in the inventory displays complete independence from all the other members. From this it

2) For a survey of the ways melodic geometry has been incorporated into phonological representations, see Backley (1998).

follows that no internal groupings of elements should be necessary. It also follows that distributional patterns and phonological processes should show no bias when it comes to targeting individual elements or combinations of elements. Instead, all melodic expressions (whether comprising a single element or a fusion of several elements) should be equally accessible by the phonology. For example, this view predicts that vowel systems should contain the segments Seg_1 and Seg_2 with equal likelihood:

(2a) Seg_1 = a high, front, rounded [y] - elements I and U combined
Seg_2 = a high, back, rounded [o] - elements A and U combined

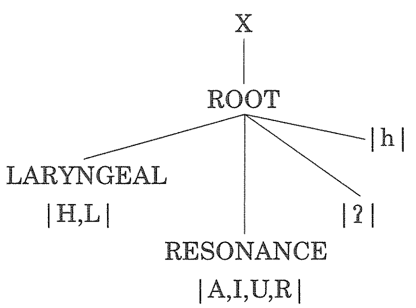
Under the same view, a phonological process that targets the set of sounds Set_1 should be just as readily observed as one that targets Set_2:

(2b) Set_1 = breathy voiced consonants [b^h,$ɡ^h$...] - elements L and H combined
Set_2 = coronal obstruents [d,θ,z,tʃ,ð...] - elements R and H combined

Clearly, predictions such as these fail to match the patterns of distribution or dynamic behaviour that we observe across different languages. Rather, there is substantial typological evidence to support the claim that |A,U| represents a far more natural and less marked combination than |I,U|, for example. Similarly, |R,H| is much more common cross-linguistically than |L,H|, either as a natural class of sounds or as the target of a phonological process.

What this minority view highlights, then, is the need to recognize some kind of internal organization within the small inventory of melodic elements. The version of element geometry I shall discuss here is presented in Harris & Lindsey (1995), where the configuration of elements shown in (3) is proposed:

(3)



Like the feature geometry models mentioned above, this structure derives from the assumption that melodic primes form natural classes in the same way that segments do. Here, each class node (given in upper case) represents a recurrent grouping of elements, where all members of a single class are united one or both of the following:

—— similar distributional properties:

e.g. they regularly occupy the same syllabic position (nucleus, onset...)

—— similar dynamic properties:

e.g. they trigger or undergo the same kind of process (assimilation, lenition...)

To illustrate, the RESONANCE node corresponds most closely to the PLACE node found in many feature geometry models,[3] and contains those primes responsible for most vowel contrasts. In addition, resonance elements define 'place' specifications in consonants, as well as characterizing the assimilation processes associated with those 'place' properties.

However, of particular interest here is the LARYNGEAL node containing the elements |H| and |L|, which is "motivated by the independent and unified behaviour of primes involved in tonal and phonation-type contrasts" (Harris & Lindsey 1995: 75). Throughout the remainder of this discussion I will maintain the importance of recognizing a separate laryngeal node, but will attempt to redefine the reasons for its place in phonological representations. Specifically, I will claim that |H| and |L| form a natural grouping primarily through their links with prosodic structure, rather than through their contribution to segmental contrasts. Support for this view will be gathered from observations of the various ways |H| and |L| are implemented cross-linguistically in phonological structures.

3 Segmental contrasts involving |H|/|L|

Before turning to the focus of this discussion, which is the prosodic behaviour of the laryngeal elements |H| and |L|, let us first consider how these primes contribute to minimal (i.e. phonemic) contrasts. To begin with, the phonological patterning of the source elements allows us to capture those contrasts subsumed under the phonetic label of Voice Onset Time (VOT) distinctions. Element Theory makes the claim that two independent melodic categories are needed to describe such distinctions. These are the high source element |H|, representing long voicing lag (or aspiration), and the low source element |L|, representing long voicing lead (or full/true voicing). Harris (1994) specifies the two elements as follows:

(4)	Element	Acoustic Pattern	Articulatory Effects
	|H|	F0 up	spread vocal folds
	|L|	F0 down	slack vocal folds

Because elements are assumed to behave as autonomous and independent objects in

3) Within a theory of elements defined in acoustic, as opposed to articulatory terms, the label *resonance* is clearly more appropriate than *place*.

representations, a (maximal) four-way distinction is possible:

(5)	Source Element(s)		Interpretation in a Plosive (CV Syllable)
	a.	none	zero or short voicing lag (= neutral stop)
	b.	|H|	long voicing lag (= voiceless aspirated)
	c.	|L|	long voicing lead (= fully voiced)
	d.	|H,L|	long voicing lead and lag (= breathy voiced)

The neutral stops of category (5a) occur in all languages, and are derived through the non-specification of both source elements. On the other hand, the presence of lone |H| and lone |L| in a representation are interpreted as (voiceless) aspiration and true voicing, respectively. Finally, owing to the compositional nature of melodic representations in Element Theory, a segment containing |H,L| in combination translates into breathy voicing or voiced aspiration. While many languages distinguish between no more than two glottal states (e.g. |H| versus 'none' in German; |L| versus 'none' in French), some allow a three-way source contrast (e.g. |H| versus |L| versus 'none' in Thai). To satisfy typological predictions, we also find a small number of systems employing the full set of source contrasts (e.g. |H| versus |L| versus |H,L| versus 'none' in Gujarati).

The VOT contrasts just outlined clearly belong to the description of obstruent consonants, which means that the source elements shown in (5) are associated with non-nuclear syllabic positions. However, Element Theory further assumes that |H| and |L| also contribute to vocalic (i.e. nuclear) contrasts. In this case, they create the tonal distinctions - |H|igh tone and |L|ow tone, either individually or in combination - that provide the additional dimension of segmental contrast used in tone languages (Harris 1998). For details of how the two source elements can be used to account for the full range of tonal distinctions (including contour tones), the reader should consult the references cited above.

The source element |L| also operates at the segmental level to create oral (the absence of |L|) versus nasal (the presence of |L|) distinctions. This assumption compares favourably with the position taken in earlier versions of Element Theory, where an independent nasality element |N| had been posited (Kaye 1989). More recently, however, evidence has come to light concerning the degree of similarity between |N| and |L|, in terms of their acoustic properties and their phonological behaviour (under alternating conditions, for example). This line of research has culminated in the conclusion that nasality and obstruent voicing should be seen as two different phonetic manifestations of the same phonological category |L| (for the relevant arguments, see Nasukawa 2000 and Ploch 1999). Following Nasukawa (1997), the presence of |L| as the head of a melodic expression is interpreted as long lead voicing, while as a non-head the same element contributes nasality.

Finally, it has been suggested in the Element Theory literature that headship distinctions create a dual interpretation of the |H| element too. As mentioned above, the presence of |H| in obstruents manifests itself as long voicing lag (i.e. aspiration or 'true' voicelessness). This is observed in, for example, most Germanic languages like English and Dutch. Let us now qualify that statement by saying that, in fact, the phonological category responsible for aspiration is |H| as a non-head, while the same element as the head of a melodic expression contributes the aperiodic ('noisy') energy we associate with the class of fricative sounds (Neubarth & Rennison, in press).

A summary of the roles of |H| and |L| in segmental contrasts is shown in (6). The references cited above discuss details of the relevant phonological factors that determine which of these possible interpretations is chosen in any given instance.

(6) |H| element:	high tone on vowels (e.g. languages with lexical tone) aspiration in plosives (e.g. English, Korean...) audible friction in fricatives (e.g. most languages)
|L| element:	low tone on vowels (e.g. languages with lexical tone) nasality in vowels and sonorant Cs (e.g. most languages) full voicing in obstruents (e.g. French, Japanese...)
|H,L| fused:	contour tones on vowels (e.g. languages with lexical tone) breathy voicing in plosives (e.g. Gujarati...)

Generally speaking, these interpretations of the source elements have scope over a minimal prosodic domain (i.e. a single segment). In this respect they have much in common with the other members of the element inventory. However, what sets |H| and |L| apart from those other elements is their tendency to correspond to larger prosodic domains. Let us now turn to examples of this association, which I claim to be the property that unites the two source elements |H| and |L| under a single LARYNGEAL category node.

4 The relation between |H|/|L| and prosodic categories

4.1 Tonal distribution

One aspect of the link between |H|/|L| distribution and prosodic structure has just been mentioned, somewhat paradoxically, in relation to segmental phonology. In tone languages, which constitute the majority of the world's languages, the function of the source elements |H| and |L| is, of course, to create lexical contrast. So, minimal pairs such as *pàn-pán* in a tonal system have the same linguistic status as ones such as *pan-pen* in systems without lexical tone. However, rather than specifying lexical tone as a purely segmental property, numerous studies in tonal behaviour have confirmed that tones are more appropriately seen as belonging to larger prosodic domains such as the syllable and the word. The collection of tonal analyses in Fromkin (1978) provides a useful source for the relevant references. See also Comrie (1987).

To illustrate the point, let us consider a couple of (well-worn) examples. The Southern Manyika dialect of Shona is given in Roca (1994) as an instance of high or low tone existing as the property of an entire prosodic word. This remains the case when the size of the prosodic word increases through suffixation. Let us assume that the verbal root *teng* 'buy' comes with a lexical |H| element, which is interpreted on its vowel. The addition of various suffixes (e.g. causative, reciprocal) to the root has the effect of extending the duration of the high tone property, as in (7a), since these affixes do not constitute their own prosodic word domain. The forms in (7b) show how the lexical specification of |L| as a prosodic property operates in a similar way.

(7)	a.	téng + á	'buy'
		téng + és + ér + á	'sell to'
		téng + és + ér + án + á	'sell to each other'
	b.	èrèng + à	'read'
		èrèng + èr + à	'read to'
		èrèng + ès + à	'make read'

Although this behaviour mirrors the effects of vowel harmony involving resonance elements such as |U| (for rounding harmony) and |I| (for palatal harmony), an important difference lies in the frequency with which each is observed. While harmonic agreement using the vowel elements |I,U,A| remains a relatively uncommon characteristic among the world's languages, the word-level (i.e. prosodic) specification of |H|igh tone and |L|ow tone is the expected pattern of distribution for these elements.

As a further illustration of how |H| and |L| are associated with prosodic domains rather than individual segments, consider cases where a mismatch exists between the number of lexically specified tones and the number of tone-bearing units (i.e. vowels). In Mende (Leben 1978) any one of five basic tone patterns (H, L, H-L, L-H, L-H-L) in the language may be associated with a given lexical item. The pattern is then distributed across the nuclei of the word, regardless of the number of syllables present, according to standard tonal association conventions. For example, the word-level specification of the pattern L-H may vary in the following way:

(8)	fàndé	'cotton'	(one tone per vowel)
	ndàvúlá	'sling'	(H spreading to unassociated vowels)
	mbǔ	'rice'	(contour tone via H dumping)

4.2 Intonation patterns

Clearly, the tonal elements in Mende are stated lexically as the property of entire words, rather than of individual segments. However, it is also common to find the elements |L| and |H| associated with still larger prosodic units, when they play an active role in the representation of intonation systems. No human language is spoken naturally on a monotone. Rather, changes in pitch regularly contribute to the overall message conveyed by longer stretches of speech. Informally, we may associate these chunks of spoken language with grammatical phrases and clauses. In terms of phonological representations, they are linked to higher nodes in the prosodic hierarchy such as the intonational phrase and the phonological phrase.

Most recent approaches to the analysis of intonation (Pierrehumbert 1980; Ladd 1996) have argued for the existence of two principal features of pitch contours, L(ow) and H(igh) - which I will loosely equate with the multi-faceted |L| and |H| in Element Theory. These features are understood to capture two rather different aspects of the pitch characteristics of utterances, and are therefore linked to the prosodic units of utterances in two different ways. First, |L| and |H| associate to the boundaries of intonational phrases to yield various 'edge' features, such as the rising pitch occurring at the end of some questions. Second, |L| and |H| can associate to syllables bearing a pitch accent, which may occur at any point between the phrasal boundaries.

To illustrate, consider the following example taken from Ladd (1996). Pitch accents (high or low) are marked with *, while % indicates a boundary tone.

(9) **H*** **L+H*** **L** **L%**
That was the whole point of the exercise.

In (9) the first word of the utterance is accented and carries a high pitch. On the following pitch accent, located on the word *point*, the effect of an emphatic stress is derived from the presence of a contour tone. The |L| tone on the right boundary encodes a long low-pitched tail at the end of the utterance.

Recent developments in the analysis of intonation (Cabrera-Abreu 2000) have explored the possibility of analysing pitch movements without reference to the element |L|. This move does not, however, detract from the arguments being made here. As well as being both interesting and desirable from a theoretical point of view, the |H|-only model continues to reinforce the close correspondence between the source element(s) and prosodic categories.

5 The function of |H|/|L| as prosodic markers

5.1 Introduction

Aside from their typical behaviour as suprasegmental features in representations, the source elements |H| and |L| also display their close relationship to the units of prosodic structure in other ways, too. In this section I will examine how these primes can function as markers to indicate the location of the boundaries of prosodic categories. The usual conception of the melody-prosody split boils down to the assumption that melodic structure refers to phonetically interpretable information while prosodic structure refers (exclusively) to organizational information. From a traditional viewpoint, therefore, the link between the two carries little significance - prosodic structure provides the pegs from which segmental material is hung.

Recent work in phonology has, of course, adopted a quite different approach to this question, and attention has shifted to discovering ways in which melody and prosody may be integrated into a unified structure (Harris 1997, Backley 1998). Below I shall review examples of how this integration manifests itself in the phonotactic patterns of different sound systems. Before that, let us consider the case of languages in which it appears that prosodic units - at least, the markers indicating the boundaries of those prosodic units - are themselves audible (i.e. phonetically interpretable).

5.2 The phonetic interpretation of prosodic boundaries

The process of word-final devoicing is observed in a number of languages, including German, Polish and Russian, in which the voicing contrast in obstruents is neutralised in word-final position. In fact, the relevant environment can be described more generally as domain-final, with the same effect taking place at certain morphological junctures too. The following examples from German illustrate how lexically 'voiced' and 'voiceless' obstruents are both interpreted as 'voiceless' in word-final position (10a) and before derivational suffixes (10b).

(10)	a.	*Hand*	[hant]	'hand'
		Hände	[hendə]	'hands'
		geben	[geːbən]	'give' (infinitive)
		gab	[gɑːp]	'gave'
	b.	*Verständ-nis*	[vəʁstɛntnɪs]	'understanding'
		verstanden	[vəʁstandən]	'understood'
		kind-lich	[kɪntlɪç]	'child-like'
		Kinder	[kɪndəʁ]	'children'

Recall from §3 that a system employing a two-way source contrast can be analysed phonologically in two different ways: the distinction may be based either on aspiration (|H| versus zero - e.g. English, Dutch) or on true voicing (|L| versus zero - e.g. French, Japanese). Independent evidence from the phonology of German indicates that this language belongs to the first group, as confirmed by processes such as the assimilation of |H| (i.e. of voiceless properties) between neighbouring obstruents (see Harris 1994).

Assuming the |H|-based analysis of voicing in German to be correct, we arrive at (lexically) minimal pairs such as the following:

(11)	*Rat*	/ʁɑːt/	[ʁɑːt]	'advice' (/t/ contains |H| lexically)
	Rad	/ʁɑːd/	[ʁɑːt]	'wheel' (/d/ contains no source element)

Like *Rad,* the neutral (i.e. voiceless unaspirated) coronal stops in the example forms *Hände* and *Kinder* contain neither |H| nor |L| in their lexical representations. This being the case, how do we capture the melodic change taking place when the neutral stop /d/ occurs domain-finally? As (10) shows, neutral obstruents are interpreted with long voicing lag in this position - that is, they undergo a process conventionally referred to as devoicing. In Element Theory terms, however, the label 'devoicing' is inappropriate, since no voicing specification is ever present in the relevant segments. Instead, we may account for the melodic change from a neutral stop to an aspirated stop by positing the addition of an |H| element not present lexically. The addition of |H| yields a segment that appears to belong to the aspirated series, a result which squares with the fact that the final segments of *Rat* and *Rad* sound identical.

The next question is an obvious one. What is the source of this additional |H|? It cannot emerge through assimilation, because the local phonological environment contains no segment from which |H| could originate. Nor can it result from any lenition process targeting the lexically specified neutral stop, because members of the neutral series have no |H| in their melodic composition. An alternative approach would be to treat the acquisition of |H| as an example of fortition, where the target segment would be expected to increase in melodic complexity by adding to its element count. However, this solution seems equally unlikely, for the reason that a fortition process is something we associate with prosodically strong contexts. If anything, domain-final position reveals itself as a classic example of a weak context where lenition effects, rather than fortition processes, are more likely to be observed (Harris 1997).

So, a purely phonological explanation for the appearance of the |H| element seems stubbornly elusive. At this point we turn to the proposed connection between the source elements |H|/|L| and the units of prosodic structure. Without doubt, making sense of the orthographic string in (12a) involves more time, effort, and backtracking than is required to understand (12b).

(12) a. howshegoingtoknowwhichonesthebesttochoose

b. How's he going to know which one's the best to choose?

Let us now extend the scenario in (12) from written to spoken language. In order to facilitate the processes of parsing and lexical access, some indication of the points where one word ends and another begins is clearly beneficial. According to one view (Kaye 1989), the primary function of dynamic phonological processes is to do just that - to make the location of prosodic boundaries more apparent to hearers, thereby increasing the overall efficiency of the parsing process.

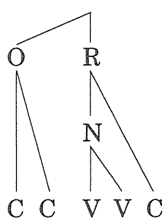
Returning to the issue surrounding the appearance of |H| domain-finally, could it be that this phenomenon serves a similar purpose? Is it possible that the |H| is a property of the prosodic (or morphological) structure, rather than of the melodic structure proper? Should this be the case, then we see the role of |H| shift from contrastive to communicative. I have already suggested that domain-final |H| does not have any obvious lexical source, which immediately limits the possibilities for explaining the 'why' and 'how' of its place in a phonological representation. So, the claim being made here is that |H| surfaces as a marker to indicate the location of the boundaries separating prosodic words. In addition to the advantages already mentioned, the segmentation of a continuous string into smaller (either word- or morpheme-sized) units has been shown to make a significant contribution to the process of lexicon building by infant language learners (Jusczyk 1999).

This approach to the presence of domain-final |H| in German (and in other languages characterised by final 'devoicing') is consistent with the overall theme of this discussion - namely, the close correspondence we find between the source elements |H|/|L| and the units of prosodic structure. While there is no evidence to suggest that other (non-source) elements behave in this way, there is further evidence from other languages to support the proposed source-prosody relationship. Let us consider some examples.

5.3 Prosodically-determined segment distribution

The phonology literature offers a range of different views on the procedure for assigning syllable structure to a given string of segments. Perhaps the most restrictive of these, and perhaps the most informative from a theoretical standpoint, is the view summarized in Brockhaus (1995). This model recognizes only three sub-syllabic constituents - onset, nucleus and rhyme - all of which may be maximally binary branching (subject to the language-specific settings of the relevant parameters). From this it follows that the most complex syllable type resembles the structure in (13):

(13) [4]



For the most part, (13) can accommodate the relatively complex phonotactics of languages such as English by allowing for the possibility of 3-consonant clusters word-internally (i.e. a branching onset preceded by a consonant occupying the complement position of a branching rhyme). This provides for strings such as *distress* and *embrace*. However, a perennial problem comes in the form of word-initial *sCC* sequences, which defy a straightforward analysis because the initial *s* must be assigned to the rhymal complement position of a syllable which contains no other melodic material. Kaye (1991) provides ample evidence to defend this syllabification of initial *sCC* sequences, but at the same time, highlights the awkwardness of this configuration as a word-initial syllable structure.

In English, a word-initial sequence of three consonants must begin with *s*, although no satisfactory explanation has been offered for why the choice of segments in this position is so drastically limited. Cross-linguistically, the number of variations on this *sCC* pattern is also very restricted, a coronal fricative typically being the only option for the initial consonant slot.

(14) **Polish** (Cyran & Gussmann 1999)

[ʃčfany]		'cunning'
[zgroza]		'terror'

German

[ʃprɑːx]	*sprach*	'spoke'
[ʃtrɛŋ]	*streng*	'strict'

Irish (Ní Chiosáin 1999)

[sprag]	*spreag*	'inspire'
[ʃkluːxəs]	*scliúchas*	'rumpus'

As (14) shows, some languages allow a palatal(ised) fricative in this position, while a voiced fricative is also possible in Polish. Importantly, however, it is regularly some kind of sibilant fricative that seems to occupy a natural place at the beginning of these unusual word-initial sequences, to the exclusion of all other segment types. Why should this be the case?

A possible solution comes from the Element Theory representation of such segments, where the element |H| as the head of a melodic expression defines the class of fricatives (Neubarth & Rennison, in press).[5] The fact that headed |H| combines with

4) Some practitioners claim that additional (locality) restrictions make this structure too complex to be grammatical: for them, the choice is either a branching nucleus or a branching rhyme, but not both. This issue does not affect the arguments being made here.

a resonance element in these segments (to reflect place specifications such as coronal or palatal) does not affect the generalisation that a source element |H| acts as the necessary ingredient in these (syllabically) unusual initial clusters. Assuming that the presence of |H| is not really a matter of lexical choice, since it is apparently obligatory, then its motivation must lie elsewhere.

We have already seen how this element behaves as a prosodic marker in German to indicate the right boundary of a prosodic word. Let us now extend this analysis by proposing that |H| can serve a similar function as the marker of a left boundary too. In the *sCC* sequences found in English and the languages given in (14), a highly marked syllable structure is assumed to be involved - marked, to the extent that it fails to match our intuitions about what a word-initial consonant sequence should sound like. In response, the phonology introduces an alternative way of reinforcing the presence of a prosodic word boundary. This comes in the now familiar form of the source element |H|, thereby lending further support to the principal claim of this paper - namely, that a special connection exists between |H|/|L| and units of the prosodic hierarchy.

Up to this point, it is the element |H| which has been the focus of attention in this discussion of source elements as prosodic markers. Let us now consider the distribution of |L|, for which we can unearth similar evidence of melodic properties driven by prosodic factors.

5.4 |L| as a prosodic marker

The first example of the |L| element behaving as a marker of prosodic word boundaries comes from consonant mutation in Irish. Eclipsis is the term given to a specific type of mutation which takes place in word-initial (or domain-initial) position and transforms a target consonant according to the options in (15):

(15)	a.	voiceless consonants become voiced	*k*→*g*, *f*→*v*...
	b.	voiced consonants become nasal	*d*→*n*, *b*→*m*...
	c.	vowel-initial words become *n*-initial	'zero'→*n*
	d.	nasal consonants remain unchanged	*m*→*m*, *n*→*n*...

These changes take place word-initially following certain prepositions and other words, including *i* 'in', *don* 'to/for/the', *den* 'of the', *bhur* 'your (pl.)', *a* 'their', and the numbers 7 through to 10.

From the descriptions set out in (15), it should be apparent that the source distinction in Irish stops is based on the presence versus the absence of 'true' voicing: neutral

5) In this particular version of Element Theory, the representation of fricatives is given as (F̲,F...). However, the authors point out (footnotes 3 and 7) that "the (F̲,F...) combination behaves in many cases as if it were an H head."

(voiceless, unaspirated) obstruents contain no source element, and contrast with fully voiced obstruents containing |L| in their melodic structure. In this way, Irish mirrors the behaviour of languages such as French and Japanese (|L| versus zero), as opposed to that of |H|-ful systems such as English, German and Polish (|H| versus zero). Examples of (15a-c) are given in (16a-c) respectively.

(16)	a.	*feidhm*	'function'	*i bhf*[v]*eidhm*	'working'
		tráth	'time'	*i dtr*[dr]*áth*	'in (good) time'
	b.	*dán*	'fate'	*i nd*[n]*án*	'fated, in store'
		bosca	'a box'	*i mb*[m]*osca*	'in a box'
	c.	*óstán*	'a hotel'	*i n*[n]*óstán*	'in a hotel'
		áit	'a place'	*i n*[n]*áit*	'in a place'

In each case, the segment occupying the leftmost syllable onset of the noun undergoes a melodic change as a means of signalling the internal morphology of the phrase. As already mentioned, we can envisage a range of psycholinguistic benefits to be gained from having such information about the edges of lexical items.

As for the melodic changes themselves, they can be captured quite neatly within an Element Theory description. It has already been claimed that, in a true voicing language like Irish, the presence of |L| contributes full voicing in stops, while its absence from the melodic structure of a stop leaves a neutral (i.e. voiceless, unaspirated) segment. In (16a) then, the voicing effect is achieved through the addition of the source element |L|. In the (16b) examples, on the other hand, a fully voiced sound already occupies the initial onset position, thus indicating that |L| is already present lexically. For this reason, the prosodic boundary must be identified by some other means - but in a way that allows us to maintain the generalisation that |L| behaves as a prosodic marker in Irish. It will be recalled that |L| can be interpreted in two distinct ways, depending on whether or not it functions as the head of a melodic expression: as a head it contributes full voicing to an expression, and as a non-head it contributes nasality (Nasukawa 1997). From the examples given in (16b), it can be seen that the eclipsis of a voiced obstruent results in a different manifestation of |L|-ness: this time it is the nasal counterpart of the obstruent which is interpreted.

The examples in (16c) are phonetically vowel-initial, suggesting that the phonological representation of the noun must begin with either a melodically empty onset or no onset at all. Nevertheless, eclipsis proceeds as before, with the introduction of |L| to indicate the presence of the morphological boundary. Because eclipsis seems to operate as a structure-preserving process, the possibility of |L| appearing as nasalization on the first vowel is not taken up. Instead, the |L| element is interpreted as a coronal (i.e. unmarked) nasal consonant, occupying the lexically empty slot at the beginning of the morphological domain.

In Irish, then, we have a set of words that call for the overt marking of certain internal domains. This comes about through the interpretation of |L| in its various phonetic guises. As we are about to see, the same source element displays its link with prosodic structure in the phonotactics of Korean, too. In this language, the liquid sonorant /l/ is interpreted as a lateral [l] word-finally and before another consonant, and as a tap [ɾ] elsewhere. Another distributional fact about this system refers specifically to native Korean words (as opposed to the Sino-Korean vocabulary), and states that these words do not begin with either [l] or [ɾ] (Iverson & Sohn 1994). The following forms show what does appear in word-initial position:

(17)	/lak-wɛn/	[nagwɛn]	'paradise'
	/pɛp-li/	[pɛpni] (→ [pɛmni])	'principle of law'
	/kyɛk-li/	[kyɛkni] (→ [kyɛŋni])	'separation'

In keeping with the assumptions made throughout this discussion, the nasal consonant that emerges in domain-initial position must be the interpretation of the |L| element. There is little evidence to indicate that this |L| is a lexical property here. Nor does it appear to have any local source. Indeed, these circumstances seem to parallel those already discussed in relation to the word-final interpretation of |H| in German and other 'final devoicing' languages, where it was concluded that the source element was present only in the capacity of a prosodic boundary marker. Nothing prevents us from pursuing the same argument here, and drawing the same conclusion for |L| in Korean, given that this effect of /l/-nasalization occurs only in this domain-initial context.

6 Summary

For a considerable time, feature-based theories have recognized the need for some hierarchical (i.e. geometric) structure of primes within segments. The same is true of models of melodic representation using alternatives to distinctive features, the element geometry of Element Theory being a case in point. In this paper I have explored some characteristics of the two elements |H| and |L| which, in the recent Element Theory literature, have been identified as belonging to an independent category node LARYNGEAL. Firstly, evidence comes from the way they are both employed (either individually, or sometimes jointly) in voicing contrasts. Secondly, this grouping is confirmed by the suprasegmental behaviour they both share, as shown by their roles in tone and intonation systems.

There is also a third respect in which |H| and |L| naturally form a separate class, the evidence coming from the way their appearance in the melodic string frequently coincides with the boundaries of prosodic categories. I have discussed examples of |H|

functioning as a prosodic marker in 'aspiration' (i.e. |H| versus zero) languages such as German and Polish, and I have also considered a similar analysis of |L| in 'true voicing' (i.e. |L| versus zero) languages like Korean and Irish. It will be encouraging to uncover further examples from a wider range of languages, in order to confirm this issue as a fruitful line of future research.

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Prosodic Markers in Melodic Representation

Phillip Backley

分節表示における韻律標識

Clements（1985）が素性階層（Feature Geometry）モデルを導入して以来，弁別素性の階層構造について多くの議論が重ねられてきた。分節の内部構造を解明する目的は，諸言語に見られる音韻現象において繰り返し言及される弁別素性のまとまりを特定し，その弁別素性群の振る舞いを示すことである。この目的に沿った研究はエレメント理論（Harris & Lindsey 1995）のように分節表示に弁別素性を用いない枠組みにおいても行われている。

エレメント |H| と |L| はともに「喉頭」という範疇節のもとに組織されており，故に共通する振る舞いが観察されると考えられている。本論はこれらのエレメントと韻律構造単位との間に見られる緊密な関係について論じ，喉頭節の存在の妥当性を改めて実証するものである。|H| と |L| の超分節的な振る舞いについては，主に声調やイントネーションに関連して研究されている。しかし，韻律構造の境界を示す標識としての（非対立的な）機能については取り上げられることが少ない。本論は，ドイツ語，英語，ポーランド語では |H| が，韓国語とアイルランド語では |L| が，韻律語の境界を示す標識として用いられることを示す。

本論の結論は，大人が発話を効率的に構文解析する場合にも，子どもが語彙を増やしていく過程においても，語の境界に関する情報が重要であるとする心理言語学の研究（Jusczyk 1999）と一致するものである。